EFFECT OF CONCEPT MAPPING INSTRUCTIONAL STRATEGY ON SENIOR SECONDARY SCHOOL STUDENTS' ACHIEVEMENT IN BIOLOGY IN ENUGU EDUCATION ZONE

Comment [w1]: Add region and country

Abstract

The study investigated the effect of concept mapping instructional strategy on secondary school students' achievement in biology. Two research questions and three null hypotheses guided the study, and quasi-experimental research design was adopted. The sample for the study comprised two hundred and forty one (241) students drawn from the population of study in three schools in Enugu Education Zone using multistage sampling technique. The instrument for data collection was Biology Achievement Test (BAT). Data collected from the research questions were analyzed using mean and standard deviation, and Analysis of Covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance. The results revealed that students taught biology using concept mapping performed better than their counterparts taught using lecture method. Female students had higher achievement scores than their male counterparts in biology when taught using concept mapping. There was no significant interaction effect of instructional methods and gender on students' mean achievement score in biology. In line with the findings of the study, the educational implications of the findings were highlighted; and recommendations were equally proffered among others that science teachers should adopt concept mapping in teaching.

Comment [w2]: Abstract should contain: Short background, objective, method, result, conclusion and recommendation. Therefore ,it needs revisions.

Keywords: *Concept mapping, lecture method. Students' achievement, Biology, Secondary schools*

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Introduction

There is no gain emphasizing the fact that the level of achievement of the objective of biology at secondary school level could be measured by students' achievement in the subject matter. The teacher's role in making students learn in a meaningful manner is paramount, and this depends essentially on the teaching approaches. According to Hornby (2019), teaching is the issuing of instruction to an individual for the purpose of learning to occur. Smith (2018) posited that teaching entails creating an environment and engaging learners so that they learn things. The primary objective of teaching is to develop learners' thinking ability and perception of the things around them. The achievement of this lofty idea by the teacher depends on the teaching methods applied. The methods of science instruction are applied to science content for learning and open for all resourceful teachers (Sakala, 2013). All sets of deliberately and systematically arranged procedures that are exchanged between science teachers and learners, learners and learners; and learning experiences with a view to causing permanent change in the behaviour of the learners are methods

of science instruction. They are the routes that carry learners from where they were to where they should be after their achievement of the objectives of the new lesson (mastery of new content).

Teaching method is seen as one comprising the principles and methods applied by the teachers to promote students' learning, and these strategies are determined partly on the subject matter to be taught and partly by the nature of the learner. Sakala (2013) elaborated that which method is right for a particular lesson depends on a number of factors, among them; the age and developmental level of the students, what the students already know and what they need to know, the subject-matter content, the objective of the lesson, time, space and material resources available.

Biology is regarded as one of the important science subjects studied in Nigerian senior secondary schools. Federal Republic of Nigeria [FRN] (2013) confirms the importance of biology in Nigerian educational curriculum by enlisting it as one of the core science subjects in 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 fulfill all righteousness. Martins-Omole and Yusuf (2017) posited that biology occupies a unique position in the school curriculum as it is central to many science 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 achievement 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 achievement in Biology (Ahmed *et al* in Martins–Omole & Yusuf, 2017), and this is essentially due to the teaching methods adopted by the biology teachers. One of the main problems students face during their studies is organizing and retaining information. Nzewi (2010) noted that students' achievement and interest in science are declining. Secondary school and college students' knowledge of science is often characterized by lack of coherence and the majority of students engage in essentially rote learning. According to Chaudhury (2011), 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. Gilbert in Erbas and Demirer (2019) also attributed poor academic achievement to the abstract and complex nature of certain biology concepts apart from the teaching method adopted by instructors. The prevailing teaching practices do not actively involve students in the learning process; and these seem to deprive them of taking charge of their learning. However, it is worthy of note that most teachers and students have developed and adopted many learning strategies and innovative methods, yet the low academic

achievement of boys and girls in schools seems to persist. Anih and Egbo (2015) indicated that problem of gender effect in achievement of science concepts is also a factor in low achievement.

Gender is the societal meaning assigned to male and female with a particular role that each should play. In other words, it is the role and responsibility of male and female that is created in families, societies and culture. The concept of gender according to Ezeh (2013) is the expectations held about the characteristics, attitudes, and likely behaviours of both men and women in the society. This is verifiable because, there is a general notion among Nigerians that males are superior to females in terms of physical built-up, cognition, logical reasoning and even in academic achievement (Ezenwosu & Nworgu, 2013). Some researchers believed that males perform better in certain science subjects than females (Oludipe, 2012; Ezenwosu & Nworgu, 2013). However, other researchers have indicated no gender differentiation in some subject areas like biology courses (Nzewi, 2010; Ogunleye & Babajide, 2011; Okoh *et al.*, 2011). According to them, gender differentiation that exist in some science related subjects which lead to variation in academic achievement of male and female students remain an issue of concern to researchers (Ezenwosu & Nworgu, 2013). Moyer, Hackett and Everett in Ajaja (2013) indicated that the contemporary students are learning science in the passive way in classroom where information is organized and presented to them by their teachers. To what extract this traditional method of instruction assists the students is also a major concern to many scholars.

Lecture method is just one of the several teaching methods, and stands to be the oldest and widely used method of instruction in classrooms. It is a long tradition, probably even dating from the dawn of mankind (Schmidt *et al.*, 2015). Lecturing is a time-tested instructional method where an instructor who has the knowledge on a given subject matter delivers all relevant information to learners verbally (Kelly, 2019). It relies on one-way communication that mostly leaves the learners as passive participants only to take notes and probably ask questions after the delivery, if and when time permits. According to Schmidt *et al.* (2015), lectures can be quite engaging if delivered by a charismatic teacher who has the ability to explain difficult concepts in a simple yet effective way. However, Kelly (2019) noted that lecturing is ultimately an out-dated form of instructional delivery that does not benefit students in that it does not accommodate individual needs but cause students to rely on the teachers. This one-sided teaching technique often leads students to develop a dependency on their teachers. Students accustomed to lectures lack self-directed learning skills and are unable to teach themselves. Lecture method does not promote meaningful learning as it often leads to rote memorization.

Researchers have highly recommended new teaching methods that may prevent superficial learning; bring about meaningful learning that may lead to improvement of critical thinking, skills, problem solving and increased memory for better academic achievement. Such new methods of instructions

which are process-based and learner-centered include discovery/inquiry method, scaffolding, programmed learning, computer-assisted learning, target task method, meta-cognition and advance organizer method, cooperative learning, field trip and excursion method, concept mapping and so on. According to Schmid and Telaro (2015), as the problem of improving the teaching/learning process preoccupies educationists/researchers, concept mapping instruction seem to promise a panacea useful for enhancing meaningful learning. According to Daley *et al.* (2016), concept mapping, a teaching and learning strategy developed by Novak and Gowin, is one strategy that can promote meaningful learning. Concept mapping is a teaching technique which permits a visual representation of concepts concerning a topic and reveals the relationship among them as a whole (Vallori, 2014). It is one of the active teaching methods that can help teachers to train students who are capable of critical thinking and problem solving (Novak & Canas in Martins-Omole & Yusuf, 2017). Concept mapping is a graphic representation of concepts showing the relationship between the ideas through the use of linking words. It motivates young learners and encourages critical thinking, innovations and creativity (Akeju *et al.*, 2011; Athuraliya, 2018; Lucid, 2018). Concept maps help learners to make evident, the key concepts or propositions to be learned and suggest connections between new and previous knowledge. Concept maps are diagrams of key concepts and relationship between those concepts. The main concept is placed at the top or centre and their concepts are arranged from top to bottom; some lines are drawn between concepts, and communicative sentences are written on the lines (Athuraliya, 2018). A knowledge acquired through a meaningful way such as concept mapping will be kept in mind for a longer time, and this leads to improvement in critical thinking skills and the ability to problem solving in students (Jibrin & Zayum, 2012). Concept mapping strategy has been proved to be effective in enhancing academic achievement and retention in many subjects such as Mathematics, Chemistry and Physics (Eriba, 2013; Luchembe *et al.*, 2014; Singh & Moono, 2015). The learning and teaching of science requires physical and mental processes, and this entails hands-on and minds-on activities that involve active and meaningful learning. Active learning means engaging students in active exchange in which students are not passively listening and taking notes during lectures only but are actively contributing their thoughts and ideas to a relevant activity often guided by the instructor (Sequeira, 2012).

Concept mapping method of instruction or learning is one of the currently evolved innovative methods of science instruction. It is process-focused and learner-centred, as well as a meta-learning technique that is based on theory of meaningful learning (Sarhangi *et al.*, 2010). It is a special two-dimensional diagrammatic learning which emphasizes the relationship between and among important concepts. However, some researchers have noted that concept mapping has its own disadvantages. It is not beneficial to low ability learners. Many science teachers lack the knowledge

and so no skills and competence required for effective use of the method. The method requires close guidance and supervision of the learners which is often not possible with large classes. It may be expensive in terms of resources for its application. Often times the important concepts and links are omitted and it may not be suitable for certain science concepts. Although instructions often use concept maps to promote learning, these visuals have the potential disadvantage if they muddle relationships and discourage critical thinking (Martins-Omole & Yusuf, 2017).

It is noted that there was no enough empirical studies on the use of concept mapping in comparison with the traditional lecture method of teaching strategies in improving students' Biology achievement. Therefore, this study was aimed at comparing the impact of lecture method and concept mapping strategy in enhancing students' achievement in biology with the objective of determining the more effective teaching method that will promote academic achievement of students in biology.

Statement of the Problem

Suffice to note that students' achievement in West African Senior School Certificate (WASSC) and other 0' level biology external examinations has been consistently poor, and that some authorities have placed the blame on the ineffective teaching methods and arrays of other problems source. This casts some doubts on the right choice of instructional methods of teaching and learning of biology to impart necessary knowledge, skills, attitudes and retention on the students which are the prerequisites for meaningful achievement in the subject. Researches have been carried out in the past to ascertain the appropriate teaching methods to enhance maximal achievement in science subjects to no avail. Biology, a vast science subject in Nigeria Educational Curriculum has been a vital subject directly or indirectly for all categories of students, be it science-inclined or arts-inclined. It becomes imperative that the appropriate teaching and learning process be put in place to better students' academic achievement especially in external examinations to enable them gain quick entrance into the higher institution after their secondary school education for their academic pursuit. Consequent upon this quest for better solution to this inherent problem, the present study sought to compare the relative effectiveness of concept mapping and lecture methods of teaching in enhancing Senior Secondary School students' academic achievement in Biology.

Purpose of the Study

The main focus of the study was to investigate the effect of concept mapping instructional strategy on SSI students' achievement in biology in Enugu Education Zone.

Specifically this study sought to:

1. determine the mean achievement scores of students taught with concept mapping and those taught with lecture method of teaching as measured by biology achievement test (BAT).

2. determine the mean achievement scores of male and female students taught with concept mapping and those taught with lecture method as measured by BAT.

Significance of the Study

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This study has both theoretical and practical significance. Theoretically, some aspects of this study are anchored on David Ausubel's meaningful learning theory as well as Jean Piaget's cognitive constructivist learning theory. Piaget's learning theory emphasized learning by doing. Ausubel who was influenced by the teaching of Jean Piaget, theorized that people acquire knowledge primarily by being exposed directly to it rather than through discovery. He believes that students should have previous knowledge to enable them acquire new one i.e. from known to unknown to enable the learner to anchor new knowledge. Ausubel stressed that meaningful learning manifest when there is link between prior knowledge and the new knowledge. Since linking concept is a learning theory in concept mapping, this study will enable people to carry out meta-learning (learning to learn). Practically, the following people would benefit immensely from the findings of the study: students, Biology teachers and the curriculum formulators, school administrators as well as researchers. The result of the study could enable the students appreciate the two methods of imparting knowledge. It could also help the students to become knowledgeable in critical thinking, research work, problem-solving, and being self-confident and sufficient in learning. The students can stand the chance of embarking on meta-learning i.e. learning how to learn by incorporating new meaning or concepts into the prior knowledge. Concept mapping is said to be a useful tool that help students learn about their knowledge structure and the process of knowledge construction (meta-knowledge) whereas lecture method encourages students to go into deep research for new knowledge. The findings of this study would enable the science teachers to appreciate the possible influence of concept mapping as well as lecture method of instruction on students' academic achievement. The findings of the study would also help the teachers to determine the appropriate time to apply either concept mapping and/or lecture method of instruction to learners. It would enhance their critical thinking and the ability to utilize innovative ideas. The research findings would as well shed more light on the instructional strategies suitable for both sexes in co-educational schools. The empirical evidence from the study stands to guide not only the teachers, but the curriculum experts and researchers on their developmental and implementation process in educational system. Specifically, the findings of the study could form a basis for introducing concept mapping in teaching as an alternative innovative instructional strategy to lecture method in school curriculum plan. Finally, the research work would assist school administrators, to encourage teachers of science subjects on the need to adopt and effectively apply concept mapping and lecture method of instruction in teaching and learning process when required. The awareness campaign can effectively be actualized during in-service training of serving teachers and proprietors of schools.

Scope of the Study

The study was carried out in Enugu Education Zone of Enugu State made up of Enugu East, Enugu North and Isi-Uzo Local Government Areas. Senior secondary I (SSI) students were used for the study. The choice of SSI students was based on the fact it was not an exam class. The content scope of the study involved animal nutrition chosen from SS1 biology curriculum of the Federal Ministry of Education.

Research Questions

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

1. What are the mean scores of concept mapping and lecture method of teaching on SS1 students' biology achievement?
2. What are the mean achievement scores of male and female students taught with concept mapping and those taught with lecture method as measured by BAT?

Research Hypotheses

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

1. There is no significant difference in the mean achievement scores of students taught biology topics using concept mapping and those taught with lecture method.
2. There is no significant difference in the mean achievement scores of male and female students taught biology using concept mapping instructional method and those taught with lecture method.
3. The interaction effect of instructional methods and gender on students' biology achievement will not be significant ($P > 0.05$)

Research Design

The research design is a quasi-experimental design of pre-test, post-test, non-equivalent control group design. This design in line with Ali in Ijoyah *et al*. (2015) is considered appropriate because it establishes a cause and effect relationship between the independent and dependent variables. The independent variables are concept mapping and lecture method of instruction while the dependent variable is students' achievement. Quasi-experimental design is considered ideal for the study due to the fact that participants are already constituted into intact classes; hence it is not ethical to randomly select them individually for experimental purposes. Beside, most school administrators are unlikely to permit splitting of classes for random assignment of learners into groups for experimental purposes. An important component of the quasi–experimental study is the use of pre-testing or the analysis of prior achievements to establish group equivalent (Githae *et al.*, 2015).

Population for the Study

The target population of the study comprised all the four thousand five hundred and sixty five (4565) SSI students in Enugu Education Zone in Enugu State for 2018/2019 academic session (Post Primary School Management Board [PPSMB], 2019).

Sample and Sampling Techniques

A sample size of two hundred and forty one (241) SS1 students was used for the study. The researcher applied multistage sampling procedure in determining the sample size. The first stage involved stratification of the zone into Local Government Areas. Purposive sampling was employed to sample all co-educational schools (21No) from the three Local Government Areas. Thereafter, three (3) co-educational schools, one (1) from each Local Government Area were selected through simple random sampling technique. Co-educational schools were used to enable the researcher to collect data from male and female students who had received the same biology instructions from the same teacher and at same time. This would ensure that differences in teacher variable and quality of instructions received in biology do not cause variations in responses given by the two sexes. Finally, the researcher drew two intact classes from each of the three co-educational schools still using simple sampling technique. Therefore, a total of six intact classes were drawn from the three co-educational schools. Simple random sampling was used to select intact classes with more than two classes of SSI students. A total of 118 males and 123 females were used to give a sample size of 241. One intact class from each school was assigned to experimental group and the other to control group using simple random sampling. For the control group, a total of one hundred and twenty (120) students from the intact classes were used while one hundred and twenty one (121) students were used for the experimental group. The schools so sampled included: Day Secondary Schools Independent Layout Enugu, Annunciation Secondary School Nkwo-Nike and Ogor Community Secondary School Ikem in Enugu North, Enugu East and Isi-Uzo L.G.A respectively.

Instrument for Data Collection

The instrument for data collection is Biology Achievement Test (BAT) as developed by the researcher. The BAT is a 40–item, four–option multiple choice test based on SSI biology syllabus. The items in the test are constructed using a test blue print. The test items; multiple choice objective questions were carefully drawn to ensure that they fall within the scope of the SSI syllabus and of the specific area that have been selected for the purpose of the study.

Validation of Research Instrument

The BAT was subjected to face and content validation by administering it to three validators: two from the Department of Science (Biology) Education and one from Department of Measurement and Evaluation in Peaceland of College, Enugu in affiliation to Chukwuemeka Odumegwu Ojukwu University, Uli in Anambra State. The lesson plans were submitted to validators to ensure clarity of items, arrangement and suitability in addressing the purpose of the study while the BAT and

contents to be taught were subjected to a two grid table of specification or test blue print to ascertain the levels of bloom's educational objectives being tested by BAT.

Reliability of the Instrument

The reliability of BAT was determined using Kuder-Richardson's 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 dichotomously. It is also suitable for items with right or wrong answers. The reliability of BAT was determined through trial testing using thirty five (35) SSI students from St. John Cross Seminary Secondary School Nsukka, Enugu State. The internal consistency/Reliability index obtained for BAT was 0.76. This result has shown a high internal consistency for BAT.

Experimental Procedure

The classroom biology teachers used as research assistants for the study were intimated and guided separately on the skills of concept mapping as well as lecture method of teaching respectively for one week. A week before the commencement of the experiment, the biology teachers were given the extracts which contained the contents for the four (4) weeks instructional unit. The lesson plans on each of the concepts in the four-week instructional unit for the two methods of teaching formats were given to specific teachers for use in teaching. That was done to ensure that all the instructional presentations followed the recommended formats for the designated classes. The lesson plans specified both the teachers' and students' activities during instruction.

Two days before the instruction began the experimental and control groups were given pre-test with the 40 items on the BAT. After the pre-test, the regular biology teachers commenced teaching in their schools, using the instructions on the lesson notes given to them by the researcher. The treatment was conducted using normal school periods. At the end of the treatment which lasted for four weeks, the biology teachers were instructed to administer post-test to the research subjects in their various groups. Data collected from pre-test and post-test were kept separately for the two groups and thereafter used to answer the research questions and test the hypotheses.

Control of Extraneous Variables

To take care of possible extraneous variables such as Hawthorne effect, the research assistants being the students' class biology teachers were used to teach the students in their normal classes and of course using the normal school time period. By implication, the use of biology teachers, so guided by the researcher on the application of the teaching methods, would go a long way to reduce the effect of instructor's variability that might have affected the outcome of the experimental procedure. In which case, the researcher was expected to play the role of monitoring the research assistants to ensure that the experimental procedure was properly carried out. The adequate guideline to the biology teachers as well as issuance of experimental packages would equally reduce

the effect of teacher variability. The proper guideline, therefore would guarantee similarity of instruction during the treatment.

To minimize students' interaction that could affect the results of the treatment, the researcher directed the research assistants not to give the students any assignment in the process of the treatment. In another dimension, intact classes were used for the treatment, so there would be no randomization of the research subjects. However, analysis of Covariance (ANCOVA) used in data analysis significantly reduced the effect of pre-test on post-test. In other words, the ANCOVA took care of non-equivalence of the intact classes i.e. since quasi-experimental design was used; the ANCOVA took care of non-randomization.

Method of Data Collection

At the beginning of the treatment, BAT was administered to the students and the pre-test data generated. The post-test data were obtained after re-administering the BAT to the students at the end of the treatment. However, it must be noted that the multiple choice questions (in the BAT) used at the beginning of the treatment were reshuffled before administrating them to the research subjects as post-test for obvious reasons. For each group, data for the pre-test and post-test were recorded separately. The test items were scored 1 mark each, the maximum mark being 40.

Method of Data Analysis

The 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 employed for answering the research questions while Analysis of Covariance (ANCOVA) was used in testing the hypotheses formulated at $P<0.05$. ANCOVA was used so as to correct the error of initial difference in the ability levels among the research subjects.

Results

The results of data analysis based on two research questions and three null hypotheses that guided the study are presented as follows:

Research question 1: What are the mean scores of concept mapping and lecture method of teaching on SS1 students' biology achievement?

Table I: Mean and Standard deviation scores of concept mapping and lecture methods.

Comment [w5]: Better to use the ff table design

N = 241 cases

Teaching Method	Pre-Test		Post-Test		Gain Score
	Mean	SD	Mean	SD	
Experimental group (Concept mapping)	12.69	3.38	33.33	2.89	20.64
Control group (Lecture method)	12.97	3.55	28.95	3.81	15.99

From Table 1, it is revealed that the lecture method had mean score of 28.96 with standard deviation of 3.81 while the mean score of concept mapping was 33.33 with standard deviation of 2.89. Also, the experimental group had a gain score of 20.64 over the control group who had a gain score 15.99.Therefore, students taught biology using concept mapping performed better than students taught with lecture method.

Research question 2: What is the mean achievement scores of male and female students taught with concept mapping and those taught with lecture method as measured by BAT?

Table 2: Mean achievement and Standard deviation scores of male and female students taught with concept mapping and those taught with lecture method.

N = 241 cases, (Nm=118, Nf =123)

Comment [w6]: Better to use the ff table design

Teaching Method	Pre-Test				Post-Test				Gain Score	
	Male		Female		Male		Female		Male	Female
	Mean	SD	Mean	SD	Mean	SD	Mean	SD		
Experimental group (concept mapping)	12.07	3.03	13.22	3.61	32.29	2.76	34.20	2.73	20.22	20.98
Control group (lecture method)	12.92	3.74	13.02	3.35	28.81	3.91	29.12	3.73	15.89	16.1

From Table 2, it is revealed that for the control group, the male students had mean score of 28.81 with standard deviation of 3.91 while the female students' mean achievement score is 29.12 with a standard deviation of 3.73. The gains for male and female students are 15.89 and 16.1 respectively. The females gained more than the males. For the experimental group, the male students had mean score of 32.29 with standard deviation of 2.76 while the female students' mean achievement score is 34.20 with a standard deviation of 2.73. The gains for male and female students are 20.22 and 20.98 respectively. The females gained more than the males. The female students gained more both for the control (lecture method) and experimental (concept mapping) groups. The male and female students in the experimental (concept mapping) group performed better than those in the control (lecture method) group.

Hypothesis 1:

H_{01}: There is no significant difference in the mean achievement scores of students taught biology topics using concept mapping and those taught with lecture method.

Table 3: Analysis of Covariance for students overall biology mean achievement scores by teaching methods; gender and by gender with interaction effect.

Comment [w7]: Create a table and present data using the above table design.

Sources	Type III Sum of Squares	Df	Mean Squares	F	Sig.
Corrected Model	2538.043[a]	4	634.511	111.311	.000
Intercept	8153.706	1	8153.706	1430.393	.000
PRETEST	1269.523	1	1269.523	222.711	.000
GENDER	30.309	1	30.309	5.317	.022
METHOD	1220.018	1	1220.018	214.026	.000
GENDER * METHOD	12.895	1	12.895	2.262	.134
Error	1345.277	236	5.700		
Total	237784.000	241			
Corrected Total	3883.320	240			

a. R Squared = .654 (Adjusted R Squared = .648)

From Table 3 above, it is observed that the significant of 'F' (214.026) for method is .000. This value is less than .05 probability level set for the study. Hence, the null hypothesis is rejected. This implies that the method influenced the students' achievement in biology. This led to the conclusion that there is a significant difference between the mean scores of students taught with concept mapping and those taught with lecture method.

Hypothesis 2:

H_{02}: There is no significant difference in the mean achievement scores of male and female students taught biology using concept mapping instructional method and those taught with lecture method.

Table 3 shows that the significance of "F" (5.317) for gender is .022. This value is less than .05 probability level set for the study. Here, the null hypothesis is rejected. It is therefore concluded that there is significant difference in the mean achievement scores of male and female students taught biology using concept mapping instructional method and those taught with lecture method.

Hypothesis 3:

H_{03}: The interaction effect of instructional methods and gender on biology achievement will not be significant.

From the Table 3, it shows that the significance of "F" (2.62) for gender*method is 0.134. This value is greater than .05 probability level set for the study. Here, the null hypothesis is not rejected. It is therefore concluded that there is no significant interaction effect between methods of instruction and gender on students' achievement in biology.

The summary of the findings are;

1. Students taught biology using concept mapping performed better than students taught with lecture method, and there is a significant difference between the mean scores of students taught with concept mapping and those taught with lecture method.

2. The male and female students in the experimental (concept mapping) group performed better than those in the control (lecture method) group. The female had a better overall performance. However, there is significant difference in the mean achievement scores of male and female students in biology achievement test (BAT).
3. There is no significant interaction effect between methods of instruction and gender on students' achievement in biology.

Discussion of the Findings of the Study

This result finding which indicated that higher academic achievement occurred when taught with concept mapping is in line with the findings of Jibrin & Zayum (2012), Githae *et al.* (2015) and Ijoyal *et al.* (2015) who found out that students who are taught with concept mapping performed better than their counterparts who are taught with lecture method. However, the finding contradicts that of Martins-Omole & Yusuf (2017) who carried out their work on the effect of concept mapping and lecture methods on the academic achievement of biology students in secondary schools in Federal Capital Territory Abuja and concluded that that there was no significant difference between students taught using concept mapping and lecture method.

Result of the study on the influence of gender on the mean achievement scores of the students in biology showed that female students performed better than their male counterparts in experimental group. The finding supports the finding of Okoh *et al.*, (2011); Ezenwosu and Nworgu (2013) who discovered that gender has influence on students' academic achievement in science. Contrary to this finding, studies carried out by Oludipe (2012); Ajaja (2013); Githae *et al.* (2015) maintained that gender has no significant difference in academic achievement in science subjects.

On interaction effect of teaching methods and gender on mean achievement score, the finding of this study showed that there was no significant interaction effect of concept mapping and lecture method and gender on students' mean achievement scores in biology. This is in line with the findings of Ajaja (2013) who concluded in his work that there was no interaction between method and genders on students' mean achievement scores in science subjects. This implies that concept mapping apart from being innovative; it is also cost effective in teaching both male and female in a combined classroom setting. Since there is no interaction between method and gender there would be need to separate instruction for females and males. However, the performance of the female students was higher than that of their male counterparts, and there was statistically significant difference. This difference in the performance of female students and their male counterparts could be as a result of the nature of instructions delivered to the students, which enabled both the male and female students to be actively involved in the teaching and learning process. This difference in the score of female students and their male counterparts could be as a result of the students'

disposition to learn, both male and female students had equal opportunity to participate actively, but maybe the female students were more determined to learn than their male counterparts.

Conclusion Reached from the Findings of the Study

From the results obtained in the study on the effect of concept mapping instructional strategy on students' achievement in biology, it was found out that:

- Students taught biology using concept mapping performed better than their counterparts, taught biology using lecture method.
- Female students performed better than their male counterparts in biology achievement test since the difference in favour of the former was statistically significant.
- There was no significant interaction effect of instructional methods and gender on students' mean achievement score in biology.

Recommendations

Based on the findings of this study, and their implications, the following recommendations are made.

i. Biology teachers should be trained on how best to involve students in concept mapping during biology instructions so as to facilitate students' achievement in the lesson. This could be achieved through seminars and workshops or in-service training for teachers.
ii. Teachers should make teaching and learning of biology gender friendly.
iii. The curriculum planners should ensure that concept mapping teaching approach is included in biology curriculum, as it will help to promote students' achievement in the subject.
iv. In view of the fact that concept mapping was more effective in enhancing students' achievement in biology than lecture method of teaching, the Ministries of Education should ensure that textbook authors should incorporate concept mapping in the instructional methods for secondary schools biology teaching and learning activity.

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