Effects of Mind Mapping Teaching Strategy on the Academic Retention of Senior Secondary School Students in Biology in Adamawa State, Nigeria

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Abstract
The study investigated the effect of mind mapping teaching strategy on the academic retention of senior secondary school students in biology in Adamawa State. The design for the study was pretest, posttest non randomized, control group quasi-experimental design. All 366 senior secondary schools in the education zones of Adamawa state with a total of 10,483 students constituted the population for the study. Purposive sampling technique was used to select 203 subjects from four schools in two education zones in Adamawa State for the study. Simple random technique was used to select and assign two intact classes in each of the schools in the two zones into experimental and control groups respectively. Biology Achievement Test (BAT) was used for data collection. Two research questions were raised and answered while two hypotheses were formulated and tested at 0.05 level of significant. Data collected were analyzed using mean and standard deviation to answer the research questions while Analysis of Covariance (ANCOVA) was used to test null hypotheses. The results obtained indicated that students taught biology using mind mapping teaching strategy significantly achieved higher retention than those taught using lecture teaching method, F= 148.669 (df1), P=.000. There is a significant gender effect on the achievement of students taught with mind mapping and lecture method of teaching and is in favor of the male students F= 4.388 (df1), P=.037 . Based on the findings it was recommended that teachers should be encouraged in the use of mind mapping teaching strategy for teaching biology.

Keywords: Mind mapping, academic retention, academic achievement

Background of the Study

The development of any nation is hinged on their acceptance of science and technology as a culture. Most nations of the world are considered developed because of their huge investment in science and technology. It is quite surprising that in the same world where opportunities are mostly even, most nations of the world still remain underdeveloped and impoverished. The difference in this case is that some has chosen to commit huge investment in science and technology while some sees no reason in investing in science and technology and even if there is an investment, there is no sincerity of purpose.

We are in the 21st century that is characterized with sustainable development in every sphere of life especially in science and technology, it therefore means that to sustain this development, it requires entrenching the culture of learning and teaching science. The application of scientific

principles and practice is what gave birth to science and technology. Science and technology cannot be made manifest without the study of science subjects. The way we go about the teaching and learning of science will determine how the products of our educational system will participate intelligently in the development of the society.

Biology is one of the basic science subjects offered at the senior secondary school in Nigeria. It is an important subject in the secondary school curriculum. One of the most important objective of teaching biology is to introduce and expose students to laboratory and field work experience and to increase their knowledge of the basic functioning of living things. Biology always remain a significant science subject because it shapes different careers. Career prospects in many fields of study like medicine, engineering, environmental management, nursing, psychology, science, teaching, and other professions have very strong connections with biology. The subject biology is one of the most interesting subject to the students and that is why majority of the student's register biology in their West African School Certificate Examination (WASCE) and Senior School Certificate Examination (SSCE). yet the percentage pass of students is very poor as opined by Balla and Ugwumba 2015 who stated that despite the importance of science as a key subject for the technological development of a nation, the students' performance is still below expectations.

In Adamawa state, the percentage score of students that had credit pass and above in biology in WAEC from 2017 – 2024 is less than 50%. A lot of reasons have been adduced as explanation for this state of affairs in this area. Some of these reasons according to Dinah and Samikwo (2013) include the unavailability of text books, laboratory apparatus and other learning resources, lack of adequate instructional materials and science equipment. Other reasons include: lack of financial support, lack of equipped libraries, lack of laboratories, poor methods of teaching and accessing biology materials (Manalanga & Awelani, 2014).

Dinah and Samikwo (2013) however drew our attention to the fact that teaching method employed by teachers' reflects on students' understanding of the subject and it is important for teachers to understand and interpret the objectives of the subject for efficient, effective teaching and learning. Based on this assertion, it is pertinent to use appropriate methods which involve students' active participation in teaching and learning. In order to effectively impact knowledge, teaching needs to be participatory, where all the three domains of learning are actively engaged, hence there is the need to introduce, adopt and adapt the recently used instructional strategy that are capable of sustaining not only the interest of the learners, but also helping them to understand the concepts (Adesoji & Ibraheem, 2009).

It is a fact that there are many instructional strategies being used in enhancing learning but this study will specifically study the effect of mind mapping teaching strategy on student's retention. Buzan (2010) defined mind mapping as "a powerful graphic technique which provides a universal key to unlocking the potential of the brain". In another definition, Bligh and Wilkinson (2002), defined mind mapping as a central idea with associated thoughts and concepts presented as linkages which, by using the technique, illustrate visually the relationships between complex ideas and processes. Mind mapping entails visual exercise aimed at helping students to organize and structure complex content. It places information in a hierarchical order thereby working out key components and their subsets and relationships link to each other. It mainly focuses on one central word or idea and uses branches to depict the importance of the ideas. In order to buttress the importance of mind mapping, Alamsyah (2009) explained that mind maps work well as their visual design enables students to see the relationship between ideas, and encourages them to group certain ideas together as they proceed. In view of this, most of the biology topics are conceptual in nature it therefore means that probably the teaching strategy may enhance learning in biology.

In contrast to mind mapping teaching strategy, is the lecture method of teaching. Most teachers in Nigerian Secondary Schools still believe that the most effective means of communicating to students is through the conventional "talk and chalk" method of teaching (Dinah & Samikwo, 2013). In this kind of teaching method, the teacher presents a verbal discourse mainly on a particular subject, theme or concepts to the learners. Lecture method will be used as a placebo in the control group in this study.

These teaching methods employed in this study is aimed at determining their effects on retention of students. The concept "retention" according to Iwuji (2012) is the ability to retain and consequently remember items learned or experienced by an individual at a later time. This makes the issue of retention a key to understanding the reasons for poor achievement of students in external examination. Information retention is a process that has direct link with the brain activities, and you can't talk about mind mapping without mentioning how information are stored in the brain. Retention plays an active key role in student's achievement because it is what is retained that can be easily retrieved (Jimmerson, 2004). But it can only be made possible when the appropriate teaching strategy is used in teaching and learning. In using appropriate teaching strategies, gender consideration must be in mind. This is because the way learners respond to instruction could be gender biased hence teaching strategy applied in teaching a subject could be affected by the gender of students.

Different opinions have been made with regard to gender issue, while some are of the opinion that male achieve better than the female, others are of the view that female achieve better than the male, at the same time others are neutral in their opinion. Gender is defined as a socially ascribed attributes which differentiates feminine from masculine (Okeke, 2008). According to Okeke, many people are of the opinion that one of the determinants of students' academic achievement in a particular subject is the sex of a student, whether female or male, feminine or masculine. Meanwhile, most parents are of the opinion that technical subjects and physical sciences are meant for boys (Suman, 2001). Gender consideration in the learning of sciences specifically biology is very important because gender disparity has not only been observed in the daily life matters, but also in academic achievements. Some research findings claim that males show better achievement in science than their female counterparts, (Dania, 2014, Kyei, Apam & Nokoe, 2011). While some other research findings claim that female perform better than the male counterpart (Nwona & Akogun 2015; Adeyemi & Ajibade, 2011). Agbaje and Alake (2014), pointed out that there is no significant gender difference in students' academic achievement and retention. Therefore, since there are contradictions in the findings of researchers on the effectiveness of the use of teaching strategy on student's retention by gender, this study will be aiming at determining whether there is a significant effect or not.

Purpose of the Study

The purpose of the study was to investigate the effect of mind mapping teaching strategy on the academic retention of senior secondary school students in biology in Adamawa state. The specific objectives of the study include to:

4. *Determine the mean academic retention score of secondary school biology students taught biology using mind mapping teaching strategy and those taught using lecture* teaching *method.*
5. *To determine the gender difference in students' academic retention when taught biology using mind mapping teaching strategy and lecture teaching method.*

Research Questions

The following research questions were raised to guide this study:

4. What is the effects of mind mapping teaching strategy and lecture teaching method on the mean retention score of students taught biology?
5. What is the gender difference in mean retention score in biology of students taught using mind mapping teaching strategy and lecture teaching method?

Research Hypothesis

The following null hypotheses were stated and tested at 0.05 level of significance:

Ho_1: There is no significant effects of mind mapping teaching strategy and lecture teaching method on student's mean academic retention score in biology.

Ho_2: There is no significant gender effects of mind mapping teaching strategy and lecture teaching method on student's mean academic retention score in biology.

Methodology

The research design adopted for this study was the pretest, posttest, non-randomized, control group of quasi experimental design. The area of the study is Adamawa state, Nigeria. The population for the study consists of all the 10,483 SS II biology students in senior secondary schools in Adamawa State for 2020/2025 session. Purposive sampling technique was used to select 203 subjects in their intact classes from two education zones in Adamawa state. Four schools were selected from the two zones. The reason for the selection of the schools was that they are grade ' A' schools according to Adamawa state post primary school board rating and they are co-education schools. The schools selected were Government Secondary School Numan and Villa Nova Government Secondary School Numan in Numan zone and Aliyu Musdafa College and Dobeli Government Secondary School in Yola zone. Simple random technique was used to select two intact classes in each of the two schools in two education zone. Two classes in each of the two zones were assigned to experimental and control group respectively. The number of male and female students in mind mapping teaching strategy is 55 and 57 respectively while the number of male and female students in lecture teaching method is 39 and 52 respectively.

Instrument for Data Collection

The instrument that was used for the collection of data for the study was the biology achievement

test (BAT). BAT consist of 50 multiple choice objective questions with four answer options. The items were adopted from past West African Examination Council exam questions from 2017 - 2024. Also items were selected based on the topic treated. The topics are respiratory, excretory. transport, reproduction and tissue and supporting system.

Validation of the Instrument

The instrument BAT was adopted from WAEC past question papers hence the face validity was assured. To ensure content validity, the instrument was thoroughly scrutinized by two experts from the department of environmental and life sciences education Modibbo Adama University, Yola. The validators looked at the BAT in line with the content area. The following

observations were made by the validators: That the lesson objectives must be clearly stated, and that the objectives should be appropriate to students' level. They also made some amendment on the instructional methods and materials. The experts also scrutinized the mind mapping teaching plan and suggested that the teaching strategy should be used in schools that have white marker board for the impact to be felt by the students since colours was key in the diagrams involved.

Reliability of the Instrument

The instrument was trial tested at Govt. Secondary School Mayo Belwa which is in a different education zone that *is outside the study area. The subjects in this school are considered of equivalent standard with the research subjects. The reliability of the test instrument was determined using Cronbach Alpha. The value of the Cronbach Alpha computed was 0.84* which was considered high enough for the study.

Method of Data Collection

The data for the study was collected in four stages; the preliminary stage, the pretreatment stage, the treatment stage and the post treatment stage. In preliminary stage, a workshop was conducted for the research assistants on the use of mind mapping teaching strategy. In pretreatment stage, the pretest was administered to the subjects. In treatment stage, the subjects were taught the topics while in the post treatment stage, the post test was administered to the subjects lastly after two weeks, another posttest was administered to determine student's retention. The data collection lasted for nine weeks.

Procedure for Data Analysis

Mean and standard deviation was used to answer the research questions while hypotheses were tested at 0.05 level of significance using Analysis of Covariance (ANCOVA). The decision taken on testing the null hypotheses is to reject the null hypotheses if $P < 0.05$ level of significance or otherwise if $P > 0.05$ level of significance.

RESULT

Research Question 1

What is the effects of mind mapping teaching strategy and lecture teaching method on the mean retention score of students taught biology?

Table 1: Mean and Standard Deviation of Students Retention score when Taught with Mind Mapping Teaching Strategy and Lecture Teaching Method

	Pretest				Posttest			
Teaching Strategy	Ո	Mean	SD	Mean diff	Ո	Mean	SD	Mean diff
MMTS (Exp I)	112	69.65	11.90	37.06	112	78.68	11.90	42.51
LTM (Cont G)	91	32.59	9.28		91	36.17	9.63	

From Table 1: The mean retention score of students taught using mind mapping teaching strategy is 69.65 at pretest, while the mean retention score of students taught using lecture teaching method at pretest is 32.59. The difference in the mean retention scores of students taught using mind mapping teaching strategy and those taught using lecture teaching method is 37.06 in favour of mind mapping group. This suggests that students taught using mind mapping teaching strategy obtain higher retention score than those taught using lecture teaching method at pretest. Similarly, students taught using mind mapping teaching strategy obtained standard deviation score of 11.90 while students taught using lecture teaching method obtained a standard deviation of 9.28. This is an indication that students taught using mind mapping teaching strategy obtained higher spread of score about their mean than students taught with lecture teaching method that obtained lower spread of score about their mean.

Similarly, to ascertain whether there is improvement on the student's retention score, a post retention test was administered to the students. From Table 1: The mean post retention score of students taught using mind mapping teaching strategy is 78.68, while the mean post retention score of students taught using lecture teaching method is 36.17. The difference in the mean post retention scores of students taught using mind mapping teaching strategy and those taught using lecture teaching method is 42.51 in favour of mind mapping group. This suggests that students taught using mind mapping teaching strategy obtain higher post retention score than those taught using lecture teaching method. Similarly, students taught using mind mapping teaching strategy obtained standard deviation score of 11.90 while students taught using lecture teaching method obtained a standard deviation of 9.63. This is an indication that at posttest retention, students taught using mind mapping teaching strategy obtained higher spread of score about their mean than students taught with lecture teaching method that obtained lower spread of score about their mean.

Research Question 2: What is the gender difference in mean retention score in biology of students taught using mind mapping teaching strategy and lecture teaching method?

Table 2: Mean and Standard Deviation of Retention Score of Students by Gender when Taught with Mind Mapping Teaching Strategy and Lecture Teaching Method.

	Pretest				Posttest			
Variables	N	Mean	SD	Mean diff	N	Mean	SD	Mean diff
MMTS (Exp I)								
Male	55	74.58	10.43	9.69	55	78.68	11.57	10.69
Female	57	64.89	11.37		57	67.99	11.80	
LTM (Cont G)								
Male	39	34.10	8.62	2.64	39	37.70	9.55	3.13
Female	52	31.46	9.68		52	34.57	9.71	

Table 2, showed that the mean retention score of male students taught using mind mapping teaching strategy is 74.58 while the mean retention score of female students taught using mind mapping teaching strategy is 64.89. The difference in the mean retention scores between male and female students taught using mind mapping teaching strategy is 9.69 in favour of the male students. This suggests that the male students taught using mind mapping teaching strategy obtained higher retention score than female counterpart taught using the same mind mapping teaching strategy. Furthermore, the male students taught using mind mapping teaching strategy obtained standard deviation score of 10.43 while the female students taught with the same mind mapping teaching strategy obtained standard deviation score of 11.37. This is an indication that the male students taught using mind mapping teaching strategy obtained lower spread of score about their mean than the female counterpart taught using mind mapping teaching strategy that obtained higher spread of score about their mean.

HO_1 : There is no significant effects of mind mapping teaching strategy and lecture teaching method on students mean retention score in biology.

Table 3: Result of the Analysis of Covariance of Students' Retention Score when Taught with Mind Mapping Teaching Strategy and Lecture Teaching Method.

Source	Type 111 Sum of Sq	df	Mean Square	F-value	Sig	Partial eta Sq	
Dec							
Corrected model	87714.417a	4	21928.618	919.651	.000	.949	
Intercept	655.706	1	655.706	27.499	.000	.122	
STRATEGY	3544.929	1	3544.929	148.669	.000	.429	S
GEN	44.836	1	44.836	1.880	.172	.009	
STRATEGY*GEN	104.621	1	104.621	4.388	.037	.022	

Error	4721.213	198	133.668
Total	663511.000	203	
Corrected total	92435.685	202	

a. R Squared = .949 (Adjusted R Squared = .948) key: Sq = squared; df = degree of freedom; Dec = decision; Sig = significance

Tabl 3 shows that, there is a significant effect of using mind mapping teaching strategy and lecture method teaching method on students' mean academic retention. F= 148.669 (df1), P=.000. since the computed P-value (.000) is less than the F=value at 0.05 level of significance, therefore, the null hypothesis of no significant effect is rejected, which means that there is significant effect in the mean retention of students taught with mind mapping teaching strategy and those taught with lecture teaching method in senior secondary biology.

Ho_2: There is no significant gender effects of mind mapping teaching strategy and lecture teaching method on student's mean retention score in biology.

Table 4: Result of the Analysis of Covariance of Students' Retention Score by Gender when Taught with Mind Mapping Teaching Strategy and Lecture Teaching Method.

Source	Type III Sum of Sq	df	Mean Square	F	Sig.	Partial Eta Sq	Dec
Corrected Model	87714.471a	4	21928.618	919.651	.000	.949	
Intercept	655.706	1	655.706	27.499	.000	.122	
STRATEGY	3544.929	1	3544.929	148.669	.000	.429	
GEN	44.836	1	44.836	1.880	.172	.009	
STRATEGY * GEN	104.621	1	104.621	4.388	.037	.022	S
Error	4721.213	198	23.845				
Total	663511.000	203					
Corrected Total	92435.685	202					

a. R Squared = .949 (Adjusted R Squared = .948)

key: Sq = squared; df = degree of freedom; Dec = decision ; Sig = significance

Table 4 shows that, there is a significant gender effect on the mean retention score of students taught using mind mapping teaching strategy and concept mapping teaching strategy. F= 4.388 (df1), P=.037. since the computed P-value (.037) is less than the F=value at 0.05 level of significance, therefore, the null hypothesis of no significant gender effect is rejected, which means that there is significant gender effect in the mean retention score of students taught with mind mapping teaching strategy and those taught with lecture teaching method.

Findings of the Study

4. Students taught using mind mapping teaching strategy obtain higher mean academic retention score than those taught using lecture teaching method
5. Male students taught using mind mapping teaching strategy obtained higher mean academic retention score than their female counterpart taught using the same mind mapping teaching strategy.
6. There is significant effect in the mean retention score of students taught using mind mapping teaching strategy and those taught using lecture teaching method in senior secondary biology
7. There is a significant gender effect in the mean retention score of students taught using mind mapping teaching strategy and those taught using lecture teaching method

Discussion of the Findings

. The discussion is organized under the following sub-headings in line with the themes of the research questions and hypotheses. The subheadings include the effect of MMTS on mean retention score, effect of MMTS and gender interaction on the mean retention score.

1. The Effect of Mind Mapping on Mean Retention Score

From table 1, the study proves that the mean retention score of students taught using mind mapping teaching strategy was higher than those taught using lecture teaching method. This implies that mind mapping teaching strategy had effectively enhanced the memory of students in mind mapping group (experimental group) more than the control group (lecture teaching method). The higher retention score of the mind mapping group could be attributed to the fact that mind mapping teaching strategy stimulates the brain of the students more than those students in control group. Also from table 3, the finding of the study showed that there is significant effect on the mean retention score of students taught using mind mapping teaching strategy and those that are taught using lecture teaching method. This finding is supported by Nouri (2013) who conducted a study to investigate the feasibility and the applicability of the mind map technique as an effective tool for summarizing, understanding, and recalling information. The finding of the study showed that students retentive capacity was highly improved after the use of mind mapping teaching strategy. Paul, Fearzana and Enid (2002) also concluded in their study on the efficacy of mind mapping teaching strategy in recalling information that the student's retention improved after the use of mind mapping teaching strategy. This implies that since mind mapping is activity based learning strategy which also

entails that students continue to repeat what the teacher is doing, retaining information is bound to be enhanced.

2. Effect of Mind Mapping Teaching Strategy and Lecture Teaching Method on Mean Retention Score by Gender

The result presented in table 2, showed that male students in mind mapping teaching strategy obtain higher mean retention score than the female students taught using lecture teaching method. Similarly,. Table 4 further confirmed the result by showing that this observed differences in the mean retention score of male and female in mind mapping teaching strategy is significant and in favour of mind mapping group. This result is consistent with Al-Fawri (2010) who confirmed that mind mapping help students to retain information for a long time because the brain handles images more easily than written materials in processing, storage and recall. The findings also confirmed that male students retain information more than the female students. The result also corroborated with the findings of Harkirat, Makarimi, and Anderson (2011) who emphasized the importance of using mind mapping in teaching and enhancing students' mental perceptions. The study also showed that male students could retrieve information and concepts more quickly and systematically than female. This is confirmed by Ackerman, Beier, and Boyle (2002) who demonstrated the efficient role of mind mapping in students' assimilation, application of dispensed concepts and information and long-life learning retention. the findings also confirmed that male students retain information more than the female students. Therefore, mind maps provide strong support for improving students' immediate achievement and retention of biology concepts.

Conclusions from the Study

Based on the findings and discussion of this study, the following conclusions were made; that the mind mapping teaching strategy stimulated and fostered students' retention more positively than the lecture teaching method. it was also concluded that the male students' retention was higher than the female. Furthermore, there is a significant effect of mind mapping teaching strategy on gender as regards retention of students in biology.

5.3 Recommendations

Based on the findings of this study, the researcher made the following recommendations.

1. Teachers should be encouraged to adapt mind mapping teaching strategy in our school system because from the findings, mind mapping teaching strategy will help to make the teaching of biology gain popularity because of the use of colour which will invariably improve the retentive capacity of students and thereby making understanding of concepts very concrete.

2. Since mapping strategy is made easier on the white board, provision of white board will encourage teachers in the use of mapping strategies.
3. Since mind mapping strategies are not frequently used by teachers, in other words, it is considered as a new innovation in teaching and learning process, the federal government and relevant professional bodies should include it as an issue to be discussed during workshops organized for teachers and professionals. Such innovations will help to make the lessons more stimulating to the learner.
4. Authors of biology textbooks should write their texts to be students centered and activity oriented as in mind mapping and concept mapping. This will help in concretizing learning and thereby improving the academic achievement and retention of students in biology

5.4 Suggestions for further Study

1. Since the basic findings suggested that the use of mind mapping teaching strategy is better than the lecture teaching method, another research effort should be conducted in other science areas for example chemistry and physics.
2. This study can also be replicated in another geographical location especially in the southern part of the country.

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