Improving Senior Secondary School Students' Performance in Chemistry through Laboratory-Based Teaching Strategy

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ABSTRACT: *This study investigated 'Improving Senior Secondary School Students Performance in Chemistry through Laboratory-Based Teaching Strategy" The study adopted pretest-posttest quiazi-experimental design. The population for the study comprised of all the senior secondary school students in public senior secondary schools in Ado Local Government Area of Ekiti State, Nigeria. The sample consisted 90 SSS 2 students selected from four Junior - Secondary Schools in Ado Local Government in Ekiti State. Laboratory – Based Chemistry Teaching Strategy was employed by the teacher as treatment in the experimental group while the control group was left with the normal classroom teaching. The Instrument for the study was a self-developed tagged "Laboratory-Based Chemistry Achievement Test". This Instrument was validated and used to generate the data for the study. The data collected were analyzed using descriptive statistics of mean, standard deviation and graphs while the hypotheses generated were tested using inferential statistics of t-test and analysis of Covance (ANCOVA). Multiple classification analysis (MCA) was used to sort for the variable that contributed to differences among groups. The result of the study revealed that, the use of Laboratory-Based Teaching Strategy improves students Problem-Solving skills, rate of learning skills and methods Scientific enquiry. It was also revealed that, there was a positive improvement in the performance of students that were taught chemistry using Laboratory-Based Teaching Strategy compared with those in the conventional group. The results of the study also showed that, there was no gender difference in the performance of students taught with the Laboratory-Based teaching Strategy and those in the conventional group. Based on the findings, appropriate recommendations were made.*

Key Words: *Senior Secondary School, Student's performance, laboratory-based, teaching strategy*

Introduction

Science is a field of human endeavor which seeks to describe accurately the events and circumstances that exist or occur within man's natural environment here on earth. It yields laws which operates all over nature, and when recognized, reduced events and circumstances in nature to orderly and predictable occurrences. It is an intellectual activity and its products leads to the design of machines or to developments that enable mankind to predict, manage or control various aspects of nature (Ayegbusi, 2001). Science is a framework for gaining and organizing knowledge. Science is not simply a set of facts but also a plan of action i.e. a procedure for processing and understanding contains types of information. (Steven & Donald, 2008). Science is concerned with finding out about things in our environment. The knowledge we gathered about our environment constitutes the field of study called "science". The basic science includes biology, chemistry and physics.

Chemistry is the study of matter. It is the study of the properties and transformation of matter. Chemistry tries to explain complex nature of substances and how interactions between two or more substances can lead to the formation of new ones and the destruction of old ones. Modern science theories in chemistry are refined to reflect new data, established ideas are applied to new system, and connections are forged with other sciences to uncover new information. Arun(2009) submitted that, as the science of matter and its changes, chemistry is central to so many sciences-physical, biological, environmental, medical and engineering. An understanding of chemistry influences a person's attitudes about public policy issue, such as the environment, health care, and energy use, while at the same time explains everyday phenomena such as the spring in running shoe, the workings of a ballpoint pen, and the fragrance of a rose.

Chemistry helps in understanding the nature, components, properties, transformation and uses of matter around us. It plays a vital role in sustainable economic development and growth. The study of chemistry also feature prominently in the areas of oil and gas, agriculture, health, solid minerals, textile, cosmetics, ceramics, polymers, water supply and sanitations, crime detections, pulp and paper waste management, hence its inclusion in the national curriculum of Nigeria educational system. The author

stressed further that the teaching of chemistry in secondary schools has assumed increasing importance in recent years and this is probably due to the important roles it plays in the development of civilization and manner at which chemistry affects attitudes of people in their environment; chemistry helps in the understanding of our immediate and larger surroundings, it exposes us to the usefulness of matter as a matter of facts, every materials will make use of in our daily life is composed of chemistry: be it, cooking food, the cloths we wear, the vehicle we drive, our houses, nylon used at home or in the factories, rubber, plastics among others.

Chemistry subject gives a stage for creating logical proficiency and for building fundamental logical information and aptitudes for deep rooted learning in science and innovation in arrange to meet the challenges postured by these advancements . Chemistry is hand –on or students centered where students carry out investigation in research facility using materials and device to solve examination problem. It is basically a research facility action situated subject for no topic in chemistry can be considered as total without students having to demonstrate their abilities. Practical work appeared probably to be one of the utmost importance because it sometimes discontinues the monotonous teaching of theory with experimental activities of science ,but most schools need utilitarian research facilities. Chemistry teaching should be approached by the use of investigatory methods. Experiments ought to be performed and results are carefully analyzed to promote students understanding of concepts. The practical instructional method is a requirement for all teachers to ensure that students are permitted to experiment and develop imaginative thinking skills required in the education system (Ronoh, 2020). The author stressed further that, Practical exams are major contributing factors to poor performance in sciences since students are not exposed to them as required. From investigating, it was realized that few students truly felt that they would have performed way better in case they had been instructed periodically in practical in a great time. It is contented that students tend to get and review what they see more than what they listen to as a result of utilizing research facilities within the instructing of sciences but most schools need utilitarian research facilities .

In his own submission, Omiko (2015} viewed practical activity as a hand_ on experience which help students to cultivate a spirit of inquiry and gives them the skills and mindset to use scientific instruments and materials .Students must comprehend not only to conduct experiments but also understand why they are important for deeper grasps of ideals, relationship or processes in other to properly use Laboratory tools and equipment on a regular basis. Faruku (2019) posited that, laboratory activity as an integral part of learning chemistry provides students with a learning experience built up through students interaction with concrete materials is difficult in science secondary school students in Nigeria.

Practical activities refers to any form of science teaching and learning activities in which students working either individually or in small group involved in manipulating and observing real object and materials. It helps science students to develop the basic scientific skills, enhances the learning of scientific skills and the learning of scientific knowledge; give insight to scientific methods; stimulates students interest. Increases motivation to study sciences and develop scientific attitudes such as open mindedness, objectivity, honesty among others. Practical activities are key to effective teaching and learning of chemistry, this is because during practical activities students tends to acquire various scientific skills such as manipulation, observation, calculation, discovery, inquiry and problem solving among others (Famuwagun & Ojobola, 2021).However, there are lots of benefits that come from engaging students in laboratory activities.

Practical activities developed students' scientific process skills; it provides students the exposure to real experiments and observation and it also provides concrete learning to the learner. Laboratory instruction is considered essential because it provides training in observations; supplies detailed information and aroused students' interest. Queens (2008) posited that, practical activities can help the students to achieve the following goals; developing intuition based on understanding of concepts.

Applying concept learned in class to new situations.
Experiencing basic phenomena.
Developing experimental and data analysis; skills.
Learning to use scientific apparatus.
Learning to estimate error and recognize systematic errors; and
Developing reporting skills (both Oral and written)

Practical work allows students to have experience that are consistent with the goal of science literacy and have been used in many natural sciences discipline to teach students of many age spams in different cultural and classroom contexts (peter and Akem 2015).

The chemistry laboratory represents a wonderful opportunity for making the connections between the unseen microscopic world and the observable microscopic world in which we live. Laboratory experience provides opportunities for team building, inquiry-based learning, hand – on activities and exposure to standard equipment and technology (American chemical society, 2012).

Chemistry is a laboratory science and cannot be effectively learned without robust practical experiences. Indeed, the identifications, manipulations and general use of laboratory equipment are integral parts of the subject of chemistry. A secondary school laboratory should have equipment necessary to conduct meaningful demonstration and experiments. The physical laboratory environment must be accessible to all students; teachers must understand that students with limited strength or mobility can have a full laboratory experience with appropriate accommodation of a laboratory assistant. The observation of the researcher as a practicing chemistry teacher had revealed that most secondary schools in Nigeria has no chemistry laboratory, adequate teaching and learning are not taking place in chemistry class probably because majority of chemistry teachers still engage the students with traditional teaching methods and strategies which probably did not allows students involvement and active participations.

In addition to the facts that the laboratories are not available to aid the teaching and learning of chemistry in secondary schools in Nigeria, the interaction of the researcher with the students shows that many schools do not have the required laboratory facilities and some schools that claimed the procession of some facilities, such cannot go round the numbers of students that needs them in the classroom. As observed by the researcher ,topics and concepts like :Separation Techniques, Acid-base reactions, Titration processes, Electrolysis, Preparations and identifications of Gases, Redox Titrations and Rate of Chemical reactions among others had been considered difficult by most students and teachers and this is likely so because these concepts are being taught to students theoretically however they are practical based. The question now is: what is actually the place of practical activities in teaching and learning of chemistry? In preparation to answer this question, the researcher had decided to investigate the effects of practical based teaching on the improvement of students performance in chemistry.

Gender as a factor in science achievement generally and chemistry in particular has generated a lot of concerns for educators. According to Oniya (2023) , besides the effects of learning strategies adopted for the instructional processes of science subjects like Chemistry, other learners characteristics such as gender might also affects students performances in practical skills acquisition in chemistry especially in Nigeria where parents believe and invest in Education of the boys than the girls. The author stressed further that students exposure to experiential learning strategy resulted into a significant increase in academic performance in sciences and at the same time earns the learners the opportunity to acquire skills and knowledge through the first hand experiences, reflects upon those experiences and convert them to functional experiences in daily life situations. Aniodoh and Joy(2013) submitted that female students achieved better than their male counterpart in sciences.

However, Ezeudu (1995) in Aniodu & Joy(2021) concluded that sex has significant effect in favour of female in cognitive achievement. In addition, (Envangeline. Emmanuel and Claude, 2021) said that gender was suggested as another factor which influences the performance of students in chemistry as it was found that science subjects requires practices and revision and in many societies homes activities are reserved for girls which in turn hinder the girls from getting enough time for revision and this as well lead to poor performance on the part of girls than did boys. These authors stressed further those teaching methodologies which do not involve practical activities and real life applications as well as calculations could make chemistry more difficulty where more girls emphasized on these factors than girls.

Statement of the Problem

Observations has shown that, students offering chemistry lack basic knowledge and skills in the practical aspect of the subject, probably because there are no adequate laboratories and laboratory facilities in schools with which they ought to have been taught with and this ugly trend might had been considered to be responsible for inability of student to carry out the required practical activities and which in turn is probably the reason for the poor academic achievement of student in chemistry. It is upon this consideration that the researcher had deemed it necessary to investigate the impact of practical-Based teaching strategy on the performance of students in chemistry.

The main purpose of this study was to examine the effects of Laboratory-Based teaching strategy on the performance of students in chemistry. The study specifically examines the effect of Laboratory-based activities on the performances of male and female students offering chemistry.

Research Question

The following research questions were formulated to guide the study

Does the use of practical-Based teaching strategy improve students' Performance in chemistry?

Research Hypotheses

1. There is no significant difference in the performance mean scores of students taught chemistry using Laboratory- based method and those taught with conventional method.
2. There is no significant difference in the performance mean scores of male and female students taught chemistry using Laboratory- based method and those taught with conventional methods.

Methodology

The study adopted the pretest, posttest control group quasi-experimental design.

The paradigm for the design is as shown below:

E:	OI	X	O2
C:	O3	X	O4

Where

E	-	Experimental group
C	-	Control group
O1O3	-	Observations(pretest)
O2O4	-	Observations(post-test)

The population for the study compromised of all the senior secondary school two (SSII) students in Ado local Government area of Ekiti state, Nigeria.

The sample consisted 90 senior secondary school two (SSII) students offering chemistry which were purposely selected from three senior secondary schools that has functional chemistry laboratory in Ado-Ekiti local government area of Ekiti state.

The experimental group was exposed to Laboratory- Based method of teaching chemistry while the conventional group was allowed to continue with their normal classroom work. Intact class was used in both groups.

The instrument used for data collection in the course of this research work was Laboratory-Based chemistry Achievement Test (LBCAT). The instrument (LBCAT) consisted of 24 option multiple objective questions covering acid-based reactions as reflected in the national curriculum of senior secondary schools in Nigeria.

Face and content validity of the instrument were ensured by giving the instrument to two experts in the field of science education and as well two experts in the department of test measurement and evaluation. Their comments and suggestions were affected and the corrected version was used for data collection.

The reliability of the instrument was determined via test retest method. This was done by administering the instrument (LBCAT) twice on 20 students who were not originally part of the sample within an interval of two weeks. The scores obtained from the two sets of administration were collated and analyzed using Pearson's Product Moment Correlation Analysis. Reliability index of 0.71 was obtained at 0.05level of significance. This value was considered high enough to be used for the study.

The data collected were collated and analyzed using descriptive statistics of mean, standard deviation and graph while the hypothesis were tested using inferential statistics of t-test, and analysis of co-variance (ANCOVA) while multiple classification analysis (MCA) was used to identify the variable that contributed to the difference among the groups

Results

Descriptive Analysis

Question 1: Does the use of practical-based teaching improve Students' performance in chemistry?

Table 1: Mean scores of students' academic performance by treatment

Groups	N	Pretest		Posttest		Mean Difference
		Mean	SD	Mean	SD	
Experimental	45	4.00	3.86	13.69	3.27	9.69
Conventional	45	3.49	3.88	5.40	4.04	1.91

Table 1 and Figure i show that Chemistry students exposed to laboratory-based teaching had mean score of 4.00 while those in the conventional group was 3.49 prior to treatment. On exposure to treatment, students in the laboratory-Based group had the higher mean score of 13.69 those in the conventional group with a post test mean score of 5.40. This implies that the use of laboratory-Based teaching improves students' Performance in chemistry and at the same time enhanced the rate of learning skills and also help the students to learn scientific methods for scientific enquiry. The performances of students on exposure to laboratory-based instructional strategy and conventional method in Chemistry before and after treatment is further depicted in Figure i.

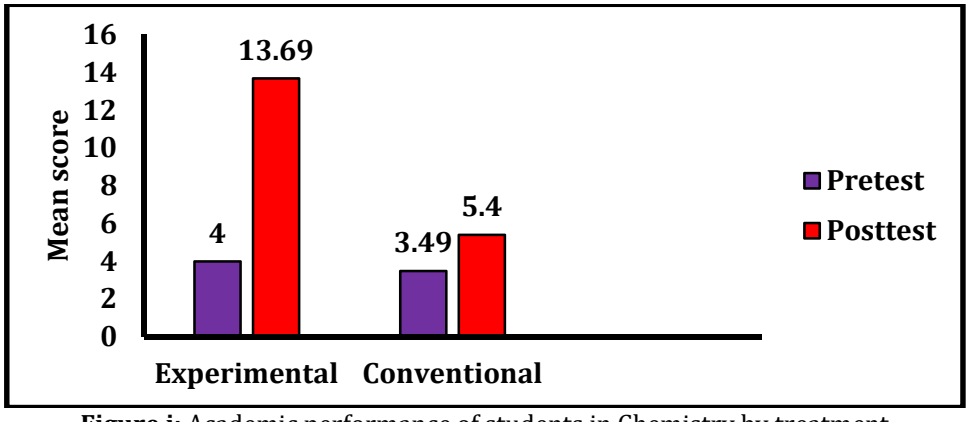

Figure i: Academic performance of students in Chemistry by treatment

Testing of Hypotheses

Hypothesis 1

There is no significant difference in the performance of secondary school students exposed to chemistry laboratory-based Teaching Strategy and those that are not.

Table 2: ANCOVA summary of students' academic performance in Chemistry by treatment

Source	SS	df	MS	F	Sig.	Partial Eta^2
Corrected Model	1757.680	2	878.840	78.448	.000	.643
Covariate (Pretest)	211.802	1	211.802	18.906	.000	.179
Group	1463.845	1	1463.845	130.668	.000	.600
Error	974.642	87	11.203			
Total	10931.000	90				
Corrected Total	2732.322	89				

*$p<0.05$

Table 2 shows that the computed F-value (130.668) at degrees of freedom 1 and 87 obtained for the groups with a p-value< 0.05 was significant at 0.05 level. The null hypothesis is rejected; implying that there is significant difference in the performance of secondary school students exposed to chemistry laboratory exercises and those that are not. The treatment accounted for about 60% (Eta^2 = 0.60) of the observed variance in the academic performance of secondary student taught chemistry. The mean difference among

the estimated marginal means of the groups, after correcting for the other effects in the model are presented in Tables 3 and 4.

Table 3: Estimated marginal mean scores by treatment

Group	N	Mean	SD	Estimated Marginal Mean
Experimental	**45**	**13.69**	**3.27**	**13.59**
Control	**45**	**5.40**	**4.04**	**5.50**

Table 3 shows that students taught with laboratory-based instructional strategy had higher estimated marginal mean of 13.59 than their counterparts in the control group (5.50).

Table 4: Adjustment for multiple comparisons of estimated marginal means

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval for Difference	
					Lower Bound	Upper Bound
Experimental	Control	8.084*	.707	.000	6.678	9.490
Control	Experimental	-8.084*	.707	.000	-9.490	-6.678

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

Table 4 shows that the academic performance of secondary student taught chemistry using laboratory-based instructional strategy differs from those exposed to conventional method of teaching at 0.05 level of significance.

Hypothesis 2: There is no significant difference in the performance of male and female students exposed to Laboratory-based Teaching Strategy and those exposed to the conventional method of teaching chemistry.

Table 5: ANCOVA showing the performance of students in the laboratory-based group by gender

Source	SS	df	MS	F	Sig.	Partial Eta^2
Corrected Model	21.355[a]	2	10.677	1.000	.376	.045
Covariate (Pretest)	.500	1	.500	.047	.830	.001
Gender	20.073	1	20.073	1.881	.178	.043
Error	448.290	42	10.674			
Total	8902.000	45				
Corrected Total	469.644	44				

p>0.05

Table 5 shows that the computed F-value (1.881) at degrees of freedom 1 and 42 obtained for the groups with a p-value > 0.05 was not significant at 0.05 level. The null hypothesis is not rejected; implying that there is no significant difference in the performance of male and female students exposed to laboratory teaching. Gender accounted for less than 4.3% (Eta^2 = 0.043) of the observed variance in the academic performance of secondary student taught chemistry using laboratory-based instructional strategy.

Discussion

The studies showed that the use of laboratory-Based teaching improves students' performance in chemistry and enhanced the rate of learning skills as well as help the students to learn scientific methods for scientific enquiry. The finding is in agreement with the views of Evrim(2016) that Laboratory experiments has unquestionable importance in chemistry education since it helps in developing understanding related to the scientific content, problem solving skills; science processes skills and the nature of science which are the key goals of chemistry education. The finding however negates the findings of Salami (1992) and Adeyegbe

(1993) which in their separate studies concluded that, despite several attempts through the use of carefully planned instructional strategies and models to improve the status of chemistry teaching and learning, students' performance in chemistry has remained persistently poor at the Senior Secondary Certificate Examination (SSCE).

It was also found out in the study that there was significant difference in the performance of secondary school students exposed to chemistry laboratory exercises and those that are not. The finding is quite close to the outcome of the study of Akinbobola (2011), which discovered that in a well-designed laboratory, students interact closely with peers and teachers, so learning can be assessed, enhanced and monitored effectively. Also the finding was in agreement with the finding of Dillon (2008) who posited that some of the most frequently stated reasons of doing experiment in chemistry are to encourage precise observation and explanation, to make situation more real, to stimulate and maintain attentiveness, to promote a logical and reasoning technique of understanding, improve student's problem understanding skill and find the solution, to develop a critical thinking.

The study further showed that there was no significant difference in the performance of male and female students exposed to laboratory teaching. This implies that male and female Chemistry students exposed to laboratory-Based instructional strategy do not differ significantly in their performance in the subject. This finding negates the submission of Aniodoh & Joy(2013) who claimed that female students achieved better than their male counterpart in sciences. Also the finding negates the submission of (Envangeline. Emmanuel and Claude, 2021) who concluded that gender was suggested as another factor which influences the performance of students in chemistry as it was found that science subjects requires practices and revision and in many societies homes activities are reserved for girls which in turn hinder the girls from getting enough time for revision and this as well lead to poor performance on the part of girls than did boys.

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