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Effect of Collaborative Concept Mapping Instructional Strategy on Senior Secondary School Students' Achievement and Retention in Ecology in Benue State, Nigeria

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***Abstract*— The study investigated the effect of collaborative concept mapping instructional strategy on senior secondary school students' achievement and retention in ecology in Benue state, Nigeria. The study was guided by four specific objectives. Four research questions were raised and answered and four hypotheses were formulated and tested at 0.05 level of significance. The study adopted a quasi-experimental design of pre-test- post-test- control group. The study was conducted in Benue State. The target population of the study was 16,322 senior secondary one (SS1) Biology students from 96 government grant-aided secondary schools in Benue state (Benue State ministry of education, 2018). The sample size for the study was 217 senior secondary I Biology students. In selecting the sample, multistage sampling procedure was followed. The instruments for data collection were researcher developed achievement test titled: Ecology Achievement Test (EAT) and Ecology Retention Test (ERT). A reliability coefficient of 0.84 was estimated using Kuder-Richardson method (formula K-R21).Descriptive statistics of Mean and Standard Deviation were used to answer the research questions while inferential statistics of Analysis of Covariance (ANCOVA) was used to test the null hypotheses at 0.05 level of significance. The study found among others that the use of collaborative concept mapping instructional strategy in teaching Ecology can improve students' achievement. The study recommended among others that teachers should use more of collaborative concept mapping instructional strategy in teaching Ecology in order to improve students' achievement and retention.**

***Index Terms*— Ecology, collaborative concept .**

I. INTRODUCTION

Biology is one of the core subjects offered at the senior secondary school level in Nigeria (NPE, 2014). According to Mohammed (2019), Biology is the study of living organisms with regards to their structure, function, growth, evolution, distribution, identification and taxonomy. Similarly, Sarojini (2013) maintains that the word Biology is derived from the Greek words 'bios' meaning 'life' and 'logos' meaning 'study' thus it is defined as the study of life. Biology plays a vital role in the socio-economic development of a nation (Ahmed, 2014). Umaru (2011) observes that the socio-biological values cannot be over stated. For instance, in agriculture, Biology has helped agriculturists to produce high quality plants and animal products in large quantities as well as resistant varieties that boost food production. In the area of medicine, Biology has helped in the production of vaccines and drugs for preventing and curing many illnesses. Nowadays, we have medical breakthroughs such as organ transplant, test tube babies, and artificial limbs among others. The knowledge of genetics which is a branch of biology has revolutionalized determination of paternity disputes and identifies crime culprits with precision and certainty through Deoxyribo-Nucleic Acid (DNA) sequencing and profiling (Githae,Keraro, &Wachanga, 2018).Biology is expanded into various fields of study such as Ecology, Genetics, Biochemistry, Physiology, Microbiology and Biotechnology among others (Aina, 2017).

The word ecology is derived from the Greek word "Oikos" meaning home and "Logos" meaning study. Ecology therefore means a study of the home life of living organisms (Micheal, 2008). It can also be defined as the scientific study of organisms and their environment (Sarojini, 2013). The knowledge of Ecology which is a branch of Biology has contributed towards conservation of the environment and endangered species (Muraya & Kimamo, 2011). Ecology gives the students an opportunity to meet with some of the most important ecological issues affecting the environment such as erosion, deforestation, climate change and global warming and provides ways of mitigating them (Adejoh & Okwara, 2015). Similarly, Mohammed (2019) asserts that the study of Ecology enables man to understand the diversity of life forms, conservation and sustainable use of natural resources. Ecology has been proven to be a difficult Biology concept and constitute 40% (Samba & Eriba, 2012). This invariably means that students are likely to achieve poorly in such area when examined on them.

Despite these socio-biological values in boosting the scientific and technological advancement as well as the educational system of the nation, there is poor achievement of students in sciences. This poor achievement becomes eminent when one considers the achievement of students in Ecology in Biology (Samba & Eriba, 2012). According to Mohammed (2019), achievement is the attainment of set objectives measured from the score obtained through a test. If a learner accomplished a task successfully and attained the specific goal for a particular learning experience, the learner is said to have achieved. Similarly Abakpa (2011) opined that students' achievement is the demonstration of their abilities to attain certain levels of instructional objectives as an

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outcome of their classroom instruction and experiences. To Adegoke (2011), students' achievement in school setting refers to exhibition of knowledge attained or skills developed in a school subject indicated by test scores or marks assigned by the teachers. Research studies (Umaru, 2011, Joda & Mohamed, 2017, Joda, 2018) have shown that there is a persistent poor achievement by student in WAEC and NECO Biology examinations annually.

According to Umoru and Onoja (2017), the poor achievement of student in Ecology (a branch of Biology) may be attributed to poor instructional delivery approaches adopted by teachers, students' attitudinal problems, teachers' laxity towards teaching, concentration on few topics for examination purpose and students inability to recall previously learnt materials. The West African Examination Council (WAEC) chief Examiner's Report (2018), points out among others the factors that cause poor achievement of students in Ecology in Biology; include: poor instructional delivery approach to teaching by teachers seems to be the most prominent factor. More so, Salau (2012) affirms that students poor achievement may be attributed to lack of mastery of the subject language, spelling errors, confusion between similar and related concepts, inability to recall previously learnt materials and poor instructional delivery approach. The author further mentioned that among the factors listed above, poor instructional delivery approach seems to be the most prominent factor that could be the cause of students' poor achievement in Ecology. Githae *et al.* (2018), argue that students' negative attitude towards Ecology which they perceive as difficult; ineffective teaching approaches that are teacher rather than learner- centered; teachers' inadequate mastery of subject content and pedagogical skills; inadequate teaching and learning resources such as text books and laboratory equipments may be the factors that contribute to students' poor achievement and retention.

Achievement in education is directly related to retention. Learners must retain knowledge acquired during teaching/learning process for them to achieve maximally in Ecology (Mohammed, 2019). Kenneth (2013) defines retention as a preservation of mind. Materials in the mind of the learners should be presented in form of images for knowledge to develop. Eka (2015) opines that retention is the ability of the working memory of an individual to retrieve stored information from long term memory for processing.

The poor achievement and retention of students in Ecology gives birth to an upsurge of researches into innovative and traditional teaching strategies to alleviate the situation. Collaborative Concept Mapping Instructional Strategy (CCMIS) is an innovative teaching strategy. Collaborative connotes sharing ideas. Consequently, concept mapping instructional strategy becomes collaborative when a group of students come together, to brainstorm, share ideas, generate a pool of concepts, which when put together; they eventually come out with a map that represents the thought of the group (Samba & Eriba, 2012).

Samba and Eriba (2012) maintain that Collaborative Concept Mapping Instructional Strategy (CCMIS) fosters understanding and enhances knowledge construction leading to the development of a good conceptual repertoire or conceptual framework in the mind of the learner. This active involvement in knowledge construction by the learner leads to meaningful learning as such concepts and their relationships to each other gets stamped on the cognitive frame of the learner. Furthermore, the CCMIS is born out of the fact that drawing individual maps could sometimes be boring and frustrating, particularly when one is not getting it right. However, when more than one person brainstorms together, each one is encouraged or stimulated to think and bring out more concepts or ideas which when shared, will go a long way to upgrade individual conceptual framework. This will not only promote meaningful learning, but will go further to help develop critical thinking and other social skills which are fundamental in functional and impactful living. Moreover, such interactions make learning more exciting, arouse interest and keep the students focused.

According to Emily (2017), collaborative classroom structure helps students discuss subject matter with each other, learn and provide encouragement for members of the group. Collaborative instructional strategy is a situation in which two or more people learn something together. It is a term used to identify a variety of educational approaches that involves work done by students or students and teachers together. There are different types of collaboration which include collaboration between teachers and teachers, teachers and students or students and students. For the sake of this research, the focus will be on students to students' collaboration in which the teacher would act as a facilitator. Students would jointly search for concepts, ideas, and facts in order to construct their knowledge. This innovative instructional strategy puts the teacher more into the role of course designer, discussion facilitator, and coach and the students more into the role of active learner, discovering the subject matter and substance of the subject (Samba & Eriba, 2012). Thus collaborative concept mapping may be more effective for students' learning outcomes than the traditional teaching method.

Traditional teaching method is the oldest teaching method which presents lessons through verbal presentation of ideas, concepts and facts (Sidhu in Eka, 2015). Another name for this method is speech, where the teacher talks continuously to a class. It is a one-way traffic flow of ideas. The teacher introduces the lesson by reviewing the constituent concepts and presents the lesson for the day. The teacher spends most of the time on talking and writing on the chalkboard. The students on their part, sit silently, listen attentively and try to catch the points. A lot of materials could be covered within a short time using this method however; students do not participate actively (Adejoh, 2015). However, it is when students participate actively that meaningful learning occurs. Hence the study seeks to determine the effect of collaborative concept mapping instructional strategy on achievement and retention of students after being taught Ecology in respect to gender.

Igbo, Ako, and Egbe-Okpenge (2008) see gender as the masculine or feminine roles prescribed by societies. To Ezeugwu, Nji, Ngozi, Chinwe, and Remigius (2016) gender refers to the social attributes and opportunities associated with being a male or female, woman or man and being a girl or boy; these attributes and opportunities are socially constructed and are learnt through socialization processes of which the school is one of the major agents. The issue of

gender is of great concern to science educators (Ecology inclusive) especially with increasing emphasis on ways of ensuring gender balance in education (Adejoh, 2015). Ezeugwu*et al.*, (2016) observes that some teaching strategies favour male students than their female counterparts. The disparity in achievement and retention of male and female students is of great concern to science educators particularly Biology (Ecology inclusive). For instance, Okoro (2011) reports that females performed better than males when co-operative learning is used. On the other hand, when individual learning strategy is used males did better than females. Thus teachers' instructional strategy may create a gap between the male and female (gender) achievement and retention in Ecology hence the need to examine male and female achievement and retention in Ecology using collaborative concept mapping instructional strategy becomes pertinent.

Statement of the Problem

Ecology is an aspect of Biology taught in Nigerian senior secondary schools. Ecology plays a central role in human activities. For instance, the knowledge of Ecology helps man in the conservation of biodiversity. Ecology as an aspect of Biology is a pre-requisite to other disciplines such as environmental biology, microbiology, biochemistry, medicine, biotechnology and genetics among others.Despite these benefits of Ecology, there is a continuous poor achievement of students in Biology (Ecology inclusive). This poor achievement becomes eminent when one considers the performance of students in public examinations. Over the years, reports have revealed to lime light the poor achievement of students in West African Examination Council (WAEC) conducted in Nigeria. This poor trend is particularly evident in the achievement of Biology students who, over the years, have not recorded an average of 50% pass in the examination (Appendix A p. 74). The poor achievement may be due to the instructional strategy employed by teachers and poor retention arising from poor grasp or understanding of ecological concepts in Biology. With this in mind, the researcher is set to investigate, what could be the Effect of Collaborative Concept Mapping Instructional Strategy (CCMIS) on Senior Secondary School Students' Achievement and Retention in Ecology with respect to gender?

Objective of the Study

The main purpose of study was to investigate the effect of collaborative concept mapping instructional strategy (CCMIS) on Senior Secondary School Students' Achievement and Retention in Ecology in Benue State, Nigeria. Specifically, the study sought to:

1. Determine the mean achievement scores of senior secondary school students' taught Ecology using collaborative concept mapping instructional strategy and those taught with traditional teaching method.
2. Find out if male and female senior secondary school students' mean achievement scores will differ after being taught Ecology using collaborative concept mapping instructional strategy.
3. Determine the mean retention scores of senior secondary school students' taught Ecology using collaborative concept mapping instructional strategy and those taught with traditional teaching method.
4. Find out if male and female senior secondary school students' mean retention scores will differ after being taught Ecology using collaborative concept mapping instructional strategy.

Research Questions

The following research questions guided the study:

1. What are the mean achievement scores of senior secondary school students' taught Ecology using collaborative concept mapping instructional strategy and those taught with traditional teaching method?
2. What are the mean achievement scores of male and female senior secondary school students' taught Ecology using collaborative concept mapping instructional strategy?
3. What are the mean retention scores of senior secondary school students' taught Ecology using collaborative concept mapping instructional strategy and those taught with traditional teaching method?
4. What are the mean retention scores of male and female senior secondary school students' taught Ecology using collaborative concept mapping instructional strategy?

Statement of Hypotheses

The following hypotheses are formulated and tested at 0.05 level of significance:

H_{O1}: There is no significant difference between the mean achievement scores of senior secondary school students' taught Ecology using collaborative concept mapping instructional strategy and those taught with traditional teaching method.

H_{O2}: There is no significant difference between the mean achievement scores of male and female senior secondary school students' taught Ecology using collaborative concept mapping instructional strategy.

H_{O3}: There is no significant difference between the mean retention scores of senior secondary school students' taught Ecology using collaborative concept mapping instructional strategy and those taught with traditional teaching method.

H_{O4}: There is no significant difference betwee
retention scores of male and female senior secon
students' taught Ecology using collaborati
mapping instructional strategy.

Methodology

The study adopted a quasi-experimental design of pre-test-post-test- control group. The study was conducted in Benue State. The target population of the study was 16,322 senior secondary one (SS1) Biology students from 96 government grant-aided secondary schools in Benue state (Benue State ministry of education, 2018). The sample size for the study was 217 senior secondary I Biology students. In selecting the sample, multistage sampling procedure was followed. The instruments for data collection were researcher developed achievement test titled: Ecology Achievement Test (EAT) and Ecology Retention Test (ERT). Ecology Achievement Test (EAT) was used for pre-test and post-test. EAT measured the students' achievement in Ecology which was taught during treatment. The Ecology Achievement Test (EAT)was reshuffled to have ERT and was administered after two weeks of the administration of the post test. In order

to establish the validity of the instruments, a table of specification was constructed for Ecology Achievement Test to ensure it content validity. The Ecology Achievement Test (EAT) and Ecology Retention Test (ERT) were also subjected to face validity by three experts. A trial-testing of EAT was conducted on 20 senior secondary I Biology students of Government Senior Secondary School Kadarko, Nasarawa State who are outside the study area but have similar characteristics with those in the study area and the scores obtained were used to compute item analysis of the instrument. All the items were found to be good. That is, the difficulty level and distractor discriminates well. A reliability coefficient of 0.84 was estimated using Kuder-Richardson method (formula K-R_{21}).This value indicated high internal consistency as such, the instrument was adjudged as appropriate for the study.

The method of data collection was face-face administration of EAT and ERT by the research assistants. The research assistants administered the Ecology Achievement Test (EAT) before treatment (pre-test), gave the treatment (taught Ecology) and administered the Ecology Achievement Test (EAT). After the treatment post-test was then administered on SS1 students the retention test (ERT) after two week from the administration of the EAT. Descriptive statistics of Mean and Standard Deviation were used to answer the research questions while inferential statistics of Analysis of Covariance (ANCOVA) was used to test the null hypotheses at 0.05 level of significance.

Results and Discussion

Research Question 1

What are the mean achievement scores of senior secondary school students taught Ecology using collaborative concept mapping instructional strategy and those taught with traditional teaching method?

The mean achievement scores, standard deviation and mean difference of senior secondary school students of the experimental and control groups are presented in Table 1.

Table 1: Mean Achievement Scores, Standard Deviations and Mean Difference of Senior Secondary School Students of the Experimental and Control Groups on EAT

Groups	N	Pre-test		Post-test	
		Mean	SD	Mean	SD
Experimental	104	20.09	5.24	33.99	5.76
Control	113	13.23	3.53	23.15	4.53
Mean Difference		6.86		10.84	
Total	217				

KEY: N = Number, SD = Standard Deviation

Table 1 shows that in Pretest, the experimental group had a mean achievement score of 20.09 with a standard deviation of 5.24 while the control group had a mean achievement score of 13.23 with a standard deviation of 3.53 respectively. The results further shows that in the Posttest, the experimental group had a mean achievement score of 33.99 with a standard deviation of 5.76, while the control group had a mean achievement score of 23.15 with a standard deviation of 4.53. The mean difference between the achievement scores of the experimental and control group in pretest was 6.86 while the mean difference in posttest was 10.84.

Research Hypothesis 1

H_{O1}: There is no significant difference between the mean achievement scores of senior secondary school students taught Ecology using collaborative concept mapping instructional strategy and those taught with traditional teaching method.

The analysis of ANCOVA to test hypothesis 1 is presented in Table 2

Table 2: Summary of ANCOVA for Mean Achievement Scores of Senior Secondary School Students of the Experimental and Control Groups in EAT

Source of Variance	Type III Sum of Squares	Df	Mean Square	F	Sig
Corrected Model	7162.737[a]	2	3581.369	155.574	.000
Intercept	6480.531	1	6480.531	281.514	.000

Achpretest	799.092	1	799.092	34.713	.000
Group	2085.305	1	2085.305	90.586	.000
Error	4926.341	214	23.020		
Total	186443.000	217			
Corrected Total	12089.078	216			

Table 2 reveals that $F_{1, 216}$=90.58, P=0.000<0.05. This implies that there is a significant difference between the mean achievement scores of senior secondary school students taught Ecology using collaborative concept mapping instructional strategy and those taught with traditional teaching method. Hence the null hypothesis 1 of no significant deference between the mean achievement scores of students taught Ecology using collaborative concept mapping instructional strategy and those taught with traditional teaching method is therefore rejected.

Research Question 2

What are the mean achievement scores of male and female senior secondary school students taught Ecology using collaborative concept mapping instructional strategy?

The mean achievement scores, standard deviation and mean difference of male and female senior secondary school students of the experimental group are presented in Table 3.

Table 3: Mean Achievement Scores, Standard Deviations and Mean Difference of Male and Female Senior Secondary School Students of the Experimental Group on EAT

Groups	N	Pre-test		Post-test	
		Mean	SD	Mean	SD
Male	45	19.60	5.50	34.04	7.37
Female	59	20.47	5.04	33.94	4.21
Mean Difference		-0.87		0.1	
Total	104				

KEY: N = Number, SD = Standard Deviation

Table 3 shows that in Pretest, the male students in the experimental group had a mean achievement score of 19.60 with a standard deviation of 5.50 while female students had a mean achievement score of 20.47 with a standard deviation of 5.04 respectively. The results further showed that in the Posttest, the male students had a mean achievement score of 34.04 with a standard deviation of 7.37, while the female studentshad a mean achievement score of 33.94 with a standard deviation of 4.21. The mean difference between the achievement scores of male and female students in the pretest was -0.87 while the mean difference in posttest was 0.1.

Research Hypothesis 2

H_{O2}: There is no significant difference between the mean achievement scores of male and female senior secondary school students taught Ecology using collaborative concept mapping instructional strategy.

The analysis of ANCOVA to test the hypothesis 2 is presented in Table 4

Table 4: Summary of ANCOVA for Mean Achievement Scores of Male and Female Senior Secondary School Students in the Experimental Group in EAT

Source of Variance	Type III Sum of Squares	Df	Mean Square	F	Sig
Corrected Model	159.414[a]	2	79.707	2.465	.090
Intercept	5603.052	1	5603.052	173.295	.000
Achpretest	159.182	1	159.182	4.923	.029

Gender	2.333	1	2.333	.072	.789
Error	3265.577	101	32.332		
Total	123581.000	104			
Corrected Total	3424.990	103			

Table 4 reveals that $F_{1=103}$=0.072, P=0.789>0.05. This implies that there is no significant difference between the mean achievement scores of male and female senior secondary school students taught Ecology using collaborative concept mapping instructional strategy. Hence the null hypothesis 2 of no significant deference between the mean achievement scores of male and female senior secondary school students taught Ecology using collaborative concept mapping instructional strategy is therefore retained.

Research Question 3

What are the mean retention scores of senior secondary school students taught Ecology using collaborative concept mapping instructional strategy and those taught using traditional teaching method?

The mean retention scores, standard deviation and mean difference of senior secondary school students of the experimental and control groups are presented in Table 5.

Table 5: Mean Retention Scores, Standard Deviations and Mean Difference of Senior Secondary School Students of the Experimental and Control Groups in ERT

Groups	N	Post-test		Retention-test	
		Mean	SD	Mean	SD
Experimental	104	33.99	5.76	27.77	5.60
Control	113	23.15	4.53	16.76	4.11
Mean Difference		10.84		11.01	
Total	217				

KEY: N = Number, SD = Standard Deviation

Table 5 shows that in post-test, the experimental group had a mean retention score of 33.99 with a standard deviation of 5.76 while the control group had a mean retention score of 23.15 with a standard deviation of 4.53 respectively. The results further showed that in the retention-test, the experimental group had a mean retention score of 27.77 with a standard deviation of 5.60, while the control group had a mean retention score of 16.76 with a standard deviation of 4.11. The mean difference between the retention scores of the experimental and control group in post-test was 10.84 while the mean difference in retention-test was 11.01.

Research Hypothesis 3

H_{O3}: There is no significant difference between the mean retention scores of senior secondary school students taught Ecology using collaborative concept mapping instructional strategy and those taught with traditional teaching method.

The analysis of ANCOVA to test hypothesis 3 is presented in Table 6

Table 6: Summary of ANCOVA for Mean Retention Scores of Senior Secondary School Students of the Experimental and Control Groups in ERT

Source of Variance	Type III Sum of Squares	df	Mean Square	F	Sig
Corrected Model	7808.063[a]	2	3904.032	214.190	.000
Intercept	2509.451	1	2509.451	137.678	.000
Achpretest	1233.899	1	1233.899	67.696	.000
Group	1805.561	1	1805.561	99.060	.000

Error	3900.563	214	18.227
Total	117133.000	217	
Corrected Total	11708.627	216	

Table 6 reveals that $F_{1, 216}$=99.060, P=0.000<0.05. This implies that there is a significant difference between the mean retention scores of students taught Ecology using collaborative concept mapping instructional strategy and those taught with traditional teaching method. Hence the null hypothesis 3 of no significant difference between the mean retention score of senior secondary school students taught Ecology using collaborative concept mapping instructional strategy and those taught using traditional teaching method is therefore rejected.

Research Question 4

What are the mean retention scores of male and female senior secondary school students taught Ecology using collaborative concept mapping instructional strategy?

The mean retention scores, standard deviation and mean difference of male and female senior secondary school students of the experimental group are presented in Table 7.

Table 7: Mean Retention Scores, Standard Deviations and Mean Difference of Male and Female Senior Secondary School Students of the Experimental Group in ERT

Groups	N	Post-test		Retention-test	
		Mean	SD	Mean	SD
Male	45	34.04	7.37	27.80	6.41
Female	59	33.94	4.21	27.76	4.95
Mean Difference		0.10		0.04	
Total	104				

KEY: N = Number, SD = Standard Deviation

Table 7 shows that in post-test, the male students in the experimental group had a mean retention score of 34.04 with a standard deviation of 7.37 while female had a mean retention score of 33.94 with a standard deviation of 4.21 respectively. The results further shows that in the retention-test, the male students had a mean retention score of 27.80 with a standard deviation of 6.41, while the female had a mean retention score of 27.76 with a standard deviation of 4.95. The mean difference between the retention scores of male and female in the post-test was 0.10 while the mean difference in retention-test was 0.04.

Research Hypothesis 4

H_{O4}: There is no significant difference between the mean retention scores of male and female senior secondary school students taught Ecology using collaborative concept mapping instructional strategy.

The analysis of ANCOVA to test the hypothesis 4 is presented in Table 8

Table 8: Summary of ANCOVA for Mean Retention Scores of Male and Female Senior Secondary School Students of the Experimental Group in ERT

Source of Variance	Type III Sum of Squares	Df	Mean Square	F	Sig
Corrected Model	351.949[a]	2	175.974	6.163	.109
Intercept	2808.472	1	2808.472	98.356	.493
Achpretest	351.913	1	351.913	12.324	.109
Gender	3.046	1	3.046	.107	.001
Error	2883.965	101	28.554		
Total	83489.000	104			

Corrected Total	3235.913	103

Table 8 reveals that $F_{1=103}$=0.107, P=0.001<0.05. This implies that is no significant difference between the mean retention scores of male and female senior secondary school students' taught Ecology using collaborative concept mapping instructional strategy. Hence the null hypothesis 4 of no significant difference between the mean retention scores of male and female senior secondary school students taught Ecology using collaborative concept mapping instructional strategy is therefore retained.

Discussion of findings

Results of the study in Table 1 shows that The mean achievement scores of senior secondary school students who were taught Ecology using collaborative concept mapping instructional strategy was higher compared to their counterparts taught using traditional teaching method. Also in Table 2, the study revealed that the achievement of students taught Ecology using collaborative concept mapping instructional strategy differed significantly from those taught using traditional method. This shows that the use of collaborative concept mapping instructional strategy in teaching Ecology can improve students' achievement. These findings lends support to the study of Githae, Keraro and Wachanga (2018), Kipkemoi, Mukwa and Too (2019), Oluwatosin and Terfa (2017) and Eyayu and Meseret (2018)who in their separate studies reports that collaborative concept mapping instructional strategy had significant effect on achievement in Ecology (Biology). The findings also agree with Mohammed (2019) who found that students taught Biology using instructional scaffolding strategy achieved higher compared to those taught using conventional method. The findings were also in line with Nkemdilim and Okeke (2014) who discovered that computer-assisted instruction (CAI) improved students' achievement in Ecology. The findings were also consistent with Zumyil (2019) who found that computer simulation and field trip instructional strategies improved students' achievement. From the foregoing, it shows that collaborative concept mapping instructional strategy can solve the problem of poor achievement of students in WAEC and NECO examinations.

Result of the study in Table 3 shows that male students in the experimental group achieved slightly higher than their female counterparts when taught Ecology using collaborative concept mapping instructional strategy. Furthermore, In Table 4, the result indicates that there is no significant difference between the mean achievement of male and female senior secondary school students taught Ecology using collaborative concept mapping instructional strategy. These findings is in accordance with Githae, Keraro and Wachanga (2018) who reported that there was no significant gender difference in achievement after been taught Biology using collaborative concept mapping instructional strategy. The findings also tallies with Kyado, Abah and Samba (2019) who found that there was no significant difference between the achievement among male and female students taught perceived difficult Biology concepts using collaborative concept mapping instructional strategy. However, the findings are in contrast with Unum (2018) who discovered that female students achieved more than their male counterparts taught Ecology using collaborative concept mapping instructional strategy. From the foregoing, it shows that collaborative concept mapping instructional strategy is gender friendly and has helped to close the gap that seem to exist in achievement of students based on gender.

Result of the study in Table 5 revealed that the mean retention scores of senior secondary school students who were taught Ecology using collaborative concept mapping instructional strategy was higher compared to their counterparts taught using traditional teaching method, Table 6 shows that there was a significant difference between the mean retention scores of students taught Ecology using collaborative concept mapping instructional strategy as compared to those taught using traditional teaching method. The findings were in line with Oluwatosin and Terfa (2017) and Unum (2018) who in their respective studies found that collaborative concept mapping instructional strategy improve students' retention. The findings also align with Fatokun, Egya and Uzoechi (2016) who report that game instructional approach improve the retention of students in Chemistry. The findings were also consistent with Yemi and Adebimpe (2017) who assert that small-group learning strategy improved students' retention in Ecology. The findings are further supported with Mohammed (2019) who found that instructional scaffolding strategy improved students' retention in Biology. From the foregoing, it shows that collaborative concept mapping can solve the problem of poor retention of students that can lead to poor achievement.

Result of the study in Table 7 revealed that Male senior secondary school students in the experimental group retained slightly higher than their female counterparts taught Ecology using collaborative concept mapping instructional strategy. More so, in Table 8, the results showed that gender has no significant effect on students' retention when taught Ecology using collaborative concept mapping instructional strategy. This implies that collaborative concept mapping instructional strategy is gender friendly and has helped to close the gap that seem to exist between gender in subjects. These findings aligned with Oluwatosin and Terfa (2017) who found no significant difference in the mean retention scores of male and female students taught electrolysis using collaborative concept mapping instructional strategy. The result also agrees with Muhammed (2019), Yemi and Adebimpe (2017), Fatokun, Egya and Uzoechi (2016) who found no significant difference between the mean retention scores of students based on gender. However, the findings contradict with Unum (2018) who found that female students retained higher than their male counterparts using collaborative concept mapping instructional strategy in Ecology.from the foregoing, it can be inferred that collaborative concept mapping is gender friendly and has help to close the gap between the difference in male and female retention.

Conclusion

This study has provided empirical evidence that, the use of collaborative concept mapping instructional strategy to teach Ecology was found to improve students' achievement and retention more than the traditional teaching method. Furthermore, there was no significant gender difference in

achievement and retention. This is because collaborative concept mapping instructional strategy is an innovative strategy that is learner centered and provides the students opportunity to construct knowledge themselves which promotes achievement and retention contrary to the traditional teaching method which is teacher centered, learners' passive and facilitates poor achievement and retention. In addition, Collaborative concept mapping instructional strategy was gender friendly since there was no significant difference in students' achievement and retention across gender.

Recommendations

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

1. Students should always work in groups or pairs when learning and go for academic help from their teachers when they get stick up in the learning task. This will improve their achievement and retention. Since the help of teacher will put them through.
2. Teachers should use more of collaborative concept mapping instructional strategy in teaching Ecology in order to improve students' achievement and retention.
3. School administrators should regularly supervise the instructional strategies to ensure that collaborative concept mapping instructional strategy among other student friendly strategies is used to teach Ecology to improve students' achievement and retention in Ecology.
4. Curriculum planners should integrate collaborative concept mapping instructional strategy for teaching and learning of Ecology to improve students' achievement and retention in Ecology.

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