

## Effect of Cooperative Learning, Expository and Inquiry Based Strategies on Chemistry Students Academic Achievement in Senior Secondary Schools in Zamfara State, Nigeria

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### **Abstract**

*The study investigated the effect of cooperative learning, expository and inquiry based strategies on chemistry students' academic achievement in chemical equations among senior secondary schools in Zamfara State, Nigeria. Four research questions were raised and four hypotheses were formulated and tested at 0.05 levels of significance. A quasi-experimental, post-test, control group design was adopted for the study. The population of this study comprised a total of 2,209 Senior Secondary School II (SS II) students from 14 secondary schools. A sample size of 120 SS2 students was drawn from three secondary schools in Zamfara State. The purposive random sampling technique was used in selecting the schools. The instrument used for data collection was Chemical Equation Assessment Test and the reliability coefficient was 0.76. Data collected was analyzed using mean score, standard deviation, independent t-test and Two-way Analysis of Covariance (ANCOVA). The experimental groups were exposed to cooperative learning and inquiry based learning while the control group was taught using the expository method. Part of the findings of the study was that there was a significant difference between the mean achievement scores of chemistry students in cooperative learning, inquiry-based learning and the expository group in the State, also; cooperative learning is potentially viable in enhancing understanding and improving students' academic achievement in chemical equation concepts and as such, the experimental group performed significantly better than those in the control group. Based on the findings from the study, it was recommended, among others, that chemistry teachers should be trained and retrained in the use of cooperative learning strategy. Secondly, chemistry teachers should incorporate cooperative learning into the teaching of chemistry so as to promote better academic achievement among secondary school students.*

**Keywords:** Cooperative learning, Academic Achievement, Chemical Equation, Secondary School

### **Introduction**

Chemistry, as a school subject, deals with the structure, composition and the properties of matter. It encompasses a wide range of subfields, which include organic, inorganic, and physical chemistry. According to Omosor *et al.* (2024) chemistry is an

interdisciplinary field that combines principles from physics, biology, and mathematics. Chemistry is crucial in understanding matter composition, structure, and raw material utilization and also relevant as a requirement for technological advancement of a nation. The level of development of any nation is measured by the number of chemists, physicists, doctors, agriculturist and science educators the nation could produce. Despite the central and important role that chemistry plays in the lives of the individual and the nation as a whole, poor academic achievement of students in chemistry at secondary level still persist. Omosor *et al.* (2024) noted that attainment of the benefits associated with chemistry is dependent on the instructional method used by the teacher who implements the curriculum. The teaching method used by a teacher can enhance or hinder students' learning, influence their social power and self-reliance.

The primary goal of a teacher is to ensure the success of his/her lesson, which is tied to the teacher's quality. Series of factors have been reported as contributing to this poor academic achievement including: inadequate laboratory equipment, poor teaching methods, and school environment. The report of June 2023 NECO examination showed that out of 11,376,906 candidates, only (24.9%), (44.17%), (30.4%) and (37%) scored credit and above in mathematics, biology, physics and chemistry respectively. Omiko (2017) noted that teachers are responsible for helping students achieve maximum achievement through appropriate instructional methods. He also indicated that a number of activity-oriented instructional strategies have been advocated for by curriculum designers to help improve on the failure rate among secondary school science students.

Oloyede and Demide (2018) added that poor achievement in chemistry among secondary school students in Nigeria are due to teaching related problems, with the lecture method being the most common teaching method, particularly in Delta State. The lecture method is a teacher-centered approach where a teacher delivers preplanned lessons to students verbally on a specific topic, using minimal resources. This method is popular and fast for disseminating knowledge in traditional classrooms. The lecture method according to Oloyede and Demide (2018) enables passive learning, allowing students to process and apply knowledge to real-life tasks. Researchers like Wanjohi (2016); Sanda and Mazila (2017) observed that lecture methods are effective but not in producing meaningful learning. Angelin and Cecily (2015) recommend minimizing the use of lecture methods as they provide learning capabilities. It is therefore very pertinent to search for an approach to the teaching of chemistry that aims at understanding rather than reshuffling of facts. There is a lot of controversy about the most effective pedagogical strategy to be used in education. Indeed, there are a variety of strategies that instructors can use to improve students achievement and attitude inside classrooms. Some of these strategies as outlined by Showel (2018) are: the cooperative

learning strategy, discussion method, demonstration method, field trip, problem-solving method as well as inquiry method. Showel (2018) however, indicated that an effective strategy designed to promote efficient and meaningful learning is the cooperative learning. Igboegwu and Egbutu (2011) have earlier reported that cooperative learning is an effective strategy for teaching chemistry at various levels.

Cooperative learning as described by Showel (2018) is a discovery method in which small groups are used. It is understood to be learning which takes place in an environment where students work collaboratively in small groups by sharing ideas while working on a given tasks. He noted that cooperative learning is a teaching approach that is not only unique but also allows students to come together as a group to teach each other and accomplish shared goals. Within cooperative situation, individuals seek outcomes that are beneficial to themselves and to all other group members. Here, students work together to maximize their own and each other's learning. Showel added that in cooperative learning, the individual attains his or her goals if the group's goal is attained. The learners are expected to work together in a way that everyone learns with the teacher serving as a facilitator. The composition of a group has effect on the types of interaction that takes place. The recommended grouping is medium and high or medium and low ability learner groups. Each group of 3-5 learners is given an activity sheet to work on at a time and each group encourages cooperation and work at their pace. Onaiba, Abdulla and Alatrissu (2016) reported that cooperative learning is a student-centered learning approach which entails students work together on structured assignments or projects under conditions that assure learning and achievement. The cooperative learning strategy overlaps with constructivist learning theory. Studies by Umar (2012) on the relationship between students' performance in practical activities and their academic achievement in integrated science using NISTEP method of teaching, reported that there was significant difference between learners taught using learners centered and those taught using traditional method. Timon et al (2022) from their study on Efficacy of Cooperative Learning Strategy on Academic Performance in Chemical Equations among Secondary School Students in Abuja, reported higher performance of students taught chemical equations using cooperative learning strategy than those taught using lecture method.

Inquiry based learning strategy is a variable in this study and it is a strategy that seek for true information or knowledge by questioning. Showel (2018) defined inquiry learning as a learning that is intrinsically motivated, that is, by curiosity and interesting learning for his own sake. Inquiry based learning is primarily a pedagogical method developed during the discovery learning movement as a

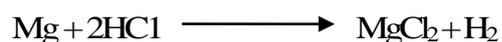
response to improve the traditional forms of instruction where people are required to memorize information from instructional materials. The philosophy of inquiry-based learning found its antecedents in constructivist learning theories such as the works of Piaget. Lucy (2015) in her study on inquiry learning and expository method on students' achievement reported that there was a significant difference between the students exposed to inquiry learning and those exposed to lecture method.

Expository learning method is an oral (lecture) method of teaching and essential one-way process of transmission of knowledge with the teacher being active while the learners are passive. Researchers like Wanjohi (2016); Sanda and Mazila (2017) observed that lecture methods are effective but not in producing meaningful learning.

Academic achievement refers to the quantified learning level demonstrated by students in school examinations encompassing admirable learning in academic areas, including information and skills acquired. Academic achievement, according to Omosor *et al.*, (2024) is the grade students receive for following instruction and learning. It can also be the demonstration of knowledge acquired through classroom exposure or developed skills in academic disciplines. Khandai (2015) emphasize the importance of student achievement in educational institutions and reported that it is a crucial outcome for parents, teachers, and students. Students can be classified as high, average, or low achievers. Factors such as learner characteristics, school environment, curriculum development, teaching methods, and home factors influence students' achievement.

The aim of this study is to address the knowledge gap on the effect of cooperative learning, expository and inquiry based learning strategies on the academic achievement of chemistry students' in secondary schools in Zamfara State, Nigeria.

For the purpose of this study, students were exposed to "Chemical equations" a basic concept in chemistry. A chemical equation is a shorthand method of using formulae to present a chemical or physical change. The reactants are written in their formulae form on the left hand side (LHS) of the equation while the products are written also in their formulae form on the right-hand side (RHS). There is an arrow symbol that leads from the reactants to the products. An example of simple equation is



An atom count for each element in the equation shows that the total number of moles of atoms for each element is the same before and after the reaction that is, the left-hand side and right hand side of the equation. The different tasks/topics given included basic requirements in balanced chemical

equations, how to obtain a balanced chemical equation, applying the mole concept and use of fractions. Students in their groups worked on the tasks listed above and came up with right answers which were presented by the group leaders.

### **Theoretical Framework**

The underlying philosophy of this study is based on the theories of cognitive science particularly that of John Dewey's (1952) theory of constructivism. The theory provides a framework through which the emergent ideas about teaching, learning and assessment can be unified. Students come into a classroom with their own experiences and a cognitive structure based on those experiences. The learner reformulates his/her existing structures only if new information or experiences are connected to knowledge already in memory. Memorized facts or information that has not been connected with the learner's prior experiences will be forgotten. The responsibility of learning should reside increasingly with the learners where they are actively involved in the learning process. The role of the teacher is to organize information around conceptual clusters of problems, questions and discrepant situation in order to engage the student's interest. The constructivist theory of learning supports cognitive pedagogy, that humans have an innate sense of the world and this domain allows the learner to move from passive observers to active learners.

### **Statement of the Problem**

The motivation to conduct this research was based on the dwindling poor performance of students in chemistry as confirmed by WAEC (2022, and 2023) Chief Examiners' report. Omosor *et al.*, (2024) has reported the growing concern regarding the right instructional methods which should be used in secondary schools to stop the downward trend in learners' achievement in chemistry. Angeline and Cecily (2015) commented on the frequent use of lecture method in teaching and therefore recommend minimizing its use as they provided some learning capabilities. A number of studies (Timon, *et al.*, 2022, Jack & Kyado, 2017 and Udo & Udofia, 2014) have been carried out on how to improve and solve the problem of poor academic performance of students in chemistry, but poor academic performance still persists. In an attempt to solve the problem of poor academic achievement, there is the need for more empirical researches to assess other teaching strategies and their effectiveness in enhancing academic achievement in chemistry at the secondary school level, hence the need for this study. It is against this background that this study was undertaken to investigate the effect of cooperative learning, expository and inquiry-based learning strategies on academic achievement in chemical equations among senior secondary school

chemistry students in Zamfara State, Nigeria. It is hoped that the findings of this study would help curriculum developers in the education sector to come up with an appropriate teaching strategy that would enable chemistry students to achieve academically in examinations with higher grades.

### **Purpose of the Study:**

Effect of Cooperative Learning, Expository and Inquiry Based Strategies on Chemistry Students Academic Achievement in Senior Secondary Schools in Zamfara State, Nigeria.

Specifically, the study sought to:

1. Determine the effect of cooperative learning and expository learning strategies on students' academic achievement in chemistry.
2. Determine the effect of inquiry based learning and expository learning strategies on students' achievement in chemistry.
3. Determine the effect of cooperative learning and inquiry based learning strategies on students' academic achievement in chemistry.
4. Determine the effect of cooperative, inquiry and expository learning strategies on students' achievement in chemistry.

### **Research Questions**

The following research questions were poised to give direction to the study:

1. What is the effect of cooperative learning and expository learning strategies on students' academic achievement in chemistry?
2. What is the effect of inquiry based learning and expository learning strategies on students' academic achievement in chemistry?
3. What is the effect of cooperative learning and inquiry based learning strategies on students' academic achievement in chemistry?
4. What is the effect of cooperative, inquiry and expository learning strategies on students' academic achievement in chemistry?

### **Null hypotheses**

The study tested the following hypotheses at 0.05 level of significance.

1. There is no significant effect of cooperative learning and expository learning strategies on students' academic achievement in chemistry.
2. There is no significant effect of inquiry based learning and expository learning strategies on students' academic achievement in chemistry.
3. There is no significant effect of cooperative and inquiry learning strategies on students' academic achievement in chemistry.

4. There is no significant effect of cooperative, inquiry and expository learning strategies on students' academic achievement in chemistry.

## Methodology

A quasi-experimental, post-test control group design was adopted for the study. The design has treatments (instruction) at two different occasions. The population of this study comprises a total of 2,209 Senior School II students offering chemistry in all the government-owned secondary schools in Zamfara State for the year 2022/2023 session (Ministry of Secondary Education, Zamfara State, 2023). A sample of 120 SS2 chemistry students was drawn from three secondary schools in Zamfara State, that is, the sample size for each school was forty students. The purposive random sampling technique was used for the selection of the schools. A class of forty students was selected from two different schools and each served as the experimental group while in the third school forty students were selected and served as the control group, each group had an intact class of forty students.

The instrument used for the study was the chemical equation Assessment Test (CEAT). The instrument was re-validated and the reliability coefficient of 0.76 was obtained. The CEAT comprised of twenty multiple choice items based on chemical equation topics and the test items (CEAT) were drawn from the West African Examination Council (WAEC) past question papers. The selection was done within a five year range (2019-2023). The multiple test items covered four topics in chemistry (Chemical Equation and Mole concept). The topics were drawn from the WAEC chemistry syllabus and scheme of work for Senior Secondary school II (SS2).

The instrument was validated by three chemistry education experts from Ahmadu Bello University, Zaria. The experts (Ph.D holders) examined the treatment packages (lesson plans) and confirmed the validity of the instruments. The researcher conducted a reliability test on 30 SS II chemistry students from a different school using the Chemistry Equation Achievement Test (CEAT). The purpose of the pilot testing was to assess the construct validity and the reliability of the instrument. The reliability coefficient of 0.76 was obtained. The data obtained was used to compute difficulty and discrimination indicators for the items that made up the instrument. The value of the difficulty index of the CEAT lies between 0.52 and 0.67.

Before the treatment, all the students in the two experimental and control groups were pre-tested with the Chemistry Equation Achievement Test to ensure equivalence in knowledge. The pretest mean scores and standard deviation (Cooperative, Inquiry and Expository) were (8.28 and 1.08; 8.32 and 1.05; 8.29 and 2.10; respectively) showing they were the same in knowledge. All the participating students were taught the following chemistry topics for four weeks, the topics were: basic requirements in balancing chemical equations, how to obtain balanced equation; applying the mole

concept; uses of fractions. During the treatment, the participants for the study (experimental group 1) who were taught with Cooperative Learning Strategy (CLS) lesson plan and were subjected to orientation activities on cooperative learning guide. The students were also oriented on the social skills and principles of intra-team cooperation in cooperative learning. The exploratory phase also involved students understanding the model, followed by formation of equations, the group members constructed new ideas and terminologies and ask questions. Students were divided into groups of 4 students in the class and given different tasks to deliberate upon. In the second experimental group 2 using inquiry based learning, (IBL) lesson plan, the students actively participated in the learning process and made inquiries by themselves, which was assessed by the teacher during and after the instruction. In the control group, the teacher used a lesson plan which involved the chemistry textbook, the chalk board and explanation on the same topics mentioned earlier. Two research assistants were involved in the research study; they were trained on what to do.

At the end of the four weeks, a post-test was administered to all the students with the same Chemistry Equation Achievement Test (CEAT) that was used during the pretest. The scripts containing the answers were collected from the students and marked. The maximum score for CEAT was 40. The total marks earned by the students were used to compute the mean achievement score.

The stated research questions were analyzed using mean scores and standard deviation while the null hypotheses 1, 2, and 3 were analyzed using t-test statistics  $p \leq 0.05$  levels of significance. Null hypothesis 4 was analyzed using two way analysis of covariance (ANCOVA) statistic.

The results of the analyses are shown in Tables 1-8. Respondents were distributed into two experimental and one control group of forty students each, making a total of one hundred and twenty students.

**Research Question 1:** What is the effect of cooperative learning and expository learning strategy on students' academic achievement in chemistry?

**Table 1: Mean and Standard Deviation of achievement post-test scores of respondents exposed to Cooperative Learning strategy (CLS) and expository learning method.**

*Variables	Methods	N	Mean	SD	Mean Diff
Achievement in chemistry	Cooperative	40	55.50	19.18	5.60
	Expository	40	49.90	17.03	
		80			

Table 1 showed the experimental group had a mean score of 55.50 and the control group had 49.90. This means that the group taught with Cooperative learning strategy achieved higher than the group taught using the expository learning method. The mean difference of 5.60 in their mean scores has answered this research question (1) and shown that there is an effect of the strategy on achievement.

**Research Question 2:** what effect does inquiry and expository learning strategies have on students' academic achievement in chemistry?

**Table 2: Mean and Standard Deviation of achievement post-test scores of respondents exposed to Inquiry and Expository learning strategies.**

Variables	Methods	N	Mean	SD	Mean Diff
<b>Achievement in chemistry</b>	Inquiry	40	50.47	14.90	0.57
	Expository	40	49.90	17.03	
		80			

Table 2 showed that the experimental group had a mean score of 50.47 and the control group had 49.90. This means that the group taught with Inquiry learning strategy did not achieved higher than the group taught using the expository learning method. The mean difference of 0.57 in their mean scores has answered the research question 2; it has shown that the strategies do not have effect on their achievement.

**Research Question 3:** is there any effect of cooperative and inquiry learning strategies on students' academic achievement in chemistry.

**Table 3: Mean and Standard Deviation of achievement post-test scores of respondents exposed to Cooperative Learning strategy (CLS) and Inquiry Learning strategy (ILS)**

Variables	Methods	No	Mean	SD	Mean Diff
<b>Achievement in chemistry</b>	Cooperative	40	55.50	19.18	5.03
	Inquiry	40	50.47	14.90	

In Table 3 it was observed that the experimental group (cooperative) had a mean score of 55.50 and the second experiment group (Inquiry) had a mean score of 50.47. This means that the group taught with cooperative learning strategy (CLS) achieved higher than the group taught using Inquiry Based Learning (IBL). The mean difference of 5.03 in their mean scores has answered the research question 3.

**Research Question 4:** what is the effect of cooperative, inquiry and expository learning strategies on students' achievement in chemistry?

**Table 4: Mean and Standard Deviation of achievement post-test scores of respondents exposed to Cooperative Learning strategy (CLS), Inquiry Learning strategy (ILS) and Expository strategy**

Variables	Methods	N	Mean	SD
Achievement in chemistry	Cooperative	40	55.50	19.18
	Inquiry	40	50.47	14.90
	Expository	40	49.90	17.03

Table 4 showed that the experimental group (cooperative) had a mean score of 55.50 and the second experimental group (Inquiry) had mean score of 50.47. While the control group (Expository) had mean score of 49.90. This means that the group taught with cooperative learning strategy (CLS) achieved highest while the group taught using Inquiry Based Learning (IBL) and those taught with the expository method achieved almost equally. The differences in their mean scores have answered the research question 4.

### Testing of Hypotheses

**Ho<sub>1</sub>:** There is no significant effect of cooperative learning and expository learning strategies on students' academic achievement in chemistry.

**Table 5: t-test of Mean Performance of Experimental and Control Groups (Cooperative learning and Expository method)**

Groups	N	Mean	SD	Df	t-value	t-cri	P-Value
Cooperative	40	55.50	19.18	78	4.33	1.96	0.000
Expository	40	49.90	17.03				

Result from Table 5 showed that calculated t-value is 4.33 while t-critical is 1.96,  $df = 78$  at 0.05 level of significance. It indicated that there is significant difference in the scores of the groups since the t-calculated of 4.33 is higher than t-critical of 1.96. The null hypothesis is therefore rejected.

**Ho<sub>2</sub>:** There is no significant effect of inquiry learning strategy and expository learning strategies on students' achievement in chemistry.

**Table 6: t-test of Mean Performance of Experimental and Control Groups (Inquiry learning strategy and Expository method)**

Groups	N	Mean	SD	Df	t-cal	t-cri	P-value
<b>Inquiry</b>	40	50.47	14.90	78	.547	1.96	.585
<b>Expository</b>	40	49.90	17.03				

Table 6 showed that calculated t-value is .547 while t-critical is 1.96, df =78 at 0.05 level of significance. It means that there is no statistical significant difference in the mean scores of the two groups (experimental and control). That is, there is no significant difference in the posttest mean achievement scores of students taught chemistry with the Inquiry learning strategy and those taught with Expository method. The null hypothesis is therefore retained.

**Ho<sub>3</sub>:** There is no significant effect of cooperative and inquiry learning strategy on students' academic achievement in chemistry.

**Table 7: t-test of Mean Performance of Experimental Groups (Cooperative and Inquiry learning strategies)**

Groups	N	Mean	SD	Df	t-cal	t-cri	P-value
<b>Cooperative</b>	40	55.50	19.18	78	3.79	1.96	0.000
<b>Inquiry</b>	40	50.90	14.90				

Result from Table 7 revealed that there is significant difference in the scores of the groups since the calculated t-value of 3.79 is higher than t-critical of 1.96 at df of 78 at 0.05 level of significance. With this result the null hypothesis is therefore rejected.

**Ho<sub>4</sub>:** There is no significant effect of cooperative, inquiry and expository learning strategies on students' academic achievement in chemistry.

**Table 8: Two-way Analysis of Covariance (ANCOVA) on the effect of Cooperative, Inquiry learning strategies and Expository method on the Post-test scores of the students**

Source	Type of squares	Df	Mean square	F	Sig
<b>Corrected model</b>	422.117	1	422.117	17.761	.000
<b>Intercept</b>	9432.387	1	9432.387	396.879	.000
<b>Method</b>	422.117	2	422.117	17.761	.000

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<b>Error</b>	7248.749	118	23.766
<b>Total</b>	<b>49255.000</b>		
<b>Corrected</b>	<b>7670.866</b>	<b>117</b>	

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Table 8 showed the result of the two experimental groups and the control group. There is a significant effect of the method on the achievement of chemistry students  $F(2,88)=17.76$ ,  $P=.000$  at 0.05 level of significance.. The result revealed that the methods had effect on the achievement of the students. Hence the null hypothesis which states that there is no significant effect of cooperative, Inquiry and expository learning strategies on chemistry achievement of students is hereby rejected.

### Summary of Findings

1. The mean score of the students in experimental group 1 (Cooperative Learning) was higher with mean difference of 5.60 than those students in control group (Expository). (Table 1)
2. The mean scores of the experimental (Inquiry) group was 50.47 which was not greater than that of the control (Expository) group 49.90 with a mean difference of 0.57. (Table 2)
3. The mean scores of the two experimental (Cooperative and Inquiry) groups were 55.50 and 50.47 with a mean difference of 5.03. (Table 3)
4. The mean scores of the group taught with cooperative learning strategy (CLS) achieved highest, the group taught using Inquiry Based Learning (IBL) and expository method achieved equally. (Table 4)
5. There is significant effect of cooperative learning and expository learning strategies on students' academic achievement in chemistry in favour of the experimental group. (Table 5)
6. There is no significant effect of inquiry learning and expository learning strategies on students' achievement in chemistry.(Table 6)
7. There is significant difference in the effect of cooperative and inquiry learning strategy on students' academic achievement in chemistry. (Table 7)
8. There is significant effect of cooperative, inquiry and expository learning strategies on students' achievement in chemistry (Table 8).

## **Discussion of findings**

### **Cooperative learning and expository learning strategies on students' academic achievement in chemistry**

Results in Table 5 testing hypothesis 1 revealed a significant difference between the posttest mean academic performance scores of students taught chemical equations using cooperative learning strategy and the expository learning strategy. The significant difference is in favor of students exposed to cooperative learning strategy. This might be due to the opportunity the students had to discuss with other members of the group, brainstorm ideas and ask questions, defend and explore the cognitive connections between previous knowledge, personal experiences. This indicates that students learn better when they are allowed to freely interact with each other and learn by themselves. The result of this study is similar to that of Timon et al (2022), Abdullahi, (2014), and Oloyede, Adeboowale and Ojo (2012), who reported that students exposed to cooperative learning strategy had significantly better academic performance over those students exposed to lecture method.

### **Inquiry based learning and expository learning strategies on students' academic achievement in chemistry**

Findings from testing hypothesis 2 in Table 6 showed that there was no significant difference in the mean achievement score of chemistry students taught with inquiry based learning and those taught with the expository strategies. The results suggest that the Inquiry learning strategy is not appealing to the students, so made no significant difference with the expository learning strategy. The findings of this study did not tally with the results of Omosor, Ajaja, and Kpangban (2024) who reported a significant difference between the process-oriented guided Inquiry learning method and the lecture method.

### **Cooperative learning and inquiry based learning strategies on students' academic achievement in chemistry**

Findings from testing hypothesis 3 in Table 7 revealed that there was significant effect in the mean achievement scores of chemistry students taught with the cooperative learning strategy and the inquiry based learning. This means that cooperative learning strategy is more acceptable to the students than the inquiry learning strategy among senior secondary school chemistry students in Zamfara State. This finding is in line with Showel (2018) who stated that students should not only be allowed to inquire things individually but should be allowed to interact with others, exchange ideas, carefully listen to their partner's answers and create new answers that are superior to each member's initial formulation by integrating both answers and build on each other's thoughts.

## **Cooperative learning, Inquiry based learning and Expository strategies on students' academic achievement in chemistry**

Findings from testing hypothesis four in Table 8 using a two way analysis of covariance (ANCOVA), revealed that a significant difference exists among the groups (cooperative, inquiry based learning and the expository learning strategies). This finding is in line with Umar (2012) who stated that cooperative learning strategy is better off to inquiry learning strategy since it involves students cooperating with each other to learn and sharing new knowledge rather than learning individually.

### **Conclusion**

The study has shown that co-operative learning strategy is potentially viable in enhancing the understanding of chemical equation concepts and improving the academic achievement of learners in chemistry than the inquiry based learning and the expository learning strategy. In conclusion, chemistry teachers should incorporate cooperative learning strategy in the teaching/learning process in secondary schools.

### **Recommendations**

In the light of the findings, the following recommendations are made:

1. Curriculum planners should consider the introduction of cooperative learning strategy into the curriculum for the teaching and learning of chemical equation concepts since these concepts deals with chemical reactions which are very relevant in our everyday lives.
2. Chemistry teachers should be trained and retrained in the use of cooperative learning strategy.
3. Cooperative learning strategy should be encouraged in the teaching and learning of chemistry concepts in place of the inquiry based learning and the expository learning strategy.

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