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Examining of crossover instructional strategy toward biology students' academic performance in secondary schools

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Abstract: The study investigated how the crossover instructional strategy (CIS) affected secondary school students' biology academic performance in Onitsha Education zone. The non-randomized control group design, a quasi-experimental research strategy, was used in the study. A multi-stage sampling technique was used to choose 52 Senior Secondary Year Two (SS2) students (21 boys and 31 girls) from the 5,132 biology students in the zone. A coin toss was used to assign the sampled students, who were enrolled in two intact classes, to the control (10 males and 15 girls) or experimental (11 boys and 16 girls) groups at random. The researchers created a 50-item biology achievement test (BAT), which has a reliability coefficient of 0.81. The results demonstrated that CIS increased biology students' academic success more than the Conventional Lecture Method (CLM). Biology student academic achievement was unaffected by gender either alone or in combination with the teaching strategies. The research found that CIS is a cutting-edge educational strategy that actively involves students in the learning process in both formal and informal settings, helping them retain biology concepts and ultimately improve their academic performance. In accordance with the findings, the study recommended that biology teachers implement CIS in schools to improve students' biology achievement.

Keywords: Academic achievement, biology, crossover instructional strategy, gender

Abstrak: Studi ini menyelidiki bagaimana strategi pembelajaran silang (SPS) mempengaruhi kinerja akademik biologi siswa sekolah menengah di zona Pendidikan Onitsha. Desain kelompok kontrol non-acak dalam penelitian kuasi-eksperimental telah digunakan pada penelitian ini. Teknik pengambilan sampel multi-tahap digunakan untuk memilih 52 siswa Sekolah Menengah Atas (SMA) kelas dua (21 laki-laki dan 31 perempuan) dari 5.132 siswa biologi di zona tersebut. Pengambilan secara acak digunakan untuk menempatkan siswa ke dalam sampel yang terdaftar di dua kelas utuh ke kelompok kontrol (10 laki-laki dan 15 perempuan) dan eksperimen (11 laki-laki dan 16 perempuan). Peneliti membuat 50 soal tes prestasi biologi (TPB) yang memiliki koefisien reliabilitas 0,81. Hasilnya menunjukkan bahwa SPS meningkatkan keberhasilan akademik siswa biologi lebih dari Metode Pengajaran Konvensional (MPK). Prestasi akademik mahasiswa biologi tidak dipengaruhi oleh jenis kelamin baik sendiri atau dalam kombinasi dengan strategi pengajaran. Penelitian ini menemukan bahwa SPS adalah strategi pendidikan mutakhir yang secara aktif melibatkan siswa dalam proses pembelajaran baik di lingkungan formal maupun informal, membantu mereka mempertahankan konsep biologi dan pada akhirnya meningkatkan kinerja akademik mereka. Sesuai dengan temuan, penelitian ini merekomendasikan agar guru biologi mengimplementasikan SPS di sekolah untuk meningkatkan prestasi belajar biologi siswa.

Kata kunci: Prestasi akademik, biology, strategi pembelajaran silang, gender

INTRODUCTION

Biology, a pure science subject taught in Nigerian high schools, has been recognized by many as a tool for modern day wealth creation and scientific advancements. Nwuba et al.

(2022) defined biology as the branch of science that studies plants and animals in their environment. It is a natural science that investigates how the living world works, its functions, how life first came to be, and how living things interact with one another and their surroundings (Asuzu & Okoli, 2019). Hence, Biology is a branch of natural sciences that focuses on living organisms, their life styles and relationships with each other.

As a subject, whose tenets ranges from human to industrial applications, its importance to man cannot be overemphasized. For instance, Basila and Ajua (2019) stated that the knowledge of biology forms the bedrock for science needed for technological boom of the nation in areas of medicine, agriculture, forestry, biotechnology, nursing and so on. Supporting the premise, Nwuba, Egwu, and Osuafor (2022) highlighted that biology's significance cannot be overstated because it offers the knowledge needed for modern agriculture, food production, environmental protection, resource conservation, and bioengineering.

Despite these importance of biology to national development, students' performance in the subject in external examinations such as West African Secondary School Certificate Examinations (WASSCE) has remained unsatisfactory. Many researchers (Attamah & Okoli, 2021; Nwuba, et al., 2022; Nwuba & Osuafor, 2021; Okafor & Okoli, 2020) have ascribed this disappointing academic outcome to many factors, ranging from students' personal factors to the various environmental factors, which exert influence in the teaching process. In light of the various study findings, many research works have been carried out and published on instructional methods and approaches that may be adopted to improve students' performance but still, students' performance have not yet adjusted to the expectations of those involved in education. Taking cognizance of the premise, the study solicited for the adoption and implementation of crossover instructional strategy in the academic process to ascertain its impact on students' academic performance in biology.

Crossover instructional strategy refers to a thorough knowledge of learning that integrates informal and formal learning environments. Matilde (2022) defined it as an innovative teaching methodology that seeks to establish connection between formal and informal education. It is an innovative learning strategy that brings together the best aspects of formal and casual learning environments aimed towards providing students with the best of both (BoredTeachers, 2017). Hence, crossover instructional strategy may simply be defined as an innovative instructional approach that applies the tenets of both the formal and informal classroom environment to promote learning.

For effective implementation of crossover learning strategy in a classroom, Srinivasa et al. (2022) posited that the teacher should objectively state the topic to be learnt and the instructional objectives of the lesson before the academic visit to the informal learning environment. Srinivasa et al. 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 alone or in groups—back to the classroom.

Srinivasa et al. stressed that in using this strategy, students are provided with a dependable setting to benefit from educational possibilities as cross learning strategy allows students to record, incorporate, reference and expand their range of educational experiences, anytime and any day.

When effectively implemented, the benefits associated with crossover instructional strategy, in the teaching and learning of science in a 21st century classroom, cannot be overemphasized. This may be why the 2015 pedagogy report identifies "crossover learning" as one of ten technologies potentially impacting education significantly (Sharples et al., 2022) 2015). Supporting the premise, Joseph et al. (2023) in their study on crossover learning strategy asserted that the strategy 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. Similarly, Popova (2019) claimed that crossover learning increases students learning autonomy, boots their motivation and enriches their formal linguistic knowledge with hands-on experience under the guidance of the teacher. Stressing further, Popova posited that crossover learning can contribute to students' learning, spark their interest and motivation, foster development of skills and competencies, as the strategy not only makes the learning process more engaging but also expose the students to the real aim of learning, for improved academic achievement.

Academic achievement is a measurable outcome of an educational programme. Nwuba, et al. (2022) defined it as a numerical measurement of a student's success in a rigorous academic program. It is the extent to which a student has acquired the expected academic knowledge, skills, and abilities after classroom instruction (Ezeugbor et al., 2019). Hence, Academic achievement, in the context of this study, is simply the product of one's time, hard work and devotion after being exposed to a learning program, usually measured in grades. In any organized formal teaching and learning process, assessment of whether learning has taken place or not is central and paramount.

In his study, Ekhasemomhe (2010) explains the significance of evaluation as follows: to identify student development in acquiring desired attitudes, abilities, understanding, and social values; to encourage students to develop a sense of responsibility; to evaluate the relative effectiveness of the program about student behavior; and to assist teachers in determining the efficacy of their teaching techniques and learning materials. Considering the aforementioned benefits of academic achievement, it is fair to infer that the development of strong academic skills is the primary objective of any academic setting. Consequently, the purpose of this study was to determine the effect of cross-gender instruction on students' academic achievement.

Gender is a biological feature that distinguishes males from females. Godpower-Echie and Owo (2019) defined it as a roles, attitudes, and values assigned according to a sociocultural construct that is regarded suitable for each sex. It as a characteristic based on biological differences that distinguishes males and females (Nunaki et al., 2019; Nwuba et al.,

2023). Therefore, gender can be defined essentially as an attribute assigned to males and females based on their social and biological characteristics. Issues related to how gender affects biology instruction and learning have garnered the attention of numerous scholars in Science Education in secondary schools regarding the direction of performance for both boys and girls. For instance, while some researchers Anenye and Osuafor, 2023, and Nwuba and Osuafor (2021) found out that in biology, male students did better than female students, others Katcha et al. (2018), and Owolabi et al. (2019) say otherwise, even Rumalolas et al., (2021) found no difference between the two genders. And so, for over the years, no consensus has been reached concerning this argument. In light of this, the study sought to explore the effect of crossover instructional technique, irrespective of gender, on secondary school student's performance in biology at Onitsha Education Zone; the rationale behind this study.

METHOD

A non-randomized control group design was used in this quasi-experimental study. 5,132 SS2 students, in the 32 government-owned secondary schools in Onitsha Education Zone, Anambra State, Nigeria, made up the population of the study. The sample for the research consisted of 52 SS2 biology students (21 males and 31 females) from two coeducational secondary schools, selected using a multistage sampling technique. Data were gathered using a 50-item biology achievement test (BAT) with four response options A-D, which the researchers created using compiled SSCE past questions. The questions in the BAT were developed based on the topics taught, during the period of the study, using a well-planned test blueprint to ensure coverage of content. Kuder-Richardson 20 (KR-20) formula was used to establish the internal consistency of the instrument. This was done by administering the BAT to a 25-student class, in a school, in Awka Education Zone who were not enrolled in the study. The instrument was extremely reliable, as evidenced by the dependability coefficient of 0.81 that was found.

On commencing the study, the biology teachers from the two sampled schools, who would serve as research assistants, were each given a separate briefing on two contacts, prior to the treatment process. In the experimental group, the research assistant was briefed on Crossover Instructional Strategy (CIS), its features, and how to effectively administer the instructional method using the lesson plans developed by the researchers, while in the control group, the teacher was instructed to continue as normal using the lesson plans on Conventional Lecture Method (CLM). Following the briefing, the BAT, which functioned as the pretest score, was given to the two drawn intact classes that were divided into the control (10 boys and 15 girls) and experimental (11 boys and 16 girls) groups. Following the pre-testing, the two groups began a 4-week long treatment (teaching) activity. After the instructional session, both groups completed a post-test, which was used to calculate the post-test score. The mean and standard deviation were determined by analyzing the data to

answer the research questions. ANCOVA was employed at the 0.05 alpha level for testing the null hypotheses.

RESULTS AND DISCUSSION

According to data in Table 1, students in the CIS group had mean achievement scores of 30.33 and 38.07 for their pretest and posttest, respectively. In contrast, the students in the CLM group had mean achievement scores of 26.08 on their pretest and 27.68 on their posttest, based on the average difference in mean increases between CIS and CLM, which was 6.14. Compared to CLM, the results showed that using a crossover instructional strategy when teaching biology greatly boosted students' academic progress.

Table 1. Achievement scores of students with respect to approaches used (CIS and CLM)

		PretestBAT		PosttestBAT		
Method	**N**	**Mean**	**SD**	**Mean**	**SD**	**Gain in mean**
CIS	27	30.33	1.76	38.07	1.67	7.74
CLM	25	26.08	1.67	27.68	1.67	1.60
Mean Difference		4.25		10.39		6.14

Analyzed data in Table 2 reveals that the experimental group's male students had their pretest and posttest mean achievement scores to be 29.55 and 35.45 respectively, while the females' had mean achievement scores of 30.88 in their pretest and 39.88 in their posttest.. With 3.10 mean difference in gain in mean, it can be inferred that when both students are taught selected topics in biology utilizing crossover instructional strategy, The female students outperformed their male counterparts.

Table 2. Achievement scores of students taught using CIS with respect to gender

		PretestBAT		PosttestBAT		
Gender	**N**	**Mean**	**SD**	**Mean**	**SD**	**Gain in mean**
Male	11	29.55	2.97	35.45	3.23	5.90
Female	16	30.88	2.23	39.88	1.68	9.00
Mean Difference	27	1.33		4.43		3.10

The two-way ANCOVA test result shows that at F-value 6.274, P-value is .016. The null hypothesis is rejected since the P-value at df 1 and 47 is less than 0.05 level of significance. This suggests a considerable achievement difference, in favor of the experimental group, between students taught biology with CIS and those taught with CLM. This suggests that the use of the crossover instructional strategy in the teaching of biology substantially influenced the academic achievement of students in CIS.

Table 3. ANCOVA measurement of student achievement in CIS and CLM

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	2721.874[a]	4	680.468	23.365	0.000
Intercept	3.291	1	3.291	0.113	0.738
PretestBAT	2426.211	1	2426.211	83.308	0.000
Methods	182.708	1	182.708	6.274	0.016
Methods*Gender	0.129	1	0.129	0.004	0.947
Error	1368.799	47	29.123		
Total	45703.000	52			
Corrected Total	4090.673	51			
a. R Squared = 0.665 (Adjusted R Squared = 0.637)					

Table 4's ANCOVA test reveals that the P-value is 0.427 for an F-value of 0.652. The null hypothesis is not rejected because the P-value at df 1 and 24 exceeds the significance threshold 0.05. This demonstrates no significant difference in mean achievement scores between male and female students taught biology using the crossover instructional strategy. CIS does not discriminate based on gender, therefore.

Table 4. ANCOVA test of achievement scores using CIS with respect to gender

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	1143.707[a]	2	571.854	13.218	0.000
Intercept	0.379	1	0.379	0.009	0.926
PretestBAT	1132.185	1	1132.185	26.170	0.000
Gender	28.188	1	28.188	0.652	0.427
Error	1038.293	24	43.262		
Total	27025.000	27			
Corrected Total	2182.000	26			
a. R Squared = .524 (Adjusted R Squared = .485)					

ANCOVA test from Table 3 shows that at F-value 0.004, P-value is 0.947. The null hypothesis is not refuted because the P-value at df 1 and 47 is greater than 0.05 alpha levels. Revealing that the academic success of students in biology was unaffected by the combination of gender and teaching strategies.

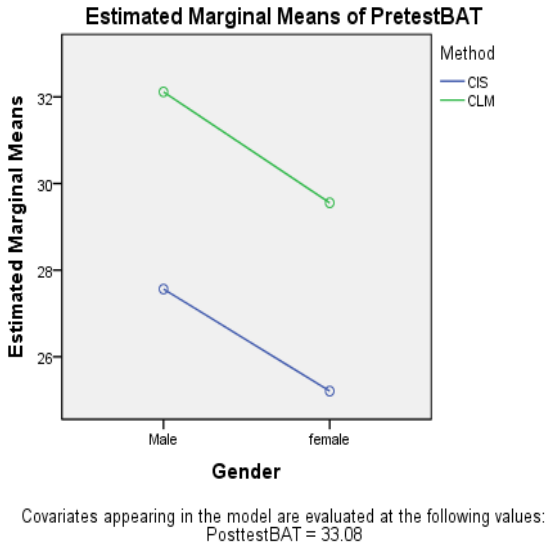

Figure 1. Profile diagram showing how gender and teaching strategies interact to affect students' academic performance in biology.

The results indicated that students taught with crossover instructional approach had increased academic achievement mean score greater than those taught using the traditional lecture method. This improved achievement proved statistically notable by the test of the null hypothesis in table 3. This increased achievement could be attributed to the features associated with CIS as it exposed students to concrete learning, both within and outside the classroom environment, prompting experiential, discovery and first hand acquisition of knowledge. The results of this study support the claims of Joseph et al. (2023) who reported in their study on environmental education that crossover learning enhanced students' awareness of environmental education.

On influence of gender, the study revealed that although girls had higher mean gain achievement score than the boys when both are taught using crossover instructional approach, the difference is statistically insignificant when tested. This reveals that crossover learning strategy, just like other innovative approaches, is gender friendly as it provided opportunities that foster equity, active participation and engagement among classroom students. The findings concur with the findings of Egwu and Okigbo (2021), Hamzat et al. (2021), Nwuba and Osuafor (2021), Onu et al. (2020), and Yisa and Ojiaku (2016) who reported in their respective studies in biology that innovative instructional approaches similar to crossover instructional strategy are gender friendly, fostering and promoting students' academic achievement irrespective of gender.

On gender and instructional approaches interaction with one another, the study revealed that both have negligible influence on academic success of students in biology. That is, the effects of the instructional approaches were consistent across gender. The study's result is consistent with that of Anenye and Osuafor (2023), and Nwuba, Egwu, and Osuafor

(2022) who reported that gender and teaching strategies have no interaction effect on students' academic progress in their respective studies in biology.

CONCLUSION

The study came to a conclusion, based on its findings, that crossover instructional strategy is an innovative teaching strategy that promotes academic performance of biology students in secondary schools irrespective gender as it is an approach that compliments formal learning with the informal classroom, exposing students to nature and first hand acquisition of knowledge, encouraging active participation and development of problem solving skills.

Acknowledging the results, the study endorsed that:

1. To boost students' academic progress in biology, secondary school biology teachers should adopt and integrate crossover instructional strategy (CIS) into their process of instruction and learning.
2. Education stakeholders should familiarize teachers with CIS and how to effectively implement the approach in the classroom though organization of workshops and conferences for biology instructors.
3. Institutions and universities that train teachers should place a strong emphasis on using CIS to prepare future educators.

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