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Investigating the Impact of Jigsaw Cooperative Learning on Senior Secondary School Students' Achievement in Chemistry

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ABSTRACT

This study examined how the Jigsaw cooperative learning approach affected the chemistry proficiency of senior secondary school pupils in Kogi State, Nigeria. The study used a quasi-experimental methodology and addressed three research issues. The study involved 160 kids from four different institutions. The pupils were divided into two groups: a control group (n = 74) and an experimental group (n = 86). While the control group received instruction using the conventional lecture approach, the experimental group was taught utilizing the Jigsaw cooperative learning strategy. The Chemistry Achievement Test (CAT) was used to gather data, and the Kuder-Richardson formula 20 (K-R20) yielded a reliability value of 0.84. Students in the experimental group outperformed those in the control group, according to the results. Furthermore, there was no discernible difference between the experimental group's male and female students' mean achievement scores. The results of the study indicate, among other things, that the Jigsaw cooperative learning model is a successful way to raise students' chemical proficiency. Curriculum designers ought to create teaching resources that facilitate the Jigsaw cooperative learning approach in chemistry classes.

INTRODUCTION

One of the core scientific disciplines that is essential to comprehending the world we live in is chemistry (Johnstone, 1991). However, a lot of students have trouble understanding chemistry topics, which makes them uninterested in the subject and results in low academic performance (Gabel, 1999). Students are expected to understand complicated concepts and apply them to real-world issues in senior secondary schools, which makes this obstacle especially apparent (Taber, 2013). Since it gives students a basis for comprehending a variety of scientific and technological developments, the value of chemistry education cannot be emphasized (National Research Council, 2012). Many students still find chemistry difficult, despite its importance, frequently as a result of poor teaching strategies (Haidar, 2017).

Teachers have been investigating creative teaching methods in recent years to improve chemistry student engagement and performance. One such method is the Jigsaw cooperative learning strategy, which has demonstrated potential in enhancing academic results and encouraging student-centered learning (Aronson, 1971; Slavin, 1990). Elliot Aronson created a cooperative learning method called the Jigsaw strategy in 1971 (Aronson, 1971). Students benefit from this planned, small-group learning method that encourages cooperation, interdependence, and active learning. Each small group of students in a Jigsaw classroom is in charge of learning a particular subject or subset of the material. According to the information above, Jigsaw is one of the creative and student-centered teaching methods that encourage teamwork among students in order to achieve academic achievement.

Cooperative learning techniques, such as the enriched lecture (Omale *et al.*, 2025) and the Jigsaw approach, have been repeatedly demonstrated in recent research to dramatically raise student achievement in a variety of topics, including chemistry (Kagan & Kagan, 2015; Tran, 2019). Particularly, the Jigsaw method has been shown to improve academic achievement, raise student engagement, and support student-centered learning (Doymus, 2008; Şimşek *et al.*, 2017; Isa & Muhammad, 2019). In their study, Mathew and Musa (2024) also discovered that students using the Jigsaw II cooperative learning approach outperformed those using the traditional teaching approach.

According to studies, the Jigsaw method can be a useful teaching technique in chemistry classes, especially when it comes to encouraging group projects, peer-to-peer instruction, and the growth of social skills (Gillies & Boyle, 2010; King & Howard, 2016). Additionally, research has shown that students who engage in Jigsaw activities typically get better academic results, have better problem-solving abilities, and are more motivated to learn chemistry (Hwang *et al.*, 2019; Sung *et al.*, 2017). Similar to this, Chinweuba-Eze (2021) conducted research on how biology students' achievement and retention were affected by jigsaw-based instructional strategies and demonstration methods. The results showed that the jigsaw-based instructional approach was more effective

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than the demonstration method at raising biology students' achievement and retention. Also, students' retention in biology was not significantly influenced by their gender.

The social interdependence idea, which holds that students cooperate to accomplish a common objective, is the foundation of the Jigsaw method (Johnson & Johnson, 2009). Constructivist learning theory supports this theory. Constructivist learning theory, which highlights the value of social interaction, active learning, and peer-to-peer instruction, lends support to this hypothesis (Vygotsky, 1978). These theoretical frameworks are supported by the Jigsaw approach, which fosters a cooperative and student-centered learning environment. Thus, this study examines how Jigsaw cooperative learning affects Kogi State senior high school students' chemistry proficiency.

Research Questions

1. What is the difference between the mean achievement scores of students taught chemistry using Jigsaw cooperative learning strategy and those taught using traditional lecture methods?
2. What is the difference in the mean achievement scores of male and female students taught chemistry using Jigsaw cooperative learning strategy?

Hypotheses

Ho_1 There is no significant difference between the mean achievement score of students taught chemistry using Jigsaw cooperative learning strategy and those taught using traditional lecture strategy

Ho_1 There is no significant difference between in the mean achievement scores of male and female students taught chemistry using Jigsaw cooperative learning strategy.

MATERIALS AND METHODS

The impact of Jigsaw cooperative learning on senior secondary school students' chemistry achievement was examined in this study using a quasi-experimental research approach. An experimental group and a control group were included in the design; the experimental group received training using Jigsaw cooperative learning, while the control group received conventional lecture-based instruction. This study was conducted in Kogi state in response to the average and subpar results of pupils' performance on external assessments such as the Chief Examiner's Report (2023) and the West African Senior School Certificate Examination (WASSCE).

All 11,391 senior secondary (SSII) chemistry students enrolled in Kogi State's 254 government secondary schools make up the study's population. There were 160 SSII chemistry students in the sample. A multi-stage sampling strategy was used in the study to choose schools from the population. First, two Local Government Areas (LGA) were chosen from the twenty-one LGA in Kogi state using a straightforward random sample approach by balloting, for a total of six (6) LGA. Second, as gender was a moderating variable, 12 schools with well-equipped chemistry labs, certified chemistry teachers, and one arm of coeducational chemistry classes were chosen from the target population using the purposive sampling technique. The third stage of sampling, which involved choosing four schools overall using a straightforward random selection procedure via balloting, was applied to the twelve schools that satisfied the aforementioned requirements. Fourth, two schools with intact classes were assigned to each of the two options using a straightforward random sample method that involved tossing a coin.

The following data collection tools were employed in the study: The Chemistry Achievement Test (CAT) comes first. A multiple-choice test consisting of thirty items was created to evaluate students' comprehension of chemical principles. To guarantee validity and reliability, the exam items were pilot-tested with a group of students and verified by chemistry education specialists. The test items' internal consistency was assessed using the Kuder-Richardson 20 (K-R20). High dependability was indicated by the reliability coefficient of 0.85 that was achieved. Second, to guarantee uniformity in instruction, lesson plans were created for the experimental and control groups.

Data was gathered by taking the following actions: First, the pre-test Prior to the intervention, the CAT was given to both groups. Second, the experimental group was instructed in Jigsaw cooperative learning, whereas the control group was given a conventional lecture. Thirdly, following the intervention, the CAT was given to both groups. The study analyzed the data using inferential statistics (ANCOVA) and descriptive statistics (mean and standard deviation). After adjusting for pre-test results, the post-test results of the experimental and control groups were compared using the ANCOVA.

RESULTS AND DISCUSSIONS

The results of the study are presented below in relation to the research questions.

Research Question 1

What is the difference between the mean achievement scores of students taught chemistry using Jigsaw cooperative learning strategy and those taught using traditional lecture methods?

The mean academic achievement scores of students

Table 1: Pretest/Posttest of the Mean Achievement Scores of Students Taught Chemistry Using Jigsaw Cooperative Learning Strategy and Those Taught Using Traditional Lecture Strategies

Group	Sample (n)	Pre-test		Post-test		Mean gain
		Mean	SD	Mean	SD	
Jigsaw Strategy	86	45.50	10.20	80.10	12.40	34.60

Traditional Lecture	74	44.20	11.50	65.50	14.20	21.30
Mean Difference		1.300		14.20		13.30
Total	160					

taught chemistry using the Jigsaw cooperative learning approach and standard lecture methods were displayed in Table 1's results. According to the findings, students' academic performance was enhanced more by the Jigsaw cooperative learning technique than by the conventional lecture method, with a bigger mean gain difference (13.30). It suggests that the average academic achievement scores of chemistry students were positively impacted by the Jigsaw cooperative learning approach.

Ho_1 There is no significant difference between the mean achievement score of students taught chemistry using Jigsaw cooperative learning strategy and those taught using traditional lecture strategy.

The ANCOVA of the difference between the mean academic performance scores of Chemistry students exposed to the Jigsaw cooperative learning technique and the traditional strategy was displayed in Table 2. A statistically significant result was obtained at (F) =511.827, p = 0.00, and η2p = 0.832. The null hypothesis was rejected because the associated probability value of 0.00 is less than the significance level of 0.05. Therefore, it can be concluded that there was a statistically significant difference between the mean academic performance of students in Chemistry classes taught using the Jigsaw cooperative learning approach and the traditional technique, with the high mean favoring the Jigsaw cooperative learning strategy. The results also revealed the impact size (η2p = 0.832), which suggests that the Jigsaw cooperative learning technique was responsible for 83.2% of the variation in the mean academic achievement of Chemistry students exposed to it.

Table 2: Analysis of Covariance (ANCOVA) of the Difference in the Mean Performance score of Male and Female Students taught Chemistry Using Jigsaw Cooperative Learning Strategy and Those Taught Using Traditional Lecture Strategies

Source	**Type III Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**	**Partial Eta Squared**
Corrected Model	18533.764[a]	2	9456.882	271.160	.000	.826
Intercept	22541.406	1	20951.406	598.612	.000	.840
Pretest	91.904	1	91.904	2.623	.108	.022
Strategy	18282.298	1	18292.298	511.827	.000	.832
Error	3894.766	157	36.042			
Total	363014.000	160				
Corrected Total	23928.530	159				

a. R Squared = .826 (Adjusted R Squared = .823)

Research Question 2

What is the difference in the mean achievement scores of male and female students taught chemistry using Jigsaw cooperative learning strategy?

Table 3: Pretest/Posttest of the Mean Achievement Scores of male and female Students Taught Chemistry Using Jigsaw Cooperative Learning Strategy

Gender	**N**	**$\bar{x}$**	**SD**	**$\bar{x}$**	**SD**	**Mean Gain**	**Mean Gain Difference**
Male	31	40.55	8.006	78.81	11.88	38.26	
							1.240
Female	27	40.95	9.010	77.97	11.01	37.02	
Mean Difference		0.400		0.840			
Total	58						

The impact of gender on the mean academic achievement scores of students taught chemistry using the Jigsaw Cooperative Learning Strategy was displayed in Table 3. The findings indicated that the male students had mean academic achievement scores of 40.55, SD = 8.006, and 78.81, SD = 11.88 on the pre-test and 77.97, SD = 11.01 on the post-test, while the female students had mean academic achievement scores of 40.95, SD = 9.010 on the pre-test and 77.97, SD = 11.03. The findings indicated that male students outperformed female students, with a mean gain of 38.26 compared to 37.02 for the female students. This resulted in a mean difference of 1.240 in favor of the male student.

HO_2: There is no significant difference between in the mean achievement scores of male and female students taught chemistry using Jigsaw cooperative learning strategy.

Table 4: Analysis of Covariance (ANCOVA) of the Difference in the mean Performance Score of Male and Female Students taught Chemistry Using Jigsaw Cooperative Learning Strategy

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	6.8727[a]	2	3.363	.376	.688	.012
Intercept	12589.319	1	12689.319	1417.834	.000	.959
Pretest	2.930	1	2.830	.316	.576	.005
Gender	1.058	1	1.018	.114	.737	.002
Error	546.987	157	8.950			
Total	278385.000	160				
Corrected Total	553.714	159				

a. R Squared = .012 (Adjusted R Squared = -.021)

The ANCOVA of the difference in the mean academic achievement of male and female students who were taught chemistry using the Jigsaw cooperative learning technique was also displayed in Table 4. A statistically insignificant result was obtained at (F) = 0.114, p = 0.737, and $\eta 2p$ = 0.002. The null hypothesis was not rejected since the associated probability value of 0.737 is higher than the significance level of 0.05. Consequently, it can be concluded that there was no discernible difference in the average academic performance of male and female students who were taught chemistry using the Jigsaw cooperative learning technique, with the male students achieving higher mean scores. Additionally, the results revealed the impact size ($\eta 2p$ = 0.002), indicating a 0.2% difference in the mean academic performance of chemistry-taught male and female students.

Discussion

The study looked into how the Jigsaw cooperative learning approach affected the chemistry proficiency of senior secondary school pupils. Tables 1 and 2's results demonstrated that students who were taught using the Jigsaw cooperative learning strategy outperformed those who were taught using the conventional lecture method. These results are in line with earlier studies that demonstrated how cooperative learning techniques might improve students' performance in science courses (Johnson & Johnson, 2009; Slavin, 2011; Tran, 2014). For instance, cooperative learning techniques enhanced students' comprehension of difficult science ideas and encouraged active learning, according to a research by Lord (2001). Some research, though, has shown contradictory findings. For example, a 2010 study by Diaz-Aguilar and McGill discovered that although cooperative learning techniques enhanced students' capacity for teamwork, they did not always result in higher academic achievement. However, the results of this study indicate that the Jigsaw cooperative learning model may be a useful way to raise chemistry students' performance.

The mean achievement scores of male and female students taught using the Jigsaw cooperative learning technique did not differ significantly, according to the study. This result is in line with earlier studies that shown how cooperative learning techniques might advance fairness in science instruction (Shachar & Fischer, 2004). One study by Lazarowitz *et al.* (2002), for instance: In accordance with the current study, Isa & Muhammad (2019) discovered that Jigsaw cooperative learning strategies decreased the achievement gap between male and female students in science subjects. This suggests that Jigsaw cooperative learning strategies may be a better strategy for achieving maximum achievement in chemistry.

CONCLUSION

The study examined the impact of Jigsaw cooperative learning strategies on senior secondary school students' achievement in chemistry. The following conclusions were made in light of the findings:

Jigsaw cooperative learning strategy is an effective approach to enhancing students' achievement in chemistry.The strategy promotes active learning, teamwork, and problem-solving skills among students. Jigsaw cooperative learning strategy is effective for both male and female students, promoting equity in science education. The study's findings have implications for teaching and learning in science education. Teachers can use Jigsaw cooperative learning strategy to promote student-centered learning, teamwork, and problem-solving skills.

RECOMMENDATIONS

The study's conclusions lead to the following recommendations:

For Teachers

1. Use the jigsaw cooperative learning strategy to promote active learning, teamwork, and problem-solving skills among students.
2. Encourage students to work in groups to enhance their understanding of chemistry concepts.

3. Provide opportunities for students to share their knowledge and experiences with their peers.

For Curriculum Developers

1. Incorporate cooperative learning strategies into the chemistry curriculum to promote student-centered learning.
2. Develop instructional materials that support the use of the Jigsaw cooperative learning strategy in chemistry classrooms.

For Future Research

1. Investigate the effect of the Jigsaw cooperative learning strategy on students' attitude towards chemistry.
2. Explore the use of the Jigsaw cooperative learning strategy in other science subjects.

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