ORIGINAL PAPER

THE EFFECT OF LABORATORY WORKS IN TEACHING AND LEARNING OF PHYSICS IN ONITSHA NORTH, ANAMBRA STATE

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Abstract. *What are the states of physics laboratories in secondary schools? Are there laboratory factors constituting constraints to effective teaching and learning of physics? Does laboratory works influence students' physics achievements and general attitudes? To seek answers to these questions is the aim of the present research. Along the line of survey research method, structured questionnaire were administered to the teachers and students of physics in 10 secondary schools sampled from 16 Government Secondary schools in Onitsha North Local Government Area of Anambra State. The instrument used for collecting data were analyzed using a simple mean due to the conformity of the question and appropriate decision on the result based on the mean was achieved through a comparison with the theoretical cut-off mean calculated as* $\overline{X}_c = 2.5$*. The result of the analysis showed inability of the students to explore diverse areas of physics as a result of insufficient supply of laboratory equipments and unsatisfactory teaching and learning due to obsolete nature of available materials. These causes lack of motivation for teaching and learning of physics. However, students with a bank of variety of practical experiences are likely to perform better in skills and confidence than those with limited experience.*

Keywords: *Laboratory works, teaching and learning, physics, practical works and students' achievements.*

1. INTRODUCTION

It can be realized with the help of researchers in physics education that students at secondary and even university levels continue to hold fundamental misunderstanding of the world around them [18]. Science learning remains within the classroom context and just a small percentage of the students are able to use the knowledge gained at school for solving various problems of larger physical world.

In most cases, students hear lectures without strong connections to their everyday experiences. Students do not usually have opportunity to form their own ideas; they rarely get a chance to work in a way to be engaged in discovery, building and testing models to explain the world around them [10].

Results from research in cognitive science and physics education shows that activities in laboratories increase students' learning, positive attitudes towards physics and permanence of knowledge [12, 19]. The one of the main goals of using laboratories in physics education is to teach students the philosophy, branches, topics, theories, laws of physics, the other one is to gain steps of the scientific method namely science process skills while learning the

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philosophy, branches, topics, theories, laws of physics. One of the researchers [18] listed the aims of widely using laboratories in science education as follows laboratories provides:

- To get students to comprehend abstract and complex scientific concepts by using concrete materials.
- To gain students problem solving and analyzing skills by comprehending the nature of science.
- To develop practical experiences and special talents of students
- To enjoy students with laboratory activities and by this way to develop positive attitude towards scientifically working.

To many researchers [1, 11], laboratory in physics education has not achieved its main goal, not provided meaningful learning and not developed positive attitudes towards science in recent years. As a result, it has been stated that more essential resources and time have to be allocated in order to enhance the effectiveness of laboratories in science teaching both in primary and secondary education [3]. It was emphasized that the laboratory activities in science teaching were put into effect in 1960s [17], however, students could not reach the desired levels by using these activities. Yager and Engen [22] concluded that laboratory experiences are not meaningfully adequate for students and therefore they do not make a significant contribution to their conceptual understanding.

Teacher's provision in the sciences [11] were examined in many countries and found that 45% of the schools surveyed indicated insufficient laboratories. This finding agreed with the finding in Saudi Arabia [4] which indicated inadequacy in the provision of laboratory facilities in schools. The findings were also consistent with those found in Uganda [5] which indicated that science education is faced with the problem of lack of resources with half the schools having no real laboratory. Few opportunities are provided for the students to discuss both experiment and its results, make and test hypothesis or design an experiment and finally perform them. Beside, these some physics experiments in secondary level are very difficult to be performed due to the time consuming, being harmful and expensive, deficiency of laboratory equipments, not representing the related concept or event precisely, teacher's anxiety about the complexity of the curriculum [13].

In hopes of improving student learning, research questionnaires have been administered to both physics students and teachers which will help elicit information on the state of physics laboratories in secondary schools and their influence on the students' achievement.

2. PRACTICAL WORKS IN TEACHING OF PHYSICS

The importance attributed to practical work, aligned with the main beliefs shared by experts in science education [8, 20, 21] can illustrate its impact. Practical work can motivate learning, develop scientific and analytical skills, enable an improved acquisition and comprehension of concepts, develop a solution-driven pragmatic mindset, develop discussion and critical analytical skills as well as introduce more rigors in science research.

3. STATEMENT OF THE PROBLEM

Common observation shows that secondary schools in Onitsha North of Anambra state have varied problems associated with their physics laboratories. Some having only one multipurpose science laboratory for all the science subjects others do not have well equipped laboratories. The implication of this is that many students seem not to be exposed to practical work in physics which is core subject in secondary school science curriculum. The problem of this study therefore, was "what influence does laboratory works have on the students' achievement?" and its implication in teaching and learning of physics in Onitsha North Local Government Area of Anambra State. In addressing these problems, the following research questions were raised.

What is the state of physics laboratory in Secondary Schools in Onitsha North?

What are the laboratory factors that constitute constraints to effective teaching and learning of physics in Onitsha North?

What influence does laboratory works have on students' achievement in physics in Onitsha North of Anambra State?

4. MATERIALS AND METHODS

The instrument for data collection in this study was questionnaire and observational techniques. Questionnaire has been defined as "survey in which the respondent reads the questions and marks the answers which are appropriate to his options on paper instead of verbally responding to an interview" [14]. There are two types of questionnaire [16], the structured or fixed response questionnaire and the unstructured or open-ended questionnaire. According to Fowler [7], the open-ended questionnaire requires responses that must have more than just yes or no answer since subject must provide descriptive information. However, this study employed structured questionnaire as stated in the research questions below:

4.1. TEACHER'S RESEARCH QUESTIONNAIRE

Question 1: What is the state if physics laboratory in Secondary Schools in Onitsha North?

S/NO	ITEM	SA	A	D	SD
1.	You have only one laboratory for all science subjects.				
2.	There are sufficient equipments in your laboratory.				
3.	Most of the laboratory equipments are already obsolete.				

Question 2: What are the laboratory factors that constitute constraints to effective teaching and learning of physics in Onitsha North?

S/NO	ITEM	SA	A	D	SD
1.	Students usually do not attend practical classes rather, they hope to cheat in examination.				
2.	Insufficient qualified teachers are responsible for ineffective laboratory works.				
3.	Insufficient time does not stop a teacher from teaching effectively.				
4.	You perform practical works up to three times in a week.				
5.	Do you agree that lack of motivation affects students' performance in practical works?				

Question 3: What influence does laboratory works have on students' achievement in physics in Onitsha North of Anambra State?

S/NO	ITEM	SA	A	D	SD
1.	Students' performance in physics is dependent on how well they can perform laboratory works.				
2.	Teachers employing variety of methods in teaching promotes better understanding of practical physics.				
3.	Using improvised materials in the laboratory does not encourage better understanding of physics concepts.				
4.	Laboratory works motivate students to study physics with relaxed mind.				

4.2. STUDENTS' RESEARCH QUESTIONNAIRE

Question 1: What is the state if physics laboratory in Secondary Schools in Onitsha North?

S/NO	ITEM	SA	A	D	SD
1.	You have physics laboratory where laboratory works are done.				
2.	You are provided with enough and varieties of laboratory equipments.				
3.	Adequate seats and benches are provided for laboratory works.				

Question 2: What are the laboratory factors that constitute constraints to effective teaching and learning of physics in Onitsha North?

S/NO	ITEM	SA	A	D	SD
1.	You use to do practical without laboratory equipment				
2.	Teachers do not cover their course contents before WAEC examinations.				
3.	You do not have enough practical text books.				
4.	You are not allowed to use laboratory on your own for rehearsals.				

Question 3: What influence does laboratory works have on students' achievement in physics in Onitsha North of Anambra State?

S/NO	ITEM	SA	A	D	SD
1.	You understand physics theories better when they are performed in the laboratory.				
2.	Do you agree that physics is a hard subject when you do laboratory works?				
3.	Most of the students in your school re-seat WAEC examination in search of credit in physics.				
4.	You can explain the world around you using physics principles.				

As regards observation, James [9] says "the major purpose of observation is to contribute descriptive information, provide in-depth accounts of individuals or group of individuals as they behave naturally in some specific setting". The researcher deemed it necessary to employ an observatory method in order to get much needed information for the problem. This method was adopted as to observe the laboratory work proceedings during administration of the questionnaire, noting the teacher's interaction and how students participated in their practical work classes.

5. SAMPLE

The sample of the study was composed of secondary school physics teachers and students that were randomly picked from 10 Government schools in Onitsha North out of 16 Government Secondary Schools. The selected schools are composed of four (4) Girls schools; four (4) Boys schools and two mixed schools. In all, 20 teachers and 300 physics students were used for the study.

The sampling technique used in obtaining data was simple random sampling. It is stated that [15] when the population is large, sampling is used. Teller defined simple random sampling as the process of selecting a representative in such a way that all individuals in the defined population have an equal independent chance of being included in the sample.

6. PROCEDURE FOR DATA ANALYSIS

The statistical tool or technique employed in analyzing the data is the mean. The mean was used as statistical standard due to the conformity of all questionnaire items. In this case, the researcher organized the information into a frequency distribution tables and bar charts, and computed the mean responses on the questionnaire item.

Thus we have,

$$\overline{X_i} = \frac{\sum F_i X_i}{N} \tag{1}$$

where

i	=	1, 2, 3 …n is the number of rows.
$\overline{X_i}$	=	mean of respondents for each questionnaire item.
F_i	=	Frequency of each questionnaire item
X_i	=	Number of each of the rating scale point.
N	=	Number of respondents

Appropriate decision on results based on the mean was achieved through comparison with the theoretical cut-off mean $\overline{X_c}$.

Based on the four point scales $\overline{X_c}$ was evaluated as follows:

Strongly Agreed (SA): 4 rating scale point
Agreed(A): 3 rating scale point
Disagreed (D): 2 rating scale point
Strongly Disagreed (SD): 1 rating scale point
Cut-off mean of the scales $\overline{X_c} = 2.5$

Hence, if

$$\begin{aligned} &\overline{X_i} < \overline{X_c} \text{ the item is rejected} \\ &\overline{X_i} \geq \overline{X_c} \text{ the item is accepted} \end{aligned} \tag{2}$$

That is, any item in instrument which had a mean equal to or higher than 2.5 was accepted while any mean score below 2.5 was rejected.

7. RESULTS

This section presents the findings derived from the statistical analysis of data acquired from the administration of the questionnaire, each table and chart according to their research questions and items. Therefore, for each of the items we have:

$$T_i R_i \qquad (3)$$

where

T = tables
R = row
i = 1, 2, 3 . . . n

Research Question 1: What is the state of physics laboratory in Secondary Schools in Onitsha North? Statistical results of the teacher's responses to this question are given in table 1.

Table 1. Statistical results of the teacher's response on the state of physics laboratory in Onitsha North.

S/NO	ITEMS	$\overline{X_i}$	DECISION
1.	You have only one laboratory for all science subjects.	2.2	Rejected
2.	There are sufficient equipments in your laboratory.	2.1	Rejected
3.	Most of the laboratory equipments are already obsolete.	2.7	Accepted

As given in table 1, T_1R_3 was located above the predetermined theoretical mean $\overline{X_c} = 2.5$. The respondents agreed that most of the laboratory equipments are already obsolete. T_1R_1 and T_1R_2 were located below the predetermined theoretical mean indicating that the respondents do not consider provision of physics laboratory as a factor affecting teaching and learning but considers provision of equipment insufficient. For students' responses towards question 1, the statistical results are presented in table 2.

Table 2. Statistical results of students' responses on the state of physics laboratories in Onitsha North.

S/NO	ITEMS	$\overline{X_i}$	DECISION
1	You have physics laboratory where laboratory works are done.	3.3	Accepted
2	You are provided with enough and varieties of laboratory equipments.	2.1	Rejected
3	Adequate seats and benches are provided for laboratory works.	2.3	Rejected

According to table 2, T_2R_1 was located above the predetermined theoretical mean $\overline{X_c} = 2.5$. The respondents do not consider provision of physics laboratory as a hindering factor to effective teaching and learning of physics in their schools. T_2R_1 and Q_1R_3 had means $\overline{X_i} = 2.1$ and $\overline{X_i} = 2.3$ which did not meet the cut-off point indicating that the respondents consider provision of laboratory equipments, seats and benches inadequate.

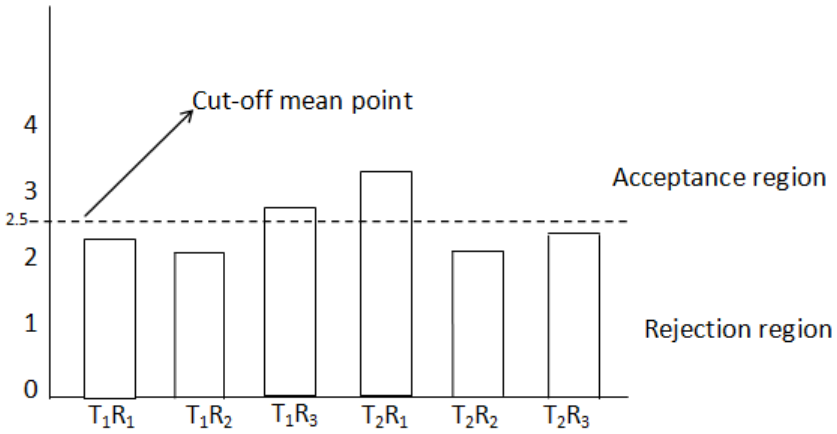

Fig. 1. Summary of the findings to research question 1.

Research Question 2: What are the laboratory factors that constitute constraints to effective teaching and learning of physics in Onitsha North? The teacher's and students' responses to this question are presented in tables 3 and 4 respectively.

Table 3. Statistical results of teacher's responses to research question 2.

S/NO	ITEMS	$\overline{X_i}$	DECISION
1	Students usually do not attend practical classes rather; they hope to cheat in examination.	2.6	Accepted
2	Insufficient qualified teachers are responsible for ineffective laboratory works.	3.6	Accepted
3	Insufficient time does not stop a teacher from teaching effectively.	1.9	Rejected
4	You perform practical works up to three times in a week.	2.3	Rejected
5	Do you agree that lack of motivation affects students' performance in practical works?	3.8	Accepted

Responding to these questions, the respondents reported students not to be attending practical classes. They also reported insufficient supply of qualified physics teachers and insufficient allocation of time to laboratory works. Most of the schools according to the respondents do not perform practical works up to three times in a week where as most of them agreed that motivation is necessary for the students to perform well in practical works.

Table 4. Statistical results of students' responses to research question 2.

S/NO	ITEMS	$\overline{X_i}$	DECISION
1	You use to do practical without laboratory equipment	2.7	Rejected
2	Teachers do not cover their course contents before WAEC examinations.	2.8	accepted
3	You do not have enough practical text books.	2.6	Accepted
4	You are not allowed to use laboratory on your own for rehearsals.	2.8	Accepted

The mean responses of table four on the issues of source of problems constituting constraints to effective laboratory works are located above mean cut-off point $\overline{X}_c = 2.5$. Except T_4R_1 which is below the cut-off mean. The implication is that all the items are true according to the way they were stated except T_4R_1 which has a mean $\overline{X}_i = 1.7$.

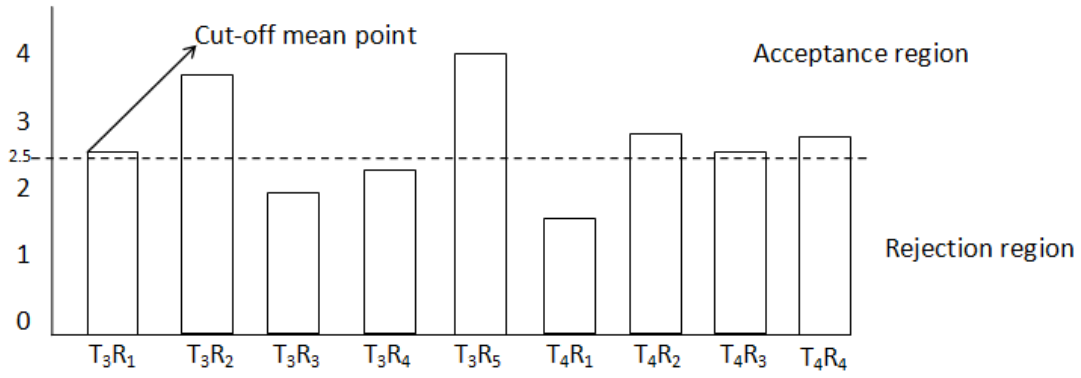

Fig. 2. Summary of the findings to research question 2.

Research Question 3: What influence does laboratory work have on students' achievement in physics in Onitsha North? This question will be answered using tables 5 and 6.

Table 5. Statistical results of the teacher's responses on the influence laboratory works have on students' achievement in physics.

S/NO	ITEMS	$\overline{X_i}$	DECISION
1	Students' performance in physics is dependent on how well they can perform laboratory works.	2.9	Accepted
2	Teachers employing variety of methods in teaching promotes better understanding of practical physics.	3.1	Accepted
3	Using improvised materials in the laboratory does not encourage better understanding of physics concepts.	2.1	Rejected
4	Laboratory works motivate students to study physics with relaxed mind.	2.6	Accepted

In table 5, the respondents' reactions to the T_5R_1, T_5R_2 and T_5R_4 yielded means of $\overline{X_i} = 2.9$, $\overline{X_i} = 3.1$, $\overline{X_i} = 2.6$ which are above cut-off mean $\overline{X_c} = 2.5$. This indicates that the statements of the items are true. T_5R_3 had mean $\overline{X_i} = 2.1$ which is below cut-off mean $\overline{X_c} = 2.5$. This implies that improvisation in the absence of materials can encourage better understanding of physics concepts.

Table 6. Statistical results of the students' response on the influence laboratory works have on students' achievement in physics.

S/NO	ITEMS	$\overline{X_i}$	DECISION
1	You understand physics theories better when they are performed in the laboratory.	3.8	Accepted
2.	Do you agree that physics is a hard subject when you do laboratory works?	1.6	Rejected
3.	Most of the students in your school re-seat WAEC examination in search of credit in physics.	2.9	Accepted
4.	You can explain the world around you using physics principles.	3.0	Accepted

Table 6 above presents students responses to research question 3. T_6R_1 indicated that students' better understanding of physics theories is dependent on how they can perform them. They also considered physics to be easy when they are doing laboratory works as in Q_3R_2 which had mean of 1.6. They agreed that most students re-seat WAEC examination in search of credit in physics, reason being that practical works constitute 50% of the entire

examination. T_6R_4 which had $\overline{X_i}$ = 3.0 indicated that with laboratory works, students can easily explain the world around them applying physics principles.

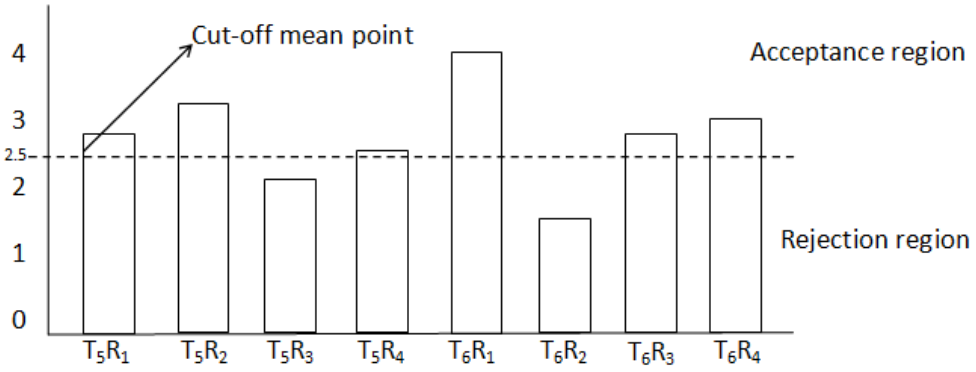

Fig. 3. Summary of the findings to research question 3.

8. DISCUSSION

The foregoing has examined the effect of laboratory works in teaching and learning of physics in secondary school in Onitsha North Anambra State. The findings have revealed significantly the state of physics laboratories and their implications in teaching and learning of physics. It appeared that greater number of schools have physics laboratories but are not provided with enough and variety of equipment, seats and benches that makes laboratory works comfortable. Teaching and learning tends to be faster and easier when adequate facilities are provided. This is in agreement with the findings of previous researcher [5] in which it was reported that in Uganda science education is faced with the problem of lack of resources with half of the schools having no real laboratory.

The findings also revealed some laboratory factors that constitute constraints to effective teaching and learning of physics such as students' nonchalant attitudes towards attending classes, insufficient time allocation and supply of qualified teachers and text book materials, lack of motivation among students, laxity among teachers and lack of students' access to laboratory equipment for private rehearsals. These findings are in consonance with suggestion of American Association of Physics Teachers (AAPT) [2] in their guidelines for school physics programme in which it was recommended that 40% of class time be devoted to laboratory activities in order to treat effectively those topics that are considered hard by the students. In the order hand, government should attend to those problems which affect teaching and learning in laboratory since it is a critical variable in determining students' achievements in physics as revealed by the findings that they tend to understand better when they are motivated and practices.

9. CONCLUSIONS

It is very clear that teaching and learning of physics to a greater extent is anchored in laboratory activities due to the fact that it is a subject that should not be taught in abstraction. The more practical done, the more likelihood of students understanding the concepts principles and laws of physics. But in a situation where reverse becomes the case, teaching will be jeopardized and learning greatly affected. This is the situation of many government secondary schools in Onitsha North Local Government Area, but it is good to point out that these problems are not insurmountable; the problems seem to be inter-dependent, one leading to another. It is clear that with good planning, hard work and cooperate efforts of all and sundry, a lot will be achieved in solving the problems.

10. RECOMMENDATION

The following recommendations can be posed with the hope that positive effect of laboratory works on teaching and learning of physics may be constituted. The Government should provide laboratory equipments and text book materials in all the schools having shortages of laboratory equipments in Onitsha North in line with the provision of the Federal Republic of Nigeria [6] in improving standards in schools. The federal government could also assist through the Educational Trust Fund in funding physics laboratories in schools. Students themselves must do the practices of physics laboratory and develop the ability of learning via experiment at secondary educations.

There is also need for more qualified physics teachers who can use laboratory equipments effectively, improvise when instructional materials are not available and manage time allocated to laboratory works.

It is believed that if these recommendations are not set aside, the factors affecting teaching and learning through laboratory works in government secondary schools will be significantly attended to. Equally, the status of physics will be much more enhanced.

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