Novelty Journals
ISSN 2394-9686
International Journal of Novel Research in Education and Learning
Vol. 6, Issue 1, pp: (56-64), Month: January - February 2019, Available at: www.noveltyjournals.com

EFFECT OF PRIOR EXPOSURE TO LABORATORY ACTIVITY ON RETENTION ABILITY AND ACADEMIC ACHIEVEMENT AMONG CHEMISTRY STUDENTS IN SECONDARY SCHOOLS

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Abstract: **This work investigates the effect of prior exposure to laboratory apparatus on the academic performance and retention ability among secondary school chemistry students. Some of the research questions formulated to guide the study include; what is the difference in the mean academic performance of senior secondary school chemistry students' prior exposure to laboratory apparatus in comparism to those not exposed? To answer these questions, some hypotheses were developed. There is no significant difference in the mean academic performance of chemistry students' prior exposure to laboratory apparatus and those not exposed. Various literatures were reviewed by the researcher. The study is a pre-test, post-test, quasi experimental and control group design. A total of sixty (60) students forms the sample of the study. Three instruments, namely; Chemistry Achievement Test (CAT), Science Process Skills, Achievement Test (SPSAT) and Chemistry Retention Test (CRT) were used for data collection. The CAT was develop by the researcher and validated by experts in chemistry education. The data was analyzed using t-test and the results from testing the hypotheses above were both found to be 0.000 at 0.05 level of significance. This revealed that the experimental group taught chemistry using prior exposure to laboratory apparatus strategy performed significantly better and with high retention ability than the control group taught using the traditional lecture method. The study recommends among others that chemistry teachers should be encouraged to use prior exposure to laboratory apparatus strategy in teaching of chemistry.**

Keywords: **laboratory apparatus, chemistry students, hypotheses, researcher.**

1. INTRODUCTION

Many colleges speak of the importance of increasing student retention. Indeed, quite a few invest substantial resources in programs designed to achieve that end. Some institutions even hire consultants who promise a proven formula for successful retention. But for all that effort, most institutions do not take student retention seriously. They treat student retention, like so many other issues, as one more item to add to the list of issues to be addressed by the institution (Engstrom and Tinto, 2001).

Chemistry is one of the three main branches of pure sciences that deals with composition, properties and use of matter (Wikipedia). The objectives of teaching chemistry in our secondary schools as identified by Bajah, Teebo, Onwu and Obikwere (1999) include amongst others;

i. To provide students with the basic knowledge in chemistry concept and principles through efficient selection of content and sequence.

ii. To provide students with adequate foundation for post-secondary chemistry course.

Current research work has shown that teachers mode of presentation of various science concept affect performance (Akinsete, 2007). Researches in psychology and education such as developmental psychology, cognitive and social psychology indicated new insight into teaching chemistry and understanding about the learning process acquisition of knowledge and skills in various subject areas.

The basic nature of the learner in school includes:

i. A learner is active in his/her environment and learns through his/her activities in the environment.

ii. A learner is curious and explorative in the environment and enjoys exploring his/her environment.

iii. The experiences, observation and activities of the learner in the social and physical environment form the background of which new learning can take place (Njoku, 2007).

The teaching and learning of chemistry demand laboratory activities i.e. prior exposure to laboratory apparatus in an environment that is inspiring, encouraging and challenging to learners to enable them acquire and utilize the necessary science process skills in the subject. Such process skills which are either generic or integrated which include observing, classifying, measuring, reporting, analyzing, communicating, using numbers and recognizing spatial relations. Others are inferring, predicting, defining operationally, hypothesizing, identifying and controlling variables, experimenting, interpreting data and using models. Science process skills are fundamental to science, allowing every category of learner to conduct investigations and reach conclusions.

A good laboratory environment, according to Aladejana and Aderibigbe (2007), promotes curiosity in students, reward creativity, encourages the spirit of healthy questioning, avoids dogmatism and also promotes meaningful understanding. In line with the above, Metzenberg (2005) suggested that skills need to develop necessary social and learning skills so that they can collaborate effectively, share, debate, defend their ideas and be able to work in groups. In this way, they can interact and help one another to acquire process skills needed in learning especially the sciences like chemistry.

Science process skills are learnt and acquired among learners in environments that encourage thinking and eagerness to work and find out new things. In schools where chemistry is compulsory for students to offer as a core science subject, the class is made of different categories of learners like males and females, science oriented and non-science oriented and high and low achievers. Such a class demands that lessons should be conducted in an environment that can elicit from the learners, the desire to work with materials, manipulate equipment and carryout experiments. However, all children who come to school can learn but some are slower at learning than others. In a normal heterogeneous class, students grouped as lowest in achievement performance in any subject constitute the slow learners and those highest in achievement performance constitute the fast learners that subject (Ekpo, 1991). Inyang and Ekpeyong (2000) noted that one of the issues often debated in educational circles is that of grouping secondary school students by ability. Sometime teachers group their students according to their scores in a given test or examination by fixing a certain mark as the grading point above which are the high achievers and below which are the low achievers. Low achievers in one subject may be high achievers in another. It is the duty of the teacher to mark a lesson as interesting and as involving to the students as possible by creating a science learning environment. In chemistry lessons, the teacher is expected to provide working materials and equipment for the students to work with. The students should be given adequate opportunity to work with the materials and equipment under the teacher's guidance. In this way, some low achievers may become high achievers in subsequent test or tasks from retained knowledge gained from active participation in the lessons. An encouraging learning environment can also build in the learners as free, critical, innovative and productive thrilling which is vital to a developing continent like Africa.

Theoretical Framework:

Ausubel's (1965) on prior knowledge and learning of science has advanced as cognitive theory of learning that is specifically intended to deal almost exclusively with what he calls meaningful verbal learning. According to Ausubel's (1965) "A concept requires real meaning when it is equivalent to an idea that is already present in the mind." This means that meaning depends on the existence of some equivalent representation in the mind.

In other words for an external stimulus concept to have meaning there must be something in the learners consciousness to which it can be equated. This "something" is labeled cognitive structure. So also the acquisition of process skills on performance and retention in chemistry will be meaningful for an individual student when he/she has been prior exposed to laboratory apparatus.

Prior exposure to laboratory apparatus is necessary for developing students understanding of chemistry concepts and explanations. Students need to have experiences on the activity in the world and in the light of a theory or model, feeling the outcomes, so as to come to the understanding of the theoretical presentations in order to help explain it and predict the behavior. This will improve students' performance and retention ability in the subject and thereby reduce the rate of failures.

Statement of the Problem:

Recent years have witnessed numerous discoveries and invention through experimentation, which is a vital element of science basics. Experimentation can work effectively only through utilizing the laboratory in teaching process (Zaytoum, 1996).

These objectives cannot be properly attained without effective rise of the science laboratory and experimentation. This attainment can be realized through the teachers' readiness to effectively use the laboratory in teaching science. But, failure to achieve the objectives of science teaching is the upper basic stage is mainly due to the fact that lots of teachers evade laboratory work and science activities though they can easily use the school laboratory (Zaytoun, 1987). Researchers like Akubuilo (2004) for example have shown that when learners are actively involved in the process of learning, they are able to retain what they have learnt.

Vygotsky's theory of scaffolding and its zone of proximal development emphasize the role of active involvement in learning in relation to learner's environment. This implies that the environment in which learning is taking place should be well-equipped challenging but also encouraging for effective learning to take place. Despite different methods and strategies adopted by teachers to assist students in the process of teaching chemistry, poor performance of students in the subject is still recorded at the West African School Certificate Examination (WAEC, 2012).

Active involvement of learners could add an impetus to the much needed paradigm shift from a producing continent of raw materials for western factories to a manufacturing one of finished products.

Therefore, the study seeks to elucidate the impact of students' prior exposure to laboratory apparatus on the acquisition of process skills, the achievement and retention ability among secondary school students.

The objectives of the study were to:

i. ascertain the impact of prior exposure to laboratory apparatus on the academic achievement among secondary school chemistry students.

ii. investigate the impact of prior exposure to laboratory apparatus on secondary school chemistry students' retention ability.

Research Questions:

The following research question were generated for the study:

i. What is the difference in the mean academic achievement of senior secondary school chemistry students' prior exposure to laboratory apparatus in comparison to those not so exposed?

ii. What is the difference in the retention ability of senior secondary school chemistry students who had prior exposure to laboratory apparatus and those not so exposed?

Research Hypothesis:

Based on the research questions, the following hypotheses stated in the null form were formulated and tested at $P \leq 0.05$ level of significance.

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i. There is no significant difference in the mean academic achievement of chemistry students' prior exposure to the laboratory apparatus and those not exposed.

ii. There is no significant difference between the retention ability of chemistry students' prior exposure to laboratory apparatus and those not so exposed.

2. METHODOLOGY

Research Design:

The study adopted quasi experimental design, using a pretest, post-test and post-post-test, experimental group and control group design. The experimental group and control group were pre-tested using CAT and SPSAT to determine their group equivalence at the start of the experiment and to test that there is no significant differences between the two groups ability level before the treatment. This was to enable the researcher measure student's level of understanding of the use of laboratory apparatus prior to teaching of chemistry concepts and to see their acquisition of process skills level before and after the administration. Later a post-post-test treatment was given two weeks after the post-test to measure the retention ability of the experimental and control groups.

Population of the Study:

The population of the study comprised of SS1 science students in five (5) selected public senior secondary schools that offered chemistry in Sabon Gari local government educational area of Kaduna State. The population comprised of single sex and coeducational schools. There were one (1) male school, two (2) female schools and two (2) coeducational schools in the population.

Table 1: Enrollment in Local Colleges, 2005

NAME OF SCHOOL	SEX		TOTAL NUMBER OF STUDENTS
	M	F	
GSS Chindit (boys)	350	-	350
GSS DogonBauchi (girls)	-	350	350
GSS Chindit (girls)	-	235	235
GSS Aminu (coeducation)	1198	98	296
GSS Muchiaa (coeducation)	157	99	256
Total			**1487**

(Source: Ministry of Education, Kaduna State 2015)

Sample and Sampling Techniques:

Sixty students served as sample for the study from two of the public schools (GSS Aminu and GSS Muchia) within SabonGari local government educational area of Kaduna State. These schools were randomly selected and grouped into experimental (GSS Aminu) and control (GSS Muchia) groups respectively. Thirty students from each school sample of SS1 chemistry students were selected by random sampling. This technique was used because, according to Freankle and Wallen (2000), it ensures that all key characteristics of individual in the population were included in the same population and it increased the likelihood of the sample being a true representation of the population.

Instrument for Data Collection:

Three instruments were used for the study. This was the Chemistry Achievement Test (CAT), Science Process Skills Achievement Test (SPSAT) and Chemistry Retention Test (CRT) respectively. A multiple choice achievement test in science (chemistry) was developed by the researcher and standardized by lecturers in chemistry department for the CAT. These tests were developed in accordance with the curriculum objectives. It comprised of 20 multiple choice items. The face and content validity of the test was determined through expert opinion. The instruments were validated by specialists in chemistry and science education. SPSAT was also developed to test the students' science process skills.

Validity of the Test

The tests were validated by three lecturers in chemistry department with at least master degree. The instrument was subjected to this process for the purpose of standardization. The validators critically examined and assessed all the items of the instrument which was aimed at;

(a) Determining the appropriations of the instruments with reference to the purpose of the study.

(b) Grammatical structure of the questions, the clarity and the content area. All the corrections and suggestions pointed out were effected to enhance the validation of the instruments.

(c) Determining whether the test item test what they were designed to test.

(d) Determining whether the questions match the ability of the students.

(e) Determining whether the questions are clear, precise and free from ambiguity.

Pilot Testing:

A pilot study was conducted on a small group to determine the effectiveness of the instrument. This was preceded by the pre-test given to the students from two schools (divided into experimental and control groups). After the treatment, the post-test was administered. Two weeks after the post-test was administered, the post-post-test was administered which was in line with Tuckman's recommendations of the use of two weeks interval for the test-retest procedure. The instruments consist of twenty (20) multiple choice questions with clear instructions on how to answer the questions. The reliability coefficient of CAT was when determined using pearson product moment coefficient statistic and r=0.79 and that of the SPSAT recorded was found to be 0.77.

3. RESULTS

The results were presented below according to the sequence of the research questions and hypotheses which guided the study. The research has three research questions.

Pre-Test Analysis of Schools Results:

Below are the t-test analyses of the pre-test scores of experimental group (students who had prior exposure to laboratory apparatus) for each of the schools before the commencement of the treatment to ensure that all the groups were of equal academic strength.

Table 2

Group	N	Mean	S.D	S.E	df	t-value	p-value
Experimental	30	7.13	1.907	0.348	58	-0.061	0.952
Control	30	7.17	2.379	0.434			

*significant level ($p \leq 0.05$)

From the table 2, the p-value of the CAT was found to be 0.952, which is above the 0.05 level of significance. This shows that the two groups (experimental and control groups) had equal academic strength in their knowledge of chemistry before the commencement of the treatment.

Table 3: t-test Analyses of Pre-Test (SPSAT) scores of experimental and control groups

Group	N	Mean	S.D	S.E	df	t-value	p-value
Experimental	30	5.08	2.665	0.487	58	-0.240	0.981
Control	30	5.10	2.440	0.446			

*significant level ($p \leq 0.05$)

From the table 3, the p-value of the SPSAT was found to be 0.981, which is above the 0.05 level of significance. This shows that the two groups (experimental and control groups) had equal academic strength in science process skills before the commencement of the treatment.

Testing Hypotheses:

Hypothesis H_{01}

The first hypothesis in this study states that:

H_{01}: There is no significant different in the mean academic achievement of chemistry students' prior exposure to laboratory apparatus and those not exposed.

The post test data of the experimental and control groups were generated Chemistry Achievement Test (CAT) and were subjected to t-test statistical analysis to determine if there is any significant different in academic achievement of students in the experimental and their counterparts in the control groups. Summary of the analysis is presented in Table 4.

Table 4: Summary of the Mean Scores, standard deviation and mean differences of experimental and control group's post-test (CAT) scores

Group	N	Mean	S.D	Mdf
Experimental	30	13.400	2.608	2.000
Control	30	11.400	1.993	

*significant level (p≤0.05)

From Table 4, it shows that there is difference in in the academic strength of those students exposed to laboratory apparatus and those not so exposed.

To test if there is a significant difference in their mean score, the data is subjected to to-test statistical analysis which is summarized in table 5 below.

Table 5: t-test Analyses of Post-Test (CAT) scores of experimental and control groups

Group	N	Mean	S.D	S.E	df	t-value	p-value
Experimental	30	13.400	2.608	0.476	58	4.033	0.000
Control	30	11.400	1.993	0364			

*significant level (p≤0.05)

The p-value = 0.000, this value is less than 0.05 at 5% alpha level with df = 58. This means that there is a significant difference between the CAT mean scores of the experimental and the control groups in favour of the experimental group. Thus the null hypothesis is rejected. This implies that the experimental group taught chemistry using prior exposure to laboratory apparatus achieved significantly higher than the control group taught same concepts using lecture method. This answered the first research question that is "there is a significant difference in the mean scores of the students' academic achievement taught chemistry concepts using prior exposure to laboratory apparatus and those taught the same concept using traditional lecture method.

Hypothesis H_{02}

H_{02}: There is no significant difference between the retention ability of chemistry students' prior exposure to laboratory apparatus and those not exposed

The post-post-test data of the experimental and control groups were generated via Chemistry Retention Test (CRT) and were subjected to t-test statistical analysis to determine if there is any significant different in their academic achievement and acquisition of science process skills by students in the experimental and their counterparts in the control groups. Summary of the analysis is presented in table 6 –9 below.

Table 6: Summary of the Mean Scores, standard deviation and mean difference of experimental and control group's post-post-test (CRT on academic achievement) scores

Group	N	Mean	S.D	Mdf
Experimental	30	14.800	2.511	
				2.000
Control	30	12.800	1.990	

From Table 6, it shows that there is difference in the mean score of those students exposed to laboratory apparatus and those not so exposed.

To test if there is a significant difference in their mean score, the data is subjected to t-test statistical analysis which is summarized in the table 9 below.

Table 7: t-test Analysis of Post-post-test (CRT on academic achievement) scores of experimental and control group

Group	N	Mean	S.D	S.E	df	t-value	p-value
Experimental	30	14.800	2.511	0.458			
					58	4.280	0.010
Control	30	12.800	1.990	0.363			

*significant level ($p \leq 0.05$)

The p-value = 010, this value is less than 0.05 at 5% alpha level with df = 58. This means that there is a significant difference between the CAT mean scores of the experimental and the control groups in favour of the experimental group. Thus the null hypothesis is rejected. This implies that the experimental group taught chemistry using prior exposure to laboratory apparatus retained more of the concepts taught than the control group taught same concepts using lecture method.

Table 8: Summary of the Mean Scores, standard deviation and mean difference of experimental and control group's post-post-test (CRT on science process skills) scores

Group	N	Mean	S.D	Mdf
Experimental	30	15.530	1.995	
				2.930
Control	30	12.600	2.608	

From Table 8, it shows that there is a difference in the mean score strength of those students exposed to laboratory apparatus and those not so exposed.

To test if there is a significant difference in their mean score, the data is subjected to t-test statistical analysis which is summarized in table below.

Table 9: t-test Analyses of Post-post-test (CRT on science process skills) scores of experimental and control group

Group	N	Mean	S.D	S.E	df	t-value	p-value
Experimental	30	15.530	1.995	0.364			
					58	6.246	0.000
Control	30	12.600	2.608	0.476			

*significant level ($p \leq 0.05$)

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The p-value = 0.000, this value is less than 0.05 at 5% alpha level with df = 58. This means that there is a significant difference between the SPSAT mean scores of the experimental and the control groups in favour of the experimental group. Thus the null hypothesis is rejected. This implies that the experimental group taught chemistry using prior exposure to laboratory apparatus retained better the science process skills acquired than the control group taught same concepts using lecture method.

Therefore it can be concluded that those students taught using prior exposure to laboratory apparatus retain better in knowledge and process skills than those taught using conventional traditional methods.

4. DISCUSSION OF RESULTS

From the analysis of data, it is empirically confirmed that experimental/laboratory method of instruction significantly improved students' performance. This finding is in line with that of Campbell (1966) who reported that practical exploration and experimentation leads to a constant interplay between students and teachers, which leads to effective learning. Similarly Wasagu (2013) observed that the lecture method would be declared obsolete and relegated like all old models to a resting place in a science museum.

Other facts that emerged from the data were that; the method encourages interaction between teachers and students on one hand and between students and students on the other hand. This observation is a reflection of Eze (2002) who observed that the teacher should train the students to recognize problems, since individual thinking, though not easy, should be encouraged because it fostered interaction and that the science class becomes alive as students get involved and pursue answers to their own problems.

The study is in line with Tamir (1976) who concluded that laboratory teaching method has advantage over the other teaching methods in the amount of information it exposes students to retention ability. Also findings from the study revealed that students taught by experimental method retain the learnt concepts more than those taught using traditional lecture method. The statistically significant difference between the two means suggests laboratory method of teaching led to effective learning outcome than the traditional lecture method. This finding is also in agreement with Bichi (2002) who compare the effectiveness of problem solving strategy and that of traditional lecture method on students' retention level of concepts and found that problem solving teaching strategy enabled the learners to have effective learning and higher retention level than the traditional lecture method.

According Leonard, Dfrense and Mester, (1998), laboratory exposure produce significantly greater educational gains than traditional methods and appeared to work equally well for college students of all ability levels, not just the very academically talented, but also for the low performing among them who appear to be the majority of the students. This is in line with this work as the pre-test and post-test score comparison shows that difference which explains that exposure to laboratory apparatus level weaker students achieve better. Akubuilo (2004) further stressed that when learners are actively involved in the process of learning, they are able to achieve better and retain what they have learnt.

According to the findings of Aladejana and Aderibigbe (2007), laboratory method promotes curiosity in students, reward creativity, encourages the spirit of healthy questioning and, avoid dogmatism and promotes meaningful understanding of concepts and their eventual recalling. Akubuilo (2004) opines that experimental method elicits adequate students' participation and promotes understanding and retention of concepts. Experimental method concretizes and elucidates difficult and abstract concepts thereby reducing students' problem of comprehension and application of concepts in problems solving situations (Njoku, 2004).

Morgil, Gungor, Seyhan and Seeken (2009) opines that laboratory practices generally improves the students' science process skills, cultivate interest in chemistry, develop team workability in problem solving and help students understand and retain complex and ambiguous empirical work. According to Babafemi 2014 (unpublished thesis), students taught using experimental method achieve better academically and retain better the concepts learn than those taught using lecture method. This is in line with the findings above.

5. CONCLUSIONS

From the findings of this study, it was concluded that the teaching method a teacher use in teaching chemistry and other science related courses has a direct effect on the students' academic achievement and retention ability. Experimental method of teaching science increases students' acquisition of process skills, academic achievement and retention ability.

6. RECOMMENDATIONS

Based on the findings of this study, the following recommendations are made:

1. In-service training programs for science teachers in form of seminars, workshops and conferences should focus more on how to use experimental instructional strategies in the teaching of chemistry concept.
2. Both governmental and non-governmental organizations should partner with the education sector to see that well equipped laboratories are built and are readily available for students' experimental usage.

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