CROSSOVER LEARNING AND COOPERATIVE LEARNING: EFFECTIVENESS OF THESE INSTRUCTIONAL STRATEGIES ON STUDENTS' ACHIEVEMENT IN BIOLOGY

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Abstract
The study investigated the effects of crossover learning strategy and cooperative learning strategy on students' achievement in Biology. Quasi-experimental pre-test, post-test non-equivalent group design was adopted for this study. Area of study is Nsukka Local Government Area of Enugu State. The population of this study comprised all the public Senior Secondary one Biology students in Nsukka Local Government Area for the 2023/2024 academic session numbering 2,637 and 31 co-educational schools. A sample size of 150 SS1 Biology students was involved in the study. Random sampling technique was used to sample two intact classes each from two public co-educational schools which were assigned to the two experimental groups. The two experimental groups were exposed to pre-test and post-test respectively. The instrument for data collection is Biology Achievement test (BAT) which was validated and trial tested with the reliability index of 0.82. Two research questions and two null hypotheses guided the study. Research questions were answered using mean and standard deviation while analysis of covariance (ANCOVA) was used in testing the hypotheses of 0.05 level of significance. Findings showed that students who were taught using crossover learning strategy achieved higher than those taught with cooperative learning strategy. Furthermore, the female students achieved higher than their male counterparts and this was not statistically significant. In line with this study, it was recommended that policy makers and the curriculum planners should incorporate innovative instructional strategies, such as crossover learning strategy into the curriculum and other teacher-education programmes. This is to enhance students' academic achievement in biology.

Keywords: Crossover learning strategy, cooperative learning strategy, Achievement, Gender

Introduction

Biology is the branch of science that deals with study of plants and animals in their natural environment. It is also a branch of science that deals with the study of living things, which includes human beings. Biology is a natural science that studies how life first came to be, how the living world works, its functions and how these living things interact with one another in their environment (Asuzu & Okoli, 2019). Biology is one of the science subjects offered in Nigeria secondary schools and most students like to take up the subject. The study of biology is therefore paramount to encourage students to understand and adequately apply its knowledge in solving human problems. Hence, its importance to man and national development is evident. According to (Nwuba, Egwu, Awosika & Osuafor, 2022), Biology offers the knowledge needed for modern agriculture, food production, forestry, resource conservation, environmental protection and bioengineering. In the same vein, Ibrahim (2015) stated that, biology offers skills and knowledge that contributes to the wellbeing of man, living organisms and their environment as well. To achieve this, one has to rely on the knowledge and understanding of biology, its theories and applications to everyday life.

In spite of the importance of biology, students' achievement in the subject in external examinations such as West African Secondary School Certificate Examinations (WASSCE) has remained unsatisfactory. This is evident in WAEC Chief Examiner's report of 2018-2021

with raw mean scores of 30, 31, 26 and 22 respectively. Researchers like Nwuba, et al., 2022; Okoro, 2018; Okafor and Okoli, 2020, have associated this poor academic outcome to many factors, ranging from students' factors to environmental factors and the teaching methods. In this respect, various findings carried out by some researchers adopted different instructional methods and strategies that may help improve students' achievement yet, students' achievement in biology have remained low. Academic achievement is the outcome of learning which is expressed as the extent to which instructional objectives have been met. Jimoh (2014) corroborates that academic achievement is the level of success attained by students in school subjects. Similarly, Ezenwosu and Nworgu (2013) referred to students' academic achievement as the degree of success attained by students after being exposed to a specific area of study or field work. Therefore, academic achievement is the learning outcomes of students from what they are taught by their teachers within the classroom. It is commonly measured by the means of class assignments, tests and examinations like West Africa Examination Council (WAEC) and National Examination Council (NECO). Hence, students' achievement is either high or low based on the degree of success attained through their scores and grades.

Some of the factors that contribute to students' low achievement with reference to literature include large class size, voluminous curriculum contents, students' learning styles and use of ineffective instructional teaching strategies by biology teachers (Nwagbo and Okoro, 2012, Okoyefi, 2014 and Okoro 2021). Based on the opinions above, the researcher concluded that academic achievement of students is dependent on the type of instructional strategies adopted by the teacher. Therefore, the need to explore other innovative instructional strategies that could help enhance students' achievement in biology becomes necessary. One of such innovative instructional strategies is the crossover learning strategy.

Crossover learning strategy refers to an understanding of learning that connects formal and informal learning environment. Crossover learning is an innovative teaching methodology that seeks to establish connection between formal and informal education (Matilde, 2022). It is an innovative learning strategy that brings together the best aspects of formal and informal learning environments aimed towards providing students with the best of both environment (BoredTeachers, 2017). According to the authors, the main idea behind crossover learning is the combination of formal (institutional) learning in the classroom with informal (self-directed) learning outside the classroom. Crossover learning provides direct experience to the students through direct interaction with nature.

An effective way to implement crossover learning involves the teacher introducing thought provoking questions in the formal classroom setting and students must try to find the answers in the informal setting they visit. Students are asked to take notes, collect photos, or any other data that can help extract as much information as they can and also by asking other people for their own thoughts. They are presenting what they learnt back in the classroom to further illuminate the given problem (Panke, 2017). When students gain knowledge at school, it is referred to as formal learning while learning gained outside of school, at home, or in the community is referred to as informal learning. Srinivasa, Kurni, & Saritha (2022) posited that the teacher should state the topic to be learnt and the instructional objectives of the lesson before the academic visit to the informal learning environment. The authors asserted that these stated instructional objectives are expected to guide and drive the students as they explore, collect photographs or documents as evidence, then submit their responses either individually or in groups back to the classroom.

So far, formal education takes place in schools, within a classroom and learning is based on a syllabus and the curriculum structured in education. Informal learning occurs at home, in the community, among friends, in homeschooling, in private, and in other settings. Learning outside of the formal schooling system supports the development of a child's skills. Likewise, bringing informal learning into the classrooms can enrich textbook knowledge with personal

experience (Joseph, et al., 2023). The author further stressed that crossover learning provides direct experience to students, through first-hand experience with nature, giving them freedom to experiment, make errors, and fully grasp things, develop competence and self-confidence. In other words, crossover learning creates an atmosphere for active participation of students in the learning process which could in turn improve students' achievement. Another strategy that encourages active students' participation and could possibly enhance students' achievement is cooperative learning.

Cooperative learning is a strategy used in teaching small number of students to work together on a common task and encouraging one another to improve their learning through cooperation with one another. Cooperative learning is a widely used instructional strategy that emphasizes group work and peer interaction to promote student learning and achievement (Slavin, 2022). It is an instructional strategy in which small groups, each with students of diverse ability levels use a variety of learning activities to improve student learning experiences (Arra, Antonio, & Antonio, 2011). Cooperative learning cannot be taught through verbal instruction but through a process that involves students working together in groups, developing ideas and solving problems using cooperative learning skills. Students in a group interact with each other, share ideas and information, seek for additional information and make decisions about their discoveries for the whole class. Conducting cooperative learning does not mean that we simply let students sit next to each other at the same desk and ask them to do their own tasks rather structuring positive interdependence (Gilles, 2016). A cooperative learning environment will exist if the group members coordinate activities to facilitate one another's learning. This involves a variety of learning activities to improve students' understanding of a topic. Hence, cooperative learning might help in improving students' achievement in biology irrespective of their gender.

Gender refers to the social or cultural construct, characteristics, behaviors and role which society ascribes to males and females. Onah (2011) refers to gender as the content of masculinity and femininity found in an individual. Godpower-Echie and Owo (2019) described gender as roles, attitudes, and values assigned according to a sociocultural construct that is regarded suitable for each sex. Additionally, Nwuba et al., 2023) sees gender as a characteristic based on biological differences that distinguishes males and females. Gender issues in relation to how it affects biology students' instruction and achievement have remained inclusive to numerous scholars in Science Education and senior secondary schools. For instance, while some researchers like Katcha et al. (2018) and Owolabi et al. (2019) found out that in biology, female students did better than male students, others like Anenye and Osuafor (2023); Nwuba and Osuafor (2021) say otherwise, even Rumalolas et al., (2021) found no difference between the two genders. In light of this, this study seeks to find out the effectiveness of crossover learning and cooperative learning strategies in improving the academic achievement of students in biology.

Purpose of the Study

The purpose of this study was to investigate the effect of crossover learning and cooperative learning strategies on students' achievement in Biology. Specifically, the study sought to determine the:

1. effects of crossover learning and cooperative learning strategies on students' mean achievement scores in Biology.
2. influence of gender on students taught crossover learning and cooperative learning strategies on senior secondary school students' achievement in Biology.

Research Questions

The following research questions guided the study:

1. What are the effects of crossover learning and cooperative learning strategies on students' mean achievement scores in Biology?
2. What is the influence of gender on students taught crossover learning and cooperative learning strategies on students' achievement in Biology?

Hypotheses

The following null hypotheses were tested at 0.05 level of significance:

1. There is no statistically significant difference between the mean achievement scores of students taught Biology using crossover learning strategy and those taught using cooperative learning strategy.
2. There is no significant difference in the mean achievement scores of male and female students taught Biology using crossover learning and cooperative learning strategies.

Method

The study employed quasi-experimental non-equivalent group design. Area of study is Nsukka Local Government Area of Enugu State. The population of this study comprised all the public Senior Secondary one Biology students in Nsukka Local Government Area for the 2023/2024 academic session numbering 2,637 from 31 schools. A sample size of 150 SS1 Biology students was involved in the study. Random sampling technique was used to sample two public co-educational schools. Two intact classes were randomly sampled from each of the schools which were assigned to the two experimental groups. The two experimental groups were exposed to pre-test and post-test respectively. The instrument for data collection is Biology Achievement test (BAT). The BAT consists of 30 multiple choice questions which have four options A, B, C, and D, scored one mark each with a total of 30 marks. The test was developed by the researcher from the specified content "Ecology of population" and also from past questions using Table of specification. The objectives of the topics served as a guide in developing the questions. The BAT was validated and trial tested with the reliability index of 0.82 using Kuder-Richardson's formula (KR-20).

One week training was organized for the training of the four research assistants who were the regular classroom teachers of the schools for this study. These teachers were trained on how to use the lesson notes prepared by the researcher to teach the students using crossover learning and cooperative learning strategies. At the end of the training, the teachers were allowed to demonstrate what they have been taught to ascertain if they understood the lesson plan. Before the commencement of the treatment, the research assistants administered the pretest to the students to ascertain their previous knowledge on Biology. The research assistants carried on with the experiment based on the earlier training and taught the two experimental groups for four weeks, each with the prepared lesson plan covering the content area. Intact classes were used for the study and students received the same content of biology lesson that lasted for 70 minutes. At the end of the experiment, the subjects for both experimental groups were given the BAT by their teachers as Post-test after which the research assistants collected the scripts for marking and scoring and then handed over to the researchers for collection and data analysis. Two research questions and null hypotheses guided the research. Research questions were answered using mean and standard deviation while analysis of covariance (ANCOVA) was used in testing the hypotheses of 0.05 level of significance.

Results

This chapter presents the results of data analysis and major findings of this study based on the research questions that guided the study.

Research Question One: What is the effect of crossover learning and cooperative learning strategy on students' mean achievement scores in Biology?

Table 1: Mean and standard deviation achievement scores of students taught biology using crossover learning strategy and those taught using cooperative learning strategy

		Pre-test		Post-test		
Teaching strategy	**N**	**x̄**	**SD**	**x̄**	**SD**	**Mean Diff.**
Crossover learning strategy	77	18.70	3.52	27.04	3.40	8.34
Cooperative learning strategy	73	17.14	3.51	22.34	3.64	5.20

From Table 1, the pre-test mean and the standard deviation scores for students taught Biology using crossover learning strategy are 18.70 and 3.52 while the pre-test mean and the standard deviation score for those taught using Cooperative learning strategy are 17.14 and 3.51 respectively. The post-test mean and standard deviation score for students taught Biology using crossover learning strategy are 27.04 and 3.40 while the post-test mean and standard deviation scores for those taught using Cooperative learning strategy are 22.34 and 3.64 respectively. The mean gain scores of 8.34 and 5.20 revealed that the students taught with crossover learning strategy outperformed those taught with Cooperative learning strategy.

Hypothesis One: There is no significant difference between the mean achievement scores of students taught Biology using crossover learning strategy and those taught using Cooperative learning strategy.

Table 2: ANCOVA showing significant difference in the mean achievement of students taught biology using crossover learning strategy and those taught using cooperative learning strategy

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	935.639a	4.00	233.91	19.72	0.00	0.35
Intercept	2209.20	1.00	2209.20	186.22	0.00	0.56
Pre-test Achiv	106.62	1.00	106.62	8.99	0.00	0.06
Teaching- strategy	621.60	1.00	621.60	52.40	0.00	0.27
Gender	1.88	1.00	1.88	0.16	0.69	0.00
Teaching_ strategy * Gender	3.41	1.00	3.41	0.29	0.59	0.00
Error	1720.23	145.00	11.86			
Total	94565.00	150.00				
Corrected Total	2655.87	149.00				

a. R Squared = .352 (Adjusted R Squared = .334)

Table 2 shows F-ratio of 52.40 with associated probability (Sig.) of 0.001 and effect size of 0.27 under Teaching- strategy. The associated probability level is less than the 0.05 level of significance stated for testing of the null hypothesis. Therefore, the null hypothesis is rejected, which implies that there is a significant difference in the mean achievement scores of students taught Biology using crossover learning strategy and those taught using Cooperative learning

strategy, in favour of the group taught using crossover learning. The significant difference is evident in the moderate effect size of 0.27.

Research Question Two: What are the mean achievement scores of male and female students taught Biology using crossover learning strategy and those taught using Cooperative learning strategy?

Table 3: Mean and standard deviation achievement scores of students taught biology using crossover learning strategy and those taught using cooperative learning strategy

		Pre-test		Post-test		
Gender	**N**	**$\bar{x}$**	**SD**	**$\bar{x}$**	**SD**	**Mean Gain.**
Male	66	17.79	3.94	24.27	4.08	6.48
Female	84	18.06	3.32	25.13	4.32	7.07

Table 3 shows that the pre-test mean and standard deviation achievement scores for male students taught Biology using both strategies are 17.79 and 3.94 while the pre-test mean and standard deviation achievement scores for female students are 18.06 and 3.32 respectively. The post-test mean and standard deviation achievement scores for the male students are 24.27 and 4.08 while post-test mean and standard deviation achievement scores for the female students are 25.13 and 4.32 respectively. The mean gain scores of 6.48 and 7.07 revealed that female students slightly outperformed their male counterparts.

Hypothesis Two: There is no significant difference between the mean achievement scores of male and female students' taught Biology using crossover learning strategy and those taught using Cooperative learning strategy?

Table 2 shows F-ratio of 0.16 with associated probability (Sig.) of 0.69 and effect size of 0.00 under gender. The associated probability level is greater than the 0.05 level of significance stated for testing of the null hypothesis. Therefore, the null hypothesis is not rejected, which implies that there is no significant difference in the mean achievement scores of male and female students. In other words, gender has no significant influence on students' achievement in Biology.

Discussion of the findings

The research result showed that crossover learning strategy was superior and more effective than the cooperative learning strategy in enhancing students' achievement in Biology. The high achievement of students taught using crossover learning strategy could possibly be due to the fact that students took active participation in their learning, as they explored nature and exchanged ideas during their informal learning process. This process fostered positive and independent thinking, enhance their abilities to integrate and synthesize academic materials and enhance understanding as reflected in higher achievement scores. This finding is in agreement with the study of Nwuba, et al., 2023 on examining of crossover instructional strategy toward biology students' academic performance in secondary schools which found out that Crossover instructional strategy increased students' academic achievement more than the Conventional lecture method. This study is also in tandem with the study of Joseph, et al., 2023 who studied Crossover learning as an innovative strategy for environmental education and the study revealed that crossover learning is an effective strategy for enhancing environmental education. Also, female students achieved higher than their male counterparts although it was not significant. This shows that the instructional strategy is gender friendly because it gave

both gender equal opportunities to explore nature and interact with each other during the instructional process. This result is in line with the findings of Nwuba, et al., 2023, Nwuba and Osuafor (2021); and Onu et al. (2020) who reported in their respective studies in biology that innovative instructional strategies similar to crossover instructional strategy are gender friendly, fostering and promoting students' academic achievement irrespective of gender. Therefore, crossover learning is a good instructional strategy in improving students' academic achievement and should be used in the teaching and learning of biology.

Conclusion

From the results obtained in the study on "crossover learning and cooperative learning: effectiveness of these instructional strategies on students' achievement in biology' it was found that students taught biology using crossover learning strategy performed better than their counterparts taught using cooperative learning strategy. Although, both instructional strategies actively involved students in the learning process which enhanced their problem-solving skills and reasoning which in turn improved their academic achievement, crossover learning strategy had more effect on students' academic achievement than cooperative learning strategy.

Recommendations

Based on the findings of this study, the following recommendations were made; Policy makers and the curriculum planners should incorporate innovative instructional strategies, such as crossover learning into the curriculum and other teacher-education programmes. This is to enhance students' academic achievement in biology and other sciences. Also, in-service training, workshops and seminars should be organized to train practicing teachers on the effective use of crossover learning strategy in bringing about greater achievement in biology.

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