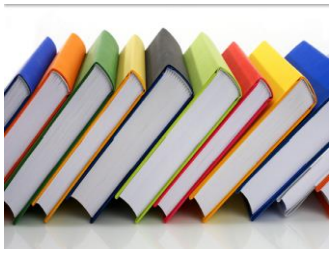

Teaching Strategies and Secondary School Students' Retention and Academic Achievement in Biology in Calabar Education Zone, Cross River State

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Abstract

The main purpose of the study is to determine whether students taught Biological concepts using cooperative learning and concept mapping strategies will experience enhanced understanding of the concepts than those taught using conventional method. To achieve the purpose of this study, two hypotheses and research questions were formulated. Literature was reviewed according to the variables of the study. Multistage sampling technique involving simple random, stratified and purposive sampling techniques were used to select 264 subjects for the study. Biology Achievement Test (BAT) and Biology Retention Test (BRT), were the two instruments used for data collection. The instruments were subjected to face and content validation. Analysis of covariance (ANCOVA) was employed to test the hypotheses under study. Each hypothesis was tested at .05 level of significance. The result of the analysis revealed a significant effect of treatment on students' academic achievement and retention of concept in Biology. It was recommended that professional associations like Science Teachers Association of Nigeria (STAN), Ministry of Education and Secondary Education Board should popularize the use of cooperative learning and concept mapping strategies in teaching Biological concepts.

Keywords: Teaching strategies, students, academic, achievement, retention Biology Cross River State, Nigeria.

Introduction:

Biology as a science subject is a branch of science that is concern with the study of plants and animals. It is primarily concerned with the nature of organisms and their relationship to each other and to their environment. Additionally, biology has assumed a vital part in giving information to current organic issues, for example, biotechnology, hereditary designing, garbage removal and food security. Despite the numerous benefits of teaching biology in schools, students' performance in the subject remains subpar, partly due to the misconception that biology is the least challenging science subject compared to chemistry and physics (Adeyemo & Onanuga, 2020)). Biology as a key science subject deals with the study of plants and animals. The major branches of biology are botany and zoology. According to Brown Özkan (2021), teaching biology to new students can be

challenging due to the abstract nature of some biological concepts, which can lead to student difficulties and misconceptions.

The importance of biology has been recognised in the development of drugs and vaccines for prevention and treatment of diseases. For instance, biological research at Vanderbilt University Medical Centre, USA, reported the isolation of two potent monoclonal antibodies from human survivors of Ebola virus disease. The cultured cell when studied revealed that these antibodies efficiently neutralized the Zaire, Sudan and Bundbugyo Ebola viruses. The antibodies, EBOV-515 and EBOV-520 also showed the capacity to protect against infections by these viruses in animal models (Crowe, 2018). Biology is fundamental to several professional courses like medicine and pharmacy. Although Biology plays a vital role in our daily lives and drives scientific progress, it is alarming to note that students' performance in the subject has been poor and shows no signs of improvement, with a persistent decline in academic achievement since the 1980s (Olutola, 2020).

Etobro and Fabinu, (2017), have also shown that a number of concepts in biology contains topics that pose difficulty for biology students to understand. The abstract nature of biology, characterized by complex and unfamiliar concepts, poses significant challenges for both teachers and students, making it a difficult subject to teach and learn effectively (Özkan, 2021). The strategies commonly used in the classroom have not sufficiently eased the learning process of the subject almost at all levels. Traditional approach contributes very little to the knowledge structure of the learner and therefore cannot promote reflective thinking in more critical and abstract manner (Igwebuike, Okri & Obi, 2021).

The WAEC Chief Examiners' reports of 2013-2017 in biology reported students' inability to answer questions in ecology satisfactorily. The same report indicates a recurring poor achievement of students in ecology aspects of Biology. The National Examination Council (NECO) annual publication (2018) shows that, candidates' Biology performance in 2015 to 2017 were 19.2%, 24.4% and 53.6% in Distinction (A1 – B3), Credit (C4-C6) and Fail (E7-F9), respectively at the national level as against the poor performance 4.0%; 33.3% and 56.3% of candidates in Cross River State in the said year.

In 2016, the national average of candidates Biology performance was 29.7%; 51.2% and 16.8% for Distinction; Credit and Fail respectively while candidates' performance in Cross River State was 28.3%; 50.6% and 19.8% respectively (NECO Annual Report, 2018). Also, in 2017, report showed that 49.5%, 30.7% and 18.4% had Distinction; Credit passes and Fail respectively at the national level as against the poor performance 9.2%; 60.5% and 26.5% for Distinction; Credit passes and Fail respectively of candidates in Cross River State in the said year, this poor performance recorded could be explained by students inability to retain what is taught.

Acut and Latonio (2021) define "retention" as the capacity to remember and apply learned facts or ideas over time. This happens when learning is successfully transferred to long-term memory, enabling students to recall and use the information at a later point, signifying effective learning. Ghassan (2017) observed that one of the reasons for the poor performance in biology is inability to recall previous knowledge easily. Retention of learning is a critical aspect of biology education, as it enables students to build upon previously learned concepts and apply them in new contexts, leading to deeper understanding and improved academic performance" (Brown, Brown, Smith & Johnson, 2021). The appropriate coding of incoming information provides the index that may be consulted so that retention takes place without an elaborate search in the memory lane. posited that the nature of the materials to be coded contributes to the level of retention. The effectiveness of teaching materials and strategies plays a crucial role in student retention and performance in biology. Teachers have the power to enhance retention rates and minimize gender differences in science and biology by adopting innovative teaching approaches. Nevertheless, most Nigerian secondary school biology teachers still use conventional methods, which lead to passive learning, inadequate interactions, and poor retention (Obikezie, Eke and Abumchukwu, 2023)..

The two instructional strategies under consideration are discussed to demonstrate an understanding of concepts that are relevant to this research work. The instructional strategies are cooperative learning strategy and concept mapping learning strategy. Cooperative learning is an educational approach that involves students working together in small groups to achieve a common goal or complete a task. This approach emphasizes collaboration, mutual support and teamwork,

promoting social interaction, communication and collective problem-solving. Concept mapping is a visual tool used to organize, explore and connect ideas, concepts and information. It involves creating a diagram that shows relationship between ideas, concepts and information, using words, images and colours (Ekon &Nsimeneabasi, 2021)

Co-operative learning as strategy for teaching and retention of concept in biology

Cooperative learning is a teaching strategy that involves students working together in small groups to achieve a common goal, promoting active learning, collaboration, and mutual support. This approach has been shown to enhance retention of biology concepts, improve academic achievement, and develop essential skills like communication, critical thinking, and problem-solving. By incorporating Co-operative Learning into biology education, teachers can create a student-centered and interactive learning environment that fosters academic success, social growth, and emotional intelligence

Cooperative learning described as a strategy in which students work together in small mixed integrated groups and help each other for (i) a common academic aim, (ii) develop communication abilities, (iii) increase problem solving, (iv) increase critical thinking abilities and (v) take an active part in their own learning process (Elpisah, Devila, and Hartini, 2020). Hence, this strategy employs a variety of learning activities to improve students' understanding of a subject matter by using a structured approach, which involves a series of steps, requiring students to not only study, memorise or analyse present knowledge, but also create, analyse and apply concepts. This leads to positive outcomes such as (i) higher achievement, (ii) more positive attitudes toward the subject, (iii) higher self-esteem, (iv) greater acceptance of differences among peers, (v) greater persistence and retention, additionally, (vi) greater understanding of the material is obtained (Elpisah, Devila & Hartini, 2020)

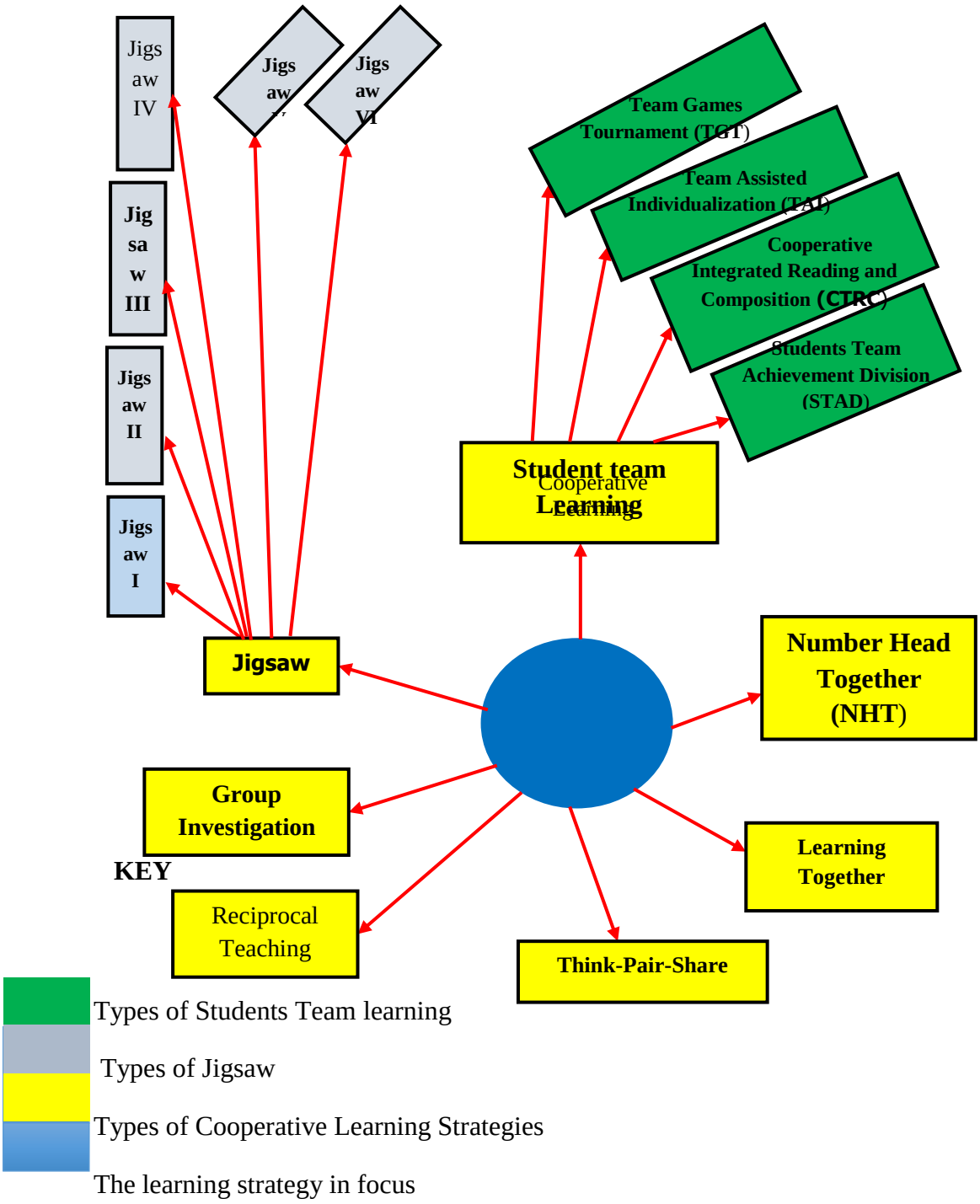

FIG 1: cooperative learning approach (Source: adapted from Slavin, (2011).

Concept mapping learning strategy

This strategy is based on the belief that no concepts exist in isolation but are interrelated with each other, to produce meaning. To comprehend complex biological phenomena, students must integrate knowledge from both microscopic and macroscopic levels. Concept mapping serves as a valuable tool to facilitate this integration, enabling students to connect concepts across levels or

reveal underlying relationships within the macroscopic level itself (Preszler, 2020). This process is regarded, as constructivist, given that the learner constructs knowledge by linking the relevant concept. A concept map is a graphical representation of the relationships between concepts, offering a visual framework for organizing and communicating knowledge. By illustrating the connections between ideas, concept maps facilitate a deeper understanding and more effective retention of complex information (Oluwatosin, Ekpa, Micheal, Amina, Bashir & Fakolade, 2022). Figure 2 presents a concept map that describes relationship between the concepts taught.

Thus, concept maps are often constructed with reference to some particular question we seek to answer. Such is called a focus question. Another important characteristic of concept maps is the inclusion of "crosslinks." These make explicit relationships between or among concepts in different regions or domains within the concept map. Cross-links show how a concept in one domain of knowledge represented on the map is related to a concept in another domain shown on the map. In the creation of new knowledge, cross-links often represent creative leaps on the part of the knowledge producer.

A final aspect of the structure of concept maps is the inclusion of specific examples of events or objects. These can help to clarify the meaning of a given concept. Normally these are not included in ovals or boxes, since they are specific events or objects and do not represent concepts. An example in figure 3 is the proposition "energy flows from the sun to primary producers and then transferred to consumers in an ecosystem. Primary producers occupy the bottom of the food chain.

In summary using concept mapping as Adapted from Adloan (2012) it explains the intricate web of life, energy flows through an ecosystem like a vital force, sustaining and connecting all living beings. It begins with the sun, the ultimate source of energy, which shines down upon the earth, nourishing the producers - plants, algae, and phytoplankton. These green wonders absorb the sun's rays, converting light into chemical energy through photosynthesis, storing it in the form of glucose. As herbivores feed on the producers, energy is transferred from one trophic level to the next, like a gentle stream meandering through the landscape. The herbivores, in turn, become the sustenance for carnivores, which feed on them, and so the energy flow continues, each level relying

on the previous one for survival. Decomposers, the ecosystem's recyclers, break down dead organic matter, releasing nutrients back into the soil, where they can be absorbed by producers, renewing the cycle. Energy is lost as heat at each trophic level, yet the flow remains, a testament to the ecosystem's resilience

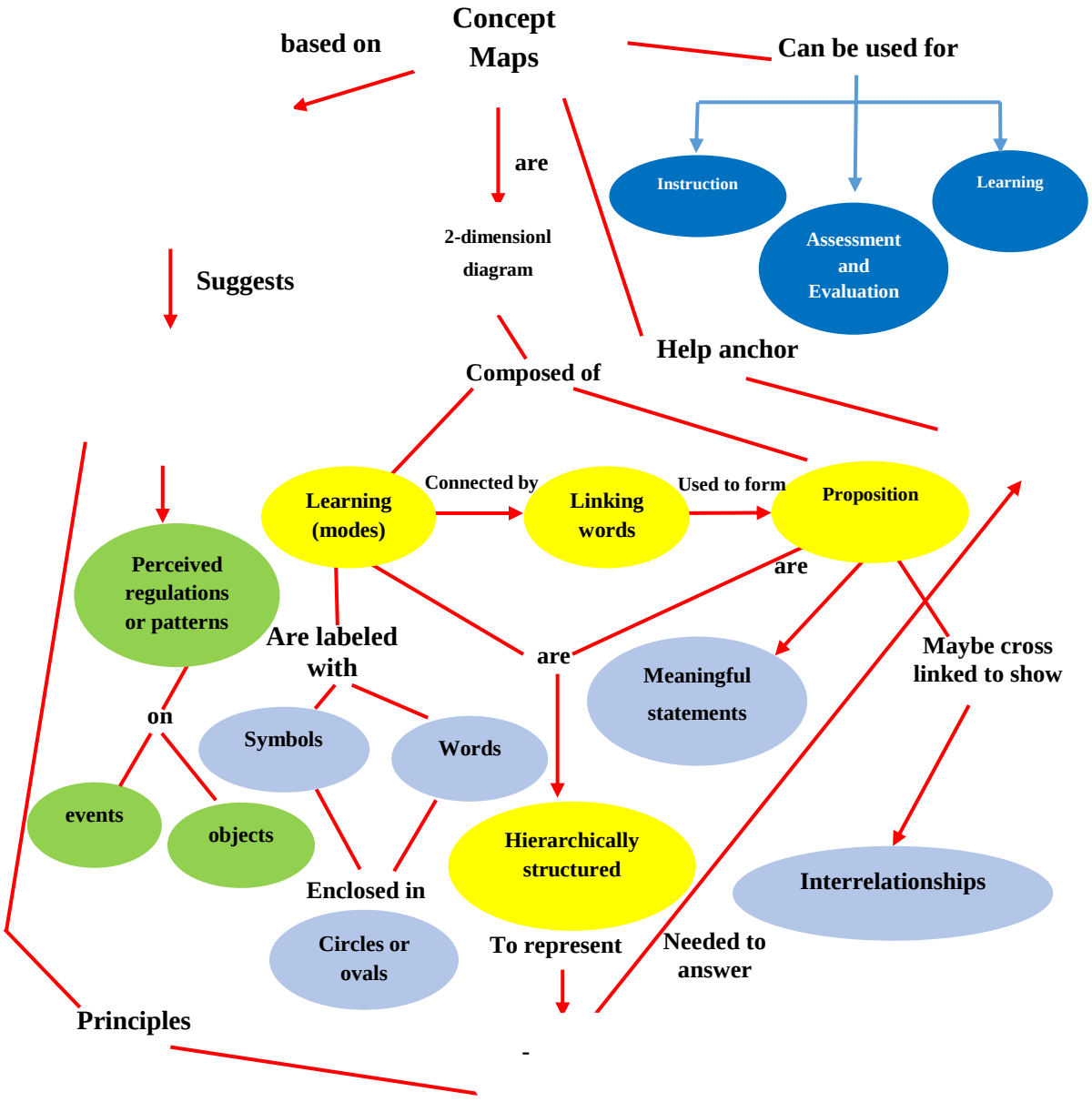

FIG 2. A concept map describing relationship between the concepts taught.

Source: Adapted from Adloan (2012).

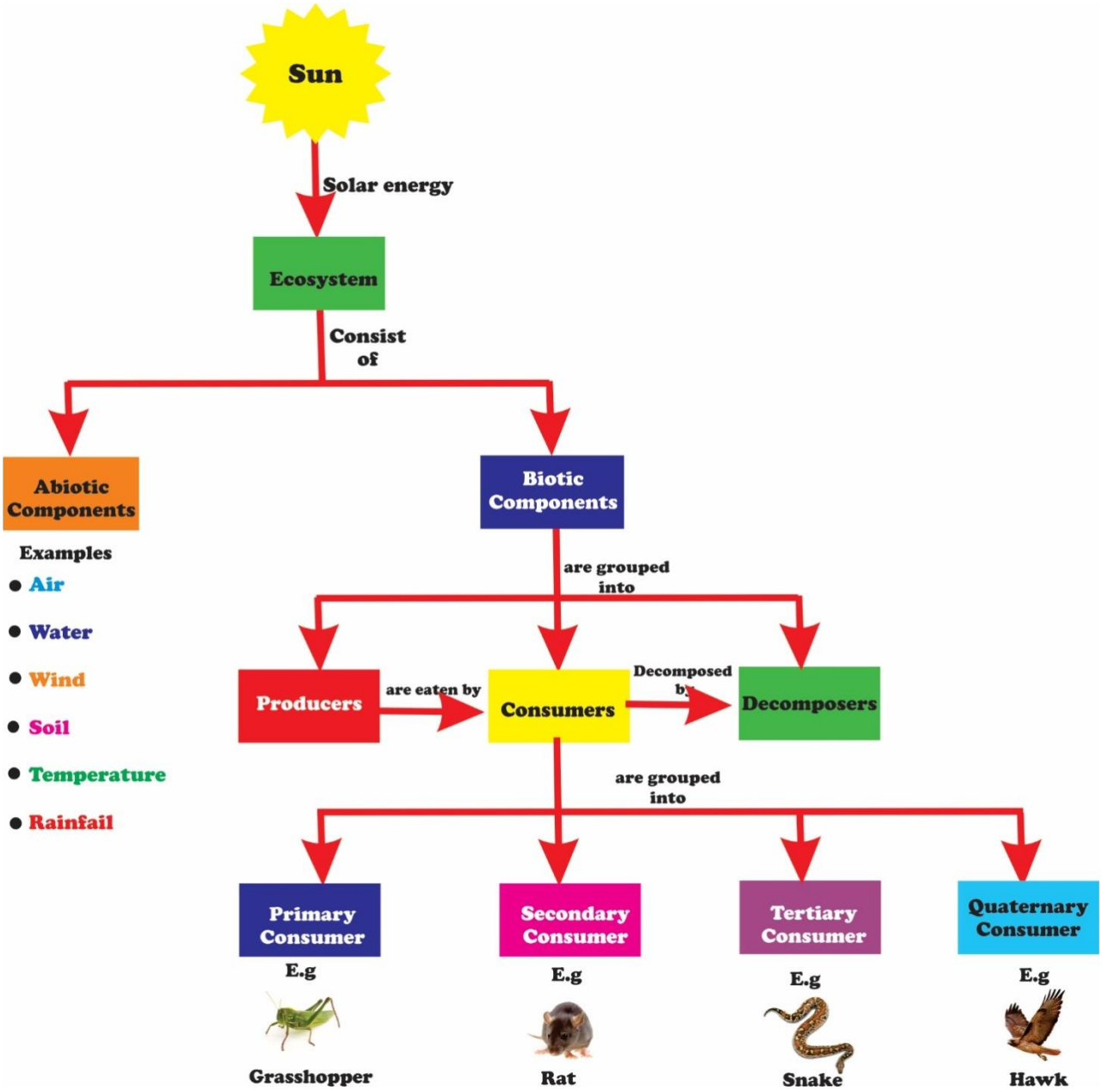

FIG 3. Concept map showing energy flows from the sun to primary producers and then transferred to consumers in an ecosystem

Source: Adapted from Adloan (2012)

Cooperative learning strategies, concept mapping and conventional method and students' academic achievement in Biology

Cooperative, and concept mapping learning strategies have been widely recognized as an effective approach to enhance students' academic achievement in Biology. By working together in small groups, students engage in collective problem-solving, critical thinking, and communication, leading to a deeper understanding of complex biological concepts. Research has consistently shown

that cooperative learning strategies outperform traditional conventional methods in promoting students' academic achievement.

A recent study by Bizimana, Mutangana and Mwesigye (2022) found that students who employed cooperative learning strategies and concept mapping techniques demonstrated significantly higher academic achievement in Biology compared to those who used conventional methods. The study highlighted the importance of visualizing relationships between concepts through concept mapping, which facilitated students' understanding of complex biological processes.

Similarly, a study by Brown et al. (2021) discovered that cooperative learning strategies combined with concept mapping significantly improved students' critical thinking skills, scientific literacy, and academic achievement in Biology. The researchers emphasized the need for educators to adopt innovative teaching approaches that foster collaborative learning and conceptual understanding

Cooperative learning strategies, concept mapping and conventional method and students' retention of concepts in Biology

The quest for effective teaching methods to enhance students' retention of concepts in Biology has led to the exploration of cooperative learning strategies and concept mapping as viable alternatives to conventional methods. Research has shown that these innovative approaches can significantly improve students' ability to recall and apply complex biological concepts.

A study by Kyado, Abah and Samba (2020) found that students who employed cooperative learning strategies and concept mapping techniques demonstrated a higher retention rate of biological concepts compared to those who used conventional methods. The researchers attributed this to the interactive and visual nature of cooperative learning and concept mapping, which facilitated students' understanding and organization of complex information.

Similarly, a study by Hadiprayitno, Muhlis and Kusmiyati (2019) discovered that cooperative learning strategies combined with concept mapping significantly improved students' retention of biological concepts, particularly in areas such as cellular respiration and genetics. The

researchers emphasized the importance of using concept maps to visualize relationships between concepts, which helped students to better retain and recall complex information

Hypotheses

1. There is no significant main effect of treatment (cooperative learning strategies, concept mapping and conventional method) on students' academic achievement in Biology.
2. There is no significant main effect of treatment (cooperative learning strategies, concept mapping and conventional method) on students' retention of concepts in Biology.

Research designs and methods

The area of study is Calabar Education Zone of Cross River State which is made up of seven local government areas with three thousand and eighty-four (3,084) senior secondary two (SSII) biology students of 2018/2019 session in eighty-four (84) public secondary schools. A quasi-experimental design was adopted for the study because the intact classes and the rigid school timetable would not allow for randomization of subjects. Multistage sampling technique involving simple random, stratified and purposive sampling techniques was used to select the subjects for the study. The sample for the study was made up of 264 Senior Secondary School Two (SSS II) biology students from six intact classes selected from six co-educational public secondary schools from one Local Government Area (Calabar Municipality) of Calabar Education Zone in Cross River State.

In each of the schools used for study, permission was sought from the school authority to carry out the study. Three groups comprising of two experimental groups and one control group were used for the study. Simple random sampling technique was used to assign schools to treatment groups. Two schools each were assigned to experimental group 1 and experimental group 2 and another two schools were assigned to control group.

Before commencement of the teaching, a pre-test was administered to both the experimental and control groups to determine the entry behaviour as well as the skills possessed by the students with respect to the dependent variable. This procedure lasted for three (3) days. Experimental group one was taught Biology using cooperative learning strategy. Experimental group two was taught

using concept mapping strategy. The instructors used concept maps of ecological successions, balance in nature, food shortage, and overcrowding which served as instructional aids. The students in this group were also taught how to construct concept maps. The control group was taught using conventional method.

The instruments used for the study include Biology Achievement Test (BAT) and Biology Retention Test (BRT). The BAT was used for both pre-test and post-test. The instruments consisted of a forty (40) items with four - options multiple choice objective test items selected from ecology of population covering succession, overcrowding, food shortage and balance in nature. Each item has one correct option and three distractors. Respondents chose the correct answer from the four options (A – D) provided. It assessed the various levels of the cognitive domain of Bloom's taxonomy. The biology retention test (BRT) contained the same items, but serially rearranged.

Results and discussion

The data collected was analysed with IBM Statistical Packages for the Social Sciences (SPSS) version 20. The results of data analyses are presented and interpreted below, one hypothesis after another. The hypotheses were tested at .05 significance level.

Hypothesis one

There is no significant main effect of cooperative teaching on students' academic achievement in Biology. The hypothesis was tested using analysis of covariance (ANCOVA). The results are presented in Table 1.

As shown in Table 1, the calculated F value for treatment, 22.227, is statistically significant ($p = .000$) at .05 significance level and (2, 251) degrees of freedom. That means there is a significant effect of treatment on students' academic achievement in Biology when the post-test scores are adjusted with the pre-test scores. Therefore, the null hypothesis is rejected. The magnitude of the mean academic achievement scores of the research subjects in different treatment groups are shown in the Multiple Classification Analysis (MCA) in Table 2.

Table 1: Summary of 3 – way ANCOVA of effect of treatment on students' academic achievement in Biology.

Source	SS	Df	Mean Square	F	Sig.
Model	129908.852	13	9992.989	769.128	0.000
Pretest	1460.788	1	1460.788	112.432*	0.000
Treatment	577.568	2	288.784	22.227*	0.000
Error	3261.148	251	12.993		
Total	133179	264			

*p.05

Table 2: Multiple Classification Analysis (MCA) of the academic achievement scores of students according to treatment

Grand Mean = 21.803

Treatment Groups	N	Unadjusted Variation	Eta	Adjusted for Independent + Covariates deviation	Beta
Concept Mapping Strategy	104	2.687	.389	1.807	
Cooperative Learning Strategy	74	1.021		.207	
Conventional method	86	- 3.356		- 2.368	
					.212
Multiple R squared					.976
Multiple R					.988

As shown in Table 2, the mean scores of the different treatment groups are: Concept mapping strategy (24.490), Cooperative learning strategy (22.824) and Conventional method (17.674). This shows that Concept mapping strategy has the highest mean score (21.803 +2.687), followed by the cooperative learning strategy (21.803 + 1.021) and then, the Conventional method (21.803 – 3.356). The teaching methods have an index relationship of .151 ($.389^2$), hence the observed relationship in favour of teaching methods indicate that the teaching methods have a significant relationship of .151 with the academic achievement of students in Biology. Table 2 also show the multiple regression coefficient R of .988 and a squared value (R^2) of .976. This implies that 97.6 per cent of the variance in the academic achievement of students can be explained by the three teaching methods.

In order to determine the point(s) of difference of the three treatment groups, a post hoc multiple comparison analysis was done using the Bonferroni technique. The results are shown in table 3.

Table 3: Multiple comparison analysis of differences in the mean academic achievement scores of students in the three treatment groups using Bonferroni technique

Treatment Groups	1	2	3
1. Cooperative Learning Strategy	22.010[a]	1.600[b]*	2.575*
2. Concept Mapping Strategy	.019[c]	23.610[a]	4.175*
3. Conventional method	.000	.000	19.435[a]

Note: a = Adjusted mean scores are along the principal diagonal
b = Difference between adjusted mean scores are above the principal diagonal
c = Significance levels of the difference between adjusted mean scores are below the principal diagonal
*p < .05

The results on table 3 indicates that students taught with concept mapping strategy have the highest adjusted mean academic achievement score (ẍ = 23.610), followed by those taught with cooperative learning strategy (ẍ = 22.010) and then those taught with conventional method (ẍ = 19.435). The difference between the mean scores pairs of the treatment groups are all respectively significantly different at .05 significance level.

Hypothesis two

There is no significant main effect of concept mapping strategies on students' retention of concepts in Biology. The hypothesis was tested with ANCOVA. The results are shown in Table 4.

As shown in Table 4, the calculated F value for treatment is 55.613 and the associated significance level which is p < .000 is less than the significance level of .05 at (2, 251) degrees of freedom. That means the calculated F value is statistically significant. It further implies that there is a significant effect of treatment on students' retention of concepts in Biology. In other words, the mean retention score of the three treatment groups significantly differ. Therefore, the null hypothesis is rejected.

Table 4: Summary of three-way ANCOVA of the effect of treatment on students' retention of concepts in Biology

Source of Variation	SS	Df	Mean Square	F-value	Sig.
Model	135133.072	13	10394.852	629.622	.000
Pre-test	1368.845	1	1368.845	82.912*	.000
Treatment	1836.316	2	918.158	55.613*	.000
Error	4143.928	251	16.510		
Total	139277.000	264			

*P.05

The magnitude of the mean retention scores of the research subjects in different treatment groups are shown in the Multiple Classification Analysis (MCA) in Table 5.

As shown in table 5, the mean scores of the different treatment groups are: Concept mapping strategy (25.962), Cooperative learning strategy (23.554) and Conventional method (15.954). This shows that Concept mapping strategy has the highest mean score (22.027 + 3.935), followed by the Cooperative Learning Strategy (22.027 + 1.527) and the Conventional method (22.027 – 6.073). The teaching methods have an index of relationship of .307 ($.554^2$), hence the observed relationship in favour of teaching methods indicate that the teaching methods have a significant relationship of .307 with the retention by students of concepts in Biology.

In order to ascertain the points of difference of the treatment groups, a post hoc multiple comparison of the groups was done using Bonferroni technique. The results are shown in Table 5.

The results in the table indicate that students taught with concept mapping strategy have the highest adjusted mean retention score (ẍ = 24.989), followed by those taught with cooperative

learning strategy (ẍ = 22.688) and then those taught with conventional method (ẍ = 17.575). The difference between the mean scores pairs of the treatment groups are all respectively significantly different at .05 significance level.

TABLE 5: Multiple Classification Analysis (MCA) of the academic achievement scores of students according to treatment

Grand Mean = 22.027

Treatment Groups	N	Unadjusted Variation	Eta	Adjusted for Independents + Covariates deviation	Beta
Concept Mapping Strategy	104	3.935		2.962	
Cooperative Learning Strategy	74	1.527		.661	
Conventional method	86	- 6.073		- 4.452	
			.554		.316
Multiple R squared					.970
Multiple R					.988

Discussion of findings

The results in hypotheses one show that cooperative learning yielded a greater significant effect on students' academic achievement in Biology as compared to the conventional teaching method. The results also indicate that concept mapping yielded a significantly greater effect on students' academic achievement in Biology, than cooperative learning and conventional teaching method. This result was so because learners were given opportunity to handle, draw and practice alongside with the teacher, they are motivated and show more interest in the lesson. With such hands-on activity that exist, students achieve and retain more under that friendly and conducive atmosphere. In other word the concept mapping and cooperative learning teaching strategies employed encourages students' active participation in the teaching learning process as against the conventional teaching method which is dominated with teacher activities during the teaching learning process.

The result corroborates Bizimana, Mutangana and Mwesigye (2022) who found that students who employed cooperative learning strategies and concept mapping techniques demonstrated significantly higher academic achievement in Biology compared to those who used

conventional methods. The study highlighted the importance of visualizing relationships between concepts through concept mapping, which facilitated students' understanding of complex biological processes.

The result equally aligns with the study by Brown et al. (2021) that discovered that cooperative learning strategies combined with concept mapping significantly improved students' critical thinking skills, scientific literacy, and academic achievement in Biology. The researchers emphasized the need for educators to adopt innovative teaching approaches that foster collaborative learning and conceptual understanding

The results of hypotheses two equally indicated that cooperative learning and concept mapping yielded a significantly greater effect on students' retention of concepts in Biology, than cooperative learning and conventional teaching method. This conclusion is in line with the study of Kyado, Abah and Samba (2020) that found that students who employed cooperative learning strategies and concept mapping techniques demonstrated a higher retention rate of biological concepts compared to those who used conventional methods. The researchers attributed this to the interactive and visual nature of cooperative learning and concept mapping, which facilitated students' understanding and organization of complex information.

The result is equally in line with the study conducted by Hadiprayitno, Muhlis and Kusmiyati (2019) that discovered that cooperative learning strategies combined with concept mapping significantly improved students' retention of biological concepts, particularly in areas such as cellular respiration and genetics. The researchers emphasized the importance of using concept maps to visualize relationships between concepts, which helped students to better retain and recall complex information

Conclusion

Based on the findings from the study, it is evident that application of cooperative and concept mapping strategies is critical for purpose of improving students' academic achievement and their knowledge retention. Cooperative learning and concept mapping strategies positively

influenced students' cognitive achievement and retention of both male and female students. The two experimental strategies have been demonstrated to be gender friendly. The conventional method was found to be less effective in teaching Biology for the purpose of achievement and retention.

Recommendations

In view of the findings of this study, the following recommendations are hereby proposed:

1. Cooperative learning and concept mapping strategies should be adopted as the pre-dominant instructional for teaching Biology in schools.
2. Professional Associations like Science Teachers Association of Nigeria (STAN) should popularize the use of cooperative and concept mapping in teaching difficult Biology concepts through seminars and workshop.

References

Acut, D. P. & Latonio, R. A. C. (2021). Utilization of stellarium-based activity: its effectiveness to the academic performance of Grade11 STEM strand students," *Journal of Physics: Conference Series*, 1835 (1): 1–7

Adeyemo, D. A., & Onanuga, A. T. (2020). Effect of Concept Mapping Instructional Strategy on Senior Secondary School Students' Academic Achievement in Biology in Ilorin, Nigeria. *European Journal of Educational Studies*, 7(12): 65-75

Adlaon, R. (2012) Assessing effectiveness of concept map as instructional tool in high school Biology. Unpublished Master's Degree Theses in Natural Science, Louisiana State University (LSU).

Bizimana, E., Mutangana, D. & Mwesigye, A. (2022). Effects of Concept Mapping and Cooperative Mastery Learning Strategies on Students 'Achievement in Photosynthesis and Attitudes towards Instructional Strategies, International Journal of Learning, *Teaching and Educational Research* 21(2):107-132

Brown, P. J., Smith, L. K., & Johnson, S. C. (2021). Teaching biology to first-year university students: An investigation of student difficulties and misconceptions. *Journal of Biological Education*, 55(2), 147-158.

Ekon, E. E. & Nsimeneabasi, M. U. (2021). Effect of constructivist model of instruction on students perception of their psychological learning environment, *Prestige Journal of Counselling Psychology*, 4(1)

Elpisah, A., Devila, R., & Hartini , A. (2020). Implementation of cooperative learning model jigsaw to improve student learning outcome. IOSR *Journal of Research and Method in Education*. 9(1), 60-66

Etobro, A. B., & Fabinu, O. E. (2017). Student's perception of difficult concepts in biology in senior secondary schools in Lagos State. *Global Journal of Educational Research,16,* 139-147.

Eze, T.I & Lasisi, B.T. (2018). Effects of cooperative learning method on academic achievement and retention of students in basic technology in Oyo State. *NAU Journal of Technology & Vocational Education, 3(1),* 157-171.

Hadiprayitno, G., Muhlis, & Kusmiyati. (2019). Problems in learning biology for senior high schools in Lombok Island. Journal of Physics: *Conference Series*, 1241(1).

Igwebuike, O, Okri, J. A. & Obi, J. J (2022). Environmental variables and academic performance of junior secondary school students in basic science in Calabar South local government area of Cross River State, Nigeria, *Global Journal of Educational research* 21: 55-61

Kyado, J. J., O. Abah, C., & Samba, R. M. A. (2020). Effect of collaborative concept mapping instructional strategy on secondary students' achievement in difficult biology concepts. *American Journal of Social Sciences and Humanities*, 4(3), 434–447.

NECO (2015-2017). *National examination council biology chief examiner quarterly publication for November/December 2018.* Abuja: NECO.

Obikezie, M., Eke, J. & Abumchukwu, A. A. (2023). *Comparative effects of teaching with improvised instructional materials and standard instructional materials on secondary school students' academic retention in chemistry,* Department of Science Education Nnamdi Azikiwe University Awka , retrieved from https://www.researchgate.net/publication

Olutola, A. T. (2020). nfluence of School Type on Students' Test Anxiety andPerformance in Biology at Senior Secondary School Level in Katsina, Nigeria, *Journal of Multidisciplinary Studies*, 9(2): 1-17

Oluwatosin, C. O., Ekpa, E. A., Micheal, N. E., Amina, S. B. Bashir, B. M. & Fakolade, B. A. (2022). Concept mapping as a pedagogic tool in teaching undergraduate biology in Nigeria, *Comprehensive Research and Reviews in Science and Technology*, 1(1): 1–10

Özkan, N. (2021). Misconceptions in Biology Teaching and Their Reasons, *Journal of Education and Training Studies* 9 (4): 1-9

Preszler, R. W. (2020). Cooperative concept mapping improves performance in biology. S*Journal of College Science Teaching*, 33, 30-35.

Slavin, R.E. (2011). Instruction based on cooperative learning. In R. E. Mayer & P. A. Alexander (Eds.). *Handbook of Research on Learning and Instruction.* New York: Taylor: Francis