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Enhancing Academic Achievement and Retention in Esterification Reaction among Secondary School Chemistry Students through Cooperative Instructional Method

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Abstract:- In senior secondary school II in the Ahoada West Local Government Area, this study was conducted, and it therefore examined the enhancement of academic achievement and retention in esterification reaction among senior secondary school chemistry students through cooperative instructional method. The research study used a design that was close to an experiment (quasi experimental). It was the non-randomized, pretest-posttest control group, specifically. Twenty (20) SSSII Chemistry students from co-educational schools were used in a trial testing session to assess the reliability of the Chemistry achievement test CAT) and retention in a non-study area. There were twenty (20) items used. The instrument's internal consistency is guaranteed by the 0.84 instrument dependability coefficient obtained by the application of Cronbach Alpha. As a result, it was decided that the instrument would work well for the Study. One hundred fifty (150) students from two classes at fifteen senior secondary schools that were sampled took the Achievement Test (CAT). Four hypotheses and four research questions were developed, and they were tested at the 0.05 significant level. For research questions, the acquired data were examined using the mean and standard deviation, and for hypotheses analysis, inferential statistics of covariance (ANCOVA) were employed. The study's findings showed that students taught using the cooperative learning approach performed noticeably better than those taught using the traditional approach. It was suggested, among other things, that delicate subjects requiring study or peer review be taught using the cooperative teaching approach.

I. INTRODUCTION

➢ *Background of the Study*

Wealth creation and economic empowerment for the teeming unemployed youths in Nigeria is possible through the application of the knowledge of chemistry (Zudonu, 2018). Burmeister, Rauch and Agu and Samuel (2018) assert that manufacturing activities in textile, food processing and technology industries as well as agricultural, petroleum and pharmaceutical industries depend mostly on the application of the knowledge of chemistry. Also, it has been opined that the knowledge of chemistry facilitates the study of both pure and applied science, medicine, pharmacy, engineering, agriculture among other professions at the tertiary level of education (Oginni, Awobodu, Alaka & Saibu, 2013). Furthermore, Zudonu (2014) asserted that the production of papers, pastes, pomades, soaps, paints, shoe polish, starch, shampoos, fertilizers, insecticides, medicines, and materials for construction works are based on chemical principles. Thus, chemistry education is the means through which chemical knowledge and skills reach the youths, which in turn promotes national development through various economic products (Emmanuel, 2013 & Igboanugo, 2013). This implies that chemistry education can empower youths to become self-employed and economically vibrant.

Despite the tall advantages of chemistry as a major subject in realizing any nation's scientific and technological aspirations, there is a public hullabaloo on the continued poor academic achievement of chemistry students over the years (Igboanugo, 2013; Njoku & Okoli, 2013). Typical example is the case of 2018, when the West African Senior School Certificate Examination (WASSCE) recorded only 45.6 percent credit pass and above in chemistry by learners (The West African Examination Council (WAEC) Chief Examiner's report (2017-2018). This further declined in 2020 with only 40.2 percent credit pass. This really portends tremendous danger to the nation's economic and technological advancement because a credit in chemistry is needed to acquire admission into higher institutions to virtually all the science-oriented courses like pharmacy, medicine and medical related courses, engineering courses and applied sciences, but many students are deficient in the subject. This factor could be a pointer to some of the reasons why there is a gradual decline in enrollment of chemistry as a course and other science related courses in tertiary institutions. This may also be an index of why tertiary institutions are running remedial programs for the sciences including chemistry.

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Poor academic performance in chemistry can be linked to various factors, including ineffective instructional methods (Baloche & Brody, 2017; Owolabi & Ogini, 2013; Zudonu, 2015). The West African Examination Council (WAEC) Chief Examiner's report (2017-2018) highlighted that students' consistently low scores in the Senior Secondary School Certificate Examination raise concerns about the effectiveness of the instructional materials and teaching strategies used by chemistry teachers.

Critics argue that the lecture method may be a significant cause of poor academic outcomes, as it primarily involves one-way communication and passive learning, lacking active audience participation (Nwagbo & Okoro, 2012). This teacher-centered approach fails to address the diverse learning styles and needs of students, as noted by Fayombo (2012). Consequently, education researchers advocate for a shift from teacher-centered methods to hands-on learning approaches, which provide students with varied opportunities to engage in the learning process. The lecture method involves verbally presenting ideas, concepts, and facts to students, intending to help them understand, analyze, and apply this knowledge in real-life situations (Bukunola, 2012). Ausubel (1986), cited in Ballantine and Oludipe (2007), emphasized that learning is dependent on experience. Therefore, teachers using the lecture method should connect the concepts being taught to students' prior experiences and knowledge to achieve meaningful learning outcomes. This approach was effective in the past, but today's students have different mindsets compared to previous generations. Modern students are highly scientifically literate and adept at using new technologies, such as the internet, to enhance their knowledge. Consequently, educational practices and technologies need to evolve with the times, necessitating innovative teaching methods that meet the needs of contemporary students (Anaduaka & Okafor, 2013).

Cooperative learning entails a teaching approach where students with varying abilities collaborate in small groups to accomplish shared objectives (Gokhale, 2015; Zudonu, 2018). This fosters a sense of unity, synergy, and interdependence among group members as they work towards common goals. Working in small groups allows learners the flexibility for competitive learning and provides opportunities for exploration and discussion of topics with peers (Abdulwahab, Onyelekan, & Olorundare, 2016).

Numerous studies have delved into the impact of teaching methodologies on learning outcomes. Gilbert (2009), Arokoyu and Obunwo (2014), and Essien (2015) investigated the effect of concept mapping on students' academic achievement in chemistry, revealing a significant improvement among those exposed to this method compared to those who were not. Consequently, they advocated for the integration of concept mapping into teaching practices to enhance student learning and achievement in the subject.

Similarly, Ogolo and Wagbara (2013) and Alabi and Lasisi (2015) explored the effects of various instructional strategies, including demonstration, guided discovery, collaborative learning, lecture, cooperative learning, discussion, and problem-solving, on secondary school students' chemistry achievement. Both studies found that students taught using innovative strategies generally outperformed those taught using conventional methods. Thus, they recommended the incorporation of these innovative strategies into chemistry teaching to bolster student achievement.

Despite the endorsement of both conventional and constructivist teaching methods, it is suggested that educators blend traditional teaching approaches with newer instructional methods. Aluko (2008) and Sani (2015) investigated the effects of cooperative instructional strategies on secondary school students' performance in chemistry, observing a significant enhancement in student achievement. Consequently, they advocated for the widespread implementation of cooperative learning strategies in teaching the subject to elevate student achievement.

A critical concern in science education is the achievement gap between genders. Gender, as defined by Zudonu (2013), encompasses societal constructs, characteristics, behaviors, and roles attributed to males and females. Researchers such as Madu (2004), Fasiku (2011), and Igboegwu and Okonkwo (2012) view gender as a cultural construct that delineates societal norms and values, shaping the roles, behaviors, and mental characteristics of males and females.

In contemporary discourse on science education, scholars like Okebukola (1987), Okereke (2011), and Zudonu (2018) have expressed varied perspectives on gender achievement in secondary school chemistry. Assessments of gender's impact on chemistry achievement have sparked intense debate. While Vikoo (2011) and Okeke (2014) assert a significant influence of gender on chemistry students' academic performance in the Senior Secondary School Certificate Examination (SSSCE), other studies, including those by Aluko (2004), Yusuf and Adigun (2010), Olatoye, Aderogba, and Duna (2011), and Lamidi, Oyelekan, and Olorundare (2015), found no significant relationship between gender and chemistry achievement.

Moreover, Udu (2016) and Sangeeta and Sunita (2018) discovered inconsistent gender influence on chemistry achievement, with neither males nor females consistently outperforming the other. Specifically, Zudonu (2013) observed a significant female advantage in guided and demonstration methods over their male counterparts in acids, bases, and salts. Similarly, Njoku and Akwali (2016) concluded that gender does not significantly impact chemistry

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students' motivation, which strongly correlates with achievement.

The literature review reveals inconclusive results regarding the influence of gender on chemistry students' academic achievement, highlighting the need to include gender as a variable in the present study.

Retention refers to the ability to recall or remember previously learned information after a period. According to Zudonu (2013), retention is demonstrated when a learner can repeatedly communicate what they have learned and how they arrived at their results over time. Essien (2015) suggests that retention may be influenced by factors such as teaching method, learner interest and attitude, and the relevance of the material to the students.

In the field of biology, researchers have noted that instructional strategies play a crucial role in students' retention of knowledge, prompting investigations into the effectiveness of field trips and discovery-based teaching methods on retention, regardless of gender. This aligns with the findings of Wala (2010), who observed that field trip teaching strategies not only enhance retention but also motivate students and are inclusive of all genders. Similarly, Ajaja (2010) noted that field trip experiences improve students' understanding of the scientific process, enhance their attitude towards biology, and significantly impact both their achievement and retention in the subject.

➢ *Statement of the Problem*

The problem at hand is that many studies such as Tolga (2010), (Tebabal & kahssay 2011), Oyekan (2014), Adesanya (2016) have investigated how different teaching methods impacted students' grades in science, including chemistry. Unfortunately, reports consistently show that students are not doing well in their chemistry exams, which is concerning for science and technology education in Rivers State. This affects how many students want to study subjects like medicine, engineering, and applied sciences, as well as the quality of science teachers in secondary schools. Parents and teachers are worried about this. One solution being considered is using cooperative teaching alongside regular lessons to see if it helps students learn better in chemistry. So, the question is, does using cooperative teaching improve how well SSS II students in Rivers State learn and remember chemistry?

➢ *Purpose of the Study*

This study aims to:

- Compare the average academic achievement scores of chemistry students taught using the cooperative teaching method versus those taught with the conventional method.
- Examine how the cooperative and conventional teaching methods impact students' retention abilities in chemistry.
- Investigate the differences in academic achievement scores between male and female students taught using the cooperative teaching method and those taught using the conventional method.
- Determine the differences in retention scores between male and female students exposed to cooperative learning strategy versus those exposed to conventional method.

➢ *Significance of the Study*

This study will benefit several groups, including teachers, school administrators, educational planners, the Teachers' Registration Council (TRCN), the Science Teachers Association of Nigeria (STAN), student researchers, textbook authors, writers, publishers, and the Ministry of Education at both the state and federal levels.

➢ *Scope of the Study*

This study examines how cooperative learning affects students' academic performance and memory retention on the topic of esterification reaction in chemistry for senior secondary school two (SSS II) students. The study is conducted in a few selected secondary schools in Ahoada West Local Government Area, Rivers State. The focus of the content is on the hardness of water, which is part of the SSS II Chemistry Curriculum.

➢ *Research Questions*

This study is guided by the following research questions.

- What is the difference in average academic achievement scores between chemistry students taught with cooperative teaching method and those taught with conventional method?
- How do the cooperative and conventional teaching methods affect students' retention abilities in chemistry?
- What is the difference in mean academic achievement scores between male and female students taught with cooperative teaching method and those with conventional method?
- What is the difference in retention scores between male and female students exposed to cooperative learning strategy and those with conventional method?

➢ *Hypotheses*

The study was guided by four null hypotheses tested at a 0.05 level of significance:

- **$H0_1$**: There is no significant difference in the academic achievement mean scores of chemistry students taught using the cooperative learning strategy and those taught using the conventional lecture method.
- **$H0_2$**: There is no significant difference in the retention abilities of students taught chemistry using the cooperative teaching method and the conventional lecture method.
- **$H0_3$**: There is no significant difference in the academic achievement mean scores of male and female students taught using the cooperative learning strategy and those taught using the conventional method.

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- **$H0_4$**: There is no significant difference in the retention mean scores of male and female students exposed to cooperative learning strategy and those exposed to conventional method.

➢ *Research Design*

This research adopted quasi-experimental design, specifically a non-randomized pretest-posttest control group design.

➢ *Area of the Study*

The study was conducted in Ahoada West Local Government Area, Rivers State, Nigeria.

➢ *Population for the Study*

The population consisted of all Senior Secondary School two (SS II) chemistry students in the local government area of Rivers State, totaling 528 students (226 males and 302 females). SSII chemistry students were chosen because the topic of esterification reaction is included in their curriculum.

➢ *Sample and Sampling Technique*

The study targeted all 15 Senior Secondary Schools in Ahoada West Local Government Area, with a total of 528 SS II chemistry students. The sample size for the study was 150 students, comprising 70 males and 80 females. A multistage sampling procedure was employed to draw the sample.

In the first stage, 5 co-educational schools were randomly chosen from the 15 senior secondary schools in the local government area using a balloting method. The names of all 15 schools were written on pieces of paper, folded, placed in a container, shuffled, and then 5 schools were randomly drawn from the container.

In the second stage, a proportionate stratified random sampling technique was used to select 150 SS II chemistry students from the 5 chosen co-educational schools. This method was employed to ensure a balanced representation of gender among the sample. Since the number of chemistry students in each of the 5 selected schools was not equal, the proportionate stratified random sampling technique was appropriate for achieving a representative sample.

➢ *Instrument for Data Collection*

The tool used to gather data in this study was the Chemistry Achievement Test (CAT), focusing specifically on questions related to water chemistry. The CAT was administered as both a pretest and posttest and consisted of 20 multiple-choice questions. Each question had four options (A, B, C, and D), with each correct answer scored 5 marks, making a total of 100 marks. The test was designed to assess students' cognitive achievement in esterification reaction lessons.

➢ *Validation of the Instrument*

The CAT underwent validation by two specialists in the Faculty of Science Education at the University of Nigeria, Nsukka. Feedback and suggestions from these specialists were incorporated into the final version of the test items. Each correct option was assigned five marks.

➢ *Reliability of the Instrument*

To assess the reliability of the achievement test and retention, a trial test was conducted on twenty SSSII Chemistry students from co-educational schools in an area not included in the study. The test consisted of twenty items. The reliability coefficient, determined using Cronbach's Alpha, was found to be 0.84, indicating good internal consistency of the instrument. This ensured that the instrument was reliable for use in the study.

➢ *Method of Data Collection*

Before the start of the study, both the researchers and the chemistry teachers administered a pre-test to the students to collect their scores. The experimental groups were taught about esterification reaction using cooperative teaching method. These groups were divided into smaller groups of four members each, with leaders and assistants assigned. During chemistry class, these smaller groups worked together cooperatively, contributing to assignments, and reaching conclusions collectively, which were then presented to the researchers by the leaders or assistants. This process continued for two weeks. The control groups, on the other hand, were taught the same topic using traditional methods. The teaching sessions lasted for two weeks, following the official chemistry timetable. Both the experimental and control groups were taught simultaneously. At the end of the two weeks, the Chemistry Achievement Test (CAT) was administered to both groups to assess students' achievement and retention. Scores from each administration of the CAT were recorded.

II. METHOD OF DATA ANALYSIS

The data collected from the pre-test and post-test CATs were used to answer the research questions and hypotheses. Descriptive statistics, such as mean and standard deviation, were employed to answer the research questions. For the hypotheses, inferential statistics, specifically analysis of covariance (ANCOVA), were used. This was done to account for any biases that might arise from using intact groups whose equivalence on certain measured variables was not fully determined.

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III. RESULTS

A. Research Question 1

What is the mean score difference in academic achievement of chemistry students taught using cooperative teaching method and those taught with conventional method?

Table 1 Mean and Standard Deviation Achievement Scores of Students Taught Chemistry Using Cooperative and Conventional Methods.

Method	N	Pretest (N)		Posttest		Mean gain/loss
		$\bar{X}$	SD	$\bar{X}$	SD	
Cooperative Strategy	**88**	35.97	14.40	64.09	20.84	28.12
Conventional Method	**62**	35.89	15.59	53.79	17.78	17.90

Table 1 indicates that the students exposed to chemistry using cooperative method ($\bar{X} = 35.87, SD = 14.40$) and those exposed to conventional method($\bar{X} = 35.89, SD = 15.59$) had similar mean and standard deviation scores at pretest. This shows that the two groups are equal in learning achievement before the instructional intervention. But, after the intervention, the group taught using cooperative method had ($\bar{X} = 64.09, SD = 20.84$) with mean gain score of 28.12 achieved higher than the group taught using conventional method ($\bar{X}$=53.79, SD=17.78) with mean gain score of 17.90. The relatively high standard deviation scores for both groups suggest that the students' scores were widely dispersed, deviating from their respective mean scores.

- *Hypothesis 1*

There is no significant difference in the academic achievement mean score between chemistry students taught using cooperative learning strategy and those taught using the conventional lecture method.

Table 2Analysis of Covariance (ANCOVA) of Students' Achievement Mean and Standard Deviation Scores by Method.

Tests of Between-Subjects Effects						
Dependent Variable: posttest						
Source	**Type III Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**	**Partial Eta Squared**
Corrected Model	25133.817[a]	2	12566.908	51.620	.000	.413
Intercept	19553.482	1	19553.482	80.319	.000	.353
Pretest	21274.530	1	21274.530	87.388	.000	.373
Method	3811.894	1	3811.894	15.658	.000	.096
Error	35787.017	147	243.449			
Total	597925.000	150				
Corrected Total	60920.833	149				
a. R Squared = .413 (Adjusted R Squared = .405)						

Table 2 indicates that the F-value is 15.658 with a p-value of 0.00, which is less than the significance level of 0.05. This suggests that there is a significant association between the teaching method used and the academic achievement mean score. Therefore, the null hypothesis is rejected, and the alternative hypothesis is supported. In other words, there is a significant difference in the academic achievement mean score of chemistry students taught using cooperative learning strategy compared to those taught using the conventional lecture method, favoring the group taught with the cooperative method.

B. Research Question 2

What is the effect of cooperative and conventional teaching methods on students' retention ability in chemistry?

Table 3 Mean and Standard Deviation Retention Scores of Students Taught Chemistry Using Cooperative and Conventional Methods.

Method	N	Posttest		Retention		Mean gain/loss
		$\bar{X}$	SD	$\bar{X}$	SD	
Cooperative Strategy	**88**	64.09	20.84	58.75	17.34	-5.34
Conventional Method	**62**	53.79	17.78	46.37	20.79	-7.42

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Table 3 display that the group exposed or taught cooperative method ($\bar{X} = 58.75,\ SD = 17.34$) with mean loss score of -5.34 retained higher than the group taught using conventional method ($\bar{X}$=46.37, SD=20.79) with mean loss score of -7.42. The high standard deviation scores of the two groups underscores that the scores of the students in the two groups were highly spread, moving away from their mean scores.

➢ *Hypothesis 2*

There is no significant difference in retention ability of students exposed to chemistry using cooperative and conventional methods.

Table 4 Analysis of Covariance (ANCOVA) of Students' Retention Mean and Standard Deviation Scores by Method.

Tests of Between-Subjects Effects						
Dependent Variable: retention						
Source	**Type III Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**	**Partial Eta Squared**
Corrected Model	20340.631[a]	2	10170.316	39.599	.000	.350
Intercept	7522.870	1	7522.870	29.291	.000	.166
Posttest	14766.766	1	14766.766	57.496	.000	.281
Method	1736.350	1	1736.350	6.761	.010	.044
Error	37754.202	147	256.831			
Total	489575.000	150				
Corrected Total	58094.833	149				
a. R Squared = .350 (Adjusted R Squared = .341)						

Table 4 reveals that the F-value is 6.76 with a p-value of 0.01, which is less than the significance level of 0.05. This indicates a significant association between the teaching method used and the academic retention mean score. Therefore, the null hypothesis is rejected, and the alternative hypothesis is supported. In other words, there is a significant difference in the academic retention mean score of chemistry students taught using cooperative learning strategy compared to those taught using the conventional lecture method, favoring the group exposed to cooperative strategy.

C. Research Question 3

What is the difference in the mean academic achievement scores between male and female students taught using cooperative learning strategy and those taught using conventional methods?

Table 5 Mean and Standard Deviation Achievement Scores of Male and Female Students Taught Chemistry using Cooperative and Conventional Methods.

Method	**Gender**	**N**	**Pretest**		**Posttest**		**Mean gain/loss**
			$\bar{X}$	**SD**	$\bar{X}$	**SD**	
Cooperative Strategy	Male	40	37.75	14.19	65.63	20.04	27.88
	Female	48	34.48	14.56	62.81	21.61	28.33
Conventional Method	Male	22	37.73	15.87	51.36	14.32	13.63
	Female	40	34.88	15.55	55.13	19.46	20.25

In Table 5, both male and female students taught chemistry using cooperative method ($\bar{X} = 37.75, SD = 14.19$) and ($\bar{X} = 34.48, SD = 14.56$) and conventional method ($\bar{X} = 37.73, SD = 15.87$) and ($\bar{X} = 34.88, SD = 15.55$) had similar mean and standard deviation scores at pretest. This indicates equality in learning achievement before the instructional intervention across both genders and teaching methods. However, after the intervention, both male and female students taught using the cooperative method achieved nearly identical mean gain scores ($\bar{X} = 65.63, SD = 20.04$) and ($\bar{X} = 62.81, SD = 21.64$)) with mean gain score of 27.88 and 28.33. Meanwhile, male, and female students taught using the conventional method had different mean gain scores ($\bar{X}$=51.36, SD=14.32) and ($\bar{X} = 55.36, SD = 19.46$)) with mean gain score of 13.63 and 20.25, suggesting a difference in effectiveness based on gender. This demonstrates that the cooperative method is inclusive of both genders, unlike the conventional method.

➢ *Hypothesis 3*

There is no significant difference in the academic achievement mean score of male and female students taught using cooperative learning strategy and those taught using conventional method.

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Table 6 Analysis of Covariance (ANCOVA) of Students' Achievement Mean and Standard Deviation Scores by Method and Gender.

Tests of Between-Subjects Effects						
Dependent Variable: posttest						
Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	25656.753[a]	4	6414.188	26.374	.000	.421
Intercept	18095.518	1	18095.518	74.406	.000	.339
Pretest	21424.073	1	21424.073	88.092	.000	.378
Method	4257.708	1	4257.708	17.507	.000	.108
Gender	298.291	1	298.291	1.227	.270	.008
method * gender	334.193	1	334.193	1.374	.243	.009
Error	35264.080	145	243.201			
Total	597925.000	150				
Corrected Total	60920.833	149				
a. R Squared = .421 (Adjusted R Squared = .405)						

In Table 6, the statistical analysis ($F(1,145)=1.374$; $p=0.243 > 0.05$) showed that there is no significant difference in academic achievement mean scores between male and female students taught using cooperative learning or conventional methods. This finding aligns with previous research that found no gender disparity in chemistry achievement.

D. Research Question 4

What is the mean retention score difference of male and female students taught using cooperative learning strategy and those taught using conventional method?

Table 7 Mean and Standard Deviation Retention Scores of Male and Female Students Taught Chemistry using Cooperative and Conventional Methods.

Method	Gender	N	Posttest		Retention		Mean gain/loss
			$\bar{X}$	SD	$\bar{X}$	SD	
Cooperative Strategy	Male	40	65.63	20.04	59.75	16.48	-5.88
	Female	48	62.81	21.61	57.92	18.16	-4.89
Conventional Method	Male	22	51.36	14.32	46.14	18.12	-5.22
	Female	40	55.13	19.46	46.50	22.34	-8.63

Table 7 illustrated that the male ($\bar{X} = 59.75,\ SD = 16.48$) with mean loss score of -5.88 and female ($\bar{X} = 57.92,\ SD = 18.16$) students with mean lost score of -4.89 taught using cooperative method had almost the same retention scores. However, the male students taught with conventional method ($\bar{X} = 46.14,\ SD = 18.12$) with mean loss score of -5.22 retained information more than the female students taught with the same method ($\bar{X} = 46.50,\ SD = 22.34$) with mean loss score of -8.63. This again, revealed that cooperative method is gender inclusive than the orthodox or conventional method in area of students' retention of information taught.

➢ *Hypothesis 4*

There is no significant difference in the academic retention mean scores of male and female students taught using cooperative learning strategy and those taught using conventional method.

Table 8 Analysis of Covariance (ANCOVA) of students' retention mean and standard deviation scores by method and gender.

Tests of Between-Subjects Effects						
Dependent Variable: retention						
Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	20378.318[a]	4	5094.580	19.586	.000	.351
Intercept	7523.737	1	7523.737	28.925	.000	.166
Posttest	14729.243	1	14729.243	56.626	.000	.281
Method	1535.481	1	1535.481	5.903	.016	.039
Gender	32.808	1	32.808	.126	.723	.001
method * gender	11.376	1	11.376	.044	.835	.000
Error	37716.515	145	260.114			

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Total	489575.000	150				
Corrected Total	58094.833	149				
a. R Squared = .351 (Adjusted R Squared = .333)						

In Table 8, the statistical analysis (F(1,145)=0.044; p=0.835 >0.05) indicated that there is no significant difference in retention mean scores between male and female students taught using cooperative learning or conventional methods. This supports the idea that gender does not significantly influence retention scores in chemistry.

IV. DISCUSSION OF RESULTS

The data in Table 1 shows that students taught chemistry using the cooperative method had an average pretest score of 35.87 and an average posttest score of 64.09, with a mean gain score of 28.12. Meanwhile, students taught using the conventional method had an average pretest score of 35.89 and an average posttest score of 53.79, with a mean gain score of 17.90. Before the teaching methods were applied, both groups had similar achievement levels. However, after the intervention, the group taught with the cooperative method performed better than the group taught with the conventional method.

Table 2 shows that F(1,147)=15.658; p=0.00 <0.05. This means the association probability (p) for the method is less than the 0.05 level of significance. Thus, the researchers reject the null hypothesis and accepts the alternative. Therefore, there is a significant difference in the academic achievement mean scores of chemistry students taught using the cooperative learning strategy compared to those taught with the conventional lecture method, favoring the cooperative method. This finding supports the results of Sabiru (2014), Njoku and Ezinwa (2014), Aluko (2008), and Sani (2015), who all stated that the cooperative method is better than the conventional method.

Table 3 shows that the group taught using the cooperative method had an average score of 58.75 with a mean loss score of -5.34, which is better than the group taught using the conventional method with an average score of 46.37 and a mean loss score of -7.42.

Table 4 shows that F(1,147)=6.76; p=0.01 <0.05. This means the association probability (p) for the method is less than the 0.05 level of significance. Thus, the researchers reject the null hypothesis and accepts the alternative. Therefore, there is a significant difference in the academic retention mean scores of chemistry students taught using the cooperative learning strategy compared to those taught with the conventional lecture method, favoring the cooperative method. This finding supports that of Vikoo (2011) who asserted that cooperative method promotes retention.

Data in Table 5 showed that male and female students taught chemistry using a cooperative method had average pretest scores of 37.75 and 34.48, respectively. Those taught using a conventional method had pretest scores of 37.73 for males and 34.88 for females. This indicates that both groups had similar learning levels before the teaching methods were applied. After the teaching methods were used, the average posttest scores for males and females taught using the cooperative method were 65.63 and 62.81, respectively. For those taught with the conventional method, the posttest scores were 51.36 for males and 55.36 for females. This means that, after the intervention, both male and female students taught with the cooperative method had similar average score increases of 27.88 and 28.33 points. In contrast, male and female students taught with the conventional method had different average score increases of 13.63 and 20.25 points. These results suggest that the cooperative teaching strategy works equally well for both genders, unlike the conventional method.

Data in Table 6 showed that F(1,145)=1.374; p=0.243, which is greater than 0.05. This means the association probability (p) for method and gender is higher than the 0.05 significance level. Therefore, the researchers did not reject the null hypothesis. As a result, there is no significant difference in the average academic scores of male and female students taught using either the cooperative learning strategy or the conventional method. This finding is consistent with the studies by Yusuf and Adigun (2010), Lamidi, Oyelekan, and Olurundare (2015), Adigun (2016), and Njoku and Akwali (2016), which also found no gender difference in the academic performance of chemistry students.

Table 7 shows that male students taught using the cooperative method had an average retention score of 59.75 and a mean loss score of -5.88. Female students taught the same way had an average retention score of 57.92 and a mean loss score of -4.89. On the other hand, male students taught using the conventional method had an average retention score of 46.14 and a mean loss score of -5.22, while female students had an average retention score of 46.50 and a mean loss score of -8.63. This suggests that the cooperative method is more effective for both genders in retaining information compared to the conventional method.

Table 8 shows F(1,145) = 0.044; p = 0.835 > 0.05. This means that the p-value for the method and gender association is higher than the 0.05 significance level. Therefore, the researchers do not reject the null hypothesis. This indicates that there is no significant difference in the retention mean scores between male and female students taught using the cooperative learning strategy and those taught using the

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conventional method. This finding supports the study of Arokoyu & Obunwo (2014) which states that there is no significant difference in the retention mean scores between male and female students taught using cooperative method and those taught with conventional method.

V. CONCLUSION

The study found that chemistry students who learned through a cooperative method had higher academic achievement scores than those who were taught through traditional lectures. Additionally, these students also had better retention scores compared to those taught with conventional methods. The study showed that both male and female students achieved similar scores when taught using the cooperative method, indicating that gender did not affect their academic performance. Furthermore, there was no significant difference in retention scores between male and female students, regardless of whether they were taught using cooperative or traditional methods.

RECOMMENDATION

Based on the findings of this study, the following recommendations were made.

- Someone who hasn't undergone training in chemistry shouldn't be allowed to teach chemistry in the classroom because he/she is not adequately fit to do so.
- Cooperative teaching method should be used in teaching sensitive topics that require peer group review or study.
- Chemistry education experts should continue to intensify efforts in their campaign to narrow the gap between male and female students' academic achievements.
- Chemistry education researchers should not rest in their oasis but work round the clock to improve chemistry pedagogy.
- Conventional teaching method should be discouraged being used in teaching sensitive topics that require collaborative study.
- Government should provide adequate materials needed for the smooth teaching of complex topics using cooperative teaching method.

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