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EFFECT OF JIGSAW LEARNING STRATEGY ON SECONDARY SCHOOL STUDENTS' ACADEMIC ACHIEVEMENT IN BIOLOGY IN AWKA SOUTH LOCAL GOVERNMENT AREA, ANAMBRA STATE

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ABSTRACT
The study investigated the effect of Jigsaw Learning Strategy (JLS) on secondary school students' academic achievement in Biology in Awka South Local Government Area (LGA) of Anambra State. It was guided by two research questions and three null hypotheses, tested at a 0.05 level of significance, using a quasi-experimental research design. The population comprised 2,361 senior secondary two (SS2) students offering Biology in State Government-owned secondary schools. The sample included 97 SS2 Biology students (50 males and 47 females) drawn from two secondary schools using a multi-stage sampling procedure. Biology Achievement Test (BAT) constructed by the researcher containing 50 multiple choice questions was used to collect data on students' academic achievement in Biology. The BAT and lesson plans were validated by three experts from Faculty of Education in Nnamdi Azikiwe University, Awka. Kuder-Richardson Formula 20 was used to establish a reliability coefficient of 0.79 for BAT. Mean and standard deviation were used to answer the research questions, while Analysis of Covariance was used to test the null hypotheses. The study revealed that the conventional lecture method (CLM) resulted in higher mean gain when compared to the Jigsaw learning strategy (JLS), although the difference was not statistically significant. Males achieved higher with the Jigsaw method, while females achieved higher with the CLM, but these differences were also not significant. The study concluded that both the JLS and the CLM enhanced secondary school students' achievement in Biology in Awka south LGA. Based on these findings, it was recommended among others that teachers should blend these instructional strategies to foster a more dynamic and inclusive learning environment since both of them enhanced achievement of both male and female students in Biology.
Keywords: Jigsaw Learning Strategy; Students; Academic Achievement; Biology.

Introduction
Science education is an important area that molds and shapes the personalities or character of contemporary civilization. It is defined as a process of instruction or training that takes place primarily in the school system with the goal of enhancing students' environmental knowledge, developing their capacity for scientific inquiry, fostering their natural disposition

(Vasconcelos & Orion, 2021). As a field of study, science education provides a body of knowledge that can be applied to solve many human, material, and environmental issues. It comprises two primary complimentary approaches: the acquisition of knowledge through natural exploration and discovery, and application of such knowledge to the advancement of both human and material progress (Badmus, 2018). In Nigerian senior secondary schools, science education is broken down and taught as subjects such as, Physics, Chemistry and Biology among others.

Biology is one of the science subjects which give students understanding into the matters of life and existence. Nwuba, Egwu, Awosika, and Osuafor (2020) define Biology as the study of plants and animals, as well as their characteristics and interactions with their surroundings. The importance of Biology cannot be overstated as it deals with all of the biochemical components of living organisms such as food digestion, breathing, sweating and the neurological system. Ghumdia and Adams (2020) stated that Biology is crucial for many fields of learning because it contributes to other fields of study such as Agriculture, Biotechnology, Nursing, and Medicine among others. All of these aid in economic growth and development in any country such as Nigeria.

Every year, students in Nigerian senior secondary schools take part in the West African Senior School Certificate Examination (WASSCE). This examination is taken twice in a year, in May/June and November/December. Following Biology students' evaluation, the Chief Examiners in Biology It is disheartening to note that the performance of students in the WASSCE from 2017 to 2022 remained unsatisfactory. In 2017, out of a total of 1,087,921 candidates who sat for the examination, only 604,558 passed, resulting in a pass percentage of 55.57%. Similarly, in 2018, 1,087,884 candidates took the exam, with 599,424 passing, yielding a pass percentage of 55.10%. This trend continued in 2019, with 1,086,449 candidates and 604,436 passing (pass percentage: 55.63%), and in 2020, with 1,032,246 candidates and 652,647 passing (pass percentage: 63.23%). In 2021, although the total number of candidates decreased to 1,023,685, only 594,674 passed, resulting in a pass percentage of 58.09%. However, there was a notable deviation from this trend in 2022, where the total number of candidates significantly increased to 1,601,047, and 1,222,505 passed, resulting in a substantially higher pass percentage of 76.36%.

This fluctuation in performances of students in Biology suggests that various factors such as curriculum changes, teaching methodologies, students' preparation strategies, and examination difficulty level could influence the performance of candidates over time. Some researchers have attributed this unsatisfactory performance to many factors. For example, Ugwu (2017) observed that lack of qualified teachers is the reason many students perform poorly in Biology. On the other hand, Njoku (2016) asserted that teaching methodology is a factor that can affect student performance in Biology. Teaching method is concerned with the tactics teachers use to meet teaching objectives, subject matter, and the use of teaching tools and materials (Onah &

Onwubuariri, 2018). In similar vein, Nwankwo and Okigbo (2021) pointed out that good teachers follow no one method, instead they use whatever methods or materials that seem best for the particular combination of individual situations in teaching the subjects. Based on the aforementioned presented, it is clear that the researchers agree on the importance of various teaching methods such as the Jigsaw learning strategy in the classroom.

The Jigsaw puzzle is one of the cooperative learning strategies developed by Aronson (1971). The goal of the strategy is to study the learning material in groups to achieve specific objectives. The strategy was developed to reduce racial conflict and promote students' learning outcomes. Kelly (2020) defines Jigsaw strategy as a type of cooperative learning which improves social interactions in learning and supports diversity. This strategy's basis is centered on students' individuality. The teacher's role is to guide the process, creating an inclusive classroom environment that promotes gender equality and breaks down stereotypes.

Gender is a set of characteristics distinguishing between male and female, particularly in the cases of men and women which depending on the context, may vary from sex to social role and to gender identity (Ezenwabachili & Okoli, 2021). In developing countries, an increase awareness of the importance of education has led to higher rates of school enrollment and literacy among girls. However, there remains a significant disparity between the academic achievements of boys and girls in science and technology-related courses (Momoh, Idoko & Fidelis, 2020).

Academic achievement refers to the extent to which a student attains their educational goals and objectives, typically measured through grades, test scores, and overall performance in coursework. Wu and Kuo (2021) define academic achievement as encompassing not only the acquisition of knowledge but also the effective application of that knowledge in various contexts, including examinations and practical applications.

Numerous studies have focused on gender issues in science education. Ezenwabachili & Okoli (2021) noted that educators often perceive science subjects like physics, chemistry, and biology as masculine, affecting both male and female students. Research has shown conflicting results regarding gender and academic achievement in Biology. Okoye (2018) and Ekineh (2019) found no significant difference between male and female students, while Bello (2016) reported differences in favour of males. However, Firas (2022) findings showed that females outperformed males in science subjects. These contradictory findings highlight the need to consider gender as a moderating variable in this study, making it a key factor in students' academic achievement in Biology.

Statement of the Problem

Students' performance in biology has been inconsistently fluctuating according to an analysis of WASSCE results from 2017-2022. This has been linked mostly to a poor instructional teaching method, which has

resulted in students' inadequate understanding of biology concepts. This is really an unfortunate situation, given the importance of biology in the education system and in the development of Nigeria, and the fact that Biology is the most popular science subject offered by both arts and science students in senior secondary school.

There is a pressing need to reassess the approaches and methods of teaching biology at the senior secondary level. In light of the changing educational trend, it is likely that a stimulating, intriguing and student-centered strategy, such as the jigsaw learning strategy, may successfully include students in the learning process and boost their Biology achievement. It is to this end that this study seeks to determine the effect of Jigsaw learning strategy (JLS) on secondary school students' academic achievement in Biology in Awka South Local Government Area of Anambra State. Specifically, the study sought to determine the:

1. Difference between the mean achievement scores of secondary school students taught Biology using Jigsaw learning strategy (JLS) and that of those taught using the Conventional Lecture Method (CLM).
2. Difference between the mean achievement scores of male and female secondary school students taught Biology using JLS and those taught using CLM
3. Interaction effect of teaching methods (JLS and CLM) and gender on secondary school students' academic achievement in Biology.

Research Questions

The following research questions were formulated to guide this study:

1. What is the difference between the mean achievement scores of secondary school students taught Biology using Jigsaw learning strategy (JLS) and those taught using the Conventional Lecture Method (CLM)?
2. What is the difference between the mean achievement scores of male and female secondary school students taught biology using JLS and those taught using CLM

Hypotheses

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

1. There is no significant difference between the mean achievement scores of secondary school students taught Biology using JLS and those taught using the CLM.
2. There is no significant difference between the mean achievement scores of male and female secondary school students taught Biology using JLS and those taught using CLM
3. There is no interaction effect of teaching methods (JLS and CLM) and gender on secondary school students' academic achievement in Biology.

Research Method

The quasi experimental research design, specifically, the pretest post-test nonrandomized control group design was used for this study. The population of the study comprised 2,361 senior secondary two (SS2) male and female students offering

Biology in State Government-owned secondary schools in Awka South Local Government Area (LGA) of Anambra State. The sample comprised 97 SS2 biology students (50 males and 47 females) drawn from two secondary schools biology students (667 males and 1,095 females) in the 16 State Government-owned secondary schools in Awka South LGA. The sample for the study was obtained using a multi-stage sampling procedure, involving purposive and simple random sampling techniques.

The instrument used for collecting data was Biology Achievement Test (BAT). The BAT contains 50 multiple-choice objective questions and each question has four (4) options A, B, C and D.). A correct answer earns 2 marks, while an incorrect answer earns zero (0) marks, giving a total maximum score of 100 marks and minimum score of 0 mark for the BAT. The BAT was administered on both the experimental and control groups to obtain the pretest and posttest. The researcher developed a key to the BAT, which guided the marking of the students' scripts. The questions for the BAT were structured by the researcher from standard examination past questions which include the West African Senior Secondary Certificate Examination (WASSCE) and Universal Tertiary Matriculation Examination (UTME), alongside the lesson plans developed by the researcher. To determine the extent to which the instrument measures what it is intended to measure, a face and content validity assessment was conducted using three experts, two from the Department of Science Education and one from the Department of Educational Foundations (Measurement and Evaluation unit), from Nnamdi Azikiwe University, Awka. To establish the degree of consistency of the research instrument, the BAT was administered on 35 SS2 students in a secondary school in Anaocha LGA, Anambra state and internal consistency established to be 0.79 using Kudder-Richardson Formula 20. The instrument is deemed appropriate as the coefficient value of 0.79 indicates that 79% of the variability in test scores is attributable to true score variance, affirming its alignment with its intended measurements according to Uyanah and Nsike (2023).

The researcher first visited the two schools selected for the research and obtained permission from the appropriate authorities to involve the SS2 students and their biology teachers in the study. Permission was granted, and the researcher met with the biology teachers (research assistants) of the selected class arms to inform them about the study and how they would assist in the research. The research assistants were trained using the training manual. After completing their training, the research assistant for the experimental group and control group began implementing the Jigsaw strategy with the students. Over four weeks, the students were organized into Jigsaw groups, and control group respectively. The students were taught conservation of natural resources, pests and diseases, reproductive system in vertebrates. Before the treatment, copies of the BAT were administered on the students in the two groups as a pretest by the research assistants. Responses were then collected, scored, and recorded by the researchers at the end of the teaching process (treatment) for both the control and experimental groups, a

reshuffled BAT with its options was administered on the same students again. The responses were collected, scored, and recorded. The data obtained from the administered tests were recorded and used for data analysis. The research questions were answered using mean and standard deviation, while the hypotheses were tested at the 0.05 alpha level using Analysis of Covariance (ANCOVA). The adoption of this statistical tool (ANCOVA) was to account for errors due to initial differences in ability among the research participants (students). In this case, pretest scores were used as covariate measures to the post-test scores. In taking decisions, do not reject the null hypotheses if the probability (P) value is greater than 0.05 (P>0.05), but reject the null hypotheses if the P-value is less than or equal to the significance value of 0.05(P ≤0.05).

Presentation of Results

Table 1: **Mean achievement scores of secondary school students taught Biology using Jigsaw learning strategy and those taught using the Conventional Lecture Method**

		Pre-test		Post-test		
Teaching method	**n**	**Mean**	**SD**	**Mean**	**SD**	**Mean Gain**
Jigsaw	49	27.39	7.651	69.94	11.082	42.55
Lecture	48	24.79	5.422	68.63	10.048	43.84
Mean difference		2.6		1.31		-1.29

Table 1 reveals that secondary school students taught Biology using the Jigsaw learning strategy achieved higher post-test scores compared to their pre-test scores, with a mean increase from 27.39 (SD = 7.651) to 69.94 (SD = 11.082). Similarly, students taught using the Conventional Lecture Method also showed significant improvement, with their mean scores increasing from 24.79 (SD = 5.422) in the pre-test to 68.63 (SD = 10.048) in the post-test. The mean gain, which reflects the improvement from pre-test to post-test, was 42.55 for the Jigsaw group and 43.84 for the Lecture group. Although both groups demonstrated substantial gains in achievement, the Lecture method resulted in a slightly higher mean gain compared to the Jigsaw method, with a difference of -1.29. In summary, both groups showed significant progress in achievement. However, the Lecture method produced a slightly greater improvement in overall student performance, as reflected in the higher mean gain.

Table 2: mean achievement scores of male and female secondary school students taught biology using JLS and CLM

Teaching method		Pre-test			Post-test		
		n	Mean	SD	Mean	SD	mean Gain
Jigsaw	Male	23	26.87	8.714	72	11.473	45.13
	Female	26	27.85	6.715	68.12	10.611	40.27
Mean difference			-0.98		3.88		4.86
CLM	Male	27	24.44	5.094	67.41	8.409	42.97
	Female	21	25.24	5.915	70.19	11.864	44.95
Mean difference			-0.8		-2.78		-1.98

Table 2 reveals the mean achievement scores of male and female secondary school students taught Biology using the Jigsaw Learning Strategy (JLS) and Conventional Lecture Method (CLM). For JLS, male students started with a pre-test mean score of 26.87 and improved to a post-test mean of 72, resulting in a mean gain of 45.13. Female students in JLS had a pre-test mean of 27.85 and a post-test mean of 68.12, with a mean gain of 40.27. This indicates that while both genders benefited from JLS, males achieved a slightly higher improvement. In contrast, under CLM, male students scored an initial mean of 24.44, which increased to 67.41, yielding a mean gain of 42.97. Female students began with a mean of 25.24 and rose to 70.19, with a mean gain of 44.95, showing a slightly greater improvement than their male counterparts in CLM. Overall, the Jigsaw method led to higher gains for both genders, with males benefiting more from this approach, whereas the CLM showed marginally better results for females.

Table 3: Summary of Analysis of Covariance of Student Mean Achievement Scores in biology by teaching method

Sources of Variation	SS	Df	MS	*F*	*p*-value	Decision
Pretest	3221.079	1	3221.079	40.812	0	
Method	21.598	1	21.598	0.274	0.602	Not Significant
Error	7418.987	94	78.925			
Total	10661.664	96				

In Table 3, the ANCOVA revealed that there was no statistically significant effect of the teaching method on the students' academic achievement scores, F (1, 94) = 0.274, p = 0.602. Since the p-value was greater than 0.05, the null hypothesis was not rejected. Therefore, there is no significant difference in the mean achievement scores of students taught Biology topics using the Jigsaw Learning Strategy and the Conventional lecture method.

Table 4: Summary of Analysis of Covariance of Mean Achievement Scores of male and female secondary school students in biology using jigsaw learning strategy

Sources of Variation	SS	Df	MS	*F*	*p*-value	Decision
Intercept	8474.967	1	8474.967	94.721	0	
JLS pretest	1594.891	1	1594.891	17.825	0	
JLS gender	259.627	1	259.627	2.902	0.095	Not Significant
Error	4115.763	46	89.473			
Total	14445.248	49				

The results presented in Table 4 reveal that there was no statistically significant effect of gender on the students' academic achievement scores, F(1, 46) = 2.902, p = 0.095. Since the p-value was greater than 0.05, the null hypothesis was not rejected. Therefore, there is no significant difference in the mean achievement scores of male and female students taught Biology using the Jigsaw instructional technique.

Table 5: Summary of Analysis of Covariance of Mean Achievement Scores of male and female secondary school students in biology using lecture method

Sources of Variation	SS	Df	MS	*F*	*p*-value	Decision
Intercept	3438.169	1	3438.169	54.622	0	
Pretest	1821.222	1	1821.222	28.933	0	
Gender	41.063	1	41.063	0.652	0.424	Not Significant
Error	2832.535	45	62.945			
Total	8132.989	48				

The results presented in Table 5 reveal that there was no statistically significant effect of gender on the students' academic achievement scores, F (1, 45) = 0.652, p = 0.424. Since the p-value was greater than 0.05, the null hypothesis was not rejected. Hence, there is no significant difference in the mean achievement scores of male and female students taught Biology using the lecture method.

Table 6: Summary of Analysis of Covariance of interaction effect of teaching methods (JLS and CLM) and gender on secondary school students' academic achievement in Biology

Sources of Variation	SS	Df	MS	*F*	*p*-value	Decision
Intercept	12352.97	1	12352.97	160.227	0	
Pretest	3271.496	1	3271.496	42.434	0	
Method	21.78	1	21.78	0.283	0.596	Not Sig
Gender	42.569	1	42.569	0.552	0.459	Not Sig
Method * gender	279.972	1	279.972	3.631	0.06	Not Sig
Error	7092.914	92	77.097			
Total	23061.7	97				

The results presented in Table 6 revealed that there was no statistically significant interaction effect of teaching methods and gender on the students' academic achievement scores, F(1, 92) = 3.631, p = 0.060. Since the p-value was found to be

greater than 0.05, the null hypothesis was not rejected. Hence, there is no significant interaction effect of teaching methods (JLS and CLM) and gender on secondary school students' academic achievement in Biology.

Discussion

The findings from the study indicate that although JLS led to higher mean scores, the overall mean gain was higher with CLM, suggesting that JLS did not significantly outperform the conventional lecture method in enhancing academic achievement. These findings align with previous research. Safkolam, El Islami, and Sari (2023) found that while JLS improved mean scores and understanding, its impact on academic achievement was not consistently superior to conventional lecture method. Similarly, Mbacho (2022) observed that although JLS fostered a collaborative environment and higher mean scores, its effectiveness relative to CLM was not statistically significant. Msuur, Isah, and Asibi (2021) also noted that the impact of cooperative learning strategies like JLS on academic achievement depends on specific implementation practices and classroom conditions, further supporting the study's findings.

The higher mean scores with JLS can be attributed to its collaborative structure, where students work in groups to teach and learn various sections of the material. This promotes active participation, accountability, and deeper understanding. However, the higher overall gain with CLM may be due to students' familiarity with traditional teaching methods, which align with established study habits, providing a structured and predictable learning environment that complements students' revision strategies and psychological comfort.

Regarding gender, the study found no significant difference in achievement between male and female students taught with JLS, suggesting that JLS is equally effective for both genders. This result supports Mbacho's (2022) study, which showed that JLS benefits all students, regardless of gender. However, CLM appeared more effective for female students, with noticeable gender-based differences in performance. This finding aligns with Mbacho's (2022) research, which suggested that female students may perform better in more structured, teacher-led environments like lectures.

The analysis also revealed no significant interaction effect between teaching method and gender, suggesting that both JLS and CLM are equally effective across genders. This finding is consistent with Mbacho (2022) and Ibrahim and Dazi (2023), who found that high-quality instructional strategies, including gender-neutral approaches, can enhance academic achievement for all students. Educators can therefore implement either JLS or CLM without concern for differential impacts on male or female students, ensuring an inclusive learning environment where all students have equal opportunities for success.

Conclusion

The study concludes that both the Jigsaw instructional technique and the lecture method have unique strengths in enhancing

students' achievement in Biology. The results indicate that while the lecture method yields a higher overall mean gain, the Jigsaw technique also offers significant benefits by promoting collaborative learning. Despite these benefits, no significant differences were found in achievement scores between the two methods. This underscores the value of employing diverse instructional strategies to address the varied needs of students.

The Jigsaw instructional technique is effective in engaging students and fostering a collaborative learning environment, benefiting students regardless of gender. On the other hand, the lecture method, with its structured and consistent content delivery, provides advantages that may be particularly beneficial for certain demographics, including female students.

Recommendations

The study recommends adopting the Jigsaw instructional technique to enhance student engagement and understanding in Biology, while integrating it into the curriculum for broader use. Teachers should receive professional development to effectively implement Jigsaw, supported by the Ministry of Education and professional associations. Additionally, educators are encouraged to continue using the conventional lecture method and blend it with Jigsaw to create a more dynamic and inclusive learning environment.

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