



## Comparative Effects of Students' Team Achievement Division and Jigsaw Cooperative Strategies on Secondary School Students' Achievement and Retention in Chemistry, Uyo, Nigeria

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### Abstract

This research explored the effects of Students' Team Achievement Division (STAD) and Jigsaw instructional methods on academic achievement and retention in chemistry among senior secondary students in Uyo, Nigeria. Using a quasi-experimental design with a non-randomized pre-test–post-test approach, the study involved 178 students from four secondary schools. A 50-item multiple-choice Chemistry Achievement Test on Electrolysis was administered, yielding a reliability coefficient of 0.72. Data analysis through mean, standard deviation, and ANCOVA revealed that students taught with the Jigsaw method scored significantly higher, while STAD students showed better retention. It is recommended that chemistry educators implement both strategies to improve learning outcomes.

**Key words:** Students' Team Achievement Division cooperative strategy, Jigsaw cooperative strategy, achievement, retention

### Introduction

Chemistry is a science subject that consists of the nature, characteristics, transformations, and interactions of matter. Teaching chemistry at the secondary school involves guiding students to gain an understanding of fundamental scientific principles as well as their usage to obtain appropriate skills and attitude for future scientific careers. Chemistry students are equipped with the knowledge to observe, ask questions, find solutions to problems of everyday activities and manipulate raw materials from the environment, converting them into basic chemicals or chemical intermediates and a wide variety of consumer goods. Therefore, effective teaching is necessary for positive outcomes, which could be achieved by the use of an appropriate teaching method capable of creating an enabling classroom climate for learning to thrive and enhance a better understanding of topics perceived to be difficult by students, leading to better academic achievement and retention of the concept taught.

One of the Chemistry topics presumed to be abstract and tough to learn is the concept of electrolysis. Electrolysis is a concept of utmost importance and has many industrial applications. It is therefore necessary for students to receive a good grounding in the concept during science learning. One

of the reasons attributed to the difficulty is that the content demands higher-order thinking skills involving microscopic, macroscopic, and symbolic representation levels. Students are required to imagine how ions and electrons migrate during the electrolytic process, and convert the process into chemical formulae and equations. Chemistry teachers need to determine how to overcome the difficulties associated with understanding the topic by researching and employing appropriate teaching strategies for meaningful understanding. Udoh (2017) observed that teaching difficult concepts using appropriate instructional strategies could help students to partake in the learning process, thereby enhancing their achievement and retention. Ifegbo (2012) also added that the teaching-learning process in the 21<sup>st</sup> century should be learner-centered where learners are encouraged to be active participants to construct knowledge and think critically as opposed to passive listening. One of such teaching strategies, which has been rated as effective, is the use of cooperative strategies.

Cooperative strategies are student-centred instructional strategies that allow small groups of students to be accountable for their learning and that



of their group members. Students are arranged into mixed-ability small groups of 5-6 students. Students in the group work collectively and assist one another to learn and achieve academic goals (Mari and Gumel, 2015). The hallmark of the cooperative teaching method is to make the students drivers of the learning process. Instead of putting the students against one another in a contest for grades, Chemistry teachers can select an appropriate cooperative teaching strategy that effectively enriches more conventional teaching strategies to address students' needs (Ekeanyanwu, 2020). The teacher's function is to facilitate the group, arrange learning activities and teams. Students learn by interacting together. Social discourse with peers during group interaction enables learners to change or reinforce their opinions. When allowed to present their thinking and hear other ideas, students can develop a personalized knowledge foundation that fosters a deeper understanding of the concepts learned. Johnson *et al.* (2010) opined that there are eight types of cooperative strategies. This research investigated two of these cooperative approaches: STAD and the Jigsaw cooperative strategy.

STAD is an instructional approach in which heterogeneous groups of students collaborate to achieve common learning objectives. In the classroom, learners are categorized into heterogeneous groups of four to five learners, ensuring diversity in terms of ethnicity, gender, and academic ability levels. According to Utami (2010), the team is the most important focus of STAD. The instructors present the chemistry concept to the whole class, followed by group discussions among various teams. Members of the team utilize worksheets to learn the academic material through tutoring and quizzes. Thereafter students individually take a test or quiz on the material they have been studying without helping one another. The quizzes/tests are marked and each student is awarded an improvement score. The group with the leading group improvement score is rewarded and recognized.

Another type of cooperative strategy is jigsaw. The jigsaw strategy was formed by Aronson in 1978. Students are split into groups of 5-6, called the home groups. The learning material is divided into segments. Each learner in the home group is allocated a topic to practice on. Learners with similar concepts form the expert groups. At the end of the practice session, students return to their home groups, where the expert teaches the allocated topic to other learners in the home group for proper understanding of the topic. Students

then take test individually without assisting each other. The scores of the individual students are totalled to form the group scores, which is used to reward the best group ( Anari *et al.*, 2024, Achor *et al.*, 2013; Emmanuel and John, 2020; Nwankwo and Okigbo, 2021). Various authors have carried out studies on cooperative strategies on students' achievement and retention.

Aşkın and Şimşek (2018) compared two cooperative teaching methods, STAD and Jigsaw, on the academic performance of pre-service teachers. The result revealed that Jigsaw is less effective than STAD on academic achievement. However, Ika and Susiani (2021) observed that the Jigsaw teaching strategy was significant than STAD. Also, Adesoji and Ibraheem (2009) conducted a study on STAD and mathematics ability on learners' performance in chemical kinetics. The findings indicated a significant effect on students' performance and attitude.

Literatures reviewed indicate that most of the studies that examined the efficacy of cooperative strategies (Students Team Achievement Division and Jigsaw) are very few in Chemistry. However, there was no literature that compared the effect of STAD and the Jigsaw method on learners' performance and retention in Chemistry using the concept of electrolysis. Using an alternative strategy like cooperative strategy, may be efficacious in improving students' achievement and retention in electrolysis since it allows the students to take ownership over their learning, thus fostering participation and understanding of difficult concepts. The gap in the literature necessitated the need to assess the comparative effect of STAD and Jigsaw on learners' academic performance and retention in Chemistry.

### Research Questions

1. Is there any mean difference in the achievement scores of Chemistry students instructed electrolysis using STAD compared with those instructed with the Jigsaw cooperative method?
2. Is there any mean difference in the retention scores of Chemistry students instructed in electrolysis with Students Team Achievement Division compared with those taught using the Jigsaw cooperative method?

### Research Hypotheses

H<sub>0</sub>1 The mean achievement scores of Chemistry students instructed in electrolysis with STAD



compared with students instructed with the Jigsaw cooperative method are not significant.

H<sub>02</sub> The mean retention scores of Chemistry students instructed in electrolysis with ST AD compared with students instructed with the Jigsaw cooperative method are not significant.

### Research Method

This research employed a non-randomized quasi-experimental design of pre-tests and post-tests. The study's population comprised 1,294 Senior Secondary Two (SS2) students taking chemistry classes in all 14 public secondary schools located in Uyo L.G.A during the 2023/2024 academic year. A sample of 178 SS2 learners was randomly chosen from four schools through a simple random sampling method. The selected schools were divided into two treatment groups. One intact class from each school was designated for the study: Group 1 was instructed using the Students Team Achievement Division cooperative strategy, while Group 2 was taught through the Jigsaw cooperative strategy. The data collection tool was the Achievement Test on Electrolysis (ATE), which included 50 multiple-choice questions offering four options (A, B, C, and D), among which three were distractors and only one was correct.

The questions were drawn from a set of multiple-choice items sourced from the Senior Secondary School Examination and past Joint Admission and Matriculation Board (JAMB) questions focused on electrolysis. The test was implemented to collect pre-test and post-test scores of the students regarding the concept of electrolysis when instructed using cooperative strategies (STAD and Jigsaw). The Achievement Test on Electrolysis (ATE) was rearranged to create a retention test on electrolysis, with the only difference being the order of the test items. This retention test was utilized to gather scores on students' retention of electrolysis knowledge when taught using the cooperative strategies of STAD and Jigsaw.

The Achievement Test on Electrolysis (ATE) was reviewed for content validity by three experts in the

fields of testing, measurement, and evaluation. The tests content relevance was obtained by employing a test blueprint established by Bloom (1972). Fifty (50) multiple-choice test questions were given to an equivalent group of fifty (50) students from another school in Uyo Local Government Area, which was not part of the study. The reliability of ATE was determined through the test-retest method. The gathered data was analyzed using Pearson Product-Moment Correlation coefficient (r). The reliability index was found to be 0.72, indicating a high reliability that showed the instrument was capable of consistently measuring students' academic achievement. The researcher immediately scored the Achievement Test on Electrolysis after its administration. Each correct answer received one mark, while an incorrect response earned zero (0) marks.

### Research procedure

The researcher visited the selected schools and obtained approval from the principals to carry out the study. Consent was also acquired from the students involved in the research. Moreover, the cooperation of the chemistry teachers from the selected classes was requested to aid with the study. These teachers received a week of training on how to use the instructional packages created by the researcher. After the preparation, a pre-test was given to both treatment groups. The topic of electrolysis was taught over a duration of five weeks. Once the treatment phase was completed, the achievement test was rearranged and administered to the groups as a post-test to evaluate the effect of the two cooperative strategies being studied. Three weeks later, the post-test was reorganized and given again as a retention test. The test scripts from the pre-test, post-test, and retention test were collected, evaluated, and subjected to relevant statistical analysis. The gathered data were analyzed using Mean, Standard Deviation, and ANCOVA. The hypotheses were examined at the 0.05 level of significance. The null hypothesis was accepted when the calculated p-value exceeded 0.05. In cases where the calculated p-value was equal to or less than 0.05, the null hypothesis was rejected.

### Data Analysis and Results

#### Mean scores and standard deviations for learners' pre-test and post-test outcomes in electrolysis, organized by treatment groups.

Treatment Groups	N	Pre-test		Post-test		Mean Gain Score
		x	SD	x	SD	
STAD	83	13.35	3.56	36.88	2.77	23.53
Jigsaw	64	13.38	3.55	39.42	3.27	25.54

Data in Table 1 shows the mean gain scores of learners given instruction on electrolysis with the STAD and Jigsaw instructional methods. Learners in the Jigsaw strategy group had a slightly better mean gain score of 23.54 compared with those in the STAD group, with a mean gain score of 23.53. However, the post-test standard deviation scores of 2.77 and 3.27 for students taught with STAD and Jigsaw show that,

although students taught using the Jigsaw cooperative method exhibited a wider range of raw scores around the group mean and had a better mean gain score, those instructed with the STAD method showed a closer clustering of raw scores in relation to the group mean. The statistical significance of the differences in mean scores between the two groups is evaluated through the results of hypothesis testing presented in Table 2.

#### Hypothesis One:

**Table 2: ANCOVA of learners' post-test scores categorized by treatment groups**

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Decision at p<.05alpha
<b>Corrected Model</b>	1029.18 <sup>a</sup>	2	514.59	103.74	.000	s
<b>Pretest</b>	28.84	1	28.84	5.82	.017	s
<b>Treatment</b>	997.30	1	997.30	201.06	.000	s
<b>Error</b>	868.06	175	4.96	-	-	-
<b>Total</b>	278438.00	178	-	-	-	-
<b>Corrected Total</b>	1897.24	177	-	-	-	-

a. R Squared = .542 (Adjusted R Squared = .537)

In Table 2, the F-value of 201.06 for treatment at df 1, 175 is significant at 0.000, which is less than the 0.05 alpha level; as such, the null hypothesis was rejected. This suggests that there was a notable difference in the average achievement scores of learners taught electrolysis with the STAD method in

comparison to those who received instruction through the Jigsaw strategy. The significance was in favour of learners instructed with the Jigsaw instructional approach, with a mean score of 39.42, compared with 36.88 for those in the Students Team Achievement Division (STAD) group.

**Table 3: Mean and standard deviation scores of students' post-test and retention in electrolysis, categorized according to treatment groups**

Treatment Groups	N	Post-test		Retention		Mean Gain Score
		x	SD	x	SD	
STAD	83	36.88	2.77	36.51	3.80	0.37
Jigsaw	95	41.63	1.68	39.88	2.55	1.73

Table 3 presents the results of the post-test, standard deviation, and retention mean gain scores of students instructed using the STAD and Jigsaw

cooperative learning strategies. The differences between post-test and retention mean scores 0.37 for the STAD group and 1.73 for the Jigsaw group,



indicate that students in the STAD cooperative learning group exhibiting lower score attrition, demonstrated better retention compared to those in the Jigsaw group. Nonetheless, the retention standard deviation scores reveal that the Jigsaw group had a

more closely clustered distribution of scores around the group mean. The statistical significance of these observed mean differences between the two groups was evaluated through the test of the first hypothesis, as presented in Table 4.

**Table 4: ANCOVA result of learners’ Retention scores categorized by treatment groups**

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Decision at p<.05alpha
<b>Corrected Model</b>	1453.35	2	726.68	150.20	.000	S
<b>Posttest</b>	947.82	1	947.82	195.91	.000	S
<b>Treatment</b>	47.55	1	47.55	9.83	.002	S
<b>Error</b>	846.66	175	4.84	-	-	-
<b>Total</b>	263529.00	178	-	-	-	-
<b>Corrected Total</b>	2300.01	177	-	-	-	-

a. R Squared = .632 (Adjusted R Squared = .628)

Table 4 indicate a calculated F-value of 9.83 for the treatment effect, which is significant at the 0.002 level, less than the 0.05 alpha threshold. This finding demonstrates a significant difference in the retention scores of learners instructed with the STAD and Jigsaw instructional strategies. Consequently, null hypothesis two was rejected. The mean score differences in Table 4 further reveal that the significant effect favored students instructed through the STAD strategy.

**Discussion of Findings**

The findings regarding the effects of the STAD and Jigsaw teaching methods on students’ achievement indicated a significant difference in favor of learners instructed with the Jigsaw instructional method. The superior enhancement effect of the Jigsaw approach on student achievement, compared to those taught through STAD, can be attributed to its capacity to foster interaction among group members, channel students' energy towards tasks, and facilitate information processing, thereby providing a broader perspective on learning objectives. This outcome contrasts with the findings of Askin and Simsek (2018), who concluded that Jigsaw was less effective than STAD, but aligns with the conclusions of Ika and Susiani (2021) who discovered that the Jigsaw teaching approach was more effective compared to STAD.

Regarding the impact of STAD and Jigsaw methods on learners' retention of information, the results revealed a significant difference favouring students taught using the STAD cooperative strategy, who exhibited a lower mean loss in post-test retention. This observation may be linked to students’ awareness of the quiz component embedded in STAD, which encouraged each participant to be more dedicated to mastering every unit of the assigned task. This finding is consistent with the research of Adesoji and Ibraheem (2009) emphasized a notable influence of STAD on the accomplishments of students. The results concerning the effect of the STAD and Jigsaw instructional methods on students' academic achievement show a clear benefit for the Jigsaw cooperative strategy. Students instructed through Jigsaw demonstrated significantly greater academic success, a result that underscores the strategy’s effectiveness. This enhanced impact can be attributed to Jigsaw’s unique ability to foster meaningful interaction among group members, engage students' energies in tasks, and promote effective information processing, all of which lead to a deeper understanding of learning objectives.

While this outcome challenges the conclusions of Askin and Simsek (2018), who argued that Jigsaw is less effective than STAD, it aligns convincingly with the result of Ika and Susiani (2021), who affirmed that the Jigsaw approach surpasses STAD in effectiveness.



When examining the influence of these strategies on students' retention of knowledge, a noteworthy distinction emerged. Students who participated in the STAD cooperative strategy exhibited a significantly lower mean loss in post-test retention. This phenomenon can likely be attributed to the inherent quiz component of STAD, which heightened student awareness and commitment to mastering each unit of their assignments. Such results align with the research of Adesoji and Ibraheem (2009), which also highlighted the pronounced effects of STAD on students' achievement, reinforcing the case for employing these effective pedagogical strategies.

### Conclusion

According to the study's results, it can be concluded that both the Students' Team Achievement Division (STAD) and Jigsaw learning methods have a considerable improvement on students' academic achievement and retention in chemistry.

### Recommendations

Chemistry teachers should make effective use of Jigsaw and STAD cooperative strategies in teaching chemistry concepts.

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