

## Comparative Effects of the Laboratory and Discussion Methods on Senior Secondary Students' Achievement in Chemistry OJAA-13-O53

**Author Details: Dr. Ogbeba Josiah**

### Abstract

*The study examined the comparative effects of the laboratory and discussion methods on senior secondary students' achievement in chemistry. Three research questions and three hypotheses guided the study. A sample of 196 students out of a population of 1,924, SS II students from zone B of Benue State, Nigeria was used for the study. A validated 30 item Chemistry Achievement Test (CAT) was the instrument used to collect data. Reliability coefficients of 0.78 and 0.68 were established using Kuder-Richardson (KR – 21) formula. Mean (M) and Standard Deviation (SD) scores were used to answer the research questions while Analysis of Covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance. The results indicated that students taught using the laboratory method achieved significantly higher than those taught using discussion method  $F(1,195) = 31.90$ ,  $P < 0.05$ . The study further revealed that students taught using both laboratory and discussion methods achieved significantly higher with a small class size in terms of student population than those with a large class size  $F(1,97) = 166.66$ ,  $P < 0.05$  and  $F(1,97) = 79.89$ ,  $P < 0.05$  respectively. The study therefore recommended among others that laboratory method should be used in teaching chemistry and small class sizes (40 students) is being advocated for all schools' offering chemistry instead of large (populated) classes.*

**Key words:** Comparative, Laboratory, Discussion, Achievement, Chemistry.

### Introduction

In Nigeria, the importance of chemistry in the development of the nation cannot be underrated especially as her national income rests on petroleum and petrochemical industries (Ameh & Dantani, [1]). The persistent failure of secondary school students in chemistry has however remained a major threat to its learning. The Chief Examiner's report on the conduct of the 2010 senior secondary school certificate examination of the West-African Examination Council (WAEC) [2] in Chemistry stated that there was no significant improvement in the performance of candidates when compared with those of previous years. In this regard NECO [3] chief examiners report concluded that the mass failure being recorded by students in external examinations seems to suggest that the end to the country's educational woes is far from being over. This decimal performance may be ascribed to the failure of teachers among other things to use appropriate methodology in handling the teaching of chemistry content.

Methodology is very vital in any teaching/learning situation. The method adopted by the teacher may promote or hinder learning. It may sharpen mental activities which are the bases of social power or may discourage initiatives and curiosity thus making self-reliance and survival difficult (Ameh & Dantani, [1]). The way a teacher presents subject matter to learners may make them like or dislike the subject (Emaikwu, [4]). It has also been reported by Mtsem [5] that teaching method affects the responses of students

and determines whether they are interested, motivated and involved in a lesson in such a way as to engage in good learning. What constitutes good teaching and learning of school subjects is the use of appropriate method of teaching. Ogunniyi [6] asserted that one of the most persistent and compelling problems besetting academic achievement in Nigeria is poor quality of teaching.

There exists a number of teaching methods for teachers to use. They include: lecture, discussion, demonstration, laboratory, individualized instructional, field-trip, peer-teaching methods and so on. Ameh and Dantani [1] observed that because chemistry as a subject is bulky in nature the subject teachers usually adopt lecture method in teaching in order to cover the syllabus within the stipulated time and this does not give room for proper understanding of the subject. In view of the foregoing, this study examined the acquisition of chemistry knowledge using two instructional methods namely, Laboratory and discussion methods with the aim of determining the effect of each method on the achievement of students in senior secondary schools.

Laboratory method is an activity-based, student-centred teaching method where students learn by carrying out activities in the laboratory (Omosewo [7]). These activities include, touching, seeing, feeling, weighting, measuring, demonstrating, carrying out tests/experiments and any other practical activities in the laboratory. A deeper understanding of the science and technological processes can be achieved through laboratory activities which encourage active participation and serve to develop critical thinking and

also provide concrete experiences to substantiate the theoretical aspect that might have been taught. Mkpa [8] maintains that laboratory activities provide exercises/problems based upon real physical situations and also appreciation of the various methods used in experimental science. Such methods include understanding competence in the use of apparatus, training in awareness of the problems involved in precise laboratory work. These methods help learners to construct definitions of concepts, formulate relevant questions and theories relating to any assumptions and arguments used in the experimental process. According to this author, the laboratory teaching method serves the following purposes: Motivating students by stimulating interest, developing understanding of scientific inquiry and expertise, inculcating scientific attitudes into students and encouraging social skill development. Omosowo [9] asserted that laboratory work promotes competence in the skill of gathering information, organizing, communicating, interpreting observing, drawing conclusions and making inferences. Okeke [10] viewed the laboratory as providing conceptual understanding, procedural knowledge and hence investigative enterprise. The author suggested that if the laboratory is to serve its purpose successfully, then the students must be actively involved in doing their own thinking, evolve solutions to problems, make use of their own hands and heads and therefore grow in skill development at the end of every laboratory exercise.

On the other hand, discussion method of teaching involves a group of people in a class who come together to exchange ideas, facts, opinions and expressions orally about a topic of mutual concern and interest under a guide (Emaikwu, [4]). The researcher maintains that in a discussion class the students talk to each other about the concept or problem until there is an agreeable understanding to it mentally. This method encourages the learner to be independent of the teacher and discover knowledge and also see relationship on their own. As a teaching method, discussion encourages learning through active involvement of students in the lesson.

Another important factor affecting academic achievement of students is the size of a class. Class size refers to pupils/students to teacher ratio. In terms of numerical strength, the revised national policy on education [11] specified maximum of 40 students per class in secondary schools. Adeyemi [12], Afolabi, [13] & Yara, [14] found that large class size is not conducive for serious academic work. The foregoing differing findings, opinions and observations call for further investigation into the relationship between class size and

students' academic achievement in Zone B of Benue State, which this present study was out to do as one of its objectives.

### Research Questions

The study raised the following research questions to guide the study:

1. How does the mean achievement scores of students taught using the laboratory method differ from those taught using the discussion method?
2. What is the difference in the mean achievement scores of students taught using the laboratory method with small class sizes and those with large class sizes?
3. What is the difference in the mean achievement scores of students taught using the discussion method with small class sizes and those with large class sizes (in terms of students' population)

### Hypotheses

The following hypotheses have been formulated to guide the study.

1. There is no significant difference in the mean achievement scores of chemistry students taught using the laboratory method and those taught using the discussion method.
2. There is no significant difference in the mean achievement scores of students taught using the laboratory method with small class sizes and those with large class sizes.
3. There is no significant difference in the mean achievement scores of students taught using the discussion method with small class sizes and those with large class sizes.

### Methodology

The purpose of the research was to determine the differential effect of the laboratory and discussion methods on senior secondary students' achievement in chemistry. The study used pre-test-post-test quasi experimental design. The study area was zone B of Benue State, Nigeria.

The population of the study comprised all the 1,924 SSII students in the 73 granted aided schools that offered science subjects. One hundred and ninety-six students were purposively sampled from 8 of the schools that had some basic facilities and equipment in their laboratories. An instrument known as "chemistry Achievement Test" (CAT) developed by the researchers and validated by two experts from science education and one other from measurement and evaluation all from

Benue State University, Makurdi was used to collect the data. The researchers considered the validators' suggestions and made relevant corrections to the instrument before it was used. The CAT, a 45 item

multiple choice instruments yielded reliability coefficients of 0.78 and 0.68 for the laboratory group and the discussion group respectively, using Kuder-Richardson (KR-21) formula.

## Results

### Research Question One

How does the mean achievement scores of students taught using the laboratory method differ from those taught using discussion method? The answer to research question one is contained in Table 1

**Table 1:** Mean and standard deviation of students score in pretest and posttest for laboratory and discussion groups.

Group	N	Pretest		Posttest		Mean gain
		$\bar{X}$	$\delta$	$\bar{X}$	$\delta$	
Laboratory	98	9.4898	.97647	16.9490	3.27242	7.4592
Discussion	98	9.3673	1.1432	13.8878	2.56817	4.5205
Mean gain		0.1225		3.0612		2.9387

**Key:**  $\bar{X}$  = Mean scores,  $\delta$  = Standard deviation scores

Results on Table 1 show that the pre-test and post-test mean scores difference for the two groups shows that students in the laboratory group achieved better. There is also a positive difference of 3.06 between the post-test mean scores of the two groups in favour of the laboratory group. This suggests that students taught using laboratory method achieved higher than their discussion group counterparts.

### Research Question Two

What is the difference in the mean achievement scores of students taught using the laboratory method with small class sizes and those with large class sizes? The answer to research question two is presented in Table 2

**Table 2:** Mean and Standard Deviations of students' scores for large and small class size taught using laboratory method.

Class Size	N	Pretest		Posttest		Mean gain
		$\bar{X}$	$\delta$	$\bar{X}$	$\delta$	
Small class	24	9.7500	.94409	21.500	2.39565	11.75
Large class	74	9.4054	.97810	15.4730	1.84482	6.07
Mean gain		0.34		6.03		5.68

**Key:**  $\bar{X}$  = Mean scores,  $\delta$  = Standard deviation scores

From Table 2, The difference between the mean pre-test scores and post-test of students in the large class is 6.07, while the difference for students in the small class is 11.75. This shows that students in the small class achieved better than their counterparts in the large class.

### Research Question Three

What is the difference in the mean achievement scores of students taught using the discussion method with a small class size and those with a large class? The answer to research question three is presented in Table 3

**Table 3:** Mean and Standard Deviations of students' Scores for large and small class size taught using discussion method

Class Size	N	Pretest		Posttest		Mean gain
		$\bar{X}$	$\delta$	$\bar{X}$	$\delta$	
Small class	27	8.9259	1.03500	16.6667	3.31662	7.74
Large class	71	9.5352	1.14431	12.8310	0.97080	3.30
Mean gain		0.61		3.84		4.44

**Key:**  $\bar{X}$  = Mean scores,  $\delta$  = Standard deviation scores

From Table 3, The difference between the mean post-test scores of students in the small class and the large class is 3.84 and is in favour of the small class. This shows that students in the small class achieved better than their counterparts in the large class.

### Hypothesis One

There is no significant difference between the mean achievement scores of students taught chemistry using laboratory method and those taught using discussion method.

**Table 4:** Tests of between-subjects effects for students' score in laboratory and discussion method

**Dependent variable: posttest**

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	520.054a	4	130.013	15.351	.000
Intercept	558.418	1	558.418	65.934	.000
Pretest	.002	1	.002	.000	.987
Method	270.195	1	270.195	31.903	.000
Gender	17.017	1	17.017	2.009	.158
Method * Gender	40.939	1	40.939	4.834	.029
Error	1617.640	191	8.469		
Total	48732.000	196			
Corrected Total	2137.694	195			

a. R Squared = .243 (adjusted R Squared = .227)

The ANCOVA was significant,  $F(1, 195) = 31.903$ ,  $p < 0.05$  (in Table 4). Therefore the null hypothesis is rejected and the conclusion is that there is a significant difference between the mean achievement scores of students taught chemistry using laboratory method and those taught using discussion method. It shows that the method of teaching has effect on academic achievement of students. Students taught using laboratory method achieved higher in the post-test scores than those taught using discussion method.

### Hypothesis Two

There is no significant difference in the mean achievement scores of students taught chemistry using the laboratory method with a small class size and those with a large class.

**Table 5:** Tests of between-subjects effects for scores of students in Large and Small class taught using Laboratory method

**Dependent Variable: posttest 4**

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	662.811a	2	331.405	83.747	.000
Intercept	413.387	1	413.387	104.465	.000
Pretest	4.512	1	4.512	1.140	.288
Class size	659.519	1	659.519	166.663	.000
Error	375.934	95	3.957		
Total	29191.000	98			
Corrected Total	1038.745	97			

a. R squared = .638 (Adjusted R squared = .630)

The ANCOVA was significant  $f(1, 97) = 166.663$ ,  $P < 0.05$  (See Table 5). The null hypothesis is rejected and this shows that there is a significant difference in the mean achievement scores of students in large and small classes taught using laboratory method. It implies that class size has effect on academic achievement of students taught using laboratory method.

### Hypothesis Three

There is no significant difference in the mean achievement scores of students taught chemistry using the discussion method with a small class size and those with a large class.

**Table 6:** Tests of between-subjects effects for scores of students in large and small class taught using Discussion method

**Dependent Variable: Post test 4**

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
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Corrected Model	293.783a	2	146.892	40.334	.000
Intercept	221.638	1	221.638	60.858	.000
Pretest	5.990	1	5.990	1.645	.203
Class size	290.948	1	290.948	79.889	.000
Error	345.982	95	3.642		
Total	19541.000	98			
Corrected Total	639.765	97			

a. R Squared = .459 (Adjusted R Squared = .448)

The ANCOVA was significant  $F(1,97) = 79.889$ ,  $P < 0.05$  (See Table 6). The null hypothesis is rejected and this shows that there is no significant difference in the mean achievement scores of students in large and small class taught using discussion method, thus class size has effect on achievement of students taught using discussion method.

### Discussion

The study examined the effects of laboratory and discussion methods on achievement of senior secondary two students in chemistry. The independent variables were the teaching methods (laboratory and discussion). The moderator variables was class size (in terms of student population) while the dependent variable was achievement. The results of data analysis showed a mean achievement score of 16.95 for laboratory method group which was higher than that of discussion method group with a mean value of 13.89. The result of hypothesis one indicated that there was a significant difference in the mean achievement scores of students taught chemistry using laboratory and discussion methods. A high achievement was recorded when laboratory method was used in instructional delivery probably because using laboratory which is an activity-based method in teaching, the teacher assumes the role of a facilitator, mediator and assessor of learning. This supports earlier report by Herwit as cited in Emaikwu [4] who asserted that children learn best by doing not just by sitting and listening. Further more the findings of this study are in conformity with Zaman [15], Omosewo [16], Ameh and Dantani [1], and Emaikwu [4] who also affirmed that activity based teaching featuring active students' participation in the learning process produces superior results than other methods. Laboratory method has great effects on students' achievement in chemistry moreso that it helps to practicalize those concepts in chemistry which are mostly abstract in nature in order to reduce them to concreteness or to reduce their degree of abstraction. In this way, students are motivated and materials are internalized more easily.

Another finding of the study was in the area of class size. Results of data analysis indicated that students taught with small size achieved higher than those with large class size using both laboratory and discussion methods. The results showed mean achievement score of 21.50 for small class which was higher than that of large class with a mean score of 15.47; using laboratory

method. Also students taught with a small class size had a mean achievement score of 16.87 which was higher than that of large class with a mean score of 12.83 when discussion method was used. The results also indicated that students in the small class size achieved higher than their counterparts in the large class in each case. The findings agree with Owoeye and Yara [17], Kokkenberg, Dillon and Sean [18] who asserted that the size of a class has considerable effect on the general performance of students in any subject and the presence of many students in a class does not make for effective teaching/learning in any subject chemistry inclusive.

### Conclusion

It is evident from the findings of this study that the use of laboratory method could provide a better way for students to learn chemistry. Laboratory method enhances students' achievement in chemistry. If this method (laboratory), proposed by this study, is adopted in chemistry teaching and learning, it will likely boost the performance of students in skills acquisition, problem solving ability and development of the right type of attitude toward chemistry as a subject.

### Recommendations

1. Since students in the laboratory method group were found to achieve higher, the method should be encouraged to be used by chemistry teachers in teaching the subject.
2. State ministries of education should ensure that each and every secondary school has at least one well-equipped chemistry laboratory before giving it approval. This is because laboratory work has been found to be essential to the development of practical skills acquisition by the students and enhances their academic achievement.
3. School proprietors, principals and the relevant stakeholders should seek for ways of motivating their chemistry teachers so as to encourage them to carryout laboratory work with the students as often as possible.



4. Workshops and seminars should be organized for in-service and practicing chemistry teachers to keep them abreast of the laboratory work. This will enable them to plan and organize adequately for the practicals.
5. Supervisors and school heads should strictly monitor the frequent use of the laboratory by both teachers and students.
6. Classes should not contain more than 40 students since students from less populated classes achieved higher than the students from highly populated classes.

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