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USING COOPERATIVE LEARNING TO REDUCE STUDENTS' MISCONCEPTIONS IN BIOLOGY: A STUDY OF SECONDARY SCHOOL STUDENTS IN DELTA CENTRAL SENATORIAL DISTRICT, NIGERIA

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Abstract:
The purpose of this study was to determine the effect of the use of cooperative learning in reducing students' misconceptions about Biology in Delta Central Senatorial District. To guide this study, six research questions and their corresponding hypotheses were raised and tested at a 0.05 level of significance. The design of the study was quasi-experimental design. The sampling technique was the simple random sampling technique. The samples of the study consisted of six mixed public secondary schools in six local government areas in Delta State, 240 students and six Biology teachers. The instrument for data collection was a two-tier diagnostic test (TTDT). The instrument's validity and reliability were properly determined before use. The reliability of TTDT was found to be 0.89 using Kuder-Richardson 21 formula. The data collected were analyzed using mean, standard deviation, t-test and ANCOVA. The major findings of the study include: a significant effect of cooperative learning; a significant difference in the mean corrected misconception score between students taught biology using cooperative learning and lecture method; a non-significant difference in mean corrected misconception scores between male and female students taught using cooperative learning; non-significant interaction effect between sex and method of instruction on students corrected misconception; significant effect of cooperative learning on students' achievement; and significant difference in achievement scores between students taught biology using cooperative learning and those taught using lecture method. It was concluded that the adoption of cooperative learning strategies may be appropriate for the teaching and learning of Biology to reduce students' misconceptions and improve achievement. It is

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therefore recommended that the Ministry of Education should organise special training for teachers on the use and implementation of cooperative learning.

Keywords: cooperative learning; students; misconceptions; Biology

1. Introduction

Biology deals with the study of many varieties of lives. It is a branch of natural science that covers the study of living things, including their taxonomy, structure, and function. Students are first introduced to Biology at the senior secondary school level, it is one of the pre-requisite subjects for many fields of learning including botany, anatomy, physiology, microbiology, medicine, agriculture, pharmacy, biotechnology, and others. As stated in the National Policy on Education (Federal Republic of Nigeria, 2013), learning Biology will provide the students with suitable laboratory and field skills in biology, meaningful and relevant knowledge in Biology, and scientific knowledge that is applicable, in health, agriculture, personal and community daily life matters and development of functional scientific attitudes. Nwagbo (2005) opined that Biology is an important subject that contributes part of the literacy needed for national growth and development. Biology also helps to develop attitudes and science process skills such as observation, inferring, classifying, hypothesizing, questioning, measuring, interpreting, communicating, predicting and others.

According to the West African Senior Secondary School Certificate Examinations' Curriculum (2004-2008), the justifications for the inclusion of Biology in the senior secondary school curriculum are as follows:

1) Understanding of the structures and functions of living organisms as well as an appreciation of nature;
2) Acquisition of necessary laboratory and fields skills in order to carry out and evaluate experiments and projects in Biology;
3) Acquisition of necessary scientific skills like observing, grouping and interpreting biological data;
4) Acquisition of relevant knowledge in biology needed for future and advanced studies in biological sciences;
5) Acquisition of scientific attitudes for problem-solving;
6) Ability to apply biological principles in everyday life in matters that affect personal, social, environmental, community health, and economic problems (p.32)

At the secondary education level, the aims and objectives of biology education as reported by the Federal Ministry of Education, FME (2007) are to prepare students to acquire:

- Adequate laboratory and field skills in biology.
- Meaningful and relevant knowledge in biology.
- Ability to apply scientific knowledge to everyday life in matters of personal and community health and agriculture.

- Reasonable and functional scientific attitude.

Biology is a compulsory subject for science students at the secondary school level because of its importance and to foster its study and related discipline at a higher level of education (West African Examination Council 2011). Unfortunately, there has been a continual report of poor performance of students in biology, this is most apparent in the examination report of the West African Examination Council (WAEC) on the performance of students every year. This poor performance of students in Biology has become an unmanageable problem in the nation's educational system. A review of WAEC Chief Examiner's report from 2016-2019 has shown that students' performance in Biology has remained poor. The WAEC Chief Examiner's Report from 2016 to 2019 in Biology practical shows that students' average performance has never exceeded the raw score of 31.0 and standard deviation of 11.79. This indicates that the overall students' performance has remained below failure grades from 2016 to 2019. In the essay part of the examination, the highest raw mean score attained by students is 31.0 and a standard deviation of 10.91 (West African Examination Council, 2016-2019). The major students' weakness deduced by the WAEC Chief Examiner's report was that students had poor expression in questions requiring explanation and poor performance in questions that require the application of knowledge. These may be ascribed to the conventional lecture method mostly used by Biology teachers.

One of the major reasons attributed to a such terrible performance by students is the use of low stimulating and no-captivating instructional strategies and teacher centred teaching methods like the lecture method which hinder students from paying attention and also impede proper understanding of biology contents as well as poor skills in a biology laboratory exercise. To substantiate this assertion, Salau (2009) provided information that many researchers have put forward that poor performance in public examination is traceable to teaching methods used by teachers, the resultant effect is the poor achievement and low retention levels in students' outcomes both in internal and external examinations. Mtsem (2011) reaffirmed that the teaching method influences the responses of students and determines whether they are interested, motivated and involved in a lesson in such a way as to engage in good learning.

The lecture is one of the oldest and, maybe still, the most widely used teaching method (Bligh, 2000). The lecture method of teaching is a teacher-directed method where students receive instruction from the teacher with little or no participation. This approach turns the students into passive listeners, offers very little room for student participation, and disregards individual differences. According to Anyafulude (2014), this approach encourages students to master course material through frequent review of facts and drills. As maintained by Ajaja (2009), the method guarantees the completion of the course outline on time, but persuades learners to memorize and regurgitate the content of learning experiences instead of digesting and assimilating them. Most of the knowledge acquired through the lecture method is forgotten rapidly. The lecture method does not take into cognizance the fact that student formulates ideas of natural phenomena before

formal instructions in the classroom and pays little attention to what students already know.

Misconceptions are non-scientific explanations of natural phenomena that are at variance with scientific ideas. Misconception refers to preconceptions that are inconsistent with an expert or accepted scientific views (Kucukozer and Kocakulah, 2007). Misconceptions are robust and difficult to change without proper intervention, often incomplete, inconsistent, and deeply held and are likely to remain in the students' cognitive structure after instruction, or even to re-emerge some weeks after students have displayed some initial understanding immediately following instruction. In the report of Yates and Marek (2014), misconceptions can vary from minor misunderstandings to complete theory rejection. Misconceptions proceed from everyday experiences, classroom instruction, incorrect explanations, textbooks, interactions with the physical and social environment, informal experience and language. Misconceptions also ensue when students merge newly learned concepts (for example: plants make their own food) with their previously held, more obsolete concepts (for example: plants get their food from the soil), such a situation generates conceptual conflict in the students' mind.

For a variety of reasons, misconceptions might prevent people from learning. Pupils interpret new information using these incorrect understandings, which prevents them from properly understanding new knowledge (Lilienfeld, 2010; Murphy & Alexander, 2013). They have an impact on how pupils respond to new ideas, and some may reject scientific concepts in favor of ideas that have already been shown to work. Deep-seated misconceptions are challenging to alter or rectify. It doesn't significantly affect these misunderstandings to simply provide pupils with proper knowledge (Taylor & Kowalski, 2014). Teachers and students often hold the same misconceptions. A number of studies corroborate that many teachers, including those with experience, operate while holding misconceptions about various biological concepts. Teachers' lack of knowledge, how teachers present the materials inappropriately, ignore student's background knowledge, explain what should not be explained, premature concept explanations, use confusing terms, and less emphasis on the importance of context will impact the clarity of lesson presentation and further results in misconception (Buaraphan, 2011; Cakir, 2008).

The most direct way teachers recognise students' misconceptions is to create scenarios that allow students to share their prior knowledge, this can be done through class discussions about the topic before instruction or by asking students to discuss with their peers and compare ideas. Having identified students' misconceptions, how to deal with them becomes the question. The way to rectify misconceptions is to show just cause for the correct information with your own experiences and understanding. To help students do this, the teacher can:

- Provide students-centred activities in which students can explore their misconceptions.
- Have students debate their ideas with peers and listen to others' justifications.
- Ask students to research why their misconceptions are incorrect.

To cater for students' needs in biology class, therefore, using interesting and stimulating instructional strategies and methods becomes vitally important. One innovation that supports students' independent study and interactive engagement in the learning process and that can enhance students' active involvement while learning biology is Cooperative learning (Ukoh and Adejimi, 2018). In variance to the traditional, teacher-centred methods, which place the teacher at the literal and figurative centre of the room, student-centred methods aim to position students at the centre of their learning process and empower them as agents of their own learning. Activity-based methods also amplify the likelihood that students will challenge each other's, or their own misconceptions, which is thought to have a more transformative effect compared to having one's idea challenged by the teacher (Goldsmith, 2006). The use of effective teaching techniques at the secondary level of education is therefore vital to the survival of the system. Based on the literature on the advantages of the student-centred teaching method above, cooperative learning could be a suitable alternative for teaching Biology to reduce students' misconceptions about Biology concepts and consequently improve students' achievement in Biology.

Cooperative learning unlike the lecture method is a student-centred, instructor-facilitated instructional strategy. Cooperative learning is a teaching method whereby students are arranged in pairs or small groups to assist each other learn assigned material (Trowbridge & Bybee, 1996). In cooperative learning students progressively take responsibility for each other's learning (Ajaja, 2013). There are five basic elements of cooperative learning according to Johnson, Johnson & Holubec (2013). These basic elements include: positive interdependence, face-to-face interaction, individual accountability, social skills and group processing. The cooperative groups are created by the teacher in a heterogeneous structure by taking into consideration the gender, interests, social, economic conditions and especially the achievement of the students (Bayrakçeken, Doymuş, & Doğan, 2013). Within the group, the students act as a group to maximize their own and each other's learning. In order to learn a subject or fulfil a responsibility in the cooperative group, each member in the group must fulfil their duty and learn the subject for which they are responsible (Laal, Laal, & Kermanshahi, 2012).

These are characteristics of cooperative learning:

- Students work together in small groups containing two to five members.
- Students are positively interdependent.
- Activities are structured so that students need each other to accomplish their common tasks or learning activities.
- Students are individually accountable or responsible for their work or learning.

A study conducted with 279 fifth-grade students found that students reported more favourable perceptions of cooperative learning when compared to traditional learning methods. Students in the study described that they felt more challenged and stimulated, while also experiencing a higher level of recognition from the teacher (Law, 2011). In addition, students are not the only ones who can gain from cooperative learning. A study carried out with 15 life science teachers from secondary schools examined their

use of cooperative learning in the classroom. The teachers were sent to a workshop to learn about cooperative learning approaches that could be used in their classrooms. Teacher attitudes were measured both pre-workshop and post-workshop, and this research demonstrated that a large percentage of biology teachers who use cooperative-learning strategies expressed that they should be used in place of direct instruction (Lord, 1994). Teacher attitudes had shifted, and they were more confident in using cooperative learning to assist students in their own classrooms.

There is a strong argument that sex is a prognosticate factor in students' academic achievement. Sex simply refers to a state of being male or female. Prince (2005) expounds on sex as the biological and psychological characteristics that define men and women. This study seeks to ascertain if cooperative learning will reduce male and female students' misconceptions of Biology differently. However, sex in this study is a moderator variable.

Effective teaching methods stimulate learners' interest which therefore forms a base for achieving desired curriculum objectives in a school setting. Essentially, teacher-centred teaching methodologies are considered obsolete, a big burden with little impact on the learning development of the child; the conventional educational system emphasizes strongly on those teaching methods that will fully and actively involve the child learner rather than considering him as a passive, ignorant and mere recipient of knowledge. Hence, it is believed that involving learners in the teaching and learning activity will make teaching and learning more interesting, make the classroom environment lively, arouse the interest of the learners and sustain their interest and attention throughout the teaching and learning period (Bello, 2015). It is apparent that science cannot thrive without using appropriate instructional methods. The quality of science education in a country will determine its future advancement in the discipline. It is against this backdrop of the ongoing deterioration in students' Biology performance that the researcher seeks to investigate the effect of cooperative learning in reducing students' misconceptions in Biology in Delta Central Senatorial District of Delta State.

2. Research Questions

The following research questions guided this study:

1) Will there be any effect of cooperative learning on the correction of students' misconceptions in Biology?
2) What will be the difference in the mean corrected misconception scores between students taught Biology using cooperative learning and lecture method?
3) What will be the difference in the mean corrected misconception scores between male and female students taught Biology using cooperative learning?
4) Will there be any effect of the interaction of teaching methods (cooperative learning and lecture method) and sex on students' corrected misconception in Biology?

5) What will be the effect of cooperative learning on students' achievement in Biology?
6) Will there be a difference in the mean Biology achievement scores between students taught Biology with Cooperative learning and those taught with lecture method?

3. Hypotheses

The following hypotheses directed this study:

1) There is no significant effect of cooperative learning on students' corrected misconception scores in Biology.
2) There is no significant difference in the mean corrected misconception scores between students taught Biology using cooperative learning and lecture method.
3) There is no significant difference in the mean corrected misconception scores between male and female students taught Biology using cooperative learning.
4) There is no significant effect of the interaction of teaching methods (cooperative learning and lecture method) and sex on students' corrected misconception in Biology.
5) There is no significant effect of cooperative learning on students' achievement in Biology.
6) There is no significant difference in mean Biology achievement scores between students taught with Cooperative Learning and those taught with the lecture method.

4. Methods

This study adopted a quasi-experimental design. The design comprises of two instructional groups (cooperative learning and lecture method groups). The independent variable is instructional methods at 2 levels (cooperative learning and lecture method), the moderator variable is sex (male and female) and the dependent variable is misconception. The population of the study consists of 19,400 Biology students in public secondary schools in Delta Central Senatorial District. The sample size for this study comprised 240 SSII students from six mixed public secondary schools in Delta Central Senatorial District in Delta State. These schools were selected using a simple random sampling technique. The choice of a simple random sampling technique is to ensure that all the public secondary schools in Delta Central Senatorial District have equal chances of being selected for this study. The researcher randomly selected six Local Governments from the eight Local Government Areas in Delta Central Senatorial District, then randomly selected six schools, one each from the six Local Governments selected using balloting with replacement in both steps. Single-sex schools were excluded from the sampling process since sex is a moderator variable in this study.

The instrument used for data collection for this study is Two-Tier Diagnostic Test. The diagnostic test was adapted and developed using procedures that have been used in earlier research by Treagust (1985), Peterson (1986), Haslam and Treagust (1987), Gorjanc-Barthel (1989), and Kiokaew (1989). Items for the diagnostic instrument are based on the two-tier, multiple-choice format. It contains fifty multiple-choice questions. The first tier consists of a content question with four choices. The second tier consists of four possible reasons for the first part: three alternative reasons and one desired reason. The two-tier diagnostic test was drawn from past WAEC questions containing biology concepts of the transport system, respiratory system and excretory system. The two-tier diagnostic test was used to determine students' misconceptions about Biology. The first stage of the two-tier diagnostic test will be used to test for students' achievements. The two-tier diagnostic test was scored by combining students' answers to the first-tier questions and reasons that they will choose for these answers in the second tier using the following evaluation criteria.

The face validity of the Two-Tier Validity Test was determined by three experts made up of one science educator in Biology at Delta State University Abraka, one experienced Biology teacher at Obiaruku Grammar School in Ukwani Local Government Area of Delta State and an expert in Measurement and Evaluation from Delta State University Abraka. They determined the face validity of the instrument by examining critically the test items and relating them to the content of the 6 weeks of instructional units. The correction includes increasing the number of items of the Two-Tier Diagnostic Test from 25 items to 50 items. The correction was effected in the instrument. The content validity of the instrument was established using a table of specification

The reliability of the Two-Tier Diagnostic Test was established using Kuder-Richardson formula 21 approach. The appropriateness for the establishment of the reliability coefficient of multiple option test items led to the choice of this method. The Two-Tier Diagnostic Test was administered to 30 SSII Biology students in a secondary school in Ukwani Local Government Area, who are outside the sample schools for this study. In order to establish the reliability of the Two-Tier Diagnostic Test for its appropriateness to measure students' misconceptions, the students' performance in both the first and second stages was scored using the evaluation criteria. A reliability coefficient of 0.89 was established. The data were analysed using paired samples t-test, independent samples t-test and Analysis of Covariance accordingly at 0.05 level of significance.

5. Results

Question 1: Will there be any effect of cooperative learning on the correction of students' misconceptions in Biology?

Hypothesis 1: There is no significant effect of cooperative learning on students' corrected misconception scores in Biology.

Table 1: Paired sample t-test showing the effect of cooperative learning on the correction of students' misconceptions

Group	N	Mean	SD	df	t-cal	Sig. (2-tailed)	Decision
Pre test	123	30.37	9.14	122	38.17	0.000	Ho is rejected
Post test	123	74.15	9.07				

P< 0.05

From Table 1 it is seen that the difference between the pre-test and post-test scores of the experimental group students is significant since the calculated sig. value of 0.000 is less than the critical sig. value of 0.05. This shows that there is an effect of cooperative learning on students' misconceptions in Biology. Therefore, $H0_1$ which states that there will be no significant effect of cooperative learning of students' corrected misconception score in Biology is rejected.

Question 2: What is the difference in the mean corrected misconception scores between students taught Biology using cooperative learning and lecture method?
Hypothesis 2: There is no significant difference in the mean corrected misconception scores between students taught Biology using cooperative learning and lecture method.

Table 2: Independent sample t-test showing mean corrected misconception score between students taught biology using cooperative learning and lecture method

Group	N	Mean	SD	df	t-cal	Sig. (2-tailed)	Decision
Cooperative Learning Method	123	74.15	9.07	238	17.42	0.000	Ho is rejected
Lecture Method	117	51.82	10.67				

P< 0.05

Table 2 shows that there was a significant difference in the mean corrected misconception scores between students taught Biology using cooperative learning and lecture method, t = 17.42, P(0.000) < 0.05. Thus, the null hypothesis was rejected. Therefore, there is a significant difference in the mean corrected misconception scores between students taught biology using cooperative learning and lecture method.

Question 3: What is the difference in the mean corrected misconception scores between male and female students taught Biology using cooperative learning?
Hypothesis 3: There is no significant difference in the mean corrected misconception scores between male and female students taught Biology using cooperative learning.

Table 3: Independent sample t-test showing Mean corrected misconception score between male and female students taught biology using the cooperative learning method

Sex	N	Mean	SD	df	t-cal	Sig. (2-tailed)	Decision
Male	52	73.15	8.61	121	1.04	0.301	Ho is accepted
Female	71	74.87	9.38				

P> 0.05

Table 3 shows that there is no significant difference between the mean achievement of male and female students taught Biology using cooperative learning, t = 1.04, P(0.301) > 0.05. Thus, the null hypothesis was not rejected. Therefore, this implies that there is no significant difference in the mean corrected misconception scores between male and female students taught Biology using cooperative learning. The treatment using cooperative learning is not sex-biased.

Question 4: Will there be any effect of the interaction of teaching methods (cooperative learning and lecture method) and sex on students' corrected misconception in Biology?
Hypothesis 4: There is no significant effect of the interaction of teaching method (cooperative learning and lecture method) and sex on students' corrected misconception in Biology.

Table 4: ANCOVA statistics on the effect of the interaction of teaching methods (cooperative learning and lecture method) and sex on students' corrected misconception in Biology

Tests of Between-Subjects Effects								
Dependent Variable: Post-Test								
Source	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**	**Partial Eta Squared**	**Noncent. Parameter**	**Observed Power[b]**
Corrected Model	30445.814[a]	4	7611.454	78.857	.000	.573	315.429	1.000
Intercept	66950.542	1	66950.542	693.631	.000	.747	693.631	1.000
Pre-Test	55.729	1	55.729	.577	.448	.002	.577	.118
Teaching Method	29576.296	1	29576.296	306.421	.000	.566	306.421	1.000
Sex	448.644	1	448.644	4.648	.032	.019	4.648	.574
Teaching Method * Sex	**59.167**	**1**	**59.167**	**.613**	**.434**	**.003**	**.613**	**.122**
Error	22682.648	235	96.522					
Total	1013643.000	240						
Corrected Total	53128.463	239						
a. R Squared = .573 (Adjusted R Squared = .566)								
b. Computed using alpha = .05								

Table 4 shows that there was no significant interaction effect between teaching method and sex on students' corrected misconception in Biology. P (0.434) > 0.05, therefore, the null hypothesis was accepted. Thus, there is no significant effect of the interaction of teaching method (cooperative learning and lecture method) and sex on students' corrected misconception in Biology. This implies that students' corrected misconception scores relative to the teaching methods is not influenced by sex as shown in Figure 1.

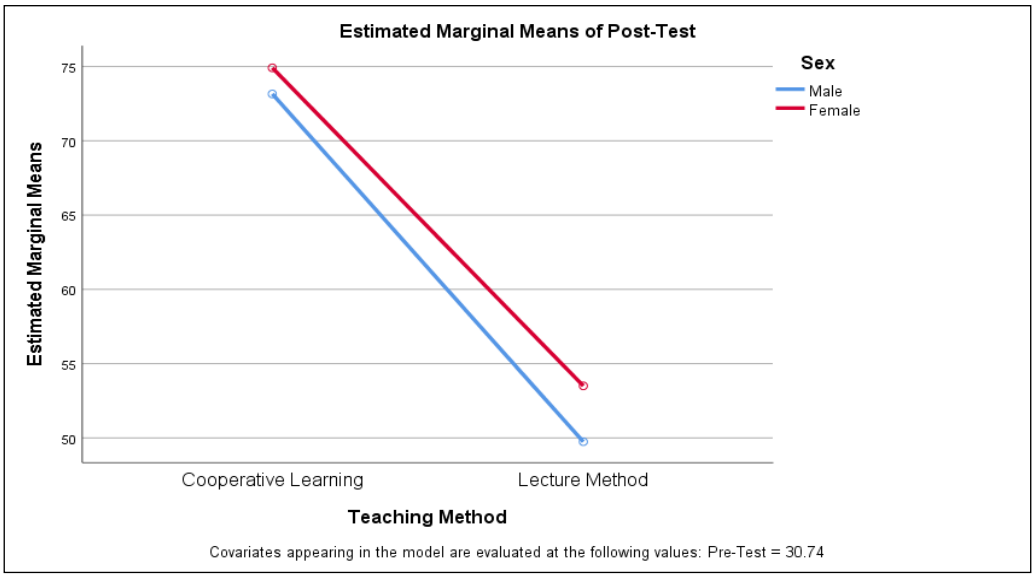

Figure 1: Plot of the interaction between teaching method and sex indicating a significant interaction effect

The plot of the interaction effect between the teaching method and sex is not significant and ordinal. This shows that the teaching methods have similar effects on the students, irrespective of their sex. Even though there were slight differences in the mean scores of male and female students, the difference was not significant in terms of the interaction of sex and teaching method.

Question 5: What is the effect of cooperative learning on students' achievement in Biology?

Hypothesis 5: There is no significant effect of cooperative learning on students' achievement in Biology.

Table 5: Paired sampled t-test showing the effect of cooperative learning on students' achievement in Biology

Group	N	Mean	SD	Df	t-cal	Sig. (2-tailed)	Decision
Pre-Test	123	33.90	10.09	122	37.96	0.000	Ho is rejected
Post-Test	123	82.33	10.01				

P<0.05

From Table 5, it is seen that the difference between the pre-test and post-test is significant since the calculated sig. value of 0.000 is less than the critical sig. value of 0.05. This shows that there is an effect of cooperative learning on students' achievement in Biology. Therefore, the null hypothesis which states that there will be no significant effect of cooperative learning on students' achievement in Biology is rejected.

Question 6: Will there be any difference in the mean Biology achievement scores between students taught Biology with cooperative learning and those taught with lecture method?

Hypothesis 6: There is no significant difference in mean Biology achievement scores between students taught with cooperative learning and those taught with the lecture method.

Table 6: Independent sample t-test showing mean biology achievement scores between students taught biology with cooperative and those taught with lecture method

Group	N	Mean	SD	df	t-cal	Sig. (2-tailed)	Decision
Cooperative Learning Method	123	82.33	10.01	238	17.54	0.000	Ho is rejected
Lecture Method	117	57.66	11.75				

P< 0.05

From Table 6, it is seen that difference between post-test scores of cooperative learning and lecture method groups is significant since the calculated sig. value of 0.000 is less than the critical sig. value of 0.05. The null hypothesis which states that there will be no significant difference in mean Biology achievement scores between students taught with cooperative learning and those taught with the lecture method is rejected. This shows that there is a significant difference in mean Biology achievement scores between students taught with cooperative learning and those taught with the lecture method.

6. Discussion

The first finding of this study revealed that there was a significant effect of cooperative learning on the correction of students' misconceptions in Biology. The study actively demonstrates that students taught using cooperative learning significantly performed better, this was because their misconceptions in biology were greatly reduced. This observation is based on the fact that the post-test scores of all the students taught biology using cooperative learning increased greatly after treatment. This increment is not due to chance but as a result of treatment with the use of cooperative learning. This suggests that students were actively engaged in the learning process, communicating with each other, and, for the most part, working as a team on their assignments. The students were more involved and competent, each student had a definite opinion on the subject but was required to argue both sides of the issue. This gave them a much broader understanding of biology concepts. Weak students working individually are likely to give up when they get stuck but they keep going when working cooperatively. When asked to explain and clarify topics to lesser students, strong students frequently discover holes in their own comprehension and fill them in.

The second finding of this study revealed that there is a significant difference in the mean corrected misconception scores between students taught Biology using cooperative learning and lecture method. This suggests that the students may have been more active and involved in the learning process which has contributed to their high achievement scores. This implies that cooperative learning reduced students' misconceptions in Biology since students had higher scores after being taught with the cooperative learning method when compared with the lecture method. In cooperative

learning, the debate of ideas within groups, referred to as argument, ideally promotes learning by helping students become more aware of their own level of understanding and by forcing them to reconsider their ideas in response to alternative and potentially conflicting views (misconceptions). Similarly, Abdullah and Sharriff (2008) reported that secondary school students who were taught gas laws through a cooperative learning approach outperformed those taught through the regular teaching method (lecture method) in conceptual understanding. In cooperative learning, team members are held accountable to provide an explanation to others in the team and this presents an opportunity to re-examine their understanding, unlike the lecture method where students have left to figure things out on their own. Interaction of students through discussions in cooperative teams enables them to evaluate different points of view and make decisions on problems which provides them with a better understanding. When students give explanations, they need to digest, connect and combine what they already know with the newly developed concept, sometimes even discard old knowledge and this enables them to discover further applications of the newly developed concept (Abdullah and Sharriff, 2008).

The third finding of this study revealed that there is no significant difference in the mean corrected misconception scores between male and female students taught Biology using cooperative learning. The study showed that there was no difference in the performance of male and female students taught using cooperative learning which then implies that all students irrespective of their sexes benefited from the use of the cooperative learning strategy. This means that cooperative learning is not sex-biased and this is very important in the teaching and learning process since science courses to be read are not gender-based. This is in agreement with the findings of Ajaja and Eravwoke (2012) whose study showed that male and female students who studied biology with cooperative learning did not differ in achievement. Wachanga and Mwangi (2004) also found no significant differences between boys and girls who were exposed to cooperative learning in chemistry. The boys and girls in the experimental groups who were instructed through cooperative learning in chemistry outperformed their counterparts in the control group who were instructed through the traditional lecture method approach.

The fourth finding of this study revealed that there is no significant effect of the interaction of teaching methods and sex on students' corrected misconception in Biology. The study showed that there was no significant interaction between methods on sex, this shows that students' achievement is solely based on the method used and not because of their sex. Similarly, Adeyemi (2008) reported no significant differences in the academic achievement of boys and girls of equivalent abilities when they were taught social studies through a cooperative learning approach. This implies that combining sex and the teaching method does not have an effect on students' achievement scores. The difference in achievement scores among students taught biology using cooperative learning or lecture method may not be linked with sex but the teaching method used.

The fifth finding of this study revealed that there is a significant effect of cooperative learning on students' achievement in Biology. Several reasons could be

attributed to the gain in students' academic scores. These reasons are mostly characteristic of the cooperative learning method that promotes effective learning. Firstly, it is attributed to the socially oriented learning environment of the cooperative learning method that facilitates effective learning (Vygotsky, 1978). Such a learning environment enabled students to interact, share ideas and support each other in their learning (Johnson & Johnson, 1990). The second reason to account for such improvement could be the equal opportunity that each member of the group had for success. Students in a group made sure that each member understood the material they were learning. This was consistent with the findings of Juweto (2015), who examined the effect of the cooperative learning method on students' achievement and attitude towards biology in Delta State and concluded that the cooperative learning method increased students' achievement and promoted a positive attitude towards studying biology.

The sixth finding of this study revealed that there is a significant difference in the mean Biology achievement scores between students taught with cooperative learning and those taught with the lecture method. This was based on the fact that the post-test scores of students taught Biology using cooperative learning were higher than those taught Biology using the lecture method. Students in the lecture method group had little or no involvement in their own learning, unlike students that worked cooperatively in small groups and discover facts for themselves. This finding was consistent with Ugwuadu and Abdullahi's (2012) research which found that students studying biology with the cooperative learning method learned, retained and scored better than students taught by the lecture method. The finding was also congruent with the findings of Kimamo and Muraya (2011) that there were significant gains in the mean achievement test scores in Biology of students taught using cooperative learning compared to the students taught using the lecture method.

7. Conclusion and Recommendations

Based on the findings of this study, the following conclusions were drawn: Since one of the findings of the study showed that cooperative learning significantly reduces students' misconceptions in Biology, it is concluded that this method could be one of the best methods to teach Biology at senior secondary school levels. Secondly, another finding of the study showed that cooperative learning has a positive influence on students' achievement, it is concluded that this method could be one of the best methods to teach Biology. Thirdly, another finding of the study showed that the use of cooperative learning has the same positive effect on male and female students' achievement taught with the method and does not interact with sex to influence students' achievement, it is concluded that the method could be one of the best in the teaching of Biology irrespective of sex.

In light of the results of this study, the researcher recommends the following:

1) The Ministry of Education should organise special trainings for practicing teachers that will focus on the use and implementation of cooperative learning so as to reduce students' misconceptions thus improving students' achievement at all

levels. This will ensure that science teachers are well-grounded on effective teaching and learning approaches for higher academic achievement in biology.

2) At the universities, the use and implementation of cooperative teaching strategies in the classrooms should be emphasized in the courses being offered by the student-teachers.
3) Biology teachers and science teachers, in general, should be encouraged to use a cooperative learning approach as an alternative to the traditional lecture method in order to enhance students' academic achievement and reduce students' misconceptions in Biology.

Conflict of Interest Statement

The authors declare no conflicts of interest.

About the Authors

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References

Ajaja, O. P. (2009). Teaching methods across disciplines. Ibadan: Boom Prints.

Ajaja, O. P. (2013). Which strategy best suits biology teaching? Lecturing, concept mapping, cooperative learning or learning cycle? *Electronic Journal of Science Education*, 17(1), 2-36.

Ajaja, O. P., & Eravwoke, O. U. (2010). Effects of Cooperative Learning Strategy on Junior Secondary School Students Achievement in Integrated Science. *Electronic Journal of Science Education*, 14(1), 2-18.

Anyafulude, J. (2014). Effects of problem-based learning strategy on students' achievement in senior secondary school chemistry in Enugu state. *IOSR Journal of Research and Method in Education*, 4(3), 27-31.

Bligh, D. A. (2000). What's the use of lectures, San Francisco. C.A. Lossey Bass.

Bransford, J., Brown, A. L., Cocking, R. R. (2000). National Research Council (U.S.). Committee on Developments in the Science of Learning, and National Research Council (U.S.). Committee on Learning Research and Educational Practice. How people learn: Brain, mind, experience, and school (Expanded ed.). Washington, DC: National Academy Press.

Briner, R. B. (1999). The neglect and importance of emotion at work. *European Journal of Work and Organizational Psychology*, 8, 323 – 346.

Buaraphan, K. (2011). Pre-service physics teachers' conceptions of nature of science. US-China Education Review, 8(2), 137-148.

Cakir, M. (2008). Constructivist approaches to learning in science and their implications for science pedagogy: A literature review. *International Journal of Environmental & Science Education*, 3 (4), 193-206

Federal Ministry of Education (2007). Senior Secondary School Curriculum: Biology for Senior Secondary Schools. Abuja. Nigerian Educational, Research & Development Council (NERDC).

Federal Republic of Nigeria (2013). *National Policy on Education*. Lagos: NERDC Press.

Goldsmith, P. A. (2006). Learning to understand inequality and diversity: Getting students past ideologies. *Teaching Sociology, 34*(3), 263-277.misconceptions. *Evolution: Education and Outreach*, 7(7).

Johnson, D. W., Johnson, R., & Holubec, E. (2013). Cooperation in the classroom (9th ed.). Edina, MN: Bayrakçeken, S., Doymuş, K., and Doğan, A. (2013). İşbirlikli Öğrenme Modelive Uygulanması. Ankara: Pegem Akademi. Interaction Book Company.

Juweto, G. A. (2015). Effects of jigsaw cooperative teaching/learning strategy and school location on students' achievement and attitude towards biology in secondary school in Delta State. Delta State University Abraka, Nigeria.

Kocukozer, H. & Kucakulah, S. (2007). Secondary school students' misconceptions about simple electric circuits. *Journal of Turkish Science Education*, 4(1) 101-115.

Laal, M., Laal, M., & Khattami-Kermanshahi, Z. (2012). 21st century learning; learning in collaboration. *Journal of Procedia - Social and Behavioral Sciences*, 47, 1696 – 1701.

Lantolf, J. P. (2000). Second language learning as a mediated process. Language Teaching 33: 79-96.

Law, Y. (2011). The effects of cooperative learning on enhancing Hong Kong fifth graders' achievement goals, autonomous motivation and reading proficiency. *Journal of Research in Reading*, 34(4), 402–425.

Liang, T. (2002). Implementing Cooperative Learning in EFL Teaching: Process and Effects (Doctoral dissertation, National Taiwan Normal University). Retried 18/08/2021 from http://www.asian-efl-journal.com/Thesis_Liang_Tsailing.pdf.

Lilienfeld, S. O. (2010). Confronting psychological misconceptions in the classroom: Challenges and rewards. *APS Observer*, 23(7). 36-39.

Lord, T. R. (1994). Using cooperative learning in the teaching of high-school biology. Am. Biol. Teach. 56(5), 280 –284.

Mtsem, A. A. (2011). Effects of diagnostic and contextual instructional strategy on students' interest and achievement in secondary school algebra. A PhD thesis of the Faculty of Education, Benue State University, Makurdi.

Muraya, D. N., & Kimamo, G. (2011). Effects of cooperative learning approach on biology mean achievement scores of secondary school students' in Machakos District, Kenya. *Educational Research and Reviews*, 6(12), 726-745.

Nwagbo, C. R. (2005) Attainment of Professionalism in Science Education: Competencies and Skills needed by Biology Teachers. *46th Annual Proceeding of Science Teachers Association of Nigeria,* 183-189.

Prince V. (2005). Sex vs gender. *International Journal of Transgenderism* 8(4): 29–32.

Salau, M. O. (2002). The effects of class size on achievement of different ability groups in mathematics. *Journal Science Teachers' Association of Nigeria*, 31 (1), 27-33.

Taylor, A. & Kowalski, P. (2014). Student misconceptions: Where do they come from and what can we do. In V. Benassi & C. Overshon, & C. Hakala (Eds.), *Applying science of learning in education: Infusing psychological science into the curriculum*. Washington, DC: American Psychological Association.

Trowbidge, L. W., & Bybee, R. W. (1996). *Teaching secondary school science: Strategies for developing scientific literacy.* New Jersey: Prentice Hall Inc.

Ugwuadu, O. R., & Abdullahi, S. (2012). Effect of cooperative learning strategy on biology students' academic achievement in Yola Educational Zone of Adamawa State. Knowledge Review. 24(1).

Vygotsky, L. S. (1978). *Mind in Society: The Development of Higher Psychological Processes*. Cambridge, MA: Harvard University Press.

Wachanga, S. W., & Mwangi, J. G. (2004). Effects of cooperative class experiment teaching method on secondary school students' chemistry achievement in Kenya's Nakuru District. *International Educational Journal*, 5(1), 26-36.

Wertsch, J. V. (1985). Vygotsky and the social formation of mind. Cambridge, MA: Harvard University Press.

West African Certificate Examinations (2004). Biology WASSCE Curriculum, Lagos: WAEC.

Yates, B. T., & Marek, E. A. (2014). Teachers teaching misconceptions: a study of factors contributing to high school biology students' acquisition of biological evolution-related. Retrieved from https://evolution-outreach.biomedcentral.com/articles/10.1186/s12052-014-0007-

2#:~:text=Research%20has%20revealed%20that%20high,fundamental%20barriers%20to%20understanding%20evolution.