EFFECT OF LABORATORY WORK ON STUDENTS' ACQUISITION OF SCIENCE PROCESS SKILLS IN BIOLOGY

Moses Ogheneovo Omayuli, *Ph.D, PDE*

And

Verisa Obaro Omayuli, *Msc. (Ed) Biology*
Department of Biology
College of Education
Mosogar, Delta State, Nigeria

Abstract
This study investigated poor performance in Biology at the senior secondary school examinations. One important aspect of teaching biology is the use of the laboratory. This problem has become worrisome because of recurrent poor performance at the WASCE and NECO. There is the need to adjust to the acquisition of science process skills as panacea to the recurrent poor performance in examinations. The research design was quasi-experimental consisting of pre-test/post-test experimental groups. The study was carried out in selected secondary schools in Ethiope West Local Government Area of Delta State. Eighty (80) students were randomly selected for the study. Results of the study was analyzed through the application of appropriate statistical procedure. In conclusion, the study revealed that the experimental group taught with laboratory work achieved more than students taught with traditional lecture method. Recommendations made towards improving student performance in biology include: Laboratory work approach should be adopted as a teaching method in senior secondary schools as it allows participation and involvement in laboratory activities. Teacher training institutions should adopt this strategy in their training of teachers. Knowledge impacting workshops, especially on new trends should be organized by individual schools and the regulatory authorities.

Keywords: *Laboratory, Performance, Biology, science process skills*

Introduction
Biology is one of the subjects offered in the senior secondary school curriculum. In recent years, the teaching and learning of biology has experienced several difficulties, one of which is poor performance in the WAEC and NECO examinations. This is one reason students shy away from biology-based sciences (pure and applied).

According to Omoifo in her inaugural lectures series in 2012, the WAEC result (Yaba, 2004) showed that more than 50% of the students who sat for biology as only core science subject failed in the years 1995 to 1997 and 2000. In the next five years (2005), the highest percentage recorded was 52%. The result for NECO was not better either. The summary of NECO results released for November/December, 2011 for external students showed that of the total number of students who sat for biology (97,595), 29.53% passed. Out of this, 8,109 or 7.5% passed at credit level and above while75,486 or 70.48% failed. This dismal performance has become a source of vary to all, parents inclusive. No country can develop technologically with these poor indices.

Laboratory work is not just putting the apparatus together when seen, but need planning, designing a problem, creating a new approach and procedure and also putting familiar things together in the new arrangement.

Laboratory work is about experimentation usually to prove a hypothesis or initiate a finding or research. Experimentation in the laboratory is underscored by the aspect of learning process called the psycho-motor domain. This domain has to do with manipulative skills and application of the five senses in order to inform judgment or get the task accomplished. Understanding biology requires these manipulative skills if students are to do well in the life and applied sciences.

The laboratory may be defined as a place equipped for experimental studies. It is therefore synonymous with scientific investigation. Laboratory experimentation provide concrete experiences to substantiate theoretical aspect that has been taught. Laboratory activities provide exercises in solving problems based on real physical situations and also an appreciation of the various methods used in experimental sciences as biology, agriculture and health sciences (Lazarowitz & Tamir, 1994).

Besides content achievement and cognitive development, the activities more succinctly help to develop skills in scientific thinking consists of more than mere deduction and induction but also involves generalizing operations and logical thinking which enhance learner abilities in:

- Identifying problems and questions
- Categorizing of attribute through observations, comparison of differences and Similarities
- Measuring qualities
- Manipulating of materials and data formulating of hypothesis and Laws
- Making conclusions/decisions based on established fact

(Fraser & McRobbie, 1995; Balogun, 1985; Tamir *et al.*, 1992).

To date, many studies have been conducted on the importance of laboratory work while teaching science. Currently, science educators and teachers agree that laboratory work is indispensable to the understanding of science (Yager *et al.*, 1969; Fisher *et al.*, 1999; Daramola, 1985; Lunette, 1998).

It is however pertinent to point out that practical work is different from laboratory work. Practical work may have to do with working outside while laboratory work has to do with experimentation performed in the laboratory under prescribed/controlled conditions (Aghenta, 1982; Urevbu, 1990).

Many studies have shown that teachers are not aware that the different practical activities in the laboratory have different objectives (Egunyomi, 1987; Bencze & Hodson, 1999; Hirvonen and Viiri (2002), also reported that as a result of learning practical skills and scientific learning methods, students experience an increase in motivation while teachers gain the opportunity to evaluate the knowledge of their students. When this occurs, the theory-practice connection in students and teachers become firmly established.

Research questions

1. Does laboratory work affect students' ability to develop science process skills in biology?
2. How does the acquisition of science process skills have effect on the student' performance?

Hypotheses

Below are the hypotheses formulated for the study;

Ho1: laboratory work will have significant effect on students' ability to develop science process skills in biology

Ho2: there is significant difference between experimental group (acquisition of science process skills) and the control group on students' performance.

Ho3: there is no significant difference between the mean scores of high and low achievers of the experimental and control on retention test.

The following are the15 skills required for the study of science (biology) according to Lazarowitz & Tamir (1994):

Observing	Measuring
Classifying	Communicating
Predicting	Inferring
Using number	Using space/time relationship
Questioning	Controlling variables
Defining operationally	Formulating models
Hypothesizing	Designing experiment
Interpreting data	

Research Methodology

The study was designed as a quasi-experimental research involving two groups. A pre-test was administered to both groups to assess them instantly. The test instrument was collected immediately and the scores obtained recorded. This was to enable the researcher know the level of acquisition of science process skills so far. Both groups were then taught using guided expository method. One group was exposed to treatment experimental that was making use of the laboratory for practical work. The control group was not exposed to treatment (not using the laboratory). A post-test was administered to both groups. The information obtained from the control group was used to determine the extent of difference of post-test between the two groups that could be attributed to treatment.

Population of the study: Two secondary schools, Ighoyota Secondary School, Ugbokpa-Mosogar and Mosogar Secondary School, Mosogar in Ethiope West Local Government Area (LGA) of Delta State, Nigeria participated in this study. Average of the students was

13 years (range 13 – 15). The gender of the students was equal to both sexes (male 40, female 40).

Sample and sampling technique::A total of 80 biology students were the study sample were drawn from SS2 biology students. The sample size consisted of two intact classes in each of the school selected

Instrument for data collection: This was developed by the researcher which was the biology achievement test. Science process skills in Biology (SPSIB) was used for measuring level of acquisition consist of 5 practical items measuring 5 separate skills. Test content covered the topics taught during the implementation period. The instrument was validated by experts in the field of study. Reliability of the instrument was the test-retest reliability over time.

Data analysis: The raw scores from the pre-test, post-test and retention test are presented in a tabular form for the purpose of interpretation. For the manipulation of data, the means, standard deviations and the differences between of means was used to compute for each group. Significance of difference between the mean scores of both the experimental and control groups on the variables of post-test and retention test scores was tested at 0.05 levels by applying t-test.

Table 1: Reliability co-efficient calculation

S/N	**X**	**Y**	**XY**	**X^2**	**Y^2**
1	37	30	1110	1369	900
2	27	28	756	729	784
3	33	31	1023	1089	961
4	33	34	1122	1089	1156
5	36	34	1224	1296	1156
6	27	27	729	729	729
7	30	27	810	900	729
8	31	31	961	961	961
9	31	26	806	961	676
10	33	31	1023	1089	961
11	32	35	1120	1024	1225
12	31	28	868	961	784
13	33	38	1254	1089	1444
14	25	21	525	625	441
15	25	21	525	625	441
16	36	36	1224	1296	1156
17	34	34	1020	1156	900
18	29	21	609	841	441
19	30	28	840	900	784
20	24	20	480	576	400
Total	**617**	**575**	**18029**	**19305**	**17029**

From Pearson's Product Moment Correlation formulae applied Coefficient r = 0.80. Therefore, the test-retest reliability is very good.

Results

Table 2: Significance of difference between the mean scores of the Experimental and control groups.

Groups	N	Mean	SD	SE
Experimental Group	69	1.0000	0.0000	0.0000
Control Group	69	1.0000	0.0000	0.0000

The t-test could not be computed because the standard error of the difference was 0.
The difference between the mean scores of the experimental group and control group on pre-test was found to be insignificant at 0.05 level, hence both groups were found to be almost equal.

Testing of the Null Hypotheses

Research hypothesis 1

Ho1: there is no significant difference between the mean scores of the students taught with the laboratory work and students taught with traditional method of teaching.

Table 3: Pair sample t-test of mean achievement scores of students taught with laboratory work and the traditional method of teaching.

Groups	N	Mean	T	df	significance
Laboratory work	40	35.4	3.00	27	0.006
Traditional method	40	28.04			

Table 3 shows that the pair sample t-test of mean achievement scores of students taught with laboratory work and the traditional methods has a tcal-value of 3.00 with degree of freedom (df) of 27 significant value of 0.006 testing at alpha level of 0.05. the null hypothesis was rejected based on this result. The results also show that treatment has effect on students' cognitive achievement scores of the students taught with laboratory work and students taught with the traditional method of teaching.

Research Hypothesis 2

Ho2: there is no significant difference between the mean scores of high and low achievers of the experimental and control group on post-test.

Table 4: Pair sample, t-test of mean scores of high and low achievers of the

experimental and control group on post-test.

Group		N	mean	T	df	sig
Experim-ental	High achievers	16	1.7565	10.078	79	0.01
	Low achievers	14	1.1685			
Control	High achievers	15	1.3472	9.901	79	0.00
	Low achievers	13	0.9028			

Table 4 shows a comparison of the post-test mean scores of high and low achievers of the experimental and control groups using t-test. The t-test reveals that the calculated t-value is for the experimental figure (high-low achievers) is10.078 at significant value of 0.01 testing at alpha level of 0.05. This indicates there was a significant difference in the performance of the post-test. As such, the null hypothesis was rejected. It was however restated thus: there is a significant difference between the mean score of high achievers and low achievers of the control group on post-test.

Research Hypothesis 3

Ho3: There is no significant difference between the mean scores of high and low achievers of the experimental and control on retention test.

Table 5: Pair sample t-test of mean scores of high/low achievers of the experimental and control groups on retention test.

Group		N	Mean	T	df	significant
Experimental Group on retention	High Achievers	16	63.75	9.01	27	0.01
	Low Achievers	12	44.64			
	Total	28				
Control Group on retention	High Achievers	15	34.64	9.01	27	0.01
	Low Achievers	13				
	Total	28				

Table 5 depicts the difference between the mean retention scores of the experimental group (high and low achievers) using t-test. It also reveals that the calculated t-value is 9.01., the degree of freedom (df) of 27 at significance value of 0.01. both (experimental and control groups) at alpha level of 0.05. Hence the null hypothesis was rejected. Thus Ho3 is a significant difference between the mean scores of high achievers and low achievers of the experimental and control group on retention test.

Discussion

Comparing post-test scores of both the experimental and the control groups by applying statistical analysis showed there was significant difference between the two groups (Table 5).

The comparison between the mean post-test scores of high and low achievers of the experimental group was significantly different at 0.05 alpha level (Table 5). Also on table

(Table 5), the comparison between post-test scores of high and low achievers of the control group showed there was significant difference at 0.05 alpha level.

Similarly, the difference between the mean post-test scores of high and low achievers of both experimental and control groups also showed significant difference at 0.05 alpha level. This showed that high and low achievers of both experimental and control groups had almost equal knowledge at the commencement of the experiment.

Ho1: the experimental group performed significantly better than the control group on post-test. This is against the null hypothesis which stated that there was no significant difference between mean scores of the students taught with the laboratory method and the students taught by the traditional lecture methods.

Ho2: The t-value obtained in the case of "treatment" as the source of variation and "achievement level" was found to be significant at 0.50 alpha level (Table 4). The null hypothesis was therefore rejected.

Ho3: considered the effect of laboratory work approach on students' academic achievement on retention. Results as shown on Table 5 indicated that there was a significant difference at 0.05 alpha level. The null hypothesis which stated the otherwise was rejected.

At the end of it all, the laboratory work method of learning group performed significantly better than the group taught by the traditional lecture method.

Conclusion

In the light of statistical analysis and the findings of the study, it can be concluded that laboratory work method of teaching biology is more effective as a teaching-learning technique for senior secondary students when compared to traditional teaching methods. Students in the experimental group (that uses the laboratory work method) had obvious supremacy over students in the control group (that uses traditional method). High achievers that were taught biology using laboratory work method retained more knowledge than students taught with the traditional method. Low achievers taught Biology with the laboratory work method also retained more knowledge compared with the low achievers taught with the traditional lecture method.

Recommendations

1. Laboratory work approach should be adopted as a teaching method in senior secondary schools as it allows participation and involvement in laboratory activities.
2. Teacher training institutions should adopt this strategy in their training of teachers.
3. Knowledge impacting workshops, especially on new trends should be organized by individual schools and the regulatory authorities.
4. All laboratories should have a constant source of power, such that experiments are not truncated as a result of power failure
5. Since the laboratory is a kind of workshop, safety measures must be built into the laboratory at the construction stage.
6. The laboratory should have its own budget to avoid shortage of funds to purchase consumables as reagents.

7. Students also be provided or asked to equip themselves with protective wears against corrosive reagents, stains and infective biological specimens.
8. Standard operating procedures must be written for every operation in the laboratory.

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