



Survey of Laboratory Activities in Senior Secondary School Physics in Nigeria

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Author's contribution

The sole author designed, analyzed and interpreted and prepared the manuscript.

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ABSTRACT

The importance of laboratory activities in the teaching and learning of physics in secondary schools cannot be overemphasized. It is on the basis of this that the author surveyed the level of laboratory activities in Physics lessons in senior secondary schools in Nigeria. The study involved examination of the extent to which teachers demonstrate practical activities in physics lessons, and the extent to which students are given the opportunities to engage in practical and experimental activities in Physics lessons. One hundred and three physics teachers who were randomly drawn from 103 public senior schools in Oyo state, Nigeria participated in the study. One research instrument titled "Physics Teacher Questionnaire" was used to collect data. Results showed that most schools have separate laboratory for physics practical; teachers, to a large extent, demonstrate practical activities in physics lessons. However, to a large extent, students are not given enough opportunity to engage in practical and experimental activities in Physics. Teachers were of the opinion that though schools have equipment and facilities for physics practical, the equipment and facilities are not enough and are obsolete. Lack of enough time on the school official time table for practical physics, lack of enough laboratory attendants and lack of motivation of the teachers are some of the factors that hinder physics teachers from engaging their students in practical work in physics lessons. Government should provide more funds for schools so that schools can buy more

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equipment and expand their facilities for physics practical. Restricting the opportunity of the students to engage in practical and experimental activities may be one of the reasons why some students still perceive physics as being abstract and not interested in it.

Keywords: Laboratory activities; senior secondary school physics; equipment and facilities for laboratory work.

1. INTRODUCTION

Physics, the study of matter, energy and their interaction, is the bedrock of development in the modern world. The word “development” as it is being used today emphasizes advancement in physics-based technology. This manifests in all areas such as economy, agriculture, medicine, computer, telecommunication and warfare. No wonder, United States of America, Britain, Japan, China, Russia and most European countries are denoted as developed countries and most countries in the sub-Saharan Africa and Asia are denoted as either underdeveloped or developing nations. Therefore any nation that pays lip service to the development of physics education will surely lag behind among comity of nations. It is on the basis of this that African countries must find ways of improving their physics education programme at the secondary and post secondary schools levels.

Though in the last three years, there has been a slight improvement in the pass rate of candidates in physics in the senior school certificate examination being conducted by the West African Examination Council (WAEC) and National Examination Council (NECO), the ultimate has not been realized. This is because a sizeable number of candidates (at least 33%) still fail to obtain credit pass in Physics. The Chief Examiners’ Report in Physics [1-3], draws attention to the fact that some students are still not doing well in Physics especially in the practical section. Some of the problems that have been identified are: inability of the students to finish their work at the stipulated time, wrong response to questions bordering on the theory of the experiment, inability of the students to handle equipment properly and take appropriate measurements. In the Chief Examiners’ Report recommendations on what schools and physics teachers should do include engaging students in more hands-on experiments. More importantly schools are advised to have more equipment and practical materials in their school laboratories.

There are important educational objectives that can be attained through school laboratory

activities. A summary of these objectives as given by [4-6] in [7] are as follows:

- To foster students’ extrinsic motivation for learning science;
- To develop scientific attitudes, that is attitudes that scientists are supposed to have (e.g., artificial thinking, probabilistic thinking, objectivity and persistence);
- To develop content knowledge, related to understanding and using science concepts, laws, theories;
- To develop laboratory skills, including mastering laboratory techniques and handling equipment as well as potentially harmful materials safely;
- To become familiar with science methods including doing problem-solving and using data to build empirically based arguments.

Laboratory activities are an integral part of Physics, the aims of which include illustrating, supplementing and driving home, points from classroom teaching and learning environment. In other words, laboratory activities play reinforcement role in learning sciences [8,9,10,11,12]. Laboratory activity provides opportunity for the learners to learn firsthand “the process of science”. It also provides experience for learners in determining physical quantities, in error analysis and hand-on-experience in real physical world [13,11,14,15]. In fact [13] advocate that an introductory Physics course should include both theory and experiment because one complements the other. In essence, an introductory Physics should convey the message that physics is not merely a body of isolated and unrelated facts but a highly unified and consistent picture of the world.

According to [16,17] laboratory activities must be designed to engage students’ minds, so that students may acquire skill and confidence in their:

- a. measurement of physical quantities with appropriate accuracy
- b. recognition of factors that could affect the reliability of their measurement

- c. manipulations of materials, apparatus, tools, and measuring instruments
- d. clear descriptions of their observations and measurements
- e. representation of information in appropriate verbal, pictorial, graphical, and mathematical terms
- f. inference and reasoning from their observations
- g. ability to rationally defend their conclusions and predictions
- h. effective and valued participation with their peers and their teacher in a cooperative intellectual enterprise
- i. articulate reporting of observations, conclusions, and predictions in formats ranging from informal discussion to a formal laboratory report
- j. ability to recognize those questions that can be investigated through experiment and to plan, carry out, evaluate, and report on such experiments.

Experimental work in sciences (Physics, Chemistry, Biology, and Agricultural Science) as stipulated in the National Policy on Education of the [18], is an important component of science and therefore the policy document recommends activity-based learning as the mode of instruction. The objective is to inculcate in the learner the spirit of enquiry and creativity through exploration of nature and environment. However, as some researchers in physics education in Nigeria (2,7,9) have shown, laboratory sessions which ideally should follow at the end of every module in Physics lessons are hardly organized for secondary school students. This observation was also raised by WAEC Chief Examiner in his report of 2013, 2014 and 2015.

Researchers such as [19,20] have shown that laboratory sessions are hardly organised for students as a result of ill-equipped laboratories in most public schools or lack of interest on the path of the teachers and of course, some students [9]. Another major reason why laboratory sessions are hardly organized for secondary school students is that the time apportioned to Physics and other science subjects, on the school official timetable, is not enough to accommodate laboratory sessions [21]. Often, quite a number of Physics teachers focus attention on completing the scheme of work rather than on the quality of teaching. Some physics teachers therefore pay little or no attention to laboratory practical activities. In this situation, the ample opportunity needed by the

students to develop new content, knowledge, techniques and approaches to scientific activities and exploration is not made possible [19].

According to [7,22], practical work, laboratory work, laboratory activities, laboratory experiments and investigations are related concepts, and they are worthwhile defining so that laboratory activities are used in a more rational way.

Practical work, according to [12], refers to any teaching and learning activity which at some point involves the students in observing or manipulating the objects and materials they are studying. To [12] in practical work, location is not a critical feature because the observation or manipulation of objects might take place in a school laboratory, but could also occur in an out-of-school setting, such as the student's home or in the field (e.g. when studying aspects of biology or Earth science). In practical work, the students may be engaged in identifying, recognizing, measuring, drawing and differentiating among varied types of samples, specimen and materials [23,24,7].

Laboratory work includes all laboratory activities that students do [7,22]. In Physics, laboratory activities include a large number of varied activities such as taking measurements and studying of physical and chemical properties of objects and samples. In laboratory activities, materials, instruments and equipment are required. For example, a practical work on measurement of resistance of a wire requires that materials such as ammeter, voltmeter, key and source of electric current such as battery/cell must be available and used. According to [20,7] laboratory activities can take place in the Physics laboratory (if available) or in a normal classroom.

In Physics, laboratory experiments have to do with activities that require control and manipulation of variables [7] and often used to mean the testing of a prior hypothesis [12]. For example, according to [25], experiment on the determination of acceleration due to gravity, the string holding the pendulum bob is usually manipulated by varying the length of the string to note the time for a specified number of oscillations (to test that g acceleration due to gravity is ten meters per second squared [10 ms^{-2}]). Experiments can be performed in the laboratory and also outside the laboratory such as in the normal classroom and even on the field [7]. More importantly with the advent of information and communication Technology,

there are several examples of computed simulated experiments that can be performed using teaching-learning software packages [9,15]. In this report, emphasis is on experiments that are carried out in the normal school physics laboratory.

The activities involved in laboratory work in physics fall broadly into two classes, which, though not mutually exclusive may be called, respectively, “demonstrations by the teacher” and “experimental activities carried out by the students”. Through demonstration various scientific procedures, processes and phenomenon are being shown to the students by the teacher for illustration, explanation and clarification of certain physics concepts. In the physics laboratory work, the teacher conducts certain kind of experiments while the students observes it and ask various kinds of questions concerning the experimental function performed by teacher. For example physical devices such as pendulum bob, string and stop watch can be used to illustrate, explain and clarify concepts such as oscillation, period, and acceleration due to gravity. As explained by [9], demonstration activities are associated with the “giving out” or transmitting to others, information and ideas already acquired by the demonstrator. However, in some situations the demonstrator may be either the teacher or a student or an expert (technician) in the aspect of the topic being taught by the teacher.

When physics teacher (or invited expert/technician) demonstrates to students how to perform an experiment to illustrate certain physics concept it is likely that the students will have deeper understanding of the concept and more importantly arouse their interest in physics. A major question in this study is: To what extent do physics teachers demonstrate practical activities in Physics lessons? One of the foci of this study was to survey the frequency at which teachers demonstrate practical activities to their students in Physics lessons. The frequency at which teachers also allow their students to demonstrate, among themselves, practical activities was also surveyed.

In the “experimental activities carried out by the students”, emphasis may be on individual student or on small groups working together. In most schools in Nigeria, according to [9], when students are given the opportunity to conduct the experiments themselves they make use of laboratory manual – where all the steps which

the students are expected to follow have been outlined. An important question in this study is: To what extent do physics teachers give students the opportunity to carry out experiment themselves in Physics laboratory? Another major focus of this study was to survey the frequency at which physics teachers allow their students to carry out experimental activities in the physics laboratory. However, to place this study into its proper perspective, the number of schools having functional laboratories was also determined. In addition, reasons why physics teachers do not give enough opportunities to their students to engage in practical activities and possible ways of solving the problems were also examined.

Results of the study would assist policy makers (Principals, Officials of the Ministry of Education and Secondary School Boards) to have empirical information about the situation of laboratory activities in physics education programme in schools. The ultimate is to provide evidence for policy makers on the need to provide funds in order to enhance the quality of teaching and learning of physics in secondary schools and more importantly to help students acquire the necessary practical skills for driving the technological, scientific and socio-economic of Nigeria. The results of this study would provide such empirical evidence.

No doubt, some studies such as [26,27] have been carried out on the survey of practical activities in physics lessons, but few such as [28] had looked at the frequency at which physics teachers demonstrate practical activities in physics lesson and allow their students to carry out physics experimental activities in the laboratory. It is on the basis of these facts that the author surveyed the level of laboratory activities in schools with the view of establishing the extent to which physics teachers demonstrate practical activities and allow their students to engage in experimental activities in Physics lessons.

Research Questions

1. Do schools have physics laboratory?
2. Do schools have equipment for physics laboratory activities?
3. To what extent do physics teachers demonstrate practical activities in physics lessons?
4. To what extent do physics teachers allow students engage in experimental activities in Physics lessons?

5. What are the factors that hinder physics teachers to engage their students in laboratory activities?
6. What are the suggestions on how to solve these problems?

to list two reasons that hinder physics teachers from engaging their students in practical activities and two ways by which such problems can be solved.

2. METHODS

2.1 Participants

One hundred and three Physics teachers were randomly sampled from 103 public senior secondary schools in Oyo State, Nigeria. The 103 teachers comprised 91 males and 12 females. Their ages ranged between 27 and 55 years. Their teaching experience ranged between 5 and 30 years. Eighty six of them had first degree in Physics and Education, 10 had Higher National Diploma in Engineering and Postgraduate Diploma in Education, while seven had first degree in Engineering and no qualification in education.

2.2 Materials

One research instrument titled "Physics Teachers Questionnaire" (PTQ) was used (see Appendix A). The PTQ has four sections A, B, C and D. Section A sought information about the sex, age, qualification and teaching experience of the sampled teachers; section B sought information about availability or otherwise of laboratory, equipment and facilities; section C sought information about number of times the teachers taught physics, demonstrate practical activities and the number of times students carry out practical activities in the laboratory each week. In Section D physics teachers were asked

2.3 Administration of the PTQ

Twenty higher degree students at the Institute of Education, University of Ibadan were employed to serve as research assistants. Each was given six or five copies of PTQ and visited five or six schools. The PTQ was administered to sampled teachers during the official school hours. The time for filling of the questionnaire, on the average, was 15 minutes.

2.4 Analysis of Data

Responses of the 103 sampled teachers were analysed using frequency counts and percentages.

3. RESULTS AND DISCUSSION

Table 1 presents the results of the Physics teachers to section B of the PTQ.

The information in Table 1 is used to answer research questions 1 and 2.

Research Question 1: Do schools have physics laboratory?

From Table 1, it is obvious that most schools have physics laboratory. This because out of the 103 teachers/schools sampled, 86 (83.5%) responded that they had physics laboratory.

Table 1. Survey of practical activities in physics lessons

Statements	Response	
	Yes	No
1. Do you have science laboratory in your school?	103 (100.0)	0 (0.0)
2. Does your school have separate laboratory for Physics practical work?	86 (83.5)	17 (16.5)
3. Does your school have equipment and facilities for physics practical work?	103 (100.0)	0 (0.0)
4. Does your school have a separate laboratory for Biology practical work?	80 (77.7)	23 (22.3)
5. Does your school have a separate laboratory for Chemistry practical work?	88 (85.4)	15 (14.5)

**Number in parenthesis represents percentages*

Research Question 2: Do schools have equipment and materials for physics laboratory activities?

The response of the Physics teachers shows that most schools have equipment and facilities for physics practical. This is because all the teachers responded that they have equipment and facilities for physics practical. However, information about the nature of the equipment and facilities as well as adequacy of such equipment and facilities were not sought.

Research Question 3: To what extent do physics teachers demonstrate practical activities in physics lessons?

To answer this question the responses of the teachers to question on the number of times in a week they carry out demonstration in physics lessons were analysed. Most of the teachers responded that they carry out demonstration of physics activities three times a week. From the responses of the teachers, it is obvious that to a great extent, physics teachers demonstrate practical activities in physics lessons. This can be inferred from the fact that in most schools, the number of times for physics lesson is either three or four times in a week on the school official time table. If the teachers responded that they demonstrate physics practical activities three times in a week, it then means that to a great extent physics teacher demonstrate practical activities in physics lessons.

Research Question 4: To what extent do physics teachers allow students engage in experimental activities in Physics lessons?

Most of the physics teachers sampled 100 (97.1%) responded that in a week, students are allowed to carry out practical activities only once. From the responses of the teachers, it is obvious that, to a large extent, students are not exposed to enough practical activities. The number of times that students are allowed to carry out practical activities is grossly inadequate.

Research Question 5: What are the factors that hinder physics teachers to engage their students in laboratory activities?

In order to answer this question, the respondents were asked to state two factors that hinder physics teacher from engaging their students in practical activities in physics lesson. Summary of some of the issues raised by the teachers are follows:

- a) Lack of enough equipment and facilities: This means that though some schools may have equipment and facilities, the question is: are these equipment and facilities enough? What one can tease out of this is that the equipment and facilities may be available but it appears they are not enough.
- b) Lack of enough time: Most teachers were of the opinion that there was no enough time for physics practical. From the unscheduled interview with some of the physics teachers, one can infer that time for physics lessons and practical activities is not enough.
- c) Lack of enough laboratory attendants: Most of the sampled teachers were of the opinion that there are no enough laboratory attendants in schools. The importance of laboratory attendants in the conduct of practical activities cannot be overemphasized. The laboratory attendants are to assist the physics teachers in the preparation and conduct of physics practical and if they are not available in schools the task of conducting practical activities is likely to be so much for the physics teacher.
- d) Lack of motivation: Most the respondents complained about not receiving salaries for about five months. When salaries are not paid for months the zeal to do work may be dampened.

Research Question 6: What are the suggestions on how to solve these problems?

In order to answer this question, the respondents were asked to state two ways by which these problems could be solved. Summary of some of the issues raised by the teachers are follows:

- a) Proper Funding of Practical activities in schools: The respondents were of the opinion that government should provide enough funds to schools for the purpose of buying enough equipment and facilities for physics practical.
- b) Employment of more laboratory attendants: Government should employ more laboratory attendants. This will go a long way in solving the problem of no enough time on the part of physics teacher. When the physics teacher is busy doing some other work; for example teaching in another class, the physics students could be engaged in laboratory

activities under the supervision of the laboratory assistant.

- c) Motivation: Most of the teachers were of the opinion that it is when government fulfils its own side of the contract that is pay up their salary that teachers too will be happy to teach and conduct practical activities as expected of them (teachers)

3.1 Discussion

The results of this study agree with the earlier findings such as [28,9]. Past studies such as [5,8] have found out that though teachers demonstrate practical work in physics lessons, students are not properly exposed to practical and experimental activities in the physics laboratory. For example in the study of [28] the major findings include that teachers used mostly transmissive pedagogy to assist students to understand physics concepts and theories. Even though there are clear and specific instructions for the teachers to do demonstrations in the secondary physics curriculum, there were constraints on teachers and on students trying to conduct practical work.

It is interesting that although teachers were very much aware of the value of doing practical work in teaching and learning physics; and although they are instructed in the secondary physics curriculum to do demonstrations in teaching physics, few of them regularly did demonstrations or used practical activities in teaching the concepts of physics. Findings show that they did demonstrations only to teach the practical experiments. They mentioned reasons for not being able to do demonstrations in classroom teaching: the teaching aids particularly related to all the contents of physics, were not available in their schools, or the equipment provided was only that which was required to do the experiments included in the syllabus. Some of them infrequently used equipment in teaching the contents of physics, because they did only practical work related to the set experiments. This indicates that in these schools, as in schools in some other developing countries, lack of equipment presents a major problem in effective teaching and learning of physics in Nigeria. The lack of equipment seemed to be one of the important factors hindering teachers and students from doing a reasonable amount of practical activities both in theoretical and practical classes in Nigeria.

Therefore one can conclude that the reason why students are not properly exposed to practical

activities may be due to ill-equipped laboratories in most public schools or lack of interest on the part of the teachers or students. Another reason why students do little practical activities in the laboratory is time allocated to Physics on the official school timetable. As rightly observed by [28] and [21] time apportioned to Physics and other science subjects is not enough to accommodate laboratory sessions. Casual visits and scheduled observations of a number of physics classes showed that quite a number of Physics teachers focus attention on completing the scheme of work rather than on the quality of teaching. In this situation, the ample opportunity needed by the students to develop new content, knowledge, techniques and approaches to scientific activities and exploration is not made possible.

4. SUMMARY OF FINDINGS AND CONCLUSION

Results of this study have shown that:

- a. Most schools have science laboratory
- b. Most schools have separate laboratory for physics practical work
- c. Teachers, to a large extent, demonstrate practical activities in physics lessons
- d. Students, to a large extent, are not exposed to enough practical and experimental activities in Physics
- e. Teachers were of the opinion that though schools have equipment and facilities for physics practical activities, the equipment and facilities are not enough
- f. Lack of enough equipment and facilities, lack of enough time on the school official time table for practical physics, lack of enough laboratory attendants and lack of motivation of the teachers are some of the factors that hinder physics teachers from engaging their students in practical work in physics lessons
- g. Teachers were of the opinion that government should provide more funds for the schools so that schools can buy more equipment and expand their facilities for physics practical. More importantly government should as a matter of urgency motivate the teachers by paying up the accumulated salaries.

5. IMPLICATIONS OF FINDINGS

The findings of this study are pointers to some of the reasons why many students are not showing

interest in Physics. Physics to be interesting to students, physics teachers must be ready to show that physics concepts can be explained using physical objects and practical activities. When students observe that physics concepts can be demonstrated using physical objects in their immediate environment and that practical activity can be conducted with real life objects the wrong impression being held by many students that physics is abstract and difficult will be corrected.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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Appendix A

This questionnaire has been developed to elicit information on the availability of functional Physics laboratory in your school. The question also seeks information on the frequency at which laboratory activities were being carried out in your physics lessons. Please kindly give your honest information on every item. All information will be treated with utmost confidentiality.

Instruction: Please respond to all questions/items

Section A

1. Name of School.....
2. School Location Urban..... Rural
3. Sex: Male..... Female.....
4. Highest Qualification
5. Years of Experience in Teaching Physics.....
6. How many students are in your class?.....No of Boys.....No of Girls...

Section B

7. Do you have science laboratory in your school? Yes..... No..... (place a tick)
8. Do you have a separate laboratory for Physics practical work? Yes..... No..... (tick)
9. Do you have equipment and facilities for Physics practical work in your laboratory? Yes... No.... (tick)
10. Does your school have a separate laboratory for Biology practical work? Yes.....No..... (tick)
11. Does your school have a separate laboratory for Chemistry practical work? Yes.... No.... (tick)

Section C

12. How many times in a week do you have Physics on your class time table?.....
13. How many times in a week do you demonstrate practical activities in physics lesson?
14. How many times in a week do your students carry out experimental activities in Physics?

Section D (Use the back of this sheet if need be).

15. List two reasons that you think hinder physics teachers from engaging their students in practical laboratory work in Physics lessons

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16. Suggest two ways by which such problems can be solved.

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