EFFECT OF JIGSAW INSTRUCTIONAL STRATEGY ON SENIOR SECONDARY STUDENTS' ACADEMIC ACHIEVEMENT IN ORGANIC CHEMISTRY IN ENUGU EDUCATION ZONE

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Abstract
This study investigated the effect of jigsaw instructional strategy in teaching of organic chemistry on senior secondary school students' academic achievement in Enugu Education zone of Enugu State. Two research questions guided the study while three null hypotheses were formulated and tested at 0.05 level of significance. Quasi-experimental research design was adopted for the study. The population for the study was 3,409 Senior Secondary School II (SS II) chemistry students. Purposive random sampling technique was used to draw a sample size of 259 SS II chemistry students. The instrument used for data collection was Organic Chemistry Achievement Test (OCAT) which was developed by the researcher and validated by three research experts. Kuder-Richardson 20 (K-20) formula was used to estimate the reliability of the instrument and a reliability index of 0.79 was obtained. A two-week training session was organized within the schools by the researcher for the regular chemistry teachers. The chemistry teachers for the experimental group used jigsaw instructional strategy while the teachers for the control group used the conventional teaching method. Mean and standard deviation were used for answering the research questions while Analysis of Covariance was used to test the null hypotheses. The findings of the study revealed that students who were taught organic chemistry using jigsaw instructional strategy had improved academic achievement than their counterparts who were taught with the lecture teaching approach. The test of hypotheses also showed that the mean difference in achievement was significant, in favour of the students in the experimental group. Based on the findings, the study recommended among others that the all levels of education should adopt jigsaw instructional strategy because it boosts the participation of students in chemistry, thereby, improving the academic achievement of students in organic chemistry.

Keywords: Jigsaw Instructional Strategy, Academic Achievement, Organic Chemistry

Introduction

Science education has become a crucial avenue for addressing the global challenges faced by Nigeria. Among the various scientific fields, Chemistry holds a significant role due to its universal importance in human progress. The practical knowledge gained in this field has real-world applications that students are likely to encounter in their future endeavours (Jegede, 2012). Chemistry involves the systematic exploration of the properties, composition, structure, and reactions of matter, encompassing all elements of the universe. Its insights contribute to the development of new materials, medicines, and technologies that drive societal progress. The pivotal role of chemistry in national development cannot be emphasized enough. However, the performance of Nigerian students in Chemistry in the Senior School Certificate Examination (SSCE) has consistently fallen short over time. For example, data from the WAEC Chief Examiners' report, as cited by Nwankwo & Okigbo (2021), demonstrates that candidates' Chemistry performance declined from 2017 to 2018.

Despite Chemistry's fundamental position as a foundational science that supports various disciplines and improves the quality of life, the poor performance of Nigerian secondary school students in this subject has remained a persistent concern for many years (Jegede, 2010; Oloyede, 2010). Similarly, these sources indicated that candidates' performance in Chemistry declined from 2017 to 2018, highlighting a drop in students' performance, especially in organic chemistry. Originally centered on the study of compounds found in living organisms, organic chemistry's scope has

expanded to include carbon compounds, excluding simpler ones like carbon oxides, carbonates, cyanides, and cyanates.

Research conducted by Eriba & Samba (2012), Agogo & Ada (2014), and Isa (2018) revealed that science students perceive organic chemistry as abstract and challenging to grasp, leading to comparatively weaker performance in this area. The West African Examination Council (WAEC) reported that examiners consider organic chemistry questions unpopular among students, with only a small number attempting these questions (West African Examination Council, 2016)."

The current method of teaching chemistry in Nigeria, especially in the Enugu Education zone of Enugu State, primarily relies on traditional techniques. These methods involve students memorizing chemistry concepts solely for the purpose of passing exams. According to Yemi, Azid & Ali (2018), this approach has resulted in significant problems in students' final year results in both internal and external examinations. Since chemistry is a subject with practical applications and a hierarchical structure, a strong understanding of prerequisites is essential to support further learning. This deficiency underscores the need for a shift in the way chemistry lessons are delivered, with a focus on creating more engaging and interactive classroom experiences, such as implementing the jigsaw instructional strategy.

The jigsaw instructional strategy is an educational approach that promotes interdependence among students to achieve success. It divides a class into smaller groups and breaks down assignments into segments, which the groups collaborate on to complete the entire task. Jigsaw falls under the category of cooperative learning techniques and relies on group dynamics and social interactions, representing a genuine cooperative learning approach (Sahin, 2010). This strategy entails dividing a larger group into smaller ones that work together to learn about a specific topic, ultimately improving students' academic achievement.

Academic achievement denotes an individual's performance level in academic subjects. Ali (2013), defined it as a measure of a student's success in a particular task within a subject following a learning experience. Chukwu, as cited in Nwanne and Agommuoh (2017), described students' academic achievement as ability to acquire valuable knowledge and effectively communicate it verbally or in written form. Nwankwo & Okigbo (2021), demonstrated that the jigsaw instructional strategy significantly improves achievement and retention scores among SS2 chemistry students more than the traditional teaching method. Yemi, Azid & Ali's (2018), findings indicated that the jigsaw strategy for teaching mathematics is more effective than traditional methods at enhancing academic achievement. Additionally, Chu (2014), conducted research on the application of the jigsaw cooperative method in an Economics course. The study's findings suggested that the use of the jigsaw cooperative learning method has a positive impact on students' academic performance and retention of knowledge. This is evidenced by an increase in average scores and a decrease in score variability.

Additionally, the results revealed disparities in mean scores and score variability between the groups that underwent the teaching method and the control groups during both the initial and final assessments. This outcome aligns with prior research (Sahin, 2010; Chu, 2014; Temesgen & Enunuwe, 2016) indicating that cooperative learning leads to better outcomes compared to traditional teaching methods. Several empirical studies have also highlighted the efficacy of the jigsaw instructional approach, particularly in subjects like mathematics and economics (Lawan, 2016).

Furthermore, gender has been identified as a factor affecting science performance among senior secondary school students. Gender is defined as the characteristic distinguishing individuals based on their biological roles as male or female in terms of reproduction (Abubakar & Uboh, 2010). While Khairulanuar, Nazre, Sairabanu & Norasikin (2010) discovered male students benefiting more, Ajaja & Eravwoke (2010) and Timayi et al (2015) found no impact of gender on academic achievement within cooperative learning. These conflicting results have prompted the consideration of gender as a moderating variable in this study. Consequently, further research is necessary to clarify how the jigsaw instructional strategy affects the academic success of both male and female students. It seems that gender-related variations in student achievement depend on the teaching method employed. This study was undertaken to address this gap, exploring the influence of the jigsaw instructional strategy in teaching organic chemistry on the academic achievement of senior secondary school students in the Enugu Education zone of Enugu State.

Statement of the Problem

The primary issue that drove the researcher to conduct this study is the continuous decrease in academic achievement among chemistry students, particularly in secondary schools within the Enugu Education zone of Enugu, Nigeria. Chemistry stands as a crucial subject essential to meet the growing demand for advancements in science and technology. Therefore, for Nigeria to make strides in

scientific and technological progress, the persistent decline in chemistry performance must be tackled. The concern deepens as to which teaching strategy at the secondary school level could reverse the declining academic performance trend in Chemistry, especially when dealing with Organic Chemistry. Various suggestions have emerged concerning the identification of Science Teaching Methods and Strategies that effectively engage students, leading to improved outcomes in the study of Organic Chemistry. Research has highlighted that the adoption of ineffective teaching methods by chemistry teachers in secondary schools, among other factors, has contributed to the deteriorating performance of students in organic chemistry. This situation calls for the integration of innovative teaching strategies that have demonstrated success in other subjects and countries. One such strategy is the Jigsaw instructional approach, which emphasizes cooperative learning and interaction among students. In contrast, prevailing research reveals that chemistry teachers in Nigerian secondary schools predominantly employ the lecture method for teaching chemistry concepts. This method lacks the collaborative engagement and interaction necessary for effective comprehension and application of abstract and challenging chemistry concepts, as found in the jigsaw instructional strategy. Therefore, the problem of this study is what are the effect of jigsaw instructional strategy in teaching of organic chemistry on senior secondary school students' academic achievement in Enugu Education zone of Enugu State?

Purpose of the Study

The purpose of the study was to investigate the effect of jigsaw instructional strategy in teaching of organic chemistry on senior secondary school students' academic achievement in Enugu Education zone of Enugu State. Specifically, the study investigated the:

1. effect of jigsaw instructional strategy on SS II Chemistry students' academic achievement when taught organic chemistry and those taught the same topic using lecture method;
2. influence of gender (male and female) on Chemistry students' academic achievement when taught organic chemistry using jigsaw instructional strategy.

Research Questions

The following research questions guided the study:

1. What are the mean achievement scores and standard deviations of SS II Chemistry students taught organic chemistry with jigsaw instructional strategy and those taught the same topic using lecture method?
2. What are the mean achievement scores and standard deviations of male and female SS II Chemistry students taught organic chemistry with jigsaw instructional strategy?

Hypotheses

The following hypotheses guided the study and they were tested at 0.05 level of significance:

Ho_1: There is no significant difference between the mean achievement scores and standard deviations of SS II Chemistry students taught organic chemistry using jigsaw instructional strategy and those taught the same topic using lecture method in both pre-test and post-test.

Ho_2: There is no significant difference between the mean achievement scores and standard deviations of male and female SS II Chemistry students taught organic chemistry with jigsaw instructional strategy.

Ho_3: There is no significant interaction effect of gender and jigsaw instructional strategy on students' academic achievement in organic chemistry.

Research Method

This study adopted a quasi-experimental design referred to as pre-test, posttest non randomized control group design. Nworgu (2015), defined quasi-experimental research design as one which random assignment of subjects to experiment and control groups is not possible According to Uzoagulu (2011) this design is often used in classroom experiment, when experiment and control groups are assembled as intact classes and no possibility of randomization. The reason for the choice of this design is because it is not possible for the researcher to randomly assign subjects to the treatment group and control group without disrupting the academic programmes of the school involved in the study (Gambari, Falode and Adegbenro, 2014). The population for the study was 3,409 Senior Secondary School II (SS II) chemistry students. Purposive random sampling technique was used to draw a sample size of 259 SS II chemistry students. Therefore, this study comprised 162

students in the experimental group (88 males and 74 females) and 97 students in the control group. The instrument used for data collection was Organic Chemistry Achievement Test (OCAT) which was developed by the researcher and validated by three research experts. Two of the experts are from the Department of Science Education while one is from Measurement and Evaluation unit of the Department of Mathematics and Computer Education, all from Faculty of Education, Enugu State University of Science and Technology.

Kuder-Richardson 20 (K-20) formula was used to estimate the reliability of the instrument and a reliability index of 0.79 was obtained. A one week intensive briefing for the teachers was conducted by the researcher. Four teachers were briefed before the treatment. The teachers were given detailed explanation on the use of jigsaw instructional strategy and other research expectation. Before the onset of the experiment, subjects in both the treatment and the control groups were given a pretest on OCAT. After the pretest, the experimental group was taught using the OCAT while the control group was taught using lecture method. The research questions were answered using mean and standard deviation. The choice of mean is because it is the most reliable measure of central tendency (Uzoagulu, 2011). Also, standard deviation was used because it shows how the scores are spread from the mean. Analysis of covariance (ANCOVA) was used in testing the hypotheses at .05 level of significance. The choice for the use of ANCOVA is because intact classes were used and initial differences cannot be guaranteed. The null hypothesis was rejected if probability value is less than or equal to the significant value of 0.05 ($P \leq 0.05$) and if otherwise ($P > 0.05$), it was not rejected.

Data Analysis and Results

Research Question 1: What are the mean achievement scores and standard deviations of SS II Chemistry students taught organic chemistry with jigsaw instructional strategy and those taught the same topic using lecture method?

Table 1: Mean achievement scores and standard deviations of students taught organic chemistry with jigsaw instructional strategy and those taught using lecture method

Groups	Number	Pre-test		Post-test		Mean Gain
		Mean ($\bar{x}$)	Standard Deviation (s)	Mean ($\bar{x}$)	Standard Deviation (s)	
Experimental	162	38.41	13.30	46.11	16.42	7.7
Control	97	33.31	12.22	38.48	13.51	5.17
Mean Diff.						2.53

Table 1 shows that the mean achievement scores of students taught with jigsaw instructional strategy is higher than those taught using the lecture teaching method because the gain in mean of 7.7 for the experimental group is greater than 5.17 gain in mean for the control group. The mean difference is 2.53 in favour of experimental group.

Research Question 2: What are the mean achievement scores and standard deviations of male and female SS II Chemistry students taught organic chemistry with jigsaw instructional strategy?

Table 2: Mean achievement scores and standard deviations of male and female students taught organic chemistry using jigsaw instructional strategy

Gender	**Number**	**Pre-test**		**Post-test**		**Mean Gain**
		Mean ($\bar{x}$)	**Standard Deviation (s)**	**Mean ($\bar{x}$)**	**Standard Deviation (s)**	
Male	88	37.89	14.19	43.39	17.44	5.50
Female	74	35.42	12.91	39.46	15.51	4.04
Mean Diff.						**1.46**

Table 2 shows that the mean achievement scores of male students taught with jigsaw instructional strategy is higher than that of their female counterparts because the gain in mean of 5.5 for the male students is greater than 4.404 gained in mean for the female students. The mean difference is 1.46 in favour of male students.

Ho_1: There is no significant difference between the mean achievement scores and standard deviations of SS II Chemistry students taught organic chemistry using jigsaw instructional strategy and those taught the same topic using lecture method in both pre-test and post-test.

Table 3: Analysis of Covariance on the mean achievement scores of Chemistry students taught organic chemistry using jigsaw instructional strategy and those taught using lecture method

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Decision
Corrected Model	1019.101	2	509.551	48.091	.000	Rejected
Intercept	3091.132	1	3091.132	108.091	.000	
Pretest	545.091	1	545.091			
GROUP	509.911	1	509.911	18.781	.000	
Error	277.098	256	.899	102.801	.080	
Total	29011.011	259				
Corrected Total	68991.091	259				

R Squared = .992 (Adjusted R Squared = .991)

Table 3 revealed that $F(1, 362) = 18.781$; $p = 0.000<0.05$. The null hypothesis is rejected meaning that there is significant difference between the mean achievement scores of students in experimental and control groups in favour of experimental group.

Ho_2: There is no significant difference between the mean achievement scores and standard deviations of male and female SS II Chemistry students taught organic chemistry with jigsaw instructional strategy.

Table 4: Analysis of Covariance on the mean achievement scores of male and female Chemistry students taught organic chemistry using jigsaw instructional strategy

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Decision
Corrected Model	204.20	2	102.10	29.014	.000	Rejected
Intercept	10452.9	1	10452.90	21.091	.000	
Pretest	6311.501	1	6311.501			
GENDER	132.10	1	132.10	37.410	.000	
Error	5905.90	159	144.041	16.581	.071	
Total	135597.00	162				
Corrected Total	6137.12	161				

a. R Squared = .231 (Adjusted R Squared = .222)

Table 4 revealed that $F(1, 195) = 37.410$; $p = 0.000<0.05$. The null hypothesis is rejected meaning that there is a significant difference between the mean achievement scores of male and female students in favour of male students.

Ho_3: There is no significant interaction effect of gender and jigsaw instructional strategy on students' academic achievement in organic chemistry.

Table 5: Analysis of Covariance on the interaction effect of gender and method (jigsaw instructional strategy) on Chemistry students' achievement in organic chemistry

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Decision
Corrected Model	114.668[a]	2	57.334	62.41	.000	
Intercept	6096.981	1	6096.981	1133.92	.000	
METHOD*GENDER	114.668	1	114.668	62.41	.009	Rejected
Error	76910.284	256	24.20			
Total	83105.891	259				
Corrected Total	78911.091	259				

Table 5 revealed that $F(1, 358) = 62.41$; $p = 0.009<0.05$. The null hypothesis is rejected meaning that there is an interaction effect between methods and gender in students' academic achievement scores.

Discussion of Findings

The finding of the study showed that students taught organic chemistry with jigsaw instructional strategy had improved achievement more than those taught using lecture method. This finding agreed with that of Nwankwo & Okigbo (2021), who posited that jigsaw instructional strategy significantly enhanced achievement of SS2 students in chemistry more than the conventional teaching method. The finding of this study agreed with the finding of Mari & Sani (2015) that the use of cooperative learning strategy has significant effect on the academic achievement of formal 'reasoners' more than that of the concrete 'reasoners'. Furthermore, this finding also supported the finding of Onuocha, Eneogu, Asogwa & Ngwuchukwu (2016) that the use of jigsaw instructional strategy and conventional teaching method for teaching social studies in junior secondary schools when compared to the conventional teaching method is significantly different. This means that students achieved meaningfully in chemistry as a result of the Jigsaw instructional strategy and that the method was adequate for the instruction process.

Conclusion

This study showed that jigsaw instructional strategy helped to improve students' academic achievement in organic chemistry than students taught using the lecture method. From the comparative analysis between the Experimental Group and Control Group on the pre-test and post-test, it was observed that before the treatment, the pretest mean scores and the standard deviation of scores of the control and treatment groups were close to each other. However, after the treatment was conducted students from the treatment groups showed better achievement than those who have learned with lecture method.

Recommendations

Based on the findings, the following recommendations were proffered:

1. The Ministry of Education should mandate all levels of education to adopt jigsaw instructional strategy because it boosts the participation of students in chemistry, thereby, improving the academic achievement of students in organic chemistry.
2. Chemistry teachers should use Jigsaw instructional strategy in teaching chemistry in order to enhance positive attitude to improve the academic achievement of the students in secondary schools.

References

Agogo, P.O. & Onda (2014). Identification of students' perceived difficult concepts in senior secondary school chemistry in Oju Local Government Area of Benue State, Nigeria *Global Educational Research Journal*: ISSN-2360-7963, 2(4): 044-049.

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),* Retrieved from http://ejse.southwestern.edu 13th March, 2017

Ali, S. (2013). Factors affecting academic achievement of students. *American Journal of Educational Research;* 1 (8), 283-289.

Gambari, A.I. Falode, C.O. & Adegbenro, D.A. (2014). Effectiveness of computer animation and geometrical instructional model on mathematics achievement and retention among junior secondary school students. *European Journal of Science and Mathematics Education* .2(2).

Lawan, Y. (2016). Impacts of Jigsaw co-operative learning strategy on academic performance and retention in mensuration among senior secondary school students in Kano State, Nigeria. *An Unpublished Dissertation*. Ahmadu Bello University, Zaria.

Nwankwo, M.U. & Okigbo, E.C. (2021). Effect of Jigsaw teaching strategy on academic achievement and retention of Anambra State secondary school students in chemistry. *Unizik Journal of Educational Research and Policy Studies;* 7(1); 375-386.

Nwanne, S.C. & Agommuoh, P.C. (2017). Computer assisted instruction (CAI) on students' interest and achievement in Physics in Imo State, Nigeria. *Journal of Research & Method in Education,* 7(3); 53-58.

Nworgu, B.G. (2015). *Educational research: Basic issues and methodology (Third Edition)*. Nsukka, Enugu: University Trust Publishers.

Sahin, A. (2010) Effects of jigsaw technique on academic achievement and attitudes to written expression course. *Educational Research and Reviews,* 5 (12), 777-787.

Eriba, J.O & Samba, R.M.O. (2012). *Background information on teaching difficult science concepts*. In Samba RMO and Eriba JO. (Eds). Innovative Approaches in Teaching Difficult Science concepts (pp.1–5) Makurdi, Nigeria: Destiny Ventures

Isa, M.I. (2018). Effect of Jigsaw IV cooperative learning strategy on students' perception, retention and academic performance in organic chemistry in Zaria Education Zone, Kaduna State. *Unpublished M.ED. Dissertation*, Department of Science Education Ahmadu Bello University Zaria.

Jegede, S.A. (2010). Nigerian students perception of technical words in senior secondary schools chemistry curriculum. Department of Curriculum Studies, Faculty of Education, University of Ekiti, Ado- Ekiti, Nigeria. *Pakistan Journal of Social Sciences 7(2), 109-111, ISSN:1683-8831*

Oloyede, O.I. (2010). Enhanced mastery learning strategy on the achievement and self concept in senior secondary school chemistry. *Humanity and Social Sciences Journal* 5(1), 19-24.

Temesgen & Enunuwe (2014). Effect of Jigsaw cooperative learning teaching style on students` achievement in organic chemistry. *South African International Conference on Education*. "Rethinking Teaching and Learning in the 21st Century" Proceedings. 226-242.

Timayi, J.M., Bolaji, C. & Kajuru, Y.K (2015). Effects of Jig-saw IV Cooperative Learning Strategy on Academic Performance of Secondary School Mathematics Students in Geometry. Department of Science Education, Ahmadu Bello University Zaria, Kaduna State, Nigeria. *International Journal of MathematicsTrends and Technology*. 28(1), 12-18.

Uzoagulu, A.E. (2011). *Writing Research/project Reports in Tertiary institutions,* (Enlarged ed.) Enugu: John Jacob's Classic Publishers Ltd.

West African Examination Council, (WAEC, 2016). May/June. *Chief Examiner's Report*. Lagos.

Yemi, T.M., Azid, N.B.H. & Ali, M.R. (2018). Effect of jigsaw strategy of cooperative learningon mathematics achievement among secondarySchool students. *European Journal of Education Studies*, 4(2); 51-61.