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Effect of laboratory teaching method on students' achievement and retention in basic science in federal capital territory Abuja, Nigeria

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Abstract
This study investigated the effect of laboratory teaching method on students' achievement and retention in Basic science in federal capital territory Abuja, Nigeria. The study has three research objectives, answered three research questions and tested three null hypotheses. A quasi experimental design of nonequivalent group was adopted. Basic science Achievement Test (BASAT) was developed and administered to 390 sample from 14,920 population of upper Basic II students using multi-stage sampling technique. BASAT was validated by five experts and its reliability was established at 0.62 using Kuder-Richardson formula 20 method. Eight lesson plans each for experimental and control group were developed. Experimental group was taught using laboratory method of teaching while the control group was taught using traditional method of teaching. The study lasted for six weeks. Research questions were answered using descriptive statistics of means, standard deviation while null hypotheses were tested at 0.05 level of significance using Analysis of Covariance (ANCOVA). The study revealed significant difference in achievement and retention of male and female students exposed to laboratory method of teaching. Based on the findings, it was concluded that laboratory method of teaching is an effective approach of teaching Basic science.

Keywords: laboratory, teaching method, students' achievement and retention

1. Introduction

The future of every nation including Nigeria lies in the quality of education given to the citizenry. For every developing nation to attain and sustain national development, a well -planned and implemented science and technology education remains the only essential tool for her national development. This is because individuals who acquire scientific and technological literacy, think innovatively and rationally, thus enabling them to conduct themselves within the global acceptable standard. Science is therefore an integral part of every educational endeavour. This was the main idea why the Federal Republic of Nigeria in her National Policy on Education (FRN, 2014) emphasized the teaching and learning of science at all levels of educational system. According to Adejoh and Ekele (2014) [4] science and technology are critical tools for sustainable development worldwide. As a result of the benefits derivable from the study of science and technology, developing nations including Nigeria today are striving hard to improve the quality of life in many areas of health, education, food security, communication, transportation, energy among others. Nations that are developed or civilized today have achieved that through deliberate efforts at developing their science and technology (Ali, 2004) [11]. Also, Okoye (2004) [25] said that most African nations including Nigeria remain underdeveloped largely due to poor state of science and technology education. Onipede (2003) [26] was also of the opinion that for the individual to be productive and consider functional in a changing society he/she must acquire the right attitudes, habits and functional skills through the appropriate teaching and learning of science education.

In the same vein, Massquoi (2009) [21] felt that application of science to the resolution of societal problems cannot take place without a sound foundation in science education. Science education according to Massquoi (2009) [21] is a field of science concerned with sharing of science content, ideas and process skills within the community of scientists. Science education is an educational discipline that promotes the spread of scientific knowledge that helps in explaining natural phenomena like rainbow, eclipse, mirage which were hitherto ascribed to witchcraft activities and evil spirit, thereby liberating the society from the power of superstition. The aims and objectives of science and technology according to Federal Ministry of Education (FME, 2014) are: To cultivate inquiry, knowing and rational mind for the conduct of good life and democracy, produce service in technology and the cause of technological development, produce scientists for national development, to provide knowledge and understanding of the complexity of the world and its forms as well as conduct of good life of the people (p. 29).

The achievement of these objectives as important as they are in Nigeria leaves much to be desired, so much challenges such as lack of qualified and trained science teachers, lack of students' interest, inadequate facilities, poor implementation policies, poor students' background, the use of outdated and archaic teaching methods and strategies, poor funding of science and technology education, lack of continuity in government policies, lack of motivation on the side of the teachers, overcrowded classrooms and laboratories, lack of awareness by most parents and poor school management by various heads of schools both in public and private sector are identified as barrier for the effective teaching and learning of science and technology (Nwosu, 2014) [23].

Poor achievements of students and poor process skills acquisition exhibited by science students in practical

examinations at Basic education levels may be responsible for the cases of school drop-out, low enrollment in science generally retarded growth of science and technology in the country. This is because the subject Basic Science taught at Basic Education level assumes a central position in science and in addition provides students with basic knowledge about themselves and their environment, equipping them with the necessary skills required to foster development.

The yearly reports of chief examiner of West African Examination Council (WAEC), and also that of the Federal Capital Territory Education Resource Centre confirm poor achievement of candidates in science (Basic science). There is an indication also that a good number of candidates could not do well in practical examinations because they lack the basic skills for carrying out simple experiments. The above achievement in science by the students in National Examination Council (NECO) and West African Senior School Certificate Examination (WASSCE) over the years has generated a great concern such that Federal Government of Nigeria in recent time organized for a probe of the results in WAEC and NECO (Umoh, 2010) [29].

In Federal Capital Territory, Abuja, the teaching of science in secondary school is in two main categories, Basic Science in the Basic Education and separate science subjects of Chemistry, Physics and Biology in the senior secondary school. In fact Basic Science is made a core and compulsory subject at both Lower and Upper Basic School so as to enhance continuity and smooth sail to the science courses in higher or tertiary institution.

According to Duru (2007) [15] Basic Science helps students to acquire scientific knowledge, science process skills and attitude that will facilitate making and informed decision and development of survival strategies in the global community. According to him, despite its relevance, students' performance in the subject in external examination has been worrisome. The poor performance of students in Basic Science may be attributed to many factors ranging from poor teaching method, lack of facilities, inadequate number of Basic Science teachers, poor policy implementation, students' negative attitude towards the subject among others (Atoo, 2011) [12]. Other causes could be students' inability to understand, comprehend and assimilate Basic Science topics taught in the class room which may be attributed to the alien nature of Basic Science in schools.

Adejoh and Ekele (2014) [4] reported Basic Science as a "pure fundamental sciences". Basic Science can be seen to be man's systematic efforts to understand natural phenomena of both living and nonliving things in his environment. They said that Basic Science comprises five major science disciplines: Physics, Chemistry, Biology and Mathematics as well as basic Medical Science; these have been organized in themes that encourage spiral curriculum. Basic Science spiral curriculum content is organized from simple to complex, known to unknown as it makes progress from one level to another. The content arrangement in themes requires child-centered and activity – oriented approach that requires laboratory method of teaching and variety of teaching strategies to ensure students' understanding of scientific concepts. The Federal Government again in an effort to consolidate on the gains of spiral curriculum policy reform the curriculum and introduced nine-year compulsory Universal Basic Education (UBE) programme for all school age children irrespective of their gender, social-economic status and circumstances (FME, 2014). The new policy is just to reinforce the 6-3-3-4 system of education to enhance students' achievement. The nine-year basic education policy has its focus on every learner to acquire appropriate levels of literacy, numeracy, manipulative skills. This lays a solid foundation for life-long learning as basis for scientific thinking.

National Educational Empowerment and Development Strategy (NEEDS) as cited in Adejoh and Ekele (2014) [4] underscores that the new policy of nine-year Basic Education system will have three sections; Lower Basic, Primary one – three, middle Basic primary four – six and upper Basic Junior Secondary School (JSS 1 – 3). This study focuses on the Upper Basic Education. This is education given to students in their first three years of secondary education of 9-3-4 system. In this section, Basic science is very central and bedrock that forms the foundation of science at the nine-year UBE which the students have ample opportunity to study the rudiments of science which anchor a sound base for academic achievement. At this level, the relevance of Basic Science as foundation of Physics, Chemistry and Biology cannot be overemphasized; hence there is need for proper teaching of Basic Science in the Upper Basic Education so that students will acquire skills needed for achievement in science subjects in the senior secondary schools.

Achievement by Abakpa (2011) [1] is the measure of accomplishment in a scientific field of study. He also reported achievements as a measure of success accrued for a given effort. The authors argued that achievement of students is the demonstration of their abilities to attain certain levels of instructional objectives in their classroom experiences. Ijir and Harbor-Peters (2005) [18] emphasize that instructional methods adopted by the instructor influence the cognitive, affective and psychomotor achievement of the learners. Method of teaching as reported by Adesoji (2008) [7] is very important aspect of students' learning of science in general and most especially Basic Science.

According to Ada (2006) [3] teaching method is a mode of organization of the instructional content, materials, the manner of presentation to the learner and the activities that learners and teachers carryout. There are a number of methods of teaching which are available for the teacher's use in teaching Basic Science. These methods are classified under two major groups; traditional and contemporary methods. The traditional method popularly called teacher-centered is where the teacher dominates in teaching and learning process. Examples are Lecture method, demonstration method, and descriptive method among others. Contemporary teaching method is also referred to as students-centered teaching approach. Here students are actively involved in knowledge generation. Example are Laboratory method, computer based approach, concept mapping, and cooperative learning among others.

Laboratory method of teaching as reported by Akuto, Aduloju and Odeh (2012) [10] is a process where the students are in direct contact with the concept or processes they are learning. This includes; any activity involving students in real situations using genuine materials and properly working equipments. The authors added that the use of laboratory method of teaching aids the development of visual, perceptual and manipulative skills and also makes learning permanent (retention) among students.

Joshi (2008) [20] reported Laboratory method of teaching as a unique way of instruction and it forms an integral part of effective science teaching. In this method, the teacher does not take recourse to lecturing nor to demonstration of experiment. Rather, the students are encouraged to derive the laws and principles of science themselves by actually performing the experiments. The students are given all necessary materials and equipments in the laboratory along with their proper instructions for carrying out their experiments with their own initiative and effort. The observations are recorded and the results are inferred. It helps the students to understand complex abstract ideas and gives students an opportunity to participate in the process and have an appreciation for the methods of science. He viewed that the knowledge and skills gained through laboratory method is more lasting and permanent as they learn by their own experience, observation, testing and verification.

Laboratory activities must be carefully planned and well organized. The science teacher should give pre-laboratory instruction which prepares the students for the laboratory exercises and orients them to the objectives to be attained and the procedures to be adopted. The teacher should give necessary directions for actual laboratory work highlighting the procedures to be taken. These instructions could be oral or written either on the black board or on instruction cards.

Retention by Agbama (2009) [8] is the amount of learned materials that are retained within some time lapse after a course is completed. This implies that without retention of knowledge, education is valueless since there would not be any application of knowledge in solving human problems. And failure to solve human problems due to lack of application of knowledge implies that, there is no physical and intellectual development. This implies that, one can determine achievement at fairly later times after the task is completed. Many scientific findings show that students easily forget most of the facts, ideas and principles they are taught, but mostly remember what they do practically. This agrees with the Chinese saying "I hear I forget; I see I remember; I do I understand". This study would determine retention mean scores of laboratory method of teaching on both male and female students' achievement in Basic Science. This is because it is not clear whether achievement of students in science is influenced by gender.

Adeniran (2013) [6] is of opinion that a good teaching method breaks the boundary of gender in students' achievement in science discipline. He maintains that female students considered science as very demanding course, which requires high intelligence and critical thinking. This may be that they are seeing science as male activity. The Federal Government of Nigeria through the National Policy on Education (FGN, 2014) closes the gap between genders that every Nigerian child has equal opportunity of nine-year compulsory Basic education system irrespective of gender, everyone according to his/her abilities. Based on this, both male and female students are offered equal right to study science starting with Basic Science using the appropriate method of instruction that is students-centered activity oriented. It is not certain that the method adopted in teaching Basic Science in the upper Basic Education in Federal Capital Territory, Abuja is an impediment for students' achievement and retention. This necessitated this study to examine the Effect of Laboratory Teaching Method on Students' Achievement and Retention in Basic Science in Federal Capital Territory Abuja, Nigeria.

2. Statement of the Problem

In any teaching and learning process, the cardinal objectives is to see that the learner should be able to perform tasks and if possible transfer the experience in solving problems in a new situation and excel in both local and external examinations. These objectives are hardly achieved over the years. The rate of failure in both local and external examination in science in recent times is a matter of concern. Many suggested that this ugly trend might have been the poor foundation of students in Basic Science and this may also be connected to the method of teaching used by the science teachers, because a good learning is a product of a good method of teaching and performance. The persistent poor achievement in Science process skills acquisition exhibited by science students in practical examination at Basic education level leaves no doubt about the ineffectiveness of the teaching method used by science teachers for teaching this subject. Students may have seen Basic Science as abstract and meaningless concepts. Students neither understand the basic concepts nor the underlying process that gave rise to the Basic Science concepts. This may be because the teaching methods used by the teacher were teacher-centered and does not allow students' participation, therefore imposing poor concept formation and reducing interest of the students in Basic Science. This makes students resort to learning by memorization, which also results into failure.

Laboratory method of teaching is associated with meaningful and mastery learning. It enables the students to identify the major concept and relate them to the concept in their existing knowledge. The students therefore, play an active role in knowledge construction, which leads to increase in achievement and retention among students. Based on this, the researcher proposed laboratory method of teaching as a tool in the hands of a teacher to determine its effect on Students Achievement and Retention in Basic Science in Federal Capital Territory, Abuja Nigeria.

3. Objectives of the Study

The study was guided by the following specific objectives:

1. To determine whether the use of laboratory method of teaching enhanced Upper Basic Education level students' achievement in Basic Science.
2. To find out whether the use of laboratory method of teaching bridged the gap in male and female students' achievement in Basic Science at Upper Basic Education level.
3. To ascertain whether the use of laboratory method of teaching enhanced students' retention in Basic Science at the Upper Basic Education level.

4. Research Questions

The following research questions are raised to guide the study.

1. What are the mean achievement scores of students taught Basic Science using laboratory method of teaching and those taught with traditional teaching method?
2. What are the mean achievement scores of male and female students taught Basic Science using laboratory teaching method?

3. What are the mean retention scores of students taught Basic Science using laboratory teaching method and those taught with traditional method?

5. Hypotheses

The following null hypotheses were tested at 0.05 level of significance.

$H0_1$: There is no significant difference between the mean achievement scores of students taught Basic Science with laboratory teaching method and those taught using traditional teaching method.

$H0_2$: There is no significant difference between the mean achievement scores of male and female students taught Basic Science with laboratory teaching method.

$H0_3$: There is no significant difference between the mean retention scores of students taught Basic Science using laboratory teaching method and those taught with traditional teaching method.

6. Methodology

The researcher adopted a quasi-experimental design of non-equivalent group. Specifically, the researcher used a non-randomized pre-test, post-test control group design. This design is selected because the subjects were not randomized as this would disrupt the normal classroom organization of the schools. Therefore, the researcher used intact classes. Hence, intact classes of students were randomly assigned to the experimental and control groups.

The population was 14,920 Upper Basic two students offering Basic Science in FCT Abuja. This population is from 134 public Upper Basic Schools that have been learning Basic science.

The sample size for the study is 390 Upper Basic II students. The sample comprised 191 students in experimental group (113 male and 78 female) and 199 students in control group (122 male and 77 female). The sample size was drawn using Taro Yamen formula for sample size determination. Multi-stage sampling technique was used for the study. One area council each was selected from the three educational zones using stratified random sampling technique of balloting. Purposive random sampling technique was used in the selection of two schools for experimental group and two other schools for control group for this study.

7. Results

The results of the descriptive analysis are presented as follows:

Research Question 1

What is the mean achievement scores of the students taught Basic Science using laboratory method of teaching and those taught using traditional method?

Table 1: Mean Achievement Scores and Standard Deviation of Students taught Basic Science with Laboratory Method and those taught with Traditional Method

Groups	N	Pre-test		Post-test	
		Mean	SD	Mean	SD
Traditional Method	199	58.18	8.204	54.09	9.331
Laboratory Method	191	58.71	9.062	65.94	7.952
Mean Diff.		0.53		11.85	
N(Total)	390				

The result from Table 1 showed that in the pre-test, the control group (traditional method) had a mean score of 58.18, while the experiment group (laboratory method) had a mean score of 58.71. The mean difference between the two groups is 0.53. The result also showed that in the post-test, the control group had a mean score of 54.09, while the experimental group had a mean score of 65.94. The mean difference between the two groups in post-test is 11.85 and this shows that the experimental group had a higher mean achievement score.

Research Question 2

What is the mean achievement scores of male and female students taught Basic Science using laboratory method of teaching?

Table 2: Mean Achievement Scores and Standard Deviation of Male and Female Students taught Basic Science with Laboratory Method

Groups	N	Pre-test		Post-test	
		Mean	SD	Mean	SD
Male	113	62.42	7.376	66.38	8.191
Female	78	53.32	8.597	65.29	7.599
Mean Diff.		9.1		1.09	
N(Total)	191				

The result in Table 2 showed that in pre-test, the male students had a mean score of 62.42 and a standard deviation of 7.376, while the female students had a mean score of 53.32 and a standard deviation of 8.597. The mean score difference between the two group is 9.10. The result also showed that in the post-test, the male students had a mean score of 66.38 and a standard deviation of 8.191, while their female counterpart had a mean score of 65.29 and a standard deviation of 7.599. The mean difference between the two groups is 1.09.

Research Question 3

What are the mean retention scores of the students taught Basic Science using laboratory method of teaching and those taught using traditional method?

Table 3: Mean Retention Scores and Standard Deviation of Students taught Basic Science with Laboratory Method and those taught with Traditional Method

Groups	N	Pre-test		Post-test (Retention)	
		Mean	SD	Mean	SD
Traditional Method	199	59.32	6.312	51.33	9.875
Laboratory Method	191	61.29	6.885	65.31	6.665
Mean Diff.		1.97		13.98	
N(Total)	390				

The result in Table 3 showed that in the pre-test, the control group had a mean retention score of 59.32, while the experiment group had a mean retention score of 61.29. The mean difference between the two groups is 1.97 and this shows that both groups were almost at the same cognitive level before the application of treatment. The result also showed that in the post-test, the control group had a mean retention score of 51.33, while the experimental group had a mean retention score of 65.31. The mean score difference between the two group is 13.98, and this shows that the experimental group had a higher mean retention score.

Research Hypothesis 1
There is no significant difference between the mean achievement scores of Upper Basic Education students taught Basic Science using laboratory teaching method and those taught using traditional teaching method.

Table 4: Analysis of Covariance on the Achievement Scores of Students taught Basic Science with Laboratory Method and those taught with Traditional Method

Source	Type III Sum of Squares	df	Mean square	F	Sig.
Corrected Model	13911.983[a]	2	6955.991	92.723	.000
Intercept	24980.293	1	24980.293	332.987	.000
Pre Test	222.518	1	222.518	2.966	.086
Groups	13569.239	1	13569.239	180.878	.000
Error	29032.276	389	75.019		
Total	1441789.000	390			
Corrected Total	42944.259	389			

The result of the Analysis of Variance in Table 4 shows that the P-value of 0.00 is less than the 0.05 level of significant at 1 degree of freedom. This shows that the difference is significant. This implies that there is a statistical significant difference in the mean achievement scores of Upper Basic Education students taught Basic Science using laboratory teaching method and those taught using traditional teaching methods. Therefore, the null hypothesis of no significant difference is rejected.

Research Hypothesis 2
There is no significant difference between the mean achievement scores of male and female students taught Basic Science using laboratory teaching method.

Table 5: Analysis of Covariance on the Achievement Scores of Male and Female Students taught Basic Science with Laboratory Method

Source	Type III Sum of Squares	df	Mean square	F	Sig.
Corrected Model	141.703[a]	2	70.851	1.122	.328
Intercept	12787.290	12787.290	202.46	.000	.000
Pre Test	87.312	1	87.312	1.382	.241
Gender	3.178	1	3.178	.050	.820
Error	11873.544	188	63.157		
Total	842428.000	191			
Corrected Total	12015.246	190			

The result of the Analysis of Variance in Table 5 shows that the P-value of 0.823 is greater than the 0.05 level of significant at 1 degree of freedom. This shows the difference is not significant. This implies that there is no statistical significant difference in the mean achievement scores of male and female students taught Basic Science using laboratory teaching method. Therefore, the null hypothesis of no significant difference is not rejected.

Research Hypothesis 3
There is no significant difference between the mean retention scores of Upper Basic Education students taught Basic Science using laboratory teaching method and those taught using traditional teaching method.

Table 6: Analysis of Covariance on the Retention Scores of Students taught Basic Science with Laboratory Method and those taught with Traditional Method

Source	Type III Sum of Squares	df	Mean square	F	Sig.
Corrected Model	19458.763[a]	2	9729.381	137.703	.000
Intercept	11015.644	1	11015.644	155.908	.000
Pre Test	405.163	1	405.163	5.734	.017
Groups	17830.980	1	17830.980	252.368	.000
Error	27343.381	387	70.655		
Total	1366662.000	390			
Corrected Total	46802	389			

The result of the Analysis of Variance in Table 6 shows the P-value of 0.00 which is less than 0.05 level of significant at 1 degree of freedom. This shows that the difference is significant. This implies that there is a statistical significant difference in the mean retention scores of Upper Basic Education students taught Basic Science using laboratory teaching method and those taught using traditional teaching methods. Therefore, the null hypothesis of no significant difference is rejected.

8. Discussion
The discussion of findings is done on the variables examined in the study which were guided by the research questions and hypotheses.
The finding of the study revealed that a significant difference was found in the academic achievement scores of Upper Basic Education students taught Basic Science using laboratory teaching method and those taught using the traditional method of teaching. The students taught using laboratory method of teaching performed better in achievement than those taught using traditional teaching methods. This implies that laboratory teaching method is a more efficient way of teaching Basic Science than the traditional teaching method. The finding of the study

supports the finding of Ozay and Ocak (2009) [28] who recommended the use of laboratory method and demonstration method at the beginning of Science lesson to attract attention and motivate students. The finding is in agreement with that of Wambugu and Changeiywo (2008) [30] who viewed that teaching methods affect the academic achievement of students.

The study also found that male students performed well than the female student although, the difference was not statistically significant. This finding is in agreement with Iwuji (2012) [19] who stated that male students appear to be higher in achievement than the females and also reported that boys are more aggressive towards requiring manipulation (psychomotor skills) than girls, and that boys are more aggressive towards laboratory and project work. The finding is also in line with the view of Iwuji (2012) [19] who stated that boys also perform better than girls in the process of measuring and experimenting. The finding of the study is also supported by Iwuji (2012) [19] who opined that right from the childhood, a boy traditionally receives more training and encouragement for achievement than girls.

Furthermore, result of the study shows that Upper Basic Education students taught Basic Science using laboratory teaching method had a better retention scores than those taught using traditional teaching methods. The result also shows statistical significant difference in the mean retention scores of students when taught Basic Science using laboratory teaching method and those taught using traditional teaching methods. The finding is in collaboration with Bichi (2002) [14] who reported that teaching in a practical class improves retention of skills of students.

9. Conclusion and Recommendations

From the results of the findings, the researcher concludes that the method employ in science teaching has significant effects on students' achievement and retention of both male and female students gained significantly and retained more skills when taught using laboratory method of teaching. Therefore, it is an effective and result oriented teaching method of teaching especially in pure science oriented subjects.

Based on the findings of the study, the following actions are hereby recommended:

1. The laboratory method of teaching is an effective approach; therefore, it should be implemented for the teaching of Basic Science at all levels.
2. Student should see laboratory as a best means/resource for learning of science that enhances skills acquisition which promotes retention of knowledge.
3. Government should make it a policy to see that teachers are train and supervised on the effectiveness of laboratory method by organizing workshops, seminars, conferences.

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