

## **Effect of Collaborative Learning Strategy on Students' Academic Achievement in Chemistry in Onitsha Education Zone, Anambra State**

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### **Abstract**

This study examined the effect of collaborative learning strategy on students' academic achievement in Chemistry in Onitsha education zone, Anambra State. Two research questions were raised and three null hypotheses were tested. Quasi-experimental research design, specifically, pretest-posttest nonequivalent groups design was adopted for the study. Findings of the study revealed that collaborative learning strategy has a higher positive effect on students' academic achievement in Chemistry than the conventional teaching method and the difference was significant. Also, the study disclosed that collaborative learning strategy had more effect on female students' academic achievement in Chemistry than on male students and the difference was not statistically significant. The study concluded that the open communication and sharing of ideas embedded in collaborative learning strategy enhances students' academic achievement in Chemistry than the conventional teaching method in secondary schools. The researchers recommended among others that, Chemistry teachers should use collaborative instructional strategy to teach the perceived difficult Chemistry topics in order to improve students' understanding on the subject in secondary schools.

**Keywords:** Secondary Education, Chemistry, Academic Achievement, Collaborative learning strategy and Gender

### **Introduction**

In Nigeria, secondary school education is divided into junior secondary schools and senior secondary schools. At the senior secondary school level, students are taught science education, Social Science education, Arts and Humanities as well as Vocational and Entrepreneurship education. Science education is a body of knowledge systematically arranged with scientific and technological principles, themes and contents. Core science education subjects in Nigerian senior secondary school system include Physics, Biology and Chemistry. Chemistry deals with the composition of matter and the changes matter undergo (Adejo, 2015).

According to Emendu and Okoye (2015), Chemistry brings up a mental picture of how synthetic substances such as dyes, plastics, fibres and drugs are manufactured by chemical processes. Hence, Mohammed, Bello and Gwandu in Okonkwo (2012) viewed Chemistry as the oracle of modern science. Despite the uniqueness of Chemistry in secondary schools, students' achievement on the subject has been consistently poor in external examinations in Nigeria. This ugly situation was confirmed by the Chief Examiners' Report of West African Examinations Council (WAEC) who attributed the poor performance of students in Chemistry to lack of qualified teachers to handle the subject in the classroom and poor instructional strategies used in presenting the technical and practical content areas of the subject to students in the laboratory (WAEC Chief Examiners' Report, 2018). Instructional strategies to a large extent play an influential role in facilitating students' academic achievement. The fact that, teaching and learning processes in the 21<sup>st</sup> century classroom are not only geared towards transferring knowledge but also equipping students with problem solving and critical thinking skills are responsible for the paradigm shift from teacher-centred approaches to student-centred strategies in educational institutions.

According to Tauritz (2012), student-centred strategies include think-pair-share, gallery walk, concept mapping, co-operative learning, collaborative learning and competitive learning among others. In their own view, Nkechinyere and Ordu (2018) described collaborative learning strategy as a methodology that transform the traditional lecture or teacher dominated classroom into students' centred classroom in the form of peer-to-peer learning environment. Correspondingly, Bassett, McWhirter and Kitzmiller in Bhowmik (2016) posited that collaborative learning strategy is an instructional technique that allow small groups of students to work jointly by sharing knowledge among each other to enhance their own knowledge on a subject matter. Here, Chemistry students encourage and support one another in the classroom by assuming responsibility for their own and each other's learning. Collaborative learning strategy facilitates group related learning where social skills are cultivated among teachers and students in course of teaching and learning in the classroom or laboratory.

Regardless of the instructional strategies adopted by science educators in Nigeria, the issue of gender disparity in the context of academic achievement is a common phenomenon in educational institutions. According to Okeke (2008), gender refers to the socially and culturally constructed characteristics and roles which are ascribed to males and females in any society. While some are of the view that, male students do better than their female colleagues in science subjects, there are some disagreements with this assumption. No wonder, Oyediji and Okwilagwe (2015) asserted that, there is no consensus on the influence of instructional strategies on students' gender in line with their academic achievement on subject matters in the classroom. Against this backdrop, the researchers sought to investigate the effect of collaborative learning strategy on students' academic achievement in Chemistry in Onitsha education zone, Anambra State.

### **Statement of the Problem**

It is a common practice in Nigerian secondary schools for the teacher to stand by the chalkboard and deliver lessons through verbal instruction without students' active participation. This instructional setting is not suitable for the practical nature of Chemistry as science students would not be able to acquire science process skills. This situation calls for the use of innovative learning strategies that will give Chemistry students the opportunity to learn among themselves

and the same time be actively involved in the teaching and learning process. From literature gathered, the effect of collaborative learning strategy on students' academic achievement in Chemistry in Onitsha Education zone, Anambra State is not empirically known. This gap in knowledge, is what the researchers intend to fill.

## **Purpose of the Study**

The main purpose of this study is to investigate the effect of collaborative learning strategy on students' academic achievement in Chemistry. Specifically the study determined the:

1. Academic achievement mean scores of students taught Chemistry using collaborative learning strategy and those taught with the conventional teaching method
2. Difference between the academic achievement mean scores of male and female students taught Chemistry with the collaborative learning strategy
3. Interaction effect between collaborative learning strategy, conventional teaching method and gender on students' academic achievement mean scores in Chemistry

## **Research Questions**

The following research questions guided the study:

1. What are the academic achievement mean scores of students taught Chemistry using collaborative learning strategy and those taught with conventional teaching method?
2. What are the academic achievement mean scores of male and female students taught Chemistry with the collaborative learning strategy?

## **Hypotheses**

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

1. There is no significant difference between the academic achievement mean scores of students taught Chemistry using collaborative learning strategy and those taught with the conventional teaching method
2. There is no significant difference between the academic achievement mean scores of male and female students taught Chemistry with the collaborative learning strategy.
3. There is no significant interaction effect between collaborative learning strategy, conventional teaching method and gender on students' academic achievement mean scores in Chemistry

## **Methodology**

Quasi-experimental research design, specifically, pretest-posttest nonequivalent groups design was adopted for the study. The population of this study comprised 3115 SS I Chemistry students (1017 males and 2098 females) in the 32 public secondary schools in Onitsha Education zone of Anambra State. A sample size of 49 (18 males and 31 females) SS I Chemistry students in intact classes from two co-educational secondary schools in Onitsha Education Zone of Anambra State were selected for the study using purposive sampling technique. The control school which have 21 students (8 males and 13 females) were taught Chemistry with the conventional teaching method, and the experimental school with 28 students (10 males and 18

females) were taught Chemistry using collaborative learning strategy. The researcher constructed a Chemistry Achievement Test (CAT) for data collection.

Chemistry Achievement Test (CAT) consisted of 30 multiple choice items with options A-D. The CAT was adapted by the researchers from the West African Examination Council (WAEC) past questions between 2010 and 2017. The instrument for data collection was subjected to face and content validation by three experts; one secondary school Chemistry teacher with 20 years of teaching experience in Anambra State, one Chemistry educator from the Department of Science Education and another expert from the Department of Measurement and Evaluation from Nnamdi Azikiwe University, Awka, Anambra State. The reliability of CAT was determined using Kuder-Richardson Formula 20 (KR-20) which yielded a reliability coefficient of 0.87. The experiment lasted for six weeks.

The scores obtained from the pre-test and post-test were analyzed using mean and standard deviation as well as ANCOVA. Mean and standard deviation were used to answer the research questions while Analysis of Covariance (ANCOVA) was used to test the null hypotheses at 0.5 level of significance. In testing the null hypotheses, the decision on hypotheses was that where the p-value is less than or equal to the level of significance (0.05), the null hypothesis was rejected, otherwise the null hypothesis was accepted. Data analysis was carried out using SPSS version 23.0.

## Results

### Research Question 1

What are the academic achievement mean scores of students taught Chemistry using collaborative learning strategy and those taught with the conventional teaching method?

The answer to research question one was presented in Table 1.

**Table 1**

#### **Academic achievement mean scores of students taught Chemistry using collaborative learning strategy and those taught with the conventional teaching method**

Source of Variance	N	Pre-test Mean	Post-test Mean	Pre-test SD	Post-test SD	Mean Gain
Experimental Group	28	33.75	72.61	4.07	9.06	38.86
Control Group	21	23.69	31.94	2.14	3.31	8.25

Data in Table 1 shows that the post-test mean score of 72.61 for the experimental group was higher than the pre-test mean score of 33.75. This signifies a mean gain of 38.86. The post-test mean score of 31.94 for the control group was higher than the pre-test mean score of 23.69. This signifies a mean gain of 8.25. The mean gain score of the experimental group was higher than the control group. The standard deviation of the experimental group for both pre-test and post-test (4.07 and 9.06) were higher than the control group (2.14 and 3.31). This shows that the scores in the experimental and control groups are homogenous. The result indicates that collaborative learning strategy has a higher effect on students' academic achievement scores in Chemistry than the conventional teaching method.

## Research Question 2

What are the academic achievement mean scores of male and female students taught Chemistry with the collaborative learning strategy?

The answer to research question two is presented in Table 2.

**Table 2**

### Academic achievement mean scores of students taught Chemistry with the collaborative instructional strategy with respect to gender

Gender	N	Pre-test Mean	Post-test Mean	Pre-test SD	Post-test SD	Mean Gain
Male	10	28.15	57.02	2.10	4.64	28.87
Female	18	25.60	55.59	1.97	4.42	29.99
<b>Mean Gain Difference</b>						<b>1.12</b>

Data in Table 2 shows that the post-test mean score of 57.02 for male students taught Chemistry using collaborative learning strategy was higher than the pre-test mean score of 28.15. This signifies a mean gain of 28.87. The post-test mean score of 55.59 for female students taught Chemistry using collaborative learning strategy was higher than the pre-test mean score of 25.60. This signifies a mean gain of 29.99. The mean gain score shows that female students taught Chemistry using collaborative learning strategy was higher than male students taught Chemistry with the same strategy. The standard deviation of male students taught Chemistry using collaborative learning strategy for both pre-test and post-test (2.10 and 4.64) were higher than female students taught Chemistry using collaborative learning strategy (1.97 and 4.42). This shows that the mean scores of students' gender in the experimental group are homogenous. The result means that, collaborative learning strategy has a higher effect on female students' academic achievement scores in Chemistry than on male students.

## Test of Hypotheses

### Hypothesis 1

There is no significant difference between the academic achievements mean scores of students taught Chemistry with collaborative learning strategy and those taught with the conventional teaching method.

The analysis of hypothesis 1 is presented in Table 3.

**Table 3**

### ANCOVA result showing difference in students' academic achievement scores between the instructional strategies

Source	SS	df	Mean Square	F	Sig.	Decision
Corrected Model	25738.553 <sup>a</sup>	2	1324.573	82.735	.000	

Intercept	44621.321	1	44621.321	38.642	.000	
Pre-test	2218.127	1	2218.127	17.119	.001	
Method	4852.152	1	4852.152	49.073	.000	S
Error	22311.204	46	146.102			
Total	181665.089	49				
Corrected Total	39293.447	48				

a. R Squared = .643 (Adjusted R Squared = .639) S = Significant, NS = Not Significant

Data in Table 3 shows that there was a significant main effect of the treatment which accounted for 64 percent of the variance in students' achievement scores,  $F(1, 48) = 49.073$ ,  $p(0.000) < 0.05$ . Since the p-value is less than the level of significance, the null hypothesis was therefore rejected. Thus, there is a significant difference between students' academic achievement mean scores taught Chemistry using collaborative learning strategy and those taught with the conventional teaching method.

### Hypothesis 2

There is no significant difference between the academic achievement mean scores of male and female students taught Chemistry with the collaborative learning strategy  
The analysis of hypothesis 2 is presented in Table 4.

**Table 4**  
**ANCOVA result showing difference in male and female students' academic achievement mean scores in Chemistry with the collaborative learning strategy**

Source	SS	Df	Mean Square	F	Sig.	Decision
Corrected Model	869.276 <sup>a</sup>	2	48.113	25.002	.611	
Intercept	16510.004	1	16510.004	323.466	.233	
Achievement	62.109	1	62.109	8.113	.400	
Gender	29.135	1	29.135	2.086	.513	NS
Error	617.011	25	38.673			
Total	174413.320	28				
Corrected Total	702.009	27				

a. R Squared = .720 (Adjusted R Squared = .714) S= Significant, NS = Not Significant

Data in Table 4 show that there was no significant main effect due to gender on the students' academic achievement mean scores,  $F(1, 27) = 2.086$ ,  $p(0.513) > 0.05$ . Since the p-value is greater than the level of significance, the null hypothesis was therefore accepted. Thus, there is no significant difference between the academic achievement mean scores of male and female students taught Chemistry using the collaborative learning strategy.

### Hypothesis 3

There is no significant interaction effect between collaborative learning strategy, conventional teaching method and gender on students' academic achievement mean scores in Chemistry  
The analysis of hypothesis 3 is presented in Table 5.

**Table 5**  
**ANCOVA result showing the interaction effect of treatments and gender on students' academic achievement mean scores in Chemistry**

Source	SS	df	Mean Square	F	Sig	Decision
Corrected Model	110035.149 <sup>a</sup>	4	421.075	80.332	.000	
Intercept	10938.174	1	10938.174	214.108	.287	
Pre-test	1991.440	1	1991.440	102.976	.000	
Method	2269.019	1	2269.019	54.103	.000	S
Gender	804.020	1	804.020	23.550	.000	S
Method * Gender	97.129	1	97.129	3.016	.000	S
Error	1013.006	44	106.015			
Total	215967.065	49				
Corrected Total	190441.991	48				

a. R Squared = .732 (Adjusted R Squared = .726) S = Significant, NS = Not Significant

Data in Table 5 reveal that the F-cal for Method\* Gender is 3.016 with a p-value of .000 is lesser than the level of significance (p-value < 0.05). Thus, the null hypothesis of no significant interaction effect between treatments and gender on students' academic achievement mean scores in Chemistry was rejected. Therefore, the interaction effect between collaborative and competitive learning strategies and gender on students' academic achievement in Chemistry is statistically significant.

## Discussion

The study revealed that collaborative learning strategy has a higher positive effect on students' academic achievement in Chemistry than the conventional teaching method. The result of this study is in line with the studies of Uroko (2010) and Adolphus, Alamina and Aderonmu (2013) which reported that collaborative learning strategy improved students' academic achievement than the traditional classroom approach on subject matters in the classroom. The positive effect of collaborative learning strategy on students' academic achievement scores in Chemistry could be as a result of the fact that collaborative learning strategy does not allow the students to sit down and absorbed whatever their teacher brings to the classroom.

In addition, outcome of the showed that there was a significant difference between students' academic achievement mean scores taught Chemistry with the collaborative learning strategy and those taught with the conventional teaching method. This finding tallies with Ishaq (2015) which discovered a significant difference between students' academic achievement when learning under collaborative learning strategy and conventional teaching method. Perhaps, the mutual exploration and constant feedback among students when grouped together significantly leads to better understanding of the difficult areas in Chemistry. This finding is consistent with the assertion of Al-kaabi (2016) who reported that the application of collaborative learning strategy allows intellectual synergy among students and teachers with the sole aim of providing mutual solutions on subject matters in the classroom.

More so, the study disclosed that collaborative learning strategy had more effect on female students' academic achievement scores in Chemistry than on male students. The finding agrees with Iji, Ochu, Adikwu and Atamonokhai (2017) which reported that collaborative

instructional strategy increased the achievement scores of both male and female students but favored female students' more in the classroom. The result of this study is not in agreement with Busola (2011) who reported that male students achieved higher than their female counterparts in Chemistry. The finding that collaborative learning strategy had more effect on female students' academic achievement in Chemistry than male students could be as a result of the fact that female students' put into practice a lot of interpersonal and communicative skills when learning in their group than their male counterparts in the classroom. However, there was no significant difference between the academic achievement mean scores of male and female students taught Chemistry using collaborative learning strategy. This implies that, collaborative learning strategy is not gender sensitive in relation to students' academic achievement. This finding is in agreement with Nkechinyere and Ordu (2018) who discovered that there is no significant difference in the academic achievement mean scores of male and female students taught Chemistry using the collaborative learning strategy.

More so, outcome of the study showed that the interaction effect between collaborative learning strategy, conventional teaching method and gender on students' academic achievement in Chemistry is statistically significant. This means that, when male and female students are taught under the collaborative learning strategy and conventional teaching method, they differ significantly in their academic achievement in Chemistry. From the experiment, when the teaching approaches are considered separately, the approach variable and gender variable have a significant effect on students' academic achievement in Chemistry. Perhaps, the fact that collaborative learning strategy motivates both male and female students to engage each other in an active social academic context than the conventional teaching method could be responsible for this finding.

## **Conclusion**

Based on the findings of the study, collaborative instructional strategy is more effective in enhancing students' achievement in Chemistry than the conventional teaching method. The researchers observed that collaborative learning strategy facilitates social skills and promotes active interaction among students in the classroom. To this end, the study concluded that the open communication and sharing of ideas embedded in collaborative learning strategy enhances students' academic achievement in Chemistry than the conventional teaching method in secondary schools.

## **Recommendations**

In the light of the findings and conclusion of the study, the following recommendations were suggested:

1. Chemistry teachers should use collaborative instructional strategy to teach the perceived difficult Chemistry topics in order to improve students' understanding on the subject in secondary schools
2. Principals' of secondary schools should provide in-service training programme for Chemistry teachers to enable them acquired the necessary instructional competencies for effective application of collaborative instructional strategy in the classroom.

3. Colleges of Education and other tertiary institutions should develop a curriculum for training present and future professional teachers on how to use collaborative instructional strategy in teaching Chemistry and other science subjects in secondary schools.

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