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Effect of Concept Mapping Teaching Strategy on Biology Students 'Academic Performance and Retention in Secondary Schools in Rivers State

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ABSTRACT

The study examined the effect of concept mapping on Biology students' academic performance and retention in secondary schools in Rivers State. To achieve the purpose of the study, the researcher formulated four objectives of the study, four research questions and four null hypotheses that guided the study. The research design used was quasi-experimental design. The population of this study comprises of total number of 11,113 Senior Secondary school students in Etche Ethnic Nationality of Rivers State. A sample size of 241 SS1 students were used for the study. The researcher applied simple random sampling techniques in determining the sample size. The instrument used for this study was Biology Performance Test (BPT) and Biology retention test (BRT). The instruments used were validated by the researcher's supervisors and one expert in field of measurement and evaluation Rivers State University port Harcourt. The reliability of the Biology performance test and Biology retention test were determined using kuder-Richardson formula -20(KR-20). The data gathered were analyzed using statistical tools of mean and standard deviation to answer the research questions while analysis of covariance (ANCOVA) was used to test the null hypotheses at 0.05 level of significance. Based on the data analysis, the findings of the study revealed that concept mapping strategy has positive and significant effect on students' academic performance when taught biology than the lecture method and that male students relatively obtained higher mean scores in retention than the female students when taught with concept mapping strategy. Based on findings, the researcher recommends that-: teachers should adopt concept mapping teaching strategy in teaching of Biology and that senior secondary schools management should organize awareness and enlightenment campaign for teachers to know importance of concept mapping strategy.

Keywords: Concept, Mapping, Biology Students, Academic Performance,

INTRODUCTION

Education has been described as a vital and indispensable key to any form of development (Offih & Achufusi, 2020). It is an instrument for economic, political and scientific development of all nations. Dabah (2016) defined Science Education as the study of the connection between science as a discipline and the application of educational principles to comprehend science teaching and learning in the classroom. Therefore, science education acquaints students with certain basic knowledge, skills and attitudes needed for future work in science and science-related fields. According to Onwu (2020) science teachers are expected to make the science subjects more relevant, enjoyable, easy and meaningful to students. Teaching methods need to be improved and appropriate teaching strategies employed as the teaching- learning situation may demand. This could be the reason why the Federal Government of

Nigeria emphasized on the teaching of science in its National Policy on Education (FGN, 2008). Teaching methods such as Concept mapping, inquiry, peer-tutoring, project, lecture-concept mapping, lecture performance, problem-solving, field trips, cooperative or group learning, excursion, remedial, laboratory and guided discussion and the use of audio-visual materials have been recommended for the teaching of science.

Despite the effort of science educators towards finding a suitable instructional strategy for effective teaching in secondary schools, there still exist some reports of poor academic performance in public examinations results such as NECO and WAEC in Biology. The poor performance were attributed to the use of inappropriate method of teaching; poor spelling of technical terms; shallow knowledge of the subject matter; and inability to differentiate between phenotypic and genotypic ratio in genetics among others. Also Omole (2021) was of the opinion that 75 per cent failure in mathematics and sciences is worrisome. There is the need to identify teaching methods that students can relate with, share ideas and interact academically within themselves. The present study is designed to look at the effects of concept map on biology students' academic performance and retention in secondary schools.

Biology is regarded as one of the important science subjects studied in Nigerian senior secondary schools. Federal Republic of Nigeria (FRN 2008) confirms the importance of biology in Nigerian educational system by enlisting it as one of the core science subjects in curriculum external examinations. Therefore, biology is an essential and somehow compulsory science subject studied in the Senior Secondary Schools in Nigeria. To science inclined students, biology is a core subject, but to arts inclined, it is a choice to fulfil all righteousness. Omole (2013) posited that biology occupies a unique position in the school curriculum as it is central to many sciences related professional courses in higher institutions such as Microbiology, Medicine, Pharmacy, Nursing, Dentistry and other related courses. It, therefore, becomes imperative that anyone who wishes to undergo the above mentioned courses in higher institution is expected to offer biology as a pre-requisite subject to enable him/her gain admission into higher institution. However, the students low performance in biology in the external examinations has been a source of worry to teachers, parents and other stakeholders.

Research has shown that many students experience poor academic performance in Biology and this is essentially due to the teaching methods or strategy adopted by biology teachers (Eriba, 2013). One of the main problems students face during their studies is organizing and retaining information. Students' performance and enthusiasm in science are falling, according to Nzewi (2017) Science knowledge among secondary school and college students is frequently lacking in coherence, and the majority of pupils learn primarily by rote. According to Chaudhury (2021), the problem is two-fold viz; the abstract and high conceptual nature of science seem to be particularly difficult for students; and teaching methods and techniques do not seem to make the learning process sufficiently easy for students. Eribas and Demirer (2022) also attributed poor academic achievement to the abstract and complex nature of certain biology concepts apart from the teaching method adopted by instructors. The current teaching methods do not actively engage students in the learning process, and they appear to deprive them of control over their education.

Conceptual Review

Concept of Biology

Biology, as defined by Ogunleye (2022), is the study of life. It is a mandatory subject offered in all senior secondary schools in Nigeria, catering to both science and arts-oriented students. Odogwu (2018) emphasized the significance of teaching biology as it enables students to understand the world around them and equips them with essential skills to contribute to the advancement of society. Furthermore, Odogwu (2018) noted that biology serves as a foundation for teaching students how to apply scientific concepts and principles to address everyday challenges.

Biology remains one of the basic sciences whose teaching and learning is universally known to be efficient and successful, if only undertaken simultaneously with the help of adequate instructional resources and facilities. Biology plays a vital role in the field of biochemistry, medicine, physiology, ecology, genetics, and molecular biology and as such, biology has been made a central focus in most

human activities including being a solution to the problem of food scarcity, health, hygiene, family life, poverty eradication, management and conservation of natural resources, biotechnology, ethics, various social vices and as well lack of appropriate infrastructural materials.

Biology is one of the science subjects that senior secondary students offer in senior secondary certificate examinations in Nigeria (FRN, 2004). Interestingly, it is a popular subject among students and its popular nature among other science subjects has made it distinct choice for all students. Biology is a very important science subject and a requirement for further studies of other science related professional courses such as medicine, agriculture, pharmacy, biotechnology, genetic engineering, etc. Biology is the key to economic, intellectual, sociological, human resource development and well being of any society.

Academic performance in Biology and its Impediments

Academic performance refers to a successful accomplishment or Performance in particular subject area. It is indicated by grades, marks and scores of descriptive commentaries. Academic performance also refers to how Students deal with their studies and how they cope with or accomplish different tasks given to them by their teachers in a fixed time or academic year. Fajola (2018), used the notion of academic self-concept in referring to Individuals' knowledge and perceptions about themselves in academic performance, and convictions that they can successfully perform a given academic tasks at designated levels. Fajola (2018) further stated that academic self-concept represents a more past-oriented, aggregated and relatively stable judgment about one's self-perceived ability in a particular academic domain while academic self-efficacy represents a context specific and relatively future oriented judgment about one's confidence for successfully performing an upcoming subject-specific academic task.

Rothstein (2020) argues that; learning is not only a product of formal schooling but also of communities, families and peers. Socio-economic and socio cultural forces can affect learning and thus school achievement. A great deal of research on the determinants of school achievement has centered on the relative effects of home-related and school-related factors. Others argued that in various studies they indicated both home and school environments have a strong influence on performance of students. Musek (2021) stated that: …there are two broad groups of definitions of academic achievement. The first one could be considered more objective, because it refers to numerical scores of a pupils knowledge, which measure the degree of a pupils adaptation to schoolwork and to the educational system. The second group is a more subjective one, as its determination of academic success in reliant upon the students attitudes towards his academic achievement and himself, as well as by the attitudes of significant others towards his/her success and him/herself. This study focuses on the effect concept mapping strategy on students academic achievement in Biology.

Meaning of Concept mapping

Ossai (2014) sees concept mapping as a graphical arrangement of key concept to show meaningful relationship among the selected concept or ideas been studied. Ajaja (2017) takes concept mapping as a learning strategy which helps students in understanding complex ideas and clarifies ambiguous relationships. Also, concept mapping may be seen as a teaching -learning strategy in which ideas that contains two or more concept are connected with other words to form a meaningful statements represented diagrammatically. It could be seen as a technique for representing the structure of information visually. Concept maps are tools for organizing and representing knowledge, they include concept which are generally enclosed in circles or boxes of some types and relationship between concept and preposition between two concepts. (Propositions are statement about some object or statement in the universe either naturally occurring or constructed.) They contain two or more concepts connected with other words to form a meaningful statement. A concept map is also a graphical representation where links (point or vertices) represent concepts and cross links (arcs or lines) represents the relationships between concepts.

To Novak, concept map is a tool that promotes meaningful learning as opposed to rote learning. A concept map is a two dimensional representation of the relationship between key ideas. It shows us how we think and suggest affinities and association that might not otherwise be obvious. At a first glance, a concept map looks like a flow chat in which the key words are placed in boxes connected by directional arrows. Concept maps are excellent tools which provide instructors with diagnostic pre-assessment prior to beginning a unit and formative assessment during learning activities. Based on educational psychology

theories of how we organize information, concept maps are hierarchical with broader more general items at the top and more specific topics arranged in a cascade below them. They are meta cognitive tools that empower the learner to take charge of his/her own learning in a highly and meaningful manner. According to Novak (2016), "meaningful learning involves the assimilation of new concept and proposition into cognitive structure. The most important factor influencing learning is what the learner has already known.

Concept maps are highly personalized and provide an opportunity to organize course material in a way that makes most sense to *you*. The main point is to end up with a diagram of all of the important ideas from your class, with terms you add that describe how the ideas are connected to each other. (Some students find that adding these linking terms is one of the most challenging part of making a concept map-actively deciding how the ideas are related is key to the effectiveness of concept maps, so don't skip the linking terms). Concept maps can be helpful learning tools in just about any class: STEM, humanities, social sciences, languages, even the arts. Similar to an outline or a flowchart, a concept map is a way of representing or organizing knowledge. However, a concept map goes beyond the typical outline in that concept maps show relationships between concepts, including bi-directional relationships. Usually, a concept map is divided into nodes and links. Nodes (often circles) represent various concepts; and links (lines) represent the relationships (propositions) between concepts. Words are used to label the links in order to explicitly depict relationships.

Concept maps were first used by Joseph D. Novak of Cornell University in the 1960s (Lanzing, 2017). Concept maps have their origin in the learning movement called constructivism. Concept maps identify the way we think, the way we see relationships between knowledge. The teacher who constructs concept maps for classes is interested in students understanding relationships between facts, not just "knowing" the facts

Types of Concept Maps

According to Dorttepe and Arikan (2019) there are different types of concept map:

(i) Hierarchical, (ii) Cyclical, (iii) Chain and (iv), Spider map or network.

1. **Hierarchy Concept Map**: Hierarchy concept map represent information in a descending order of importance. The most important information is placed on the top. According to Novak and Gowin (2014), the hierarchical structure arises as a result of new information that is often related to and subsumable under more general or more inclusive concept. However, the hierarchy expands according to the principle of progressive differentiation. New concept and new links are added to the hierarchy either by creating new branches or by differentiating existing ones even further. Meaning increase for students as they recognize new links between set of concept or proposition at the same level in the hierarchy.
2. **Spider Concept Map**: In spider concept map, the central team or unifying factor is placed on the center of the map. Outwardly, radiating sub teams surrounds the centre of the map.
3. **Flow Chat Concept Map**: In this concept map information are organized in a linear form.
4. **System Concept Map:** In this type of map, information is organized in a similar way like that of a flow chart with the addition of 'INPUT and OUTPUT.

Features of a Concept Map

Concept map provides a variety of features that make it possible for teachers to use concept maps for a variety of the tasks that students perform.

There are two features of concept map that are important in the facilitation of creative thinking and they are:

1. The hierarchical structure that is represented in a good map and the ability to search for and characterize cross links. In a concept map, the concept will be represented in a hierarchical fashion with the most inclusive, most general concept at the top of the map and the more specific less general concept arranged hierarchically below. The hierarchical structure of a particular domain is been applied or considered. It is best to construct concept map with reference to some

particular question will seek to answer or situation or event that we are trying to understands through the organization of knowledge in form of a concept map.

2. The second importance of concept map is the inclusion of cross links. These are relationships between concepts in different domains of the concept map. The cross links in the concept map shows how some domains of knowledge represented in the map are related to each other. Cross links often represent creative leaps on the part of the knowledge procedures in the creation of new knowledge. Final features that will be added to concept maps are specific examples or actual images of event or object that helps clarify the meaning of a given concept.

Characteristics of Concept Mapping

The following are the characteristics of concept mapping:

1. **Underlying Theory**: It is grounded on Ausubels assimilation theory which shows that new knowledge can be learned effectively by relating it to previously existing knowledge. Concept map may be viewed as a methodological tool of assimilation theory that displays fundamental element of the theory such as subsumption, integrative reconciliation and progressive differentiation.
2. **Semi-Hierarchical Organization**: The basic motivation for the hierarchical arrangement **of** concept in concept map is from Ausubels notion of subsumption, that more general, super ordinate concept subsume more specific detailed concept. This theoretical notion translates to an arrangement of concept from those that are more general towards the top of the page, with those that are more specific or detailed distributed beneath. In practice, the concept in concept map are not arrange in a semi-hierarchical manner. Concept map allow for the representation of un-hierarchical relationship or cross links as well as other types of nonhierarchical arrangement.
3. **Links**: This is another defining factor of concept map. Novak and Gowin (2014) stated that a link phrase should join concept to form meaningful proposition which is a basic unit of knowledge according to the theory of meaningful learning and Ausubels assimilation theory. Researchers using other types of graphing method have prescribed a limited number of linking phrases that can be used universally.
4. **Label**: A label for most concepts is a word. It could be a symbol such as + or %. Concept mapping theory does not constrain the label that can be used. This allows map makers more freedom and precision in describing the relationship among concepts.
5. **Definition of Nodes:** One of the defining characteristics of concept map is the limiting node content to concepts which allows for a more explicit representation of the interrelationships among concepts.

Uses of Concept Map and its Application in Educational Settings

According to Ausubel, Novak and Hanessian, the following are the uses of concept maps; 1.

Concept map as Advance Organizer:

They are regarded as global overview of what is to be learnt. Ausubel, Novak and Hanessian (2018) advocated the use of Advance organizers to foster meaningful learning. He suggested that the advance organizers foster meaningful learning by;

a. Promoting the learner pre-existing super ordinate concepts that are already in the students cognitive structure.
b. Providing a context of the most general concepts into which students can in corporate progressively differentiated details.

1. Advance organizers are most effective if they make explicit the relationship among learned concepts that are already known, thus providing structure into which the new concept can be integrated. Advance organizer concept map can be constructed by the teacher or other experts. The constructed concept map advance organizers can be used in various ways as part of the classroom experience. They can be presented at the beginning of a text book chapter or other instructional unit or used as a guide for a lecture that is presented in the class. They can also be

used to present an overview multimedia with links to instructional materials associated with different topics.

2. **As a tool for supporting learning:**
The concept map created by students can be used in several ways to facilitate meaningful learning. It was pointed out by Novak and Gowin (2014) that concept map is some kind of schematic summary of what students know. It (concept map) can be used to display students prior knowledge about a given topic or they can be used to summaries what has been learned by students after reading or completing class work. In this regard, it is often used for note taking or as a study aid. The art of map creation is a creative activity in which the learner must exert effort to clarify meanings by identifying important concepts, relationships and structure within a specified domain of knowledge and understanding, providing a kind of feedback that helps students monitor their learning and perhaps with the assistance of teachers or peers to focus attention on learning needs. As a creative activity, concept mapping can also be used as a planning alternative to easy writing. Most reviewed literature shows that the prevalent use of concept mapping is for teaching and learning.

3. Identification of Current Understanding, Misconception and Conceptual change:
The conceptual transformation technique is one of the well-known strategies and guidelines used to refute myths about scientific issues. The prior understanding of an idea substantially influences students capacity to understand it. As a result, when organizing classroom activities and instructional strategies, it is critical to grasp and comprehend the students conceptual frameworks (Gafoor and Akhilesh, 2020). Teachers should consider their students past knowledge in addition to how they present the topic. Thomas Khuns ground-breaking notion of a paradigm shift in the history and philosophy of science in 1962 is credited with giving rise to conceptual change. As the basis for creating precise and solid scientific understandings, it involves a learning process that calls for the alteration of preexisting ideas. Understanding concepts involves many different interpretations. Rather than depending solely on rote memorization, it refers to students ability to produce and integrate meaningful and practical interconnected ideas and facts (Mills, 2016).

4. **Concept Map as an Assessment Tool:** It can be used as formative or summative assessment procedures. In the formative assessment, learners may be asked to make a concept map at various points in the learning process to show their understanding and the teachers can use these maps both to assess the learners understanding and to modify the curriculum. In summative assessments, it can be used at the end of an instructional unit to determine a learners understanding of that unit and to assign grade.

Statement of the Problem

It is worth mentioning that the academic performance of students in the West African Senior School Certificate (WASSC in 2017) and other O'level biology external examinations has consistently been subpar. Some authorities attribute this issue to ineffective teaching methods and various other underlying problems. This raises questions regarding the appropriateness of instructional approaches in teaching and learning biology in order to instill the necessary knowledge, skills, attitudes, and retention in students, which are essential for achieving success in the subject. Previous research endeavors have been undertaken to identify suitable teaching methods that can optimize achievement in science subjects, albeit with limited success.

Biology, being a comprehensive scientific discipline within the Nigerian Educational Curriculum, holds significant importance for students of all academic inclinations, whether in the realm of sciences or arts. It is crucial to establish effective teaching and learning processes to enhance students' academic performance, particularly in external examinations, thereby facilitating their seamless transition into higher education institutions for further academic pursuits. In light of the persistent challenge at hand, the current study aims to explore the effect of concept mapping teaching strategy on biology students' academic performance and retention in secondary schools in Rivers State.

Purpose of the Study

The main objective of this study is to investigate the effect of concept mapping teaching strategy on biology students 'academic performance and retention in secondary schools in Rivers State.

Specifically, this study sought to:

1. Investigate the academic performance of students taught Habitat using concept mapping and those taught with Lecture method in Etche Ethnic Nationality of Rivers State
2. Examine the retention of students taught Habitat with concept mapping and those taught using Lecture method in Etche Ethnic Nationality of Rivers State
3. Examine the academic performance of male and female students taught Habitat using concept mapping in Etche Ethnic Nationality of Rivers State
4. Ascertain the retention of male and female students taught Habitat using concept mapping in secondary schools in Etche Ethnic Nationality of Rivers State?

Research Questions

The following research questions formulated by the researcher guided the study:

1. What is the academic performance of students taught Habitat using concept mapping and those taught with Lecture method in Etche Ethnic Nationality of Rivers State?
2. What is the difference in the retention of students taught Habitat using concept mapping strategy and those taught using Lecture method in Etche Ethnic Nationality of Rivers State?
3. What is the difference in academic performance of male and female students taught Habitat using concept mapping in secondary schools in Etche Ethnic Nationality of Rivers State?
4. What is the difference in the retention of male and female students taught Habitat using concept mapping in secondary schools in Etche Ethnic Nationality of Rivers State?

Hypotheses

The following Null Hypotheses were formulated by the researcher guided the study, and were tested at a 0.05 level of significance:

1. There is no significant difference between the academic performance of students taught Habitat with concept mapping teaching and those taught with Lecture method in Etche Ethnic Nationality of Rivers State
2. There is no significant difference between the retention of students taught Habitat using concept mapping teaching and those taught using Lecture method in Etche Ethnic Nationality of Rivers State
3. There is no significant difference between the academic performance of male and female students taught Habitat using concept mapping teaching strategy in Etche Ethnic Nationality of Rivers State.
4. There is no significant difference between the retention of male and female Students taught Habitat using concept mapping teaching strategy secondary school in Etche Ethnic Nationality of Rivers State.

METHODOLOGY

The study employed quasi-experimental design, there are two groups in this study; the first group is the experimental group (EG) which was exposed to Concept mapping method (X), while the second was the control group (CG) which was exposed to lecture method. All the two groups were pre-tested (O1) to ensure that selected participants were not different significantly in terms of Academic Performance. The treatment and teaching periods lasted for five (5) weeks. Immediately after the treatment, post-test (O2) was administered to the two groups to determine the effect of treatment on students' academic Performance and after one week Biology retention test was given to the students. The population of this study comprises a total number of 11,113 Senior Secondary school biology students in the 18 public senior secondary schools in Etche and Omuma local government area. The total number consist of 5317 male students 5,796 female students offering Biology in 18 public schools in Etche and Omuma local government area of Rivers State. (Source Planning Research and Statistics Rivers state senior secondary schools board (RSSSSD) 2023/2024 session). Simple random sampling technique through the use of

balloting with replacement was used to select four intact classes from two schools (non-equivalent intact classes) from the target population to obtain two hundred and fortyone (241) SS1 Biology students, (123) in the experimental group and (118) in the control group. The Co-educational schools were used to enable the researcher collect data from male and female students who had received the same biology instructions from the same teacher and at same time. The instrument used for data collection was Biology Performance Test (BPT) and Biology Retention Test (BRT). The BPT and BRT used were from a composed questions by the researcher from the topic (Habitat). BPT and BRT had 30 objective test items of multiple choice question with options A, B, C and D. BPT has two sections. Section A contains name of students, sex, class and year. Section B contains 30 objective test items on the concept, Habitat. The researcher constructed the Biology Performance Test (BPT) and Biology Retention Test (BRT) for the study and submitted to the project supervisors and one expert in the field of measurement and evaluation who use their intellectual knowledge to critically, analytically and logically examine the instruments relevance of the contents and statements and then made the instrument valid for the study. The reliability of Biology performance test (BPT) and Biology was determined using Kuder-Richardson formular-20 (KR-20). The choice of KR-20 was influenced by the fact that it is most suitable in determining the internal consistency scored. The internal consistency/Reliability index obtained for BPT and BRT were 0.76. and 0.82 respectively. This results have shown a high internal consistency for Biology Performance Test (BPT) and Biology Retention Test (BRT). Data collected from both the experimental and control groups in the pre-test and post-test were analyzed using the following statistical tools: the mean and standard deviation was used to answer research questions while Analysis of Covariance (ANCOVA) was used to test the hypotheses, because it is the most effective method used when comparing two groups.

RESULTS

Research question one: *What is the academic performance of students taught Habitat using concept mapping and those taught with Lecture method in Etche Ethnic Nationality of Rivers State?*

Table 1: Showing the mean difference in academic performance of students taught Habitat using concept mapping and those taught with Lecture method in Etche Ethnic Nationality of Rivers State

Teaching Method	N	Pretest		Posttest		Mean Difference	
		Mean	SD	Mean	SD	Mean	SD
CMS	123	12.19	4.01	22.02	3.14	**9.83**	**-0.87**
LM	118	13.67	4.48	18.43	2.87	**4.76**	**-1.61**
Mean Difference		**-1.48**	**-0.47**	**3.58**	**0.27**	**5.07**	**0.75**

Source: field survey 2024.

The data on table 1 showed that the mean difference in academic performance of students taught Habitat using concept mapping teaching strategy is 9.83 while the standard deviation is -.0.87. On the other hand, the mean score of students taught Habitat using lecture method is 4.76 while the standard deviation is -1.61. The mean difference between the instructional strategies is 5.07 while the standard deviation is 0.75. Meaning that, students taught Habitat with concept mapping teaching strategy have higher performance mean scores than their counterparts taught with lecture method. Also, the students' knowledge of the concept of Habitat improved teaching with the instructional strategies especially concept mapping strategies.

Research question two: *What is the difference in the retention of students taught Habitat using concept mapping strategy and those taught using lecture methods in Etche Ethnic Nationality of Rivers State?*

Table 2: Showing the mean difference in the retention of students taught Habitat using concept mapping strategy and those taught using Lecture methods in Etche Ethnic Nationality of Rivers State

Teaching Method	N	Posttest		Post-Posttest		Mean Difference	
		Mean	SD	Mean	SD	Mean	SD
CMS	123	22.02	3.14	27.74	3.17	**5.72**	**0.04**
LM	118	18.43	2.87	20.77	3.54	**2.34**	**0.67**
Mean Difference		**3.58**	**0.27**	**6.97**	**-0.37**	**3.38**	**-0.64**

Source: field survey 2024.

The data on table 2 showed that the retention mean score difference of students taught Habitat using concept mapping is 5.72 while the standard deviation is 0.04. On the other hand, the mean difference for

retention score of students taught Habitat using lecture method is 2.34 while the standard deviation is 0.67. The mean difference between the instructional strategies is 3.38 while the standard deviation is -0.64. Meaning that students taught Habitat with concept mapping teaching strategy have higher retention mean scores than their counterparts taught with lecture method. It indicated that there was slight good understanding of the concept of Habitat after the experiment by the students.

Research question three: *What is the difference in academic performance of male and female students taught Habitat using concept mapping in secondary schools in Etche Ethnic Nationality of Rivers State?*

Table 3: Showing the mean difference in academic performance of male and female students taught Habitat using concept mapping in secondary schools in Etche Ethnic Nationality of Rivers State

Gender	N	Pretest		Post-test		Mean Difference	
		Mean	SD	Mean	SD	Mean	SD
Male	69	11.20	4.01	22.15	3.21	**10.94**	**-0.80**
Female	54	13.17	4.00	22.13	3.07	**8.96**	**-0.94**
Mean Difference		**1.97**	**-0.01**	**-0.02**	**-0.14**	**-1.98**	**-0.14**

Source: field survey 2024.

The data on table 3 showed that the difference in academic performance of male students taught Habitat using concept mapping in secondary schools in Etche Ethnic Nationality of Rivers State is 10.94 while the standard deviation is -0.80. On the other hand, the academic performance mean score of female students taught Habitat using concept mapping is 8.96 while the standard deviation is -0.94. The mean difference between the gender is -1.98 while the standard deviation is -0.14. Meaning that male students taught Habitat with concept mapping teaching strategy have higher academic performance mean scores than their female counterparts taught with the same method.

Research question four: *What is the difference in the retention of male and female students taught Habitat using concept mapping in secondary schools in Etche Ethnic Nationality of Rivers State?*

Table 4: Showing the mean difference in the retention of male and female students taught Habitat using concept mapping in secondary schools in Etche Ethnic Nationality of Rivers State

Gender	N	Posttest		Post-Posttest		Mean Difference	
		Mean	SD	Mean	SD	Mean	SD
Male	69	22.01	3.21	28.00	2.81	**5.99**	**-0.40**
Female	54	22.02	3.06	27.48	3.60	**5.46**	**0.53**
Mean Difference		**-0.01**	**0.15**	**0.52**	**-0.78**	**0.52**	**-0.94**

Source: field survey 2024.

The data on table 4 showed that the retention mean score difference of male students taught Habitat using concept mapping is 5.99 while the standard deviation is -0.40. On the other hand, the retention mean score of female students taught Habitat using concept mapping is 5.46 while the standard deviation is 0.53. The mean difference between the gender is 0.52 while the standard deviation is -0.94. Meaning that male students taught Habitat with concept mapping teaching strategy have higher retention mean scores than their female counterparts taught with the same method.

Testing of Hypotheses

$H0_1$: There is no significant difference between the academic performance of students taught Habitat with concept mapping teaching and those taught with Lecture method in Etche Ethnic Nationality of Rivers State.

Table 5: Summary of ANCOVA on the between the academic performance of students taught Habitat with concept mapping teaching and those taught with Lecture method in Etche Ethnic Nationality of Rivers State

Dependent Variable: Posttest

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	38.778[a]	2	19.389	2.162	.117
Intercept	6150.132	1	6150.132	685.728	.000
Pretest	28.359	1	28.359	3.162	.077
Teaching Method	36.643	1	36.643	**4.086**	**.024**
Error	2134.566	238	8.969		
Total	121161.000	241			
Corrected Total	2173.344	240			

The data on table 5 showed that there is significant difference between the academic performance of students taught Habitat with concept mapping teaching and those taught with lecture method in Etche Ethnic Nationality of Rivers State ($F_{1, 238} = 4.086$, Sig.<0.05). Implies, the teaching Habitat with concept mapping strategy effectively improved academic performance of students than lecturer method.

$H0_2$: There is no significant difference between the retention of students taught Habitat using concept mapping teaching and those taught using lecture method in Etche Ethnic Nationality of Rivers State.

Table 6: Summary of ANCOVA on the difference between the retention of students taught Habitat using concept mapping teaching and those taught using lecture method in Etche Ethnic Nationality of Rivers State

Dependent Variable: Post_Posttest

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	301.297[a]	2	150.649	14.969	.000
Intercept	779.391	1	779.391	77.443	.000
Posttest	301.238	1	301.238	29.932	.000
TeachingMethod	89.920	1	89.920	**8.925**	**.000**
Error	2395.259	238	10.064		
Total	116759.000	241			
Corrected Total	2696.556	240			

The data on table 6 showed that there is a significant difference between the retention men scores of students taught Habitat with concept mapping teaching and those taught with Lecture method in Etche Ethnic Nationality of Rivers State ($F_{1, 238} = 8.925$, Sig.<0.05). Implies, the teaching Habitat with concept mapping strategy effectively improved student's retention of Biology concept than lecturer method.

$H0_3$: There is no significant difference between the academic performance of male and female students taught Habitat using concept mapping teaching strategy in Etche Ethnic Nationality of Rivers State.

Table 7: Summary of ANCOVA on the difference between the academic performance of male and female students taught Habitat using concept mapping teaching strategy in Etche Ethnic Nationality of Rivers State

Dependent Variable: Posttest

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	103.328[a]	2	51.664	5.643	.005
Intercept	1241.160	1	1241.160	135.567	.000
Pretest	100.726	1	100.726	11.002	.001
Gender	3.755	1	3.755	**.410**	**.523**
Error	1098.639	120	9.155		
Total	60822.000	123			
Corrected Total	1201.967	122			

The data on table 7 showed that there is no significant difference between the academic performance of male and female students taught Habitat using concept mapping teaching strategy in Etche Ethnic Nationality of Rivers State ($F_{1, 120}$ = 0.410, Sig.>0.05). Implies, teaching Habitat with concept mapping strategy effectively improved academic performance of male and female students equally. Hence, concept mapping teaching strategy is gender neutral.

$H0_4$: There is no significant difference between the retention of male and female Students taught Habitat using concept mapping teaching strategy secondary school in Etche Ethnic Nationality of Rivers State.

Table 8: Summary of ANCOVA on the difference between the retention of male and female Students taught Habitat using concept mapping teaching strategy in secondary school in Etche Ethnic Nationality of Rivers State

Dependent Variable: Post_Posttest

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	53.825[a]	2	26.912	2.747	.068
Intercept	730.130	1	730.130	74.513	.000
Posttest	47.400	1	47.400	4.837	.030
Gender	4.892	1	4.892	**.499**	**.481**
Error	1175.850	120	9.799		
Total	59362.000	123			
Corrected Total	1229.675	122			

The data on table 8 showed that there is no significant difference between the retention of male and female Students taught Habitat using concept mapping teaching strategy in secondary school in Etche Ethnic Nationality of Rivers State ($F_{1, 120}$ = 0.499, Sig.>0.05). Implies, teaching Habitat with concept mapping strategy effectively improved retention of male and female students equally. Hence, concept mapping teaching strategy is gender neutral.

DISCUSSION OF FINDINGS

The first objective of the study sought to investigate the academic performance of students taught Habitat using concept mapping and those taught with Lecture method in Etche Ethnic Nationality of Rivers State. The study reveals that students taught with concept mapping strategy have higher performance mean scores than their counterparts taught with lecture method. It also revealed that there is a significant

difference between the academic performance of students taught Habitat with concept mapping teaching and those taught with Lecture method in Etche Ethnic Nationality of Rivers State. The finding of the study is in agreement with that Udeani and Okafor (2022) who carried out a study on "The Effect of Concept Mapping Instructional Strategy on the Biology Achievement of Senior Secondary School Slow Learners" and group taught by the concept mapping instructional strategy performed significantly ($p<0.05$) better than their expository group counterparts.

The second objective of the study examine the retention of students taught Habitat with concept mapping and those taught using lecture method in Etche Ethnic Nationality of Rivers State. The findings of this study revealed that students taught with the concept mapping strategy demonstrated higher retention mean scores compared to their counterparts taught using the lecture method. This result underscores the effectiveness of the concept mapping strategy in enhancing students' retention of learned material. Concept mapping, as an instructional strategy, encourages students to actively engage with the content by organizing and connecting key concepts, which promotes deeper learning and understanding. This contrasts with the traditional lecture method, which is often teacher-centered and may limit students' active participation and critical thinking. The higher retention mean scores observed among students taught with concept mapping, the analysis revealed a statistically significant difference in the retention scores of students taught Habitat using the concept mapping strategy and those taught using the lecture method.

The third objective of the study examine the academic performance of male and female students taught Habitat using concept mapping in Etche Ethnic Nationality of Rivers State. The result showed that the mean scores of male students taught Habitat with concept mapping teaching strategy is slightly higher than the performance mean score of their female counterparts. Also, there is no significant difference between the academic performance of male and female students taught Habitat using concept mapping teaching strategy in Etche Ethnic Nationality of Rivers State. The finding of the study is in line with Udeani and Okafor (2022) who carried out a study on "The Effect of Concept Mapping Instructional Strategy on the Biology Achievement of Senior Secondary School Slow Learners" and found that female slow learners taught with the concept mapping instructional strategy performed significantly ($p<0.05$) better than their male counterparts taught by the same method. Although, Scantlebury and Baker (2017) have also affirmed a significant connection between students' performance and gender in biology, particularly in favour of male. It also reported that male students have higher level of academic performance in science, technology and arithmetic than their female counterparts.

The fourth objective of the study seek to ascertain the retention of male and female students taught Habitat using concept mapping in secondary schools in Etche Ethnic Nationality of Rivers State. The findings of this study revealed that the retention mean score of male students taught Habitat using the concept mapping teaching strategy was slightly higher than that of their female counterparts. This result suggests that female students may exhibit a slight advantage in retaining information when taught with concept mapping. This advantage could be attributed to the ability of concept mapping to facilitate detailed organization and visualization of ideas, which may align with learning styles that females often exhibit, such as preference for collaborative and organized approaches. However, the study also found no statistically significant difference in the retention scores of male and female students taught Habitat using the concept mapping strategy. This implies that while slight variations in retention mean scores were observed, gender did not play a significant role in determining the effectiveness of concept mapping on students' retention. This is to emphasize that concept mapping benefits both male and female students equally in enhancing understanding and retention, as it emphasizes active engagement with the content rather than relying on individual gender-based learning preferences.

CONCLUSION

The study investigated the effects of concept mapping on biology students' academic performance and retention in secondary schools in Etche Ethnic Nationality of Rivers State. Based on the findings, the study found that concept mapping teaching strategy proved to be significantly more effective in enhancing students' academic performance and retention compared to the lecture method. Students taught

Habitat with the concept mapping strategy achieved higher performance mean scores than their counterparts taught using the lecture method. The significant difference obtained suggest that concept mapping is a student-centered teaching approach that promotes deeper understanding and active engagement with the subject matter.

Secondly, students taught using the concept mapping strategy also demonstrated higher retention mean scores compared to those taught using the lecture method. However, the difference in retention scores was statistically significant. This finding suggests that concept mapping improve retention practically. Thirdly, the study revealed that male students taught Habitat using concept mapping achieved relatively higher performance and retention mean scores than their female counterparts. However, the differences in academic performance and retention between male and female students were not statistically significant. This highlights the inclusivity of concept mapping as a teaching strategy that benefits both male and female students equally in fostering academic performance and retention.

Hence, the study underscores the effectiveness of concept mapping as a teaching strategy for improving biology students' academic performance and retention. Its ability to promote meaningful learning through the visualization and organization of concepts makes it a valuable tool for teachers in secondary schools. Moreover, the gender-neutral impact of concept mapping highlights its potential to ensure equitable learning outcomes for all students. It is recommended that biology teachers incorporate concept mapping into their instructional practices to enhance students' learning experiences and outcomes.

RECOMMENDATIONS

Based on the findings of the study, the researcher made the following recommendations to achieve the purpose of the study.

1. Teachers should blend concept mapping teaching strategy with other traditional teaching method like lecture method in teaching of biology, because it improves the students' academic performance.
2. Senior secondary school management should organize workshop, programme for teachers on how to use innovative teaching technique such as concept mapping instructional strategy among others to improve professional development of Biology teachers in Secondary schools.
3. While utilizing concept mapping teaching strategy in teaching and learning of Biology concepts, the teachers should ensure that classroom implementation process is totally free from cultural views instigating gender inequality and treatment.
4. Curriculum developer should incorporate this strategy in curriculum guidelines for achievement of intended learning outcomes and content development for meaningful and higher order learning.

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