

EFFECT OF CONCEPT MAPPING TEACHING STRATEGY ON SENIOR SECONDARY SCHOOL STUDENTS' ACADEMIC ACHIEVEMENT AND RETENTION IN BIOLOGY IN ADAMAWA STATE

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Abstract

The study investigated effect of concept mapping teaching strategy on Biology students' academic achievement and retention in senior secondary school in Adamawa State. The study was guided by four research questions raised and four hypotheses formulated. Quasi-experimental research design which consisted of pre-test, post- test non equivalent groups was employed. The population of the study consisted of all the 23,549 SS II Biology students in all the Senior Secondary Schools in Adamawa State, from which sample size of 298 (122 male and 176 female) SS II Biology students were randomly selected from four intact classes. The experimental group was taught Biology using concept mapping teaching strategy while the control group was taught through lecture methods. The treatment lasted for six weeks. The retention test was administered after two weeks after the post-test. Biology Achievement Test (BAT) which contains 50 multiple choice items adapted from West African Senior School Certificate Examination (2010-2020) was use as the instrument for data collection. The instrument was validated and the reliability coefficient of 0.81 was established using K-R 21 formula. Data collected were analyzed using descriptive statistics of mean and standard deviation, to answer the four research questions. The four hypotheses were tested using ANCOVA at 0.05 level of significance. Results from the study showed higher students' academic achievement, $F(1\ 298) = 108.992, p < 0.05$. There is students' retention $F(1\ 298) = 119.448, p < 0.05$ in favour of concept mapping teaching strategy. Also there was no gender influence across students' academic achievement (0.78 mean difference and p - value of 0.693) and retention (1.70 mean difference and p - value of 0.397). Concept mapping teaching strategy enhanced biology students' academic achievement and retention. Base on the findings of the study, it was recommended amongst others that secondary school Biology teachers should adopt concept mapping teaching strategy to teach Biology concepts irrespective of the gender of the students. Adamawa state government should organize workshops and seminars for Biology teachers to keep them abreast of using concept mapping in teaching Biology concepts.

Key words: Concept Mapping, Academic Achievement, Biology Students, Retention, Gender.

Introduction

Science is a great enterprise and nations of the world depend on it in order to advance technologically. It is also regarded as a foundation upon which the bulk of the present technological breakthrough is built. Science education is essential for any nation that wants to maintain its independence, authority, self-reliance, growth and recognition among civilized nations. The Federal Republic of Nigeria, as stipulated in the National Policy on Education (FRN, 2013), stresses that science education shall emphasize the teaching and learning of science process and principles. The goals of science education, as stipulated in the National Policy on Education (FRN, 2013), among others shall be to: cultivate inquiring, knowing and national mind for the conduct of a good life and democracy. In order to promote citizen's interest in science education, a policy was set up by the Nigerian government that 40% of the students should be considered for arts and social science courses, while 60% of the students are to seek admission into the nation's universities, polytechnics and colleges of education and should be admitted for science-oriented courses. This advocates improvements in the teaching and learning of Science, Technology and Mathematics (STM) in order to create the foundation of technologically oriented workforce in line with the needs of national development, and Biology is one of such science subjects introduced.

Biology as one of the integral part of science is described as the study of life and its evolution, of organisms and their structures, functions, processes, and interactions with each other and with their environments (Ibrahim, 2018). Similarly Mohammed (2021), opine that biology is the study of living organisms with regards to their structure, function, growth, evolution, distribution, identification and taxonomy. The importance of biology includes; medicine, pharmacy, veterinary, nursing, agriculture, horticulture, forestry, biotechnology, among others. This implies that the study of biology in senior secondary school may equip students with useful concepts, principles and theories that will enable them to face life challenges. The position occupied by biology in human life and development, calls for effective teaching strategies for teaching of the subject.

Despite the importance of biology, students' academic achievement in the subject from West African Senior School Certificate Examination (WASSCE) has been persistently poor (Moses, Gospel, & Femi, 2016; Joda & Mohamed, 2017; Joda, 2018). According to the chief examiners' reports by the West African Examinations Council (WAEC), students' achievement in Biology in Nigeria is poor and this implies that the use of Biology to achieve sustainable development can be slowed down. The achievement of students in Biology examinations conducted by the WAEC over the years from 2014 to 2023 reveals that for the years reviewed, the students mean achievement in Biology fluctuated between 25.00 and 31.00. This is not good for a nation that is generally regarded as the "Giant of Africa" and a signatory to Sustainable Development Goals (SDGs) agenda (Ezeh (2013). Research studies have pointed out some factors that may be responsible for low students' academic achievement in biology. The most common factors are teaching methods and strategies, large class size, English language, difficult concepts, large curriculum, inadequate laboratory and instructional materials and teachers' qualification amongst others (Irinoye, Bamidele, Adetunji & Awodele, 2015 & Joda, 2019). Students' inability to retain biology concepts may lead poor academic achievement. Therefore, innovative instructional strategies such as, collaborative strategy, peer tutoring and concept mapping when applied effectively may improve students' academic achievement and retention in Biology.

Concept mapping is a visual representation of a student's understanding of concepts, hierarchically organized and connected by labeled lines. The lines denote the relationship

between concepts and the labels on the lines indicate how the two concepts are related (Novak, 2010). Novak and Cañas (2006) describe concept mapping as a graphical tool for organizing and representing knowledge in networks of concepts and linking statements about a problem or subject. Concept maps are graphical or pictorial arrangements that deal with a specific subject matter. Concept mapping is a procedure of arranging facts or data in way of maps as two-way diagram which comprises of concept connected by stipulated outline to illustrate relationship among words Canas (2013). This is because knowledge acquired through meaningful learning is assimilated into the existing cognitive structure and is retained longer, even much longer in many instances among gender.

Apart from teaching strategies, gender is another factor that may influence students' academic achievement in biology. Gender is described as a cultural construct and social positions which members of society attach to being male or female. Moreover, Joda (2018) and Mohammed (2021) opined that, gender is a social or cultural determinant that varies from place to place or culture to culture. Some research works in science education reveal that promoting achievement in students' understanding of science does not depend on gender rather it is through determination of the students (Terhemba, Okwara & Jirgba, 2021). While Ahmed, Shittu, Yahaya and Dada (2021) found that females achieved higher than males in the science subjects, and on the other hand, Kehinde and Paul (2014) found that males achieved higher than females in science in Biology and this may lead to retention.

Retention, like students' academic achievement, may or may not be affected by concept mapping teaching strategy. Retention of scientific concepts are products of teaching strategies that take into cognizance the learner-readiness which include current knowledge, stage of cognitive development and mode of intellectual functioning (Joda & Mohammed, 2017). The ability of students to recall past biology concepts as an objective of biology teaching and learning process may likely enhance achievement in the subject. Gatlin (1998) reported that for knowledge to be retained for a long time by the learners the teachers must use effective teaching strategies in the classroom. Gatlin declared that students who received the constructivist teaching strategy (such as concept mapping) have a higher retention over time than those who received lecture method. This reaffirmed that poor retention of materials by students have contributed enormously to their poor achievements in science subjects especially, biology. Therefore, there is need to investigate effect of concept mapping teaching strategy, the interactive effect of concept mapping, lecture method and gender on senior secondary school students' academic achievement and retention in Biology.

Statement of the Problem

Government, in Nigeria, over the years has made huge investment in teacher training (pre-service and in-service), through Science Teacher Education Programme, in order to raise the needed skilled manpower for national development. Students' academic achievement in secondary school Biology has not been encouraging. Studies show that there is a steady increase in yearly enrolment in Biology, but each year candidates achieved poorly in examination 2015-2017. The result for Senior Secondary Certificate Examination (SSCE) in Biology shows very poor achievement, hence, the dire need to increase the students' academic achievement in Biology. Students' WASSCE results in Biology in the past five years (2014 – 2018) in Adamawa State revealed that students' academic achievement is very poor with less than 20% students that obtained grades at credit level and above in the period under review (Adamawa State Ministry of Education, Yola 2019).

The results indicated that out of the 73, 091 candidates that sat for the WASCE in Biology only 14, 582 candidates obtained credits and above while the remaining 58, 509 candidates failed to obtain credits and above which would qualify them for college and university admission in Biology and other science related disciplines. In spite of the methods and strategies of teaching employed by teachers to improve on the teaching and learning of Biology, there is still persistent poor students' academic achievement in the subject. This downward trend, persistent poor students' academic achievement in Biology, if left unchecked will to a large extent hinder the nation's achievement of Biology education objectives and by extension the nation's quest for scientific and technological development among the comity of nations will be truncated.

In view of the above stated problem, the researcher set to investigated, the effect of concept mapping teaching strategy on Senior Secondary School students' academic achievement and retention in Biology with respect to gender in Adamawa State?

Purpose of the Study

The purpose of this study is to investigate effect of concept mapping teaching strategy on Senior Secondary School students' academic achievement and retention in Biology in Adamawa State. Specifically, the study sought to determine the effect of:

1. Concept mapping teaching strategy and lecture teaching methods on senior secondary school students' academic achievement in Biology in Adamawa State.
2. Gender on senior secondary school students' academic achievement when taught Biology using concept mapping teaching strategy and lecture teaching methods in Adamawa State.
3. Concept mapping teaching strategy on senior secondary school students' retention of Biology concepts in Adamawa State.
4. Gender on senior secondary school students' retention of Biology concepts when taught using concept mapping teaching strategy in Adamawa State.

Research Questions

The study answers the following research questions:

1. What is the difference in the post-test mean achievement scores of students taught Biology using concept mapping teaching strategy and lecture method in senior secondary schools in Adamawa State?
2. What difference exists due to gender in the post-test achievement mean scores of students taught Biology using concept mapping teaching strategy in senior secondary schools in Adamawa State?
3. What is the difference in the mean retention scores of students taught Biology using concept mapping teaching strategy in senior secondary schools in Adamawa State?
4. What difference exists due to gender in the mean retention scores of students taught Biology using concept mapping teaching strategy in senior secondary schools in Adamawa State?

Hypotheses

The following null hypotheses were formulated to guide the study:

H0₁: There is no significant difference of concept mapping teaching strategy and lecture methods on Biology students' academic achievement in senior secondary schools in Adamawa State.

H0₂: There is no significant difference between male and female students' academic achievement when taught Biology using concept mapping teaching strategy in senior secondary schools in Adamawa State.

H0₃: There is no significant difference of concept mapping and lecture method on senior secondary schools students' retention of Biology concepts in Adamawa State.

H0₄: There is no significant difference between the mean retention scores of male and female students when taught Biology using concept mapping teaching strategy in senior secondary schools in Adamawa State.

Theoretical framework

This research work is hinged on the subsumption theory. The theory was founded by David Ausubel in the year 1963. The theory states that learning is based upon the kinds of superordinate, representational and combinatorial processes that occur during the reception of information. Ausubel posited that learners absorb new information by tying it to existing concepts and ideas that they have already acquired. Rather than building an entirely new cognitive structure, they are able to relate it to information that is already present within their minds. A primary process in learning is subsumption in which new material is related to relevant ideas in the existing cognitive structure on a substantive, non-verbatim basis. Cognitive structures represent the residue of all learning experiences, forgetting occurs because certain details get integrated and lose their individual identity. In the same way, concept mapping teaching strategy doesn't call for developing existing cognitive structure, but just through the graphic organizers reorganize it within the learners' memory.

Methodology

The research design employed for this study is the quasi experimental pre-test, post-test and non equivalent control group design using 2 x 2 x 2 factorial matrix. The area of the study is Adamawa State. Population of the study consisted of all the 23,549 (15,211 male and 8,338 female) SSII Biology students in all the public senior secondary schools in Adamawa State. The sample of the study comprised of 298 (122 male and 176 female) SS II Biology students from four senior secondary schools' intact classes in Yola and Numan education zones of Adamawa State using stratified random sampling to select the 2 education zone and purposive sampling techniques based on teachers with degree with Biology education and at least five years of experience. A 50 items Biology Achievement Test (BAT) was adopted from WAEC past question papers 2010-2020 was used as instrument for data collection. The instrument had four (A-D) options with one correct answer and three distractors. The topics covered were on cell, skeletal system, aquatic and terrestrial habitats. The instrument was subjected to face and content validity by two experts in the department of Environmental and Life Sciences Education, Modibbo Adama University, Yola and one senior master from General Murtala College Yola (GMMC). The instrument was trial tested on 75 SSII Biology students from GDSS Doubeli, a non-participating school to obtain the internal consistency of the instrument. Split-half method was utilized and the coefficient was computed using Kuder-Richardson (KR-21) formula and the reliability coefficient index of 0.81 was obtained.

A pre-test of BAT was administered to both the experimental group and the control group in their respective schools and their scores were recorded. Experimental group were taught using concept mapping teaching strategy, while the control group were taught using the lecture teaching methods. At the end of six weeks, a post-test was administered to the both groups. After two weeks of delay a retention test was administered to the two groups at the end of eight weeks. The data collected using Biology Achievement Test were analysed using Mean and standard deviation to answer research questions and Analysis of Covariance

(ANCOVA) was used to test the null hypotheses at 0.05 level of significance. The decision rule on the hypothesis testing entails that if the P-value ≤ 0.05 then reject the null hypotheses or otherwise do not reject

Presentation of Results

Research Question 1: What is the difference in the post-test mean achievement of students taught Biology using concept mapping teaching strategy and lecture method in senior secondary schools in Adamawa State?

Table 1: Mean Difference in the Post-test Mean Achievement of Students Taught Biology Using Concept Mapping Teaching Strategy and Lecture Methods in Senior Secondary Schools in Adamawa State.

Group	N	Pretest		Posttest		Mean Difference
		Mean	S.D	Mean	S.D	
Concept Mapping	151	33.32	9.88	68.29	11.88	34.97
Lecture Method	147	32.57	6.75	55.82	7.28	23.25

Results of analysis in table 1 show the mean and standard deviation of academic achievement of students taught Biology using concept mapping teaching strategy and lecture method. The concept mapping teaching strategy mean pretest score was 33.32, the mean posttest score was 68.29, resulting in a mean difference of 34.97. The standard deviations for the pretest and post test were 9.88 and 11.88 respectively. On the other hand, the lecture method group, comprising 147 students, exhibited a mean pretest score of 32.57 and a mean posttest score of 55.82, yielding a mean difference of 23.25, with a pretest and post test standard deviation of 6.75 and 7.28. Both groups experienced a substantial increase in mean scores from pretest to posttest, signifying notable positive shifts in academic performance.

Research Question 2: What difference exists due to gender in the post-test mean achievement of students taught Biology using concept mapping teaching strategy in senior secondary schools in Adamawa State?

Table 2: Mean Difference Between Post-test Mean Achievement of Male and Female Students Taught Biology Using Concept Mapping Teaching Strategy in Senior Secondary Schools in Adamawa State.

Gender	N	Pretest		Posttest		Mean Difference
		Mean	S.D	Mean	S.D	
Male (M)	63	34.09	10.32	67.84	11.57	33.75
Female (F)	88	32.54	9.43	68.62	12.16	36.08

Table 2 provides a breakdown of the mean difference between post-test scores for male (M) and female (F) students. For male students (N=63), the mean pre-test score is 34.09 with a standard deviation of 10.32, the mean post-test score is 67.84 with a standard deviation of 11.57. In contrast, female students (N=88) the mean pre-test score is 32.54 with a standard deviation of 12.16 and achieved a slightly higher mean post-test score of 68.62, with a standard deviation of 12.16. The mean difference between the two genders is reported as 0.78, in favour of female students. This suggests that, on average, female students performed slightly better than their male counterparts in the post-test assessment when taught Biology using the concept mapping teaching strategy in senior secondary schools in Adamawa State.

Research Question 3

What is the difference in the mean retention scores of students taught Biology using concept mapping teaching strategy and lecture methods in senior secondary schools in Adamawa State?

Table 3: Mean Difference in the Retention Scores of Students Taught Biology Using Concept Mapping Teaching Strategy and Lecture Method in Senior Secondary Schools in Adamawa State.

Group	N	Posttest		Post-Posttest		Mean Difference
		Mean	S.D	Mean	S.D	
Concept Mapping	151	68.29	11.88	69.36	12.18	1.07
Lecture Method	147	55.82	7.28	53.52	6.25	-2.30

The results of analysis in table 3 reported that concept mapping group, comprising 151 students, then a Post-test mean score of 68.29 with a standard deviation of 11.88 while students achieved a Post-Post-test mean score of 69.36 with a standard deviation of 12.18. In contrast, the lecture method group, consisting of 147 students, a Post-test mean score of 55.82 with a standard deviation of 7.28, while a Post-Post-test mean score of 53.52 with a standard deviation of 6.25. Consequently, the mean difference between the two groups is 15.84. These results suggest a substantial difference in mean retention scores between the two teaching methods, indicating that students taught using the concept mapping teaching strategy exhibited a higher mean retention score compared to those taught through the lecture methods in senior secondary schools in Adamawa State.

Research Question 4: What difference exists due to gender in the mean retention scores of students taught Biology using concept mapping teaching strategy in senior secondary schools in Adamawa State?

Table 4: Mean Difference in the Retention Scores of Male and Female Students Taught Biology Using Concept Mapping Teaching Strategy in Senior Secondary Schools in Adamawa State.

Gender	N	Posttest		Post-Posttest		Mean Difference
		Mean	S.D	Mean	S.D	
Male (M)	63	67.84	11.57	65.38	12.05	-2.46
Female (F)	88	68.62	12.16	67.08	12.29	-1.54

Table 4 displays the mean difference in retention scores between male (M) and female (F) students. The results indicate that the post test mean retention score for male students is 67.84 with a standard deviation of 11.57, the Post-post test mean retention score for male students is 65.38 with a standard deviation of 12.05. The post test mean retention score for female students is 68.62 with a standard deviation of 12.16, while the Post-post test mean retention score for female students is 67.08 with a standard deviation of 12.29. While the mean difference between the two genders is -1.70. This suggests that, on average, female students scored higher in retention when taught Biology using the concept mapping teaching strategy compared to their male counterparts.

H0₁: There is no significant effect of concept mapping teaching strategy and lecture methods on Biology students' academic achievement in senior secondary schools in Adamawa State.

Table 5: Summary of ANCOVA of Effect of Concept Mapping and Lecture Methods on Biology Students' Academic Achievement in Senior Secondary Schools in Adamawa State

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	11646.40 ^a	4	2911.60	29.58	.00	.29
Intercept	78739.84	1	78739.84	799.97	.00	.73
Pretest	27.74	1	27.74	.28	.60	.08
Teaching methods	10727.99	1	10727.99	108.99	.00	.27
Gender	.31	1	.31	.00	.96	.00
Teaching methods * gender	46.82	1	46.82	.48	.49	.46
Error	28839.68	293	98.43			
Total	1191212.00	298				
Corrected Total	40486.08	297				

a. R Squared = .29 (Adjusted R Squared = .28)

Analysis in Table 5 results show that there is significant effect of concept mapping and lecture method on senior secondary schools students' academic achievement in Biology in Adamawa State, $F(1, 298) = 108.99$, $p < 0.05$ with moderate effect size as indicated by the partial Eta squared of 0.27.

H0₂: There is no significant difference between male and female students' academic achievement when taught Biology using concept mapping teaching strategy in senior secondary schools in Adamawa State.

Table 6: Summary of Independent sample t – test of Difference Between Male and Female Students' Academic Achievement when Taught Biology Using Concept Mapping Teaching Strategy in Senior Secondary Schools in Adamawa State.

Gender	N	Mean	S. D	Df	t - value	p-value	Decision
Male	63	67.84	11.57	149	-0.40	0.69	H0₂ retained
Female	88	68.62	12.16				

The results of analysis in table 6 show the mean academic achievement score for male students was 67.84 with a standard deviation of 11.57, while the mean score for female students was 68.62 with a standard deviation of 12.16. The t-value was calculated to be -0.396 with 149 degrees of freedom, resulting in a p-value of 0.69. The decision based on the p-value was to retain the null hypothesis that is there is no significant difference between male and female students' academic achievement when taught Biology using concept mapping teaching strategy in senior secondary schools in Adamawa State.

H0₃: There is no significant effect of concept mapping and lecture method on senior secondary schools students' retention of Biology concepts in Adamawa State.

Table 7: Summary of ANCOVA of Effect of Concept Mapping Teaching Strategy and Lecture Methods on Senior Secondary Schools Students' Retention of Biology Concepts in Adamawa State

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	12430.68 ^a	4	3107.67	32.76	.00	.31
Intercept	72075.71	1	72075.71	759.84	.00	.72
Pretest	54.89	1	54.89	.58	.45	.00
Teaching method	11330.49	1	11330.49	119.45	.00	.29
Error	27793.12	293	94.86			
Total	1113984.00	298				
Corrected Total	40223.79	297				

a. R Squared = .31 (Adjusted R Squared = .30)

Results of analysis in table 7, the results show that there is significant effect of concept mapping and lecture method on senior secondary school students' retention of Biology concepts in Adamawa State, $F(1, 298) = 119.45$, $p < 0.05$ with moderate effect size as indicated by the partial Eta squared of 0.30.

H0₄: There is no significant difference between the mean retention scores of male and female students when taught Biology using concept mapping teaching strategy in senior secondary schools in Adamawa State.

Table 8: Summary of Independent Sample t – test of Difference Between the Mean Retention Scores of Male and Female Students when Taught Biology Using Concept Mapping Teaching Strategy in Senior Secondary Schools in Adamawa State

Gender	N	Mean	S. D	Df	t - value	p-value	Decision
Male	63	65.38	12.05	149	-0.85	0.40	H0₄ retained
Female	88	67.08	12.29				

Table 8 shows that mean retention score for male students was 65.38 with a standard deviation of 12.05, while for female students; it was 67.08 with a standard deviation of 12.29. The t-value obtained was -0.85 with 149 degrees of freedom, resulting in a p-value of 0.40. The decision based on this analysis is to retain the null hypothesis as the p-value exceeds the conventional significance level of 0.05. Therefore, there is no significant difference in the mean retention scores of male and female students when taught Biology using concept mapping teaching strategy in senior secondary schools in Adamawa State.

Summary of Findings

The summary of the findings of the study are:

1. The students that were taught Biology with concept mapping teaching strategy achieved significantly higher, than those of lecture methods in senior secondary schools in Adamawa State.
2. The students subjected to concept mapping teaching strategy in Biology showed no significant mean difference in academic achievement due to gender in senior secondary schools in Adamawa State.

3. The students exposed to concept mapping teaching strategy significantly retained higher Biology concepts than those of lecture methods in senior secondary schools in Adamawa State.
4. The students that were treated Biology with concept mapping teaching strategy significantly retained equally, irrespective of gender in senior secondary schools in Adamawa State.

Discussion of Findings

The findings state that students that were taught Biology with concept mapping teaching strategy achieved significantly higher than those of lecture method in senior secondary school in Adamawa State. This finding has lent credence to earlier similar studies in Biology (Ibrahim, 2018; Sakiyo & Waziri, 2015; Mohammed, 2021) declare that concept mapping teaching strategy improves students' academic achievement. It means that concept mapping teaching strategy enhances students' academic achievement compared to lecture method. This finding disagrees with the finding of Fang (2018) which opined that students disliked concept mapping because it was a busy work and did not help in understanding concepts.

The finding stated that students that were subjected to concept mapping teaching strategy in Biology showed no significant difference in academic achievement due to gender in senior secondary schools in Adamawa State. This finding corroborated the earlier findings that affirm that there is no influence of gender on students' academic achievement, that concept mapping teaching strategy is gender friendly (John, Sani, Ranccas & Maskawa, 2018; Terhemba, Okwara & Jirgba, 2021) However, the finding is at variance with Sor et al, (2018); Dada (2021) and Mohammed (2021) who revealed a significant difference in male and female post-test scores with female achieving better than male students and also those that ascertain that there is significant difference due to gender in students' academic achievement, but in favour of the male counterparts (Kehinde & Paul, 2014).

The finding revealed that students exposed to concept mapping teaching strategy significantly retained higher Biology concepts than those of lecture methods in senior secondary schools in Adamawa State. This finding agrees with the earlier findings that established that concept mapping teaching strategy improves students' retention (John, Sani, Ranccas & Maskawa, 2018; Oyovwi, 2021) but disagrees with findings of Bika (2015) that posited that lecture method enhances students' retention than cooperative learning.

The finding stated that students that were treated Biology with concept mapping teaching strategy significantly retained equally irrespective of gender in senior secondary school in Adamawa State. The finding of the study corroborated the earlier findings (Sakiyo & Kawu 2015; Mohammed, 2021, Bizima, Mutangana & Mwesigye, 2021) reported that concept mapping teaching strategy is gender friendly. But the study is in conflict with some findings (Mohammed, 2021; Ahmed, Shittu, Yahaya & Dada, 2021) that posited that concept mapping teaching strategy is biased since there are significant differences in students' retention of biology concepts in favour of female students. It also contradicts some findings (Kehinde & Paul, 2014) that establish that concept mapping teaching strategy is gender sensitive since male students retain higher biology concepts than their female counterparts.

Conclusion

The study concluded that the use of concept mapping teaching strategy, encourages students' active participation in learning process, improves students' achievement and retention of Biology concepts regardless of gender. This led to higher students' academic achievement and retention revealed by the mean scores of male and female students exposed to concept mapping teaching strategy than those taught with lecture methods..

5.3 Recommendations

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

1. Senior secondary school Biology teachers should adopt concept mapping teaching strategy to teach Biology concepts in Adamawa State.
2. Senior secondary school Biology teachers should adopt the use of concept mapping teaching strategy to teach Biology concepts irrespective of the gender in Adamawa State
3. National Curriculum Development Council (NCDC) should re-emphasis on concept mapping teaching strategy for the teaching of Biology concepts in secondary schools.
4. Adamawa State government should organize workshops, seminars, symposia and conferences for senior secondary schools Biology teachers to keep them abreast of using concept mapping in teaching Biology concepts.

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