

Effect of Teaching Methods on Unity School Students' Academic Achievement and Retention in Practical Chemistry in South-East Nigeria

*Dr. Eucharia N. Okorafor, Prof. Ursula N. Akanwa & Dr. Anthonia N. Ugwu

Department of Science Education, College of Education,
Michael Okpara University of Agriculture, Umudike.

* Corresponding Author: E. N. Okorafor Email: enokorafor@gmail.com

ABSTRACT

The study investigated the effects of guided discovery, demonstration and lecture teaching methods on South East Nigeria's Unity School Students' academic achievement and retention in practical chemistry. It was guided by two research questions and two hypotheses, and adopted a quasi-experimental non-equivalent, pre-test, post-test and delayed post-test design. Multistage sampling technique was used to select 226 Senior Secondary Two (SS2) chemistry students from two coeducational Unity Schools, out of 2135 chemistry students in the twelve Unity Schools in the South East, Nigeria 2020 academic session. The instruments for data collection were the Practical Achievement Test ($r=0.77$), Practical Chemistry Evaluation Exercises for qualitative analysis ($r=0.85$) and the Practical Chemistry Evaluation Exercises for volumetric analysis ($r=0.80$). The questions were adopted from the West African Examination Council's past questions and validated by three experts in Science Education Department of Michael Okpara University of Agriculture, Umudike. The reliability coefficients were established using Kuder Richardson, KR20 formula. Data collected were analyzed using Mean and Standard Deviation for research questions, while Analysis of Covariance was used to test the hypotheses at 0.05 level of significance. Findings revealed, among others, that the demonstration teaching method enhanced the students' academic achievement and retention most, followed by the guided discovery method while the lecture method had the least effect. It was therefore recommended among others that the class demonstration teaching method be used by chemistry teachers for teaching practical chemistry instead of the guided discovery method as recommended by the Curriculum in Nigeria. Furthermore, workshops should be organized regularly by the Federal and State Ministries of Education for chemistry teachers to acquaint them with modern process skills and instructional materials needed for effective lesson demonstrations during practical chemistry classes.

Keywords: Academic achievement, Retention, Practical chemistry, Guided discovery, Demonstration method.

Cite as:

Okorafor, E. N., Akanwa, U.N. & Ugwu, A.N. (2023). Effect of Teaching Methods on Unity School Students' Academic Achievement and Retention in Practical Chemistry. *Rivers State University Journal of Science and Mathematics Education*. 1(1). 34-43.

INTRODUCTION

Chemistry, being one of the science subjects which occupy a prominent place in the school curriculum is central to such various vocations as teaching services, home management, food processing, engineering, petroleum and petrochemical industries, health services, pharmaceutical and other manufacturing and extractive industries. It is a branch of science and therefore, a body of knowledge (a product), a way of conducting enquiry (a process) and an institutionalized pursuit of knowledge of matter (an enterprise). Chemistry deals with the structure, composition, properties and uses of matter, with even the principles governing how matter interacts to form new products. From this definition, one can easily appreciate why man's attempt to build and develop a modern and civilized society is usually predicated on the productive application and use of the knowledge skills of Chemistry. The importance of Chemistry in the development of any nation cannot be underrated, especially in

Nigeria, where the national income rests on petroleum and petrochemical industries, hence making it one of the basic science subjects needed for sustainable development. In spite of the importance and utility value of Chemistry to man, it has been observed that students perform poorly in both internal and external examinations yearly. The West Africa Examination Council (WAEC) Chief Examiner's report of 2014, 2017 and 2019 on Chemistry results and students' general performance attributed this general poor performance to the fact that students are weak in observation and identification of sample ions, lack recording and mathematical skills, have poor practical or experimental exposure and lack the ability to show understanding of such physical chemistry concepts as chemical reaction, ionic equations and redox reactions. A greater number of these areas of weaknesses pointed out here are in the practical section of chemistry and Abdulahi (2007) blames it on the lack of adequate exposure and experience in practical sessions.

Practical chemistry lends great weight to the student's spirit of experimentation, keen observation and such personality qualities as self-confidence, critical attitudes and perseverance. It also inspires students to pursue scientific studies and helps them to develop manipulative skills (Irinoye, Bamidele, Adetunji & Awodele, 2015). Practical work also helps the students to retain knowledge as Gbamanja, in Abdullahi (2007), sums up the importance of practicals in teaching with this statement: "What I hear, I forget, but what I do, I remember". This is because in practicals, the teacher, acting as a facilitator and co-discoverer with the students helps them to acquire practical experiences and process skills which are essential for learning and retaining knowledge of chemistry concepts and ideas.

There are varieties of methods for teaching chemistry, some of which are project, discussion, demonstration, lecture, concept-mapping and guided discovery methods. All these methods show various forms of teacher-student activities, though some are more activity-oriented than others. The guided discovery method has been recommended for teaching the contents of senior secondary school chemistry curriculum (FRN 2013). This method is activity-oriented for both students and their teacher. It applies abundantly the principle of effective questioning and appropriate directives by the teacher, high quantity and quality student activities like laboratory work and class discussions. Here the students participate actively in the teaching-learning situation and so actually 'do' chemistry, not just being taught about chemistry. According to Unogu (2015), guided discovery teaching method encourages students to take more active role in their learning process by answering series of questions or solving problems designed to introduce a general concept. It is learner-centered and according to Nbina (2013), is effective in teaching chemistry as it involves observation and hands-on-activities by the learner. It also has advantage of allowing the learners know how to use process skills to generate content information. As a powerful experimental and interactive instructional approach, it guides and motivates learners to explore information and concept provided by the teacher, in order to construct new ideas, identify new relationships and create new models of thinking and behaviour (Unogu, 2015). Hence the students proceed from concrete to abstract, from a specific example to the universal law or from particular to general. The demonstration teaching method, according to Unogu (2015), is based on simple, but sound principle that we learn by 'doing'. This method, according to Irinoye et al

(2015), is effective in teaching a subject like chemistry which can be observed and then performed. Here the teacher, either alone or with the help of an assistant, or even with few students, teaches through displays or exhibition while the students watch. Sometimes demonstrations can be performed by students, either individually or in small groups. It can help to motivate students to learn, save time and materials and also avoid breakages and laboratory accidents. As the teacher demonstrates the students observe carefully in order to draw meaningful inferences. Demonstration, according to Nbina (2013), can be practiced in three major ways such as classroom, group and individual demonstrations.

Class demonstration as posited by Unogu (2015) invokes much enthusiasm and interest among the learners, especially as the entire class members are actively involved in watching the teacher and asking questions on some points not clear to them. Although the demonstration method is described by many as teacher-centered, this class demonstration type acts as a bridge between teacher-centered and student-centered approaches. Group demonstration involves presentation to a section of the class members while the rest are engaged in another assignment not related to the topic. This results when a gap is created in maintaining a uniform demonstration due to individual differences in ability and aptitude. Individual demonstration, which as a result of differences in background, mechanical aptitude and general learning ability, irregularity in attendance and differences in tackling problems by students, involves teaching presentation to a student while others will be occupied with another lesson topic.

For the purpose of this study, the class demonstration method was adopted. The lecture method is adopted by most teachers in order to cover the bulky syllabus put together by the curriculum planners to prepare secondary school students for internal and external examinations in such subjects as chemistry. In this conventional teacher-centred method, knowledge is transferred mostly verbally to students who remain passive listeners, except when taking down notes. This method is very useful in covering a lot of ground within a short time and also enables the teacher to spend little or no money on teaching materials and other equipment. On the other hand, it does not cater for individual differences and gives no room for student-teacher interaction during lesson (Awotua-Efebo, 2007). For effective use of the lecture method, Ajama (2007) opines that the teacher should use ideas and words the students are familiar with, present the matter orderly, clearly and distinctly and also make use of illustrations.

The effects of these teaching methods can be measured by the academic achievement of the students after being subjected to the learning methods. Achievement in the teaching and learning process has to do with attainment of set objectives of instruction (Nbina, 2013). According to Unogu (2015) academic achievement refers to the accomplishment of academic goals, the education outcomes of students or the extent to which a student or a teacher has achieved the stated educational objectives. Fakotun and Eninyeju (2014) posit that student's academic achievement involves the general mental capability to reason and understand new materials profiting from past experience, which will be measured against the stated specific objectives. As an assessment strategy it gathers evidence about students' learning through their work on a performed task. Academic retention, on the other

hand, is the ability to so understand and store learned facts in memory as to remember or recall it for use on a later day (Ngwoke & Eze, 2010). Hence retention ability helps to assess how well the students learnt and understood the lesson and this is especially enhanced by student-centred and hands-on activity methods. Ibe (2004) worked on the effects of guided discovery and demonstration teaching methods on science process skill acquisition among Senior Secondary One (SS1) Biology students in Nsukka Local Government Area of Enugu State. Data collected from the three different groups through researchers-made Biology achievement test and analyzed using ANCOVA, he found out that those taught with the guided discovery method performed significantly better than those taught using demonstration method which in turn did better than the lecture control method group. On the other hand those taught with demonstration method showed a better retention ability. Nbina (2013) carried out a study on the relative effectiveness of guided discovery and demonstration teaching methods on achievement of 245 SS2 chemistry students in the different levels of scientific literacy in Port Harcourt Education Zone. His findings revealed that the guided discovery method was significantly superior to the demonstration method in enhancing cognitive achievement in chemistry for all levels of scientific literacy students. Similarly, Sanusi (2007) conducted a study to compare the relevance of guided discovery and demonstration methods of students' achievement and retention in physics in Senior Secondary Schools in Kano. The result from the data he collected from teacher-made tests and analyzed using ANOVA, showed the demonstration method as more effective and relevant than the guided discovery method. The demonstration method also showed a higher retention ability. On the other hand, Unogu (2015) investigated the effects of guided discovery and demonstration methods on academic performance and retention of financial accounting students in Federal Government Colleges in Kaduna State. Quasi experimental research design was used. Her findings showed that there were no significant differences in the mean achievement and retention scores of the students taught with guided discovery and those taught with demonstration methods, but that both of them were higher than those taught with the lecture (control) method.

Statement of the Problem

Students' poor performance in chemistry in Unity Schools has been attributed to the methods of teaching used by the teachers, especially the lecture method. Furthermore, according to the WAEC Chief Examiner's (WAEC, 2017) report, this consistent poor performance is majorly caused by the students' poor performance in practical chemistry. The study therefore examined the effects of guided discovery and class demonstration methods on the students' academic achievement and retention in practical chemistry.

Purpose of the Study

The study determined the effects of guided discovery and class demonstration teaching methods on students' academic achievement and retention in practical chemistry in Unity Schools in South East, Nigeria. It specifically sought to:

1. determine the effects of guided discovery, demonstration and lecture methods on Unity Schools students' academic achievement in practical chemistry;
2. determine the effects of guided discovery, demonstration and lecture methods on Unity Schools students' retention in practical chemistry.

Research Questions

The following research questions guided the study;

1. What are the mean achievement scores of Unity School students taught practical chemistry using the guided discovery, demonstrations and lecture methods?
2. What are the mean retention scores of Unity School students taught chemistry using the guided discovery, demonstration and lecture methods?

Hypotheses

The following null hypotheses formulated to guide the study were tested at 0.05 level of significance:

1. There is no significant difference in the mean achievement scores of Unity School students taught practical chemistry using guided discovery, demonstration and lecture methods.
2. There is no significant difference in the mean retention scores of Unity School students taught practical chemistry using guided discovery, demonstration and lecture methods.

METHODOLOGY

The study adopted a Quasi-experimental design which specially applied pre-test, post-test and delayed post-test non-equivalent-control group design, Quasi-experimental design is considered appropriate for the study as intact classes were used to avoid disruption of class lessons.

Two research question and two null hypothesis guided the study. Out of a total population of 2,135 Senior Secondary Two (SS2) Chemistry students in the twelve Unity Schools of the five states of the South East geopolitical zone of Nigeria in 2019, multistage sampling technique was used to first, select two states by simple random sampling. Then one Coeducational Unity School was selected from each of the two selected states by purposive sampling. Three intact classes were then selected from each of the two schools by simple random sampling giving a total sample size of 226 SS2. Chemistry students. Unity (Federal Government) Colleges were chosen for this study because, apart from having qualified professional teachers, they generally have better equipped laboratories than most of the State Government or private-owned secondary school. This is because the study involved practical chemistry, hence well-equipped laboratories were needed to rule out such interferences as poor infrastructural facilities and lab equipment. Moreover co-educational Unity Schools were chosen to ensure inclusiveness in the Unity Schools which already admit students, irrespective of tribe, creed and physical ability status.

The instrument used for data collection were the Practical Chemistry Achievement Test (PCAT) and Practical Chemistry Evaluation Exercise (PCEE qualitative, and PCEE quantitative), both of which were adopted from past WAEC questions and still validated by two chemistry education experts and one expert from statistics unit of Sciences Education Department of the Michael Okpara University of Agriculture, Umudike.

The reliability coefficient of the PCAT, which consisted of 25 multiple choice questions was found to be 0.77 using Kuder Richardson (KR_{20}). That of the PCEE (qualitative) with 18 dichotomously scored question items was also found using Kuder

Richardson (KR_{20}) to be 0.85 while for PCEE (quantitative), Cronbach Alpha was used for the 20 questions items and found to be 0.80.

In each of the two schools, three groups of students were used in their three different intact classes to take care of the three different teaching methods of guided discovery, demonstration and lecture. Their regular chemistry teachers served as Research Assistants to teach them so as to avoid Hawthorne's effect, novelty effect or any other error that might arise due to teacher difference, though the Researcher designed all the teaching instrument. And lesson notes. The pre-test was administered before the lesson, the post-test after the lesson while delayed post-test was administered three weeks after the lessons were on the identification of cations and anions in substances (qualitative analysis) and the calculation of molar and mass concentrations and percentage purity of substances using titrations (quantitative analysis).

The data collected were analyzed using Mean and Standard Deviation for the research questions while the hypotheses were tested using Analysis of Covariance (ANCOVA) at 0.05 level of significance.

RESULTS

Research Question 1

What are the mean achievement scores of Unity School students taught practical chemistry using the guided discovery, demonstrations and lecture methods?

Table 1

Mean Achievement Scores and Retention Gain of Students when taught practical chemistry using guided discovery, demonstration and lecture methods

Method	N	Pre-test mean	SD	Delayed post-test mean	SD	Mean Retention Gain
Guided Discovery	78	40.92	7.06	70.92	8.10	30.00
Demonstration	79	36.91	8.67	71.54	9.10	34.63
Lecture	69	39.43	9.35	58.49	8.24	19.06

From Table 1, it was found that learning took place with the three methods but the demonstration method with a mean achievement gain of 34.63 enhanced achievement better, followed by guided discovery method with a mean achievement gain of 30.00 while the lecture method, which served as the control, was the least with 19.06.

Research Question 2

What are the mean retention scores of Unity School Students taught practical chemistry with guided discovery, demonstration and lecture methods?

Table 2

Mean Retention Scores and Gain of Students Taught Practical Chemistry Using the Guided Discovery, Demonstration and Lecture Methods

Method	N	Pre-test mean	SD	Delayed post-test mean	SD	Mean Retention Gain
Guided Discovery	78	40.92	7.06	53.47	8.46	12.55
Demonstration	79	36.91	8.67	53.29	7.13	16.38
Lecture	69	39.43	9.35	45.22	8.63	5.79

Table 2 shows that the Demonstration method with mean retention gain of 16.38 had the highest retention, followed by the guided discovery method with 12.55 and lastly by the lecture method with 5.79.

Hypothesis 1

There is no significant difference in the mean achievement scores of Unity School students taught practical chemistry using the guided discovery, demonstration and lecture methods.

Table 3a

Analysis of Covariance (ANCOVA) on the mean achievement scores of students taught practical chemistry using guided discovery, demonstration and lecture methods

Source	Type III Sum of squares	df	Mean square	F	Sig
Corrected model	13,053.681 ^a	3	4351.227	88.969	.000
Intercept	18,710.874	1	1870.874	382.579	.00
Pre-test	5254.981	1	5254.981	107.448	.000
Method	9241.775	2	4620.887	94.483	.000
Error	10,857.398	222	48.901		
Total	1048904.000	226			
Corrected total		225			

R.square = .546 (Adjusted R-square = 540)

Table 3a shows that F-ratio (94.483) is significant at .000 for the methods at 2 and 225 degrees of freedom. Hence the null hypothesis is rejected, showing that there is significant difference in the mean achievement scores of the students taught with the three different methods.

To ascertain the direction of significance, a post-hoc analysis was carried out on the methods:

Table 3b

Post hoc Analysis - Scheffe Test on Achievement

(I) Method	(J) Method	Mean difference (I-J)	Std Error	Sig	95% Confidence level Lower bound Upper bound	
Guided Discovery	Demonstration	-62	1.357	.901	-3.96	2.72
Guided Discovery	Lecture	12.43*	1.405	.000	8.97	15.89
Demonstration	Guided discovery	62	1.357	.901	-2.72	3.96
Demonstration	Lecture	13.05*	1.401	.000	9.60	16.50
Lecture	Guided discovery	-12.43	1.045	.000	-15.89	-8.97
Lecture	Demonstration	-13.05*	1.401	.000	16.50	-16.50

* The mean difference is significant at 0.05level.

As shown in Table 3b, the mean difference between demonstration and guided discovery methods is 62.00, between demonstration and lecture is 13.05 and between guided discovery and lecture is 12.43. This shows that the demonstration method is the most effective in enhancing students' achievement in practical Chemistry, followed by the guided discovery method.

Hypothesis 2

There is no significant difference in the mean retention scores of Unity School students taught practical Chemistry using guided discovery, demonstration and lecture methods.

Table 4a

Analysis of Covariance (ANCOVA) on the Mean Retention Scores of Students taught practical Chemistry using guided discovery, demonstration and lecture Methods

Source	Type III Sum of squares	df	Mean square	F	Sig
Corrected model	9196.853 ^a	3	3065.618	76.630	.000
Intercept	6617.572	1	6617.572	171.893	.000
Pre-test	5994.932	1	5994.932	155.720	.000
Method	4223.155	2	2111.578	54.849	.000
Error	8546.56	222	38.498		
Total	603124	226			
Corrected total	17743.451	225			

a.R squared = .518 (adjusted R squared = .512)

To know the direction of the retention, post-Hoc analysis (Scheffe test) is carried out.

Table 4b

Post-Hoc (Scheffe test) on retention

(1) Method	(J)Methods	Mean differences I-J	Std Error	Sig	95% Confidence Level	
					Lower Bound	Upper Bound
Guided	Demonstration	-20.0	1.275	.988	-294	3.34
Discovery	Lecture	8.27*	1.319	.000	5.02	11.52
Demonstration	Guided	20	1.274	.988	-3.94	2.94
	discovery					
	Lecture	8.07*	1.317	.000	4.83	11.32
Lecture	Guided	-8.27	1.319	.000	-11.52	-5.02
	discovery					
	Demonstration	-8.07	1.315	.000	-11.32	-4.83

Table 4b shows that the difference between demonstration and lecture is 8.07, between guided discovery and lecture is 8.27, and that between demonstration and guided discovery is 20. Hence demonstration method is most effective in facilitating retention in practical chemistry followed by guided discovery and lecture method.

DISCUSSION OF FINDINGS

Findings from the study shows that Demonstration teaching method was more effective in enhancing achievement and retention among chemistry students in Unity schools in South-East Nigeria, than the Guided discovery and Lecture methods. The findings agree with that of Sanusi (2007) who investigated the compared the relative effectiveness of Guided discovery and demonstration methods on physics students' achievement and retention in senior secondary schools in Kano and reported that the Demonstration method was more effective. However, the findings from this study do not agree with those of Nbina (2013) and Ibe (2014) who both reported that students taught using Guided discovery performed better than those taught with Demonstration method. Nbina (2013) investigated the relative effectiveness of guided discovery and demonstration teaching methods in enhancing cognitive achievement in chemistry for all levels of scientific literacy in secondary schools in Port Harcourt. Ibe (2014) investigated the effects of guided discovery and demonstration teaching methods on science process skill acquisition among Senior Secondary One Biology students in Nsukka Local Government Area of Enugu State. The difference in the population used

for the studies and the content areas of focus may account for the disparity in the findings with the present study.

The superiority of the demonstration method over the guided discovery method in academic achievement might be attributed to the practical exposure of the students to the use of the apparatus and materials for the experiments, detailed demonstration and explanation of the instruments to meet the students' level of understanding, and the demonstration method that invokes much enthusiasm and interest among the learners as they were all actively involved in watching the teacher and asking questions for clarifications.

CONCLUSION:

Based on the findings from this study it was therefore concluded that Unity School students taught practical chemistry with the demonstration method showed the highest academic achievement and retention than the guided discovery method, while the lecture method which served as the control method showed the least.

RECOMMENDATION

Based on the findings of the study, the following recommendations have been made.

1. The class demonstration method should be used by chemistry teachers for teaching practical chemistry instead of the NERDC's insistence on the use of guided discovery method.
2. Workshops should be organized regularly by the Federal and State Ministry of Education for chemistry teachers to acquaint them with modern process skills and instructional materials needed for effective lesson demonstrations during practical chemistry classes.

REFERENCES

- Abah, R. K. (2006). Attitudes towards science: A quantitative synthesis. *Science Education* 106 (21), 547-567.
- Abdullahi, A. B. (2007). Improving the teaching methods of chemistry practical, *STAN chemistry panel National workshop proceedings* (3)120-123
- Awotua – Efebo, E.B. (2007). *Effective teaching principles and practices*. Paragraphics.
- Ajama, U.C. (2009). Analysis of methods and strategies for teaching and learning in business education: the place of ICT in Nigeria. *Association of Business Education of Nigeria (ABEN)* 1 (9), 110 – 122
- Fatokun, K.V. & Eniayeju, A.P. (2014). Enhancing students' achievement, interest and retention in Chemistry through integrated teaching (learning approach). *British Journal of Education, society 4 behavioural science* 4 (12) 1653 – 1663. www.sciencedomain.org
- Federal Republic of Nigeria. (2013). *National Policy on Education*. NERDC Press.
- Ibe, E. (2004). *Effects of guided discovery and demonstration on science process skills acquisition among Biology Secondary School students*. Unpublished M.Ed thesis, University of Nigeria, Nsukka.
- Irinonye, J. Bamidele, E.F. Adetunji, A.A.F. & Awodele, B.A. (2015) Relative effectiveness of guided inquiry and demonstration methods of students'

- performance in practical chemistry in Secondary Schools in Osun State. *Advances in Social Sciences Research Journal* 2 (2), 21 – 30
- Nbina, J.B. (2013). The relative effectiveness of guided discovery and demonstration teaching methods on achievement of chemistry students of different levels of scientific literacy. *Journal of research in Education and Society* 4 (1)
- Ngwoke, D.U & Eze, U. (2010). School learning theories and applications. Enugu: Immaculate Publications Ltd.
- Sanusi, I.G. (2007). *Relevance of guided discovery and demonstration methods on students; achievement in Physics in senior secondary schools in Kano State* Unpublished M.Ed. thesis, ABU, Zaria
- West African Examination Council (2014 – 2017, 2019). *Chief Examiner's report in the May/June Ordinary level SSCE*. WAEC.