

## Effect of Laboratory–Demonstration Method on Senior Secondary School Students Achievement in Chemistry Practical Contents

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### Abstract

*This study investigated the effect of laboratory-demonstration method on senior secondary school students' achievement in chemistry practical content. The study area was Itu Education zone of Akwa Ibom State, Nigeria. Quasi experimental of pretest posttest non-equivalent control group design was adopted. The population of the study comprised 679 chemistry students in Itu Education zone. The sample comprised of 124 chemistry students. Simple random sampling and purposive sampling technique was used to get the sample. The experimental group was exposed to laboratory-demonstration method and the control group was exposed to expository method. Practical Chemistry Achievement Test (PCAT) was used to collect the data for the study with a reliability coefficient of 0.88. Three research questions with a corresponding hypothesis was raised tested at  $P \leq 0.05$  level of significance. The data collected was analyzed using descriptive statistics of mean and standard deviation and Analysis of Covariance (ANCOVA). Major findings from the study is that there is a significant difference in the mean achievement scores of urban and rural students taught chemistry practical contents. The study also showed mean achievement score of 28.03 for urban students and 21.67 for rural taught chemistry practical content using laboratory-demonstration and expository method. It was recommended among others that laboratory-demonstration method should be used in teaching practical chemistry content in secondary schools, since it is activity-oriented.*

**Keywords:** Achievement, Expository, Laboratory-demonstration, and School location.

### Introduction

Science education is very crucial in the development of the nation. Science education is described as the art of sharing science content and process with individuals, Umana (2018). In Nigeria science education concentrates on the teaching of science concepts, method of teaching and addressing misconceptions held by learners regarding science concepts. Chemistry is one of the science subjects that are offered at the secondary school level in Nigeria. Chemistry is a branch of pure science, a core subject for science students and a prerequisite for many fields of science, Nnoli (2015). However chemistry as an experimental science depends on the harmony between theory and practical, Muhammed (2014). The knowledge of concepts in practical chemistry would enhance students understanding of chemistry. According to Kokaia (2015), understanding chemistry is impossible without realization of practical experiment which is the goal of reaction demonstration at class time. Practical activities are fundamental to science teaching especially chemistry. Practical activities in chemistry

composed of those learning experiences in which there are interactions with apparatus and instances of scientific principles or concepts, Okorie and Ugwuanyi (2019).

In spite of the importance of chemistry to national development, students' poor achievement in chemistry from (2010-2018) is still below average. The Chief Examiners Report in chemistry West African Examination Council of 2015 revealed that most of the chemistry candidates displayed many weaknesses resulting in poor achievement in practical chemistry as follows:

- i. arithmetical errors in volume of acid used
- ii. averaging non-concordant titre values
- iii. poor mathematical skills
- iv. poor knowledge of S.I units of mass concentration and molar concentration
- v. test on solids instead of solutions
- vi. lack of knowledge of confirmatory test for carbon IV oxides
- vii. poor knowledge of laboratory set-up and names of laboratory apparatus
- viii. poor knowledge of solubility of gases in water and assigning wrong charges to ions.

In addition, WAEC Chief Examiners Report of (2015) showed that students' achievement in chemistry is generally poor due to lack of understanding of what is required from them especially when it comes to qualitative analysis questions. It seems teachers of chemistry are using teaching methods that does not bridge the gap between theory and practical aspect of qualitative analysis concepts. It seems chemistry students are not taught how to observe and record observed reactions; write correct changes on cations and anions when carrying out specific chemistry test. This study therefore searched for effective teaching method that could bridge the gap between the teaching and learning outcome of students in chemistry. The study considers laboratory-demonstration.

Laboratory demonstration method is a process of presenting or establishing fact or principle. It is a procedure of doing or performing something in the presence of others or either as a mean of showing them how to do it or illustrating a principle. Tersoo (2018) described laboratory demonstration method as a method of explaining science principle that require visualization to the learners. This strategy improves understanding of complex skill and principles knowledge acquired becomes permanent because this method requires different human senses. Laboratory method forms integral part of effective science teaching. The various forms are experimental and demonstration. This study focus on demonstration method particularly when there are few materials and reagents available for the teaching of the qualitative analysis. Demonstration is useful in imparting psychomotor skills and lesson that require practical knowledge. According to Dorgu, (2015), the gain of using demonstration method in teaching lies in the fact that it bridges the gap between theory and practice, enable leaners to become good observers and generate their interest. Again students see immediate progress as a result of a correct effort and it enables the teacher to teach manipulative and operational skills.

Efe and Suleiman (2016) carried out a study entitled "an investigation into the effects of laboratory, guided unguided discovery (inquiry) and lecture-demonstration teaching methods on senior secondary student's achievement in acid-base titration

practical test in selected secondary schools in Giwa Local Government Area of Kaduna State”. The result of the study showed that laboratory method enhanced better performance in acid-base titration in practical better than either inquiry or lecture-demonstration method. In addition, Achimugu (2018) investigated the relative effective of enriched demonstration and lecture instructional strategies on senior secondary school students’ achievement in chemistry. Findings from the study revealed that there is a significant difference between the achievement of students exposed to enriched instructional strategies than those exposed to enriched traditional lecture strategy.

The expository method is considered the control group in this study. This instructional method is widely used in teaching chemistry in Nigerian secondary schools. In expository teaching strategy, the teacher presents students with the subject matter rules and provides examples that illustrate the rules. Maheshwari (2013). This method involves presenting clear and concise information in a purposeful way that allow students to easily make connection from one concept to the next. Mangal and Mangal (2009) emphasized that in the expository strategy, the manner and way of exposing topic and subject matter to students should be logically sequenced and organized by the teacher. This instructional method is teacher centered and it is basically a direct instruction.

School location is described as the particular place, in relation to other areas in the physical environment (rural and urban) where the school is cited. School location in terms of rural and urban areas have been reported to have influenced science achievement. Alordiah, Akpadaka and Oviogbodu (2015) in their study on the influence of gender, school location and socio-economic status on students academic achievement in mathematics found out that urban students performed better than rural students. A study conducted by Agbaje and Awodun (2014) entitled “Impart of school location on academic achievement of science students in senior secondary school certificate examination indicated that there was no statistical significant difference in the achievement of mean scores of students in rural and urban school located areas. However Ezendu, Gbendu and Umefekwem (2014) in their study on school location versus academic achievement in geography using reflective inquiry instructional technique reported that school location has no significant effect on student achievement in geography.

The concept of qualitative analysis was considered in this study. Qualitative analysis in chemistry is the determination of the chemical composition of a sample. It encompasses a set of analytical chemistry technique that provide non numerical information about a specimen. In qualitative analysis, one can identify an atom, ion functional group or a compound present or absent in a given sample but not the quantity of that sample, Helmenstine, (2019). This study deals with quantitative identification of ions which is an aspect of inorganic qualitative analysis to be taught by research assistance during the research procedure.

### **Statement of the Problem**

The academic performance of chemistry students at the senior secondary school examination in chemistry practical is unimpressive thereby leading to poor achievement in WAEC examination, Chief Examiner Report in chemistry (2010 – 2018). Researchers such as Njoku (2010) and Achimugu (2016) attributed the poor achievement rate to inadequate conventional method employed by teachers and inadequate. The facilities and the place of laboratory practical in teaching chemistry cannot be over emphasized. It is therefore pertinent to employ a strategy that would enhance students' achievement in chemistry practical in particular and in chemistry generally. Hence, this present study seeks to investigate the relative effectiveness of laboratory-demonstration and expository methods of teaching on students' achievement in qualitative analysis.

### **Purpose of the Study**

The general purpose of this study is to examine the effect of laboratory demonstration method on senior secondary school students' achievement in chemistry practical.

Specifically, the study intends to determine the:

1. Mean achievement scores of students taught qualitative analysis using laboratory-demonstration and expository methods.
2. Influence of school location on students' achievement when taught using laboratory-demonstration method.
3. Interaction effect of school location and instructional methods on students' achievement in qualitative analysis.

### **Research Questions**

The following research questions were raised to guide the study.

1. What are the mean achievement scores of students taught qualitative analysis using laboratory-demonstration and expository methods?
2. What are the mean achievement scores of urban and rural students taught qualitative analysis using laboratory-demonstration and expository methods?
3. What are the interaction effects of instructional method and school location on students' achievement in qualitative analysis?

### **Null Hypotheses**

The following null hypothesis are formulated and tested at 0.05 level of significance.

1. There is no significant difference in the mean achievement scores of students taught qualitative analysis using laboratory-demonstration and expository method of teaching.
2. There is no significant difference in the mean achievements of urban and rural scores of students taught qualitative analysis using laboratory-demonstration and expository method of teaching.
3. There is no significant interaction effect of school location and instructional methods on students' achievement in qualitative analysis.

### **Methodology**

The study employed quasi-experimental design particularly the pretest posttest non-equivalent control group design. The study design is quasi experimental because intact classes was used for the experimental and control group, Nworgu (2015). The

population of the study comprised of all the chemistry students in Itu Education zone numbering 679 (340 males and 339 females), (data from Itu Education zone). Four co-educational public secondary schools were used for the study, out of eight (8) in the study area. Four intact classes from four schools was selected using simple random sampling technique. Purposive sampling technique was used to select the 4 intact classes from 2 urban and 2 rural class respectively. The sample sizes of 124 chemistry students were used for the study. The instrument used for the data collection is Practical Chemistry Achievement Test (PCAT). The PCAT developed were 20 item select/supply response objectives and essay questions used as pretest and posttest to determine the students' achievement in qualitative analysis concepts. The PCAT was validated by two chemistry educators and one expert in measurements and evaluation, all from science education department Michael Okpara University of Agriculture, Umudike in Abia State. PCAT has reliability coefficient of 0.88 established using Kuder-Richardson formular 20. Descriptive statistics of mean and standard deviation were used to answer the research question while ANCOVA was used to test the null hypothesis at 0.05 level of significance.

## Results

**Research Question 1:** What are the mean achievement scores of student taught qualitative analysis using laboratory-demonstration and expository methods.

**Table 1:** Mean and Standard deviation scores of students' pretest and posttest achievement classified by instructional method.

Method	N	Pretest		Posttest		Mean Gain
		$\bar{X}_1$	SD <sub>1</sub>	$\bar{X}_2$	SD <sub>2</sub>	
Laboratory-demonstration	<b>64</b>	13.28	2.31	28.94	5.54	<b>15.66</b>
Expository	<b>60</b>	12.83	3.06	21.87	4.26	<b>9.04</b>

The result in Table 1 showed that the achievement mean gain scores of students taught qualitative analysis using laboratory-demonstration and expository methods are 15.66 and 9.04 respectively. These results indicate student taught qualitative analysis using laboratory-demonstration had higher achievement scores that those in expository method group. This implies that laboratory-demonstration method enhance students' achievement than expository method.

**Research Question 2:** What are the mean achievement scores of urban and rural students taught qualitative analysis using laboratory-demonstration and expository method.

**Table 2:** Mean and standard deviation of students' pretest and posttest classified by school location.

School Location	N	Pretest		Posttest		Mean Gain
		$\bar{X}_1$	SD <sub>1</sub>	$\bar{X}_2$	SD <sub>2</sub>	
Urban	<b>57</b>	13.28	2.37	28.03	5.78	<b>14.75</b>
Rural	<b>67</b>	12.73	3.13	21.67	4.31	<b>8.94</b>

In Table 2, the mean achievement scores of students taught qualitative analysis using laboratory-demonstration and expository methods in urban and rural areas are 14.75 and 8.94 respectively. This implies that students taught qualitative analysis in urban areas had higher achievement scores than their rural counterparts.

**Research Question 3:** What are the interaction effects of instructional method and school location on students' achievement in qualitative analysis?

**Table 3:** Mean and standard deviation scores of students pretest and posttest scores classified by instructional methods and school location.

Method	Location	N	Pretest		Posttest		Mean Gain
			X <sub>1</sub>	SD <sub>1</sub>	X <sub>2</sub>	SD <sub>2</sub>	
Laboratory-demonstration	<b>Urban</b>	<b>46</b>	13.02	2.34	29.52	5.68	<b>16.5</b>
	<b>Rural</b>	<b>18</b>	13.94	2.44	27.44	5.03	<b>13.51</b>
Expository	<b>Urban</b>	<b>11</b>	13.27	2.83	22.73	4.13	<b>9.46</b>
	<b>Rural</b>	<b>49</b>	12.73	3.13	21.75	4.32	<b>9.02</b>

Table 3 reveals that the pretest-posttest mean gain of the urban students in laboratory-demonstration is 16.5 while that of their rural counterpart is 13.51, in achievement mean gain of urban students in expository method is 9.46 while that of their rural counterpart is 9.02. These results indicate that urban students in laboratory-demonstration and expository method had higher achievement scores respectively.

**Null Hypothesis 1:** There is no significant difference in the mean achievement scores of students taught qualitative analysis using laboratory-demonstration and expository method of teaching.

**Table 4:** Analysis of Covariance (ANCOVA) of students' mean achievement scores on instructional methods (laboratory-demonstration and expository)

Source	Type III Sum of square	Df	Mean square	F	P-value	Decision
Corrected model	1607.664 <sup>a</sup>	2	803.832	33.001	.000	
Intercept	2428.379	1	2428.657	99.707	.000	
Pretest	59.379	1	59.379	2.438	.121	
Method	1487.618	1	1487.618	61.073	.000	S
Error	2947.304	121	24.358			

Total	85288.000	124
Corrected total	4554.968	123

*a. R.squared = .353 (Adjusted R. Squared .342)*

Table 4 shows that at 0.05 level of significance, the calculated  $F(1,121)$  is 61.073 with P-value of 0.000 which is less than 0.05. Therefore, the null hypothesis is rejected. Thus the effect of laboratory-demonstration method on senior secondary school students' achievement in qualitative analysis differs significantly when compared with that of expository method.

**Null Hypothesis 2:** There is no significant difference in the mean achievement scores of students taught qualitative analysis using laboratory-demonstration and expository method of teaching.

**Table 5:** Analysis of covariance (ANCOVA) of mean achievement scores of urban and rural students exposed to qualitative analysis.

Source	Type III Sum of square	df	Mean square	F	P-value	Decision
Corrected model	884.724 <sup>a</sup>	2	442.362	14.584	.000	
Intercept	2209.997	1	2209.997	72.859	.000	
Pretest	118.872	1	118.872	3.919	.050	
Method	764.678	1	764.678	25.210	.000	S
Error	3670.244	121				
Total	85288.000	124				
Corrected total	4554.968	123				

*a. R.squared = 194 (Adjusted R. Square = 181).*

Table 5 show that F value for location is 25.210 at significant P-value of 0.000. Therefore the null hypothesis is rejected; implying that the mean achievement scores of urban and rural students taught qualitative analysis using laboratory-demonstration and expository method differ significantly.

**Null Hypothesis 3:** There is no significant interaction effect of school location and instructional methods on students' achievement in qualitative analysis.

**Table 6:** Analysis of covariance of an interaction effect of school location and instructional method on students' achievement in qualitative analysis.

Source	Type III Sum of square	df	Mean square	F	P-value	Decision
Corrected model	1685.175 <sup>a</sup>	4	421.294	17.470	.000	
Intercept	1781.458	1	1781.458	73.871	.000	
Pretest	71.088	1	71.088	2.948	.089	
Method	130.183	1	130.183	5.398	.022	
Location	55.631	1	10.849	2.307	.131	
Method*location	10.849	1	24.116	.450	.504	NS

Error	2869.792	119
Total	85288.000	124
Corrected total	4554.968	123

a. R. Squared = 370 (Adjusted R. Squared = .349).

Table 6 shows that at 0.05 level significant, the calculated  $F(1,119)$  is .450 with P-value of .504 which is greater than 0.05. Therefore the null hypothesis is not rejected. Therefore the interaction effect of teaching methods and location on the students' achievement mean scores is not significant.

## Discussion of Findings

### **Achievement scores of students taught qualitative analysis using laboratory-demonstration and expository method of teaching.**

The findings of this study showed that laboratory-demonstration method significantly improved chemistry students' achievement in practical chemistry. The students in the laboratory-demonstration method had a higher means achievement scores as compared to those exposed to expository method. The reason behind the superiority of laboratory-demonstration method over expository could be attributed to the fact that laboratory-demonstration captures and sustains the students' attention during learning process. The finding agrees with the findings of Efe and Suleman (2016) which indicated that laboratory method enhance better performance in acid-based titration in practical better than either inquiry or lecture-demonstration method. The result of the study is in line with the findings of Achimugu, (2018) which indicated that there was a significant difference between the achievement of students exposed to enriched instructional strategies than those exposed to enriched traditional lecture strategy.

### **School location on students' achievement when taught using laboratory-demonstration method.**

Findings of this study showed that there is a significant difference between the mean achievement scores of urban and rural student taught qualitative analysis using laboratory-demonstration and expository method. This could be due to the fact that teachers are not willing to go and teach in rural schools where there are no basic amenities unlike their urban counterparts hence students prefer going to market especially on markets days to sell farm produce rather than attending classes. The findings agrees with the works of Alordiah, Akpadaka and Oviogbodu 2015 and Owoeye and Yara (2011) who reported that students in urban schools achieved significantly better than students in rural schools. The findings of this study is at variance with the findings of Agbaje and Awodun 2014; Ezeudu and Obi, (2013) which indicated that there was no significant difference in the academic achievement of students in urban and rural school.

### **Interaction effect of school location and instructional methods on students' achievement in qualitative analysis.**

The findings also showed that there is no significant interaction effect of school location and instructional methods on student achievement in qualitative analysis. This explains the fact that school location and instruction methods are not factors interacting

with student achievement in chemistry practical contents (qualitative analysis). The findings from this study is at variance with the findings of Agboghroma (2009) which indicated that there was a significant interaction effects in terms of instructional mode and school setting on students' knowledge of integrated science.

### Conclusion

The following conclusions were made based on the findings of this study: Laboratory-demonstration methods enhance students' achievement in practical chemistry content, students in urban schools had higher achievement as compared to their rural counterpart in practical chemistry content. The findings from the study revealed that there was a significant difference in the mean achievement scores of students taught chemistry practical content using laboratory-demonstration and expository method, and also there was a significant difference between the mean achievement scores of urban and rural student taught qualitative analysis using laboratory-demonstration and expository method. The study also showed no significant interaction effects of school location and instructional methods on students' achievement in chemistry practical content.

### Recommendations

Based on the findings of the study, the following recommendations were made:

1. Laboratory-demonstration methods should be used by chemistry teachers in teaching practical chemistry content in secondary schools, since it is activity-oriented. Laboratory-demonstration improves students' understanding of principles psychomotor skills critical thinking skills and interaction among students.
2. Stakeholders in education should organize workshops and seminars for chemistry teachers to acquire knowledge and mastery of utilizing laboratory-demonstration in practical chemistry content.
3. Curriculum developers should include laboratory-demonstration method in the curriculum of secondary school chemistry curriculum for the teaching of practical chemistry contents.
4. The federal and state governments should upgrade the infrastructures and equipment of chemistry laboratories in school. Since this could improve students' achievement in chemistry practical examinations.

### References

- Achimugu, L. (2016). Factors affecting the effective implementation of senior secondary education chemistry curriculum in Kogi State, Nigeria, *International Journal of Scientific and Research Publications*, 6(5), 561-566.
- Achimugu, L. (2018). Effectiveness of enriched demonstration and lecture instruction strategies on senior secondary school students' achievement in chemistry. *Journal of contemporary education research*, 2(1), 1-9.
- Agbaje, R. O. & Awodin, A. O. (2014). Impact of school location on academic achievement of science student in secondary school certificate examination. *International Journal of Scientific and Research Publications*, 4(9), 1-4.

- Agboghoroma, T. E. (2009). Interaction effects of instruction mode and school settings on students knowledge of integrated science. *International Journal of Scientific Research in Education*, 2(2), 67-75. Retrieved 28/10/2019 from <http://www.ij sre.com>.
- Alordiah, C.O; Akpadaka, G. & Oviogbodu, C.O. (2015). The influence of gender, school location and socio-economic status on students' academic achievement in mathematics. *Journal of Education and Practice*, 6(17), 130-136.
- Atordiah, C. O., Akpadaka, G. and Oviogbodu, C. O. (2015). The influence of gender, school location and socio-economic status on students' academy achievement in mathematics. *Journal of education and practice*, 6(17), 130-136.
- Dorgu, T. E. (2015). Different teaching methods: A panacea for effective curriculum implementation in the classroom. *International journal of secondary education*, 3(6), 77-78.
- Efe, M. O. & Suleiman L. (2016). Investigation into the effect of laboratory, guided-unguided discovery (inquiry) and lecture-demonstration teaching methods on senior secondary students achievement teaching method on senior secondary students' achievement in acid-base titration practical test in selected secondary schools in Giwa Local Government Area of Kaduna State, Nigeria. *Journal of Research and Method in Education*, 6(3), 20-26.
- Ezendu, F. O. & Obi, T. N. (2013) Effect of gender and location on students achievement in chemistry in secondary schools in Nsukka Local Government Area of Enugu State, Nigeria. *Research on humanities and social sciences*, 3(15), 50 -55.
- Ezendu, S. A. Gbendu, G. O & Umefekwem, J. E. (2014). School location versus academic achievement in geography: does reflective inquiry instructional technique has effect. *Indian Journal of Research*, 3(9), 209-216.
- Helmenstine, A. M. (2019). Definition of qualitative analysis in chemistry. Available at [Error! Hyperlink reference not valid...](#)retrieved 16/09/2019.
- Kokaia, K. (2015). Practical lessons of chemistry at secondary school. Proceeding of ISER 8th International Conference Istanbul, Turkey.
- Maheshwari, V. K. (2013). Expository teaching-a direct instructional strategy. Available at [www.vkmahewari.com/wp/?P=928...Retrieved](http://www.vkmahewari.com/wp/?P=928...Retrieved) 6/10/2019.
- Mangal, S. K. & Mangal Uma (2009). Essential of educational technology. New Delhi PH1 Learning Private Limited.

- Muhammed B.A. (2014). An evaluation of the efficacy of conceptual instructional method of teaching practical chemistry: The case of secondary schools in Zaria educational zone Kaduna State, Nigeria. *Africa Journal of Education and Technology*, 4(1), 12-18.
- Njoku, Z. C. (2010). Strategies for meeting school-based challenges in gender and STM education. Science Teachers Association of Nigeria. Gender and STM Education Series, 1(1), 12-18.
- Nnoli, J. N. (2015). Effective application of science, technology engineering and mathematics (STEM) pedagogy: implication for teachers' improvement and vision 20:20. A lead paper presented at the School of Science, College of Education Afaha Nsit, Akwa Ibom State 5th Annual National Conference
- Nworgu, B. G. (2015) Educational Research: Basic issues and methodology, Ibadan, Wisdom Publishers.
- Okorie, E. U. & Ugwuanyi, A. A. (2019). An investigation into the extent of use of practical activities in teaching chemistry in Nigeria schools. *Journal of CUDIMAC*, 6(1), 37-44.
- Owoeye, J. S. & Yara, P. O (2011). School location and academic achievement of secondary school in Ekiti State Nigeria. *Asian Social Science (ASS)*, 7(5), 170-173.
- Tersoo, A. (2018). Definition, advantages and disadvantages of demonstration method of teaching. Available at <https://www.legit.ng/1142120.definition...retrieved/30/9/2019>.
- Umana, K. (2018). Role of science education in national development. Available at <https://researchcyber.com/role-science...retrieved/27/09/2019>.
- WACE (2015) May/June Chief Examiners Report in Science Subjects.