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An assessment of physics laboratory teaching and learning resources in two Nigerian universities

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Abstract

It is hard to imagine learning science without doing laboratory or fieldwork. The research work in this paper assessed the state of physics laboratory teaching and learning resources in some selected universities in the South West geopolitical zone of Nigeria. The survey was carried out in five universities namely The University of Lagos, University of Agriculture, Lagos State University, Olabisi Onabanjo University and Covenant University. An 88-item inventory assessment questionnaire was administered and responses were collated for analysis. Descriptive statistics were used to analyse the data derived from the study. Findings revealed that there is dearth of modern and specialised physics laboratory equipment/resources; and the obsolete state of most workshops. Inadequacy of the available resources was also observed where some universities combine physics students from the Faculties of Education and Science for most practical sessions. Based on the findings, the study proffers some recommendation that could improve the resource situations in these universities.

Keywords: Physics, laboratory, learning.

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1. Introduction

Physics as a science subject is activity oriented and resource intensive. This suggests that the mastery of physics concepts cannot be fully achieved without the use of laboratory teaching and learning resources. The teaching of physics without learning materials and laboratory resources will certainly result in poor performance in the course. Franzer, Okebukola and Jegede (1992) stressed that for any professionally qualified science teacher, no matter how well trained, it would be impossible to put his ideas into practice if the school setting lacks the equipment and materials necessary for him or her to translate his competence into reality. Furthermore, Ogunleye (2000), Mkpanang (2005) and Obioha (2006) have pointed out that most secondary schools in Nigeria lack adequate laboratory resources for the teaching of science subjects. They further remarked that the few resources that are available are generally not in good conditions, while the few that were in good conditions were not enough to go round those who needed them.

In Nigeria, laboratory work has always been an integral component of the physics curriculum at all levels of our educational system. Laboratory practical activities at the secondary level are primarily based on 'discovery' learning while in an undergraduate physics laboratory, for example, students are expected to make precise measurements, have investigative skills and discover the interplay between experimentation and fundamental principles underlying physical phenomena. Unfortunately, such innovations in the teaching–learning of physics have not impacted much at the undergraduate level in our universities. In fact, physics laboratory instruction has all along consisted primarily of performing pre-set repetitive experiments, where students are made to go through a prescribed series of steps wherein they are advised to verify certain laws/concepts learnt in theory. Such a routine exercise neither promotes scientific investigative skills nor an understanding of the subtle interplay between observation and experimentation. As a result, most students in our tertiary institutions of learning tend to view physics as merely an abstract collection of laws, mathematical equations and textbook problems rather than as a way of understanding and modelling physical phenomena.

2. Review of literature

Laboratory work is an active learning activity which involves students performing experiments with concrete objects and concepts. According to Hofstein and Lunetta (2004), laboratory work not only promotes science content and knowledge but also science process skills, creative thinking and problem solving ability in students. Similarly Wang and Coll (2005) also stated that students learn science more effectively by engaging in practical work where they have an opportunity to gain knowledge in the same way as scientists do. In addition, Havdala and Ashkenazi (2007) pointed out, when students engage in laboratory activities, they are expected to link previous theoretical knowledge with experimental design, data analysis and experimental interpretation and to link laboratory results with theory. According to Wellington (1989), the benefits of the laboratory activities for students in learning science can be summarised in three domains: to develop the cognitive domain (e.g. science content and the nature of science); to develop the affective domain (e.g. promote positive attitude toward science); and to develop skills (e.g. science process skills, laboratory skills, problem solving skills, inquiry skills and communication skills).

Laboratory activities have been defined as learning experiences in which students interact with material, apparatus and chemicals to observe phenomenon. Effective learning takes place when science is taught through this medium of practical work (Okebukola, 1985).

According to Omosewo (2001), when students do practical work, besides content achievement and cognitive development, the activities more succinctly help to develop skills in scientific thinking. Such thinking, she further stated, consists of not only deductive and inductive reasoning but also involves generalising operations and logical thinking that enhances learners' abilities in identifying problems and questions; discrimination and categorisation which are fundamental in physics learning;

measuring quantities; manipulating materials and data; formulating hypothesis and law. Ogunleye and Baiyelo (1988) examined students' achievement in physics by utilising three laboratory methods. The results of their findings show that laboratory work contributes more to concept learning and experimentation than problem solving. The study also revealed that low ability students benefit more from laboratory work than high and medium ability students.

Allie (1998) remarked thus: 'Unfortunately, in many cases, the laboratory has turned into a place to either 'demonstrate the truth of something taught in lecture' or to 'produce good result'. The focus in both cases is on the content and not on what might be valuable for a student to learn from the activity'. He further stated that these 'cookbook' laboratories—those in which highly explicit instructions are given and the student don't have to think—are common and unpopular with students as they tend to produce little learning.

Okebukola (1990), Jegede (1999) and Omosewo (2001) apart from emphasising the importance of laboratory work to the teaching and learning of science also bemoaned the non-availability and inadequacy of laboratory materials and equipment. Infact, Ajewole, Ajogbasile and Okebukola (1990) observed a situation where over 20 students crowded a piece of equipment while performing laboratory practical work.

3. Goals and purposes of laboratory work

Laboratory practical work even though has been an essential element of the physics curriculum for more than a century, unfortunately, science education has still not yet reached a consensus as to the educational goals or the best way to assess those goals for physics laboratories. Some research studies, reviews and summaries of research in science education literature up to 1970s such as those of Wilson (1962), Novak (1963), Hurd and Row (1966) and Novak (1970) gave a long list representing the purposes of laboratory work which can be summarised according to four different categories of: (a) skills (accurate use and manipulation of instruments, inquiry skills, order and communication, critical thinking and problem solving), (b) concepts (concrete representation of concepts, application of learned concepts to higher levels and discovery of new concepts), (c) the nature of science (understanding the nature of science and its development, and knowing how scientists work) and (d) attitudes (curiosity, openness, reality, objectivity, accuracy and cooperation in teamwork). Hodson (1993) claims that empirical substantiation regarding the effectiveness of laboratory work as a way of learning scientific concepts is hard to interpret and somewhat uncertain while (Hofstein & Lunetta, 1982) on the whole believed that, it cannot be argued that laboratory work is superior to other approaches Likewise, research findings on the impact of laboratory work on students' understanding the nature of science are also unsatisfactory (Klopfer, 1990; Millar, 1989). A major change in the goals and purposes of the laboratory work took place, however, when an alternative approach to science learning and constructivism began to gain acceptance. Constructivists hold that learning is an interpretive development, as new information is given sense in terms of the student's prior knowledge. Hence, from a constructivist point of view, each learner actively constructs and reconstructs his or her understanding rather than receiving it passively from a more authoritative source. According to these constructivist principles, the AAPT (1997) published a new set of goals for the physics laboratory as follows:

Goal 1. The art of experimentation: the introductory laboratory should engage each student in significant experiences with experimental processes, including some experience designing investigations.

Goal 2. Experimental and analytical skills: the laboratory should help the students to develop a broad array of basic skills and tools of experimental physics and data analysis.

Goal 3. Conceptual learning: the laboratory should help students to master basic physics concepts.

Goal 4. Understanding the basis of knowledge in physics: the laboratory should help students to understand the role of direct observation in physics and to distinguish between inferences based on theory and the outcomes of experiments.

Goal 5. Developing collaborative learning skills: the laboratory should help students to develop collaborative learning skills that are vital to success in many lifelong endeavours.

4. Resources: their scope and definition

Resources can be defined as all those sources of help, which may be utilised by an individual or a student for the purpose of achieving the goals of learning. According to Osiyale (1998), it encompasses all persons and things capable of conveying information, values, processes, experiences and techniques that can be used to actively engage the student in the learning process.

There are various resources that can be used for science teaching. Some of these are as follows:

- Physical resources such as school buildings, classrooms, school plants, laboratories, libraries etc.
- Human resources such as teachers and students.
- Material resources such as laboratory equipment and chemicals, teaching aids, bulletin boards, etc.
- Time resources such as number of periods per week, duration of lesson, school calendar, etc.
- Environmental resources such as items in the locality, household appliances, teaching or storage spaces, industrial resources, etc.
- External resource persons such as carpenters, mechanics, etc.
- Technological resources such as computers, radio/television, projectors, etc.
- Instructional materials such as textbooks, teachers' guides, exercise books, etc.

Today, we are not unaware of the inadequacies of the provision, usage, availability and management of these resources in schools. However, for learning to be effective, the optimal utilisation of these resources is of great importance for a subject like physics.

Schwab (1971) emphasised this when he said thus:

> ***'Theories of curriculum teaching and learning cannot alone tell us what and how to teach, because questions of what to teach and how to teach, arise in concrete situations loaded with concrete examples of time, place, person and circumstances'***

These concrete situations could be taken to mean the resources that are available. Thus, the implementation of the present science curriculum in Nigerian schools would be more likely to succeed if adequate resources are provided for in each.

5. Statement of the problem

In Nigeria, one of the most striking problems of science education is that of inadequate science teaching materials (Abimbola, 2001). Many scholars such as Ivowi (1992) and Ogunleye (2000) apart from stressing the importance of learning and teaching resources to scientific literacy and development had also decried their non-availability and inadequacy. Ogunmode (2006) traced the low level of our scientific and technological advancement after over four decades of independence due to lack of learning resources for science, technology and mathematics and the poor state of our schools' science laboratories and infrastructure, amongst other factors.

Furthermore, Akunyili (2010) in a lecture on 're-branding of Nigerian Universities' lamented thus: 'unfortunately, what we have today in many universities are insufficient, over-crowded classrooms spaces and non-existent or dilapidated laboratories. I visited a pharmacy school a few years ago and did not find a single functional tableting machine—we are training students, especially in the sciences, who may turn out to be illiterates in their fields of specialisation'. Ukah (2009) in his treatise on 'Nigeria's tertiary education and the twenty-first century' collaborated the scholars' positions when he emphasised thus: 'It is also important to remind us that most of the solutions to our nation's economic, social, scientific and technological woes reside within the walls of well-equipped classrooms and functional laboratories—a critical realisation that remains the true genius of the developed world'.

6. Purpose of study

This paper assesses the physics laboratory resources available in some selected tertiary institution (universities) in Lagos and Ogun States of Nigeria. The purpose of study is as follows:

1. To appraise the different types of laboratory facilities and materials available in each of the institutions selected.
2. To identify how adequate are the available equipment/resources.
3. To identify how often the available equipment/resources are utilised.

7. Research questions

1. What laboratory equipment/resources are available for the teaching and learning of physics in the Universities in Lagos and Ogun States of Nigeria?
2. How adequate are these available laboratory and workshop equipment/resources for the teaching and learning of physics in the Universities in Lagos and Ogun States of Nigeria?
3. How often are these laboratory facilities utilised for the teaching and learning of physics in the Universities in Lagos and Ogun States of Nigeria?

8. Methodology

The descriptive survey method was used for the study. Data for the research work were collected with the use of a checklist, which was developed by the researchers during visits to the selected universities. The questionnaire solicited for information on the availability, adequacy and the utilisation of physics teaching and learning resources in the selected tertiary institutions. The questionnaire was administered to physics lecturers, laboratory staff and students in the South West geopolitical zones of Lagos and Ogun states of Nigeria. These states were chosen because of the features in the variable of study. The five universities used in the study were selected through purposive sampling from the two states. This comprised of two federal universities, two state universities and one private university. The purposefully selected universities were: Federal universities—University of Lagos, Akoka (UNILAG), University of Agriculture, Abeokuta (UNAAB); State universities—Lagos State University, Ojo (LASU), Olabisi Onabanjo University, Ago-Iwoye (OOU); Private university—Covenant University, Ota (CU). A total of five teachers, 20 students and non-academic staff were randomly selected from each sampled school.

9. Research instrument

The research instrument used was a questionnaire designed by the researchers for the physics lecturers, laboratory staff and students. It consists of two sections. Section A sought demographic information such as school, age and qualifications of respondents. Section B of the questionnaire consists of five sub-divisions of equipment/resources inventory on the laboratories which were grouped under their appropriate sections for easy analysis. These are measurement/instrumentation, general physics, electronics, optics laboratories and machine shop. A total of 150 items were initially listed under the aforementioned sections. The questionnaire was later validated which occasioned the reduction of the items to 88. The coefficient of reliability of the questionnaire was 0.80. Furthermore, the researchers did not rely only on the common instructional and laboratory resources available in these institutions, but extensively sought information from physics departments of reputable universities abroad on the latest resources and technologies available and used in the teaching and learning of physics.

Responses for availability, adequacy and usage were solicited in respect of the listed physics teaching and learning resources. The responses were then sorted, collated and analysed using simple frequency counts and percentages. The Microsoft excel software package was employed in the analysis of the data due to the large number of items and subsequent data generated. The statistical analysis also employed the SPSS software for the Chi-square test analysis. The results were presented and displayed in tables and figures.

10. Results and discussions

Research Question 1: What laboratory resources are available for the teaching and learning of physics in the Universities in Lagos and Ogun States? The detailed analysis to answer research question 1 is shown in Table 1.

Table 1. Percentage of responses indicating availability of laboratory resources groupings in the universities

	Teaching/learning resources	Available (%)	Not available (%)
1	Measurement/Instrumentation Physics Laboratory	50.05	49.95
2	General Physics Laboratory	37.88	62.12
3	Electronics Laboratory	31.82	68.18
4	Optics Laboratory	23.74	76.26
5	Machine Shop	42.81	57.19

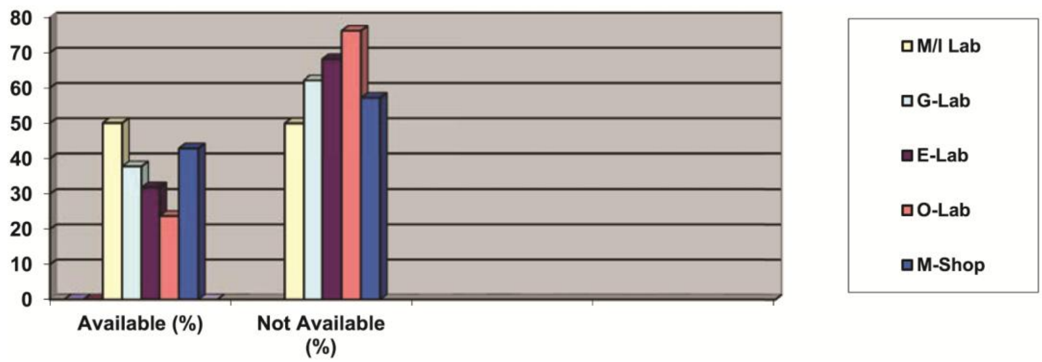

Figure 1. Bar Chart indicating percentage of availability of equipment/resources

Data in Table 1 above reveal that majority of the responses indicated the availability of items within the measurement/instrumentation, machine shop and general physics laboratories. However, the most frequently available of these laboratory resources groupings include measurement/instrumentation physics laboratory (50.05%) and machine shops (42.81%). General physics laboratory items (37.88%) were less frequently available in the universities laboratories, while electronics laboratory (31.82%) and optics laboratory (23.74%) items were rarely available for the teaching/learning of physics in schools.

A further analysis of the percentage of responses for each of the equipment/resources in the laboratories of the participating universities is shown in Table 2.

Table 2. Percentage of responses indicating availability for each individual equipment/resources in the universities

	Availability	UNAAB (%)	LASU (%)	OOU (%)	UNILAG (%)	CU (%)
S/N	**Section B: Types of Laboratories**					
B1	**Measurement/Instrumentation Physics Laboratory**					
1	Moving Die Rheometer	25.00	14.28	30.00	64.26	25.00
2	Oscillating Disc Rheometer	50.00	14.28	30.00	64.26	25.00
3	Dynamic Mechanical Analyser	37.50	14.28	10.00	21.42	18.75
4	Tensile Testing Machines	37.50	14.28	40.00	57.12	12.50
5	Capillary Viscometers	37.50	14.28	50.00	71.40	62.50
6	Fatigue Tester (Flexometer)	25.00	0	20.00	21.42	12.50
7	Hardness Tester	50.00	0	40.00	42.84	50.00
8	Micro Hardness Tester	37.50	0	40.00	28.56	68.75
9	Thermal Conductivity Tester	37.50	14.28	60.00	78.54	37.50
10	Gas permeability Tester	62.50	42.84	40.00	21.42	18.75
11	Density Tester	37.50	28.56	50.00	64.26	25.00
12	Ozone Ageing Chamber	12.50	0	20.00	14.28	18.75
13	Electronic Thermometer Set	62.50	28.56	80.00	85.68	75.00
14	Stiffness Tester	37.50	0	30.00	14.28	25.00
15	UV and Visible Light Tester	37.50	0	20.00	14.28	31.25
16	Rotational Flexometer	12.50	0	10.00	35.70	25.00
17	Bending Flexometer	25.00	0	10.00	35.70	25.00
18	Cathetometer	12.50	0	30.00	14.28	18.75
19	Digital Stopwatch	75.00	57.12	80.00	64.26	62.50
20	Horizontal and Vertical Microscope	100	14.28	70.00	49.98	62.50
21	Meter Rule	87.50	57.12	100	99.96	100
22	Vernier Calipers	87.50	71.4	100	99.96	100
23	Spherometer	37.50	28.56	10.00	49.98	43.75
24	Telescope	50.00	28.56	40.00	49.98	43.75
25	Micrometer Screw Gauge	87.50	99.96	90.00	99.96	100
	Total (%)	**46.15**	**21.42**	**44.62**	**51.63**	**43.27**
B2	**General Physics Laboratory**					
26	Waveform Synthesiser	12.50	0	30.00	7.14	31.25
27	Precision Sine Drive	12.50	0	30.00	7.14	31.25
28	Jumping Ring Apparatus	50.00	0	30.00	7.14	37.50
29	Kater’s Pendulum	37.50	0	40.00	42.84	31.25
30	Master Spectrum Analyser	37.50	28.56	30.00	42.84	31.25
31	Steam Heater (Boiler)	37.50	85.68	20.00	42.84	43.75
32	Solar Educational Kit	25.00	0	30.00	21.42	43.75
33	Steam Engine Unit	12.50	0	20.00	21.42	31.25
34	Malvern Energy Conversion Unit	25.00	0	20.00	28.56	18.75
35	Gold leaf Electroscope	37.50	28.56	40.00	71.40	37.50
36	Van de graff Generators	25.00	28.56	50.00	28.56	43.75
37	Magnetising and Demagnetising Solenoid	37.50	28.56	40.00	49.98	43.75

38	Coil Apparatus	50.00	99.96	60.00	64.26	50.00
39	Induction Coil Dynamo	50.00	85.68	60.00	57.12	43.75
40	Electrical Vibrator	25.00	0	40.00	57.12	37.50
41	Tangent Galvanometer	12.50	14.28	20.00	42.84	37.50
42	Linear Air Track	12.50	0	40.00	14.28	31.25
43	X-ray Recorders	37.50	0	30.00	57.12	31.25
44	Atomic Force Microscopy	12.50	0	0	0	31.25
45	Gamma Spectrometers	25.00	0	20.00	21.42	31.25
	Total (%)	**28.75**	**19.99**	**32.50**	**34.27**	**35.94**
B3	**Electronics Laboratory**					
46	Cathode Ray Oscilloscope	37.50	99.96	30.00	71.40	50.00
47	Frequency Counter	37.50	14.28	40.00	49.98	56.25
48	Spectrum Analyser	12.50	0	20.00	42.84	43.75
49	Signal Generator (range: 20Hz and above)	12.50	0	40.00	21.42	56.25
50	Multiplexers	12.50	14.28	30.00	42.84	50.00
51	Frequency Generator (R.F)	25.00	0	30.00	49.98	56.25
52	Vernier Detectors for: (Motion, Microtones, Light, Sensors, Temperatures, Magnetic, Force)	12.50	0	40.00	42.84	43.75
53	Digital Oscilloscope (range 20 mHz–19 Hz)	12.50	28.56	50.00	42.84	62.50
54	Pulse Generator (1 seconds to 1 nanoseconds)	12.50	0	20.00	14.28	50.00
55	Pulse Counters	12.50	0	30.00	21.42	43.75
56	Power Supplies (low voltage, High voltage)	50.00	99.96	80.00	57.12	75.00
57	Amplifiers	62.50	99.96	80.00	49.98	81.25
58	Avalanche Photodiode (1-GHz bandwidth)	12.50	0	10.00	28.56	18.75
59	Monochrometers (1/4 and ½ meters)	25.00	0	20.00	21.42	25.00
60	Transistor Apparatus	62.50	85.68	70.00	42.84	43.75
	Total (%)	**25.78**	**27.67**	**36.87**	**38.38**	**47.66**
B4	**Optics Laboratory**					
61	Optically Pumped Molecular Lasers	0	0	30.00	14.28	12.50
62	Optical Parametric Oscillator	12.50	0	10.00	14.28	18.75
63	Optical Tweezers	37.50	0	30.00	14.28	6.25
64	Far Infrared Laser Stark	0	0	20.00	14.28	0
65	Direct Vision prism	37.50	71.40	40.00	28.56	18.75
66	Spherometer	75.00	14.28	30.00	35.70	37.50
67	Sextant	37.50	0	0	28.56	31.25
68	Spectrometer	62.50	14.28	50.00	42.84	43.75
69	Interference Lens	37.50	85.68	40.00	42.84	37.50
70	Fibre Optics	25.00	85.68	30.00	35.70	31.25
71	Kliger Electron Diffraction Apparatus	12.50	0	50.00	21.42	18.75

72	Laser Photonics Nitrogen-Dye System	37.50	0	0	0	12.50
73	Optical Cryostat	12.50	0	30.00	14.28	12.50
74	Stroboscope	12.50	0	30.00	42.84	25.00
75	Telescopes	37.50	14.28	30.00	57.12	37.50
76	Gamma Vision Software	0	0	20.00	35.70	18.75
77	SQUIDS	0	0	0	0	0
	Total (%)	25.73	16.80	26.47	26.04	22.06
B5	**Machine Shop**					
78	Lathe Machine	12.50	42.84	40.00	35.70	43.75
79	Milling Machine	25.00	0	20.00	21.42	25.00
80	Band Saws	25.00	14.28	50.00	64.26	37.50
81	Drilling Machine	37.50	14.28	70.00	64.26	31.25
82	Work Table	62.50	57.12	80.00	99.96	93.75
83	Vice (Varieties)	25.00	14.28	60.00	71.40	62.50
84	Variety of hand Tools	75.00	71.40	70.00	99.96	50.00
85	Personnel protective Equipment	62.50	14.28	40.00	99.96	56.25
86	Furnace or Oven	12.50	0	10.00	14.28	12.50
87	Centrifugal Mill	25.00	0	50.00	21.42	18.75
88	Laboratory Presses	0	0	40.00	42.84	18.75
	Total (%)	**32.95**	**20.77**	**48.18**	**57.76**	**40.91**

Data in Table 2 indicated the responses from the universities. UNILAG has the highest availability responses in machine shop (57.76%) and measurement/instrumentation physics laboratory (51.63%). OOU's low availability response of 26.47% for optics laboratory equipment is the highest for this group. The data further revealed that the most available laboratory resources for the teaching/learning of physics in the universities include meter rule, Vernier calipers, micrometer screw gauge with 100% availability in almost all the universities. However, optics laboratory equipment such as super conducting quantum devices (SQUIDS) has a zero (0%) response in all the universities sampled.

Research Question 2: How adequate are the available laboratory and workshop facilities for the teaching and learning of physics in the Universities in Lagos and Ogun States?

The percentage of responses indicating the adequacy or otherwise of the various equipment/ resources is shown in Table 3.

Table 3. Percentage of responses mentioning the adequacy of the items in the various physics laboratory/workshop in the universities

	Physics Laboratory/Workshop	Very adequate (%)	Fairly adequate (%)	Not adequate (%)
1	Measurement/Instrumentation Physics Laboratory	52.00	28.17	19.83
2	General Physics Laboratory	35.65	43.89	20.46
3	Electronics Laboratory	23.74	27.29	48.97
4	Optics Laboratory	20.15	22.78	57.07
5	Machine Shop	24.45	32.74	42.81

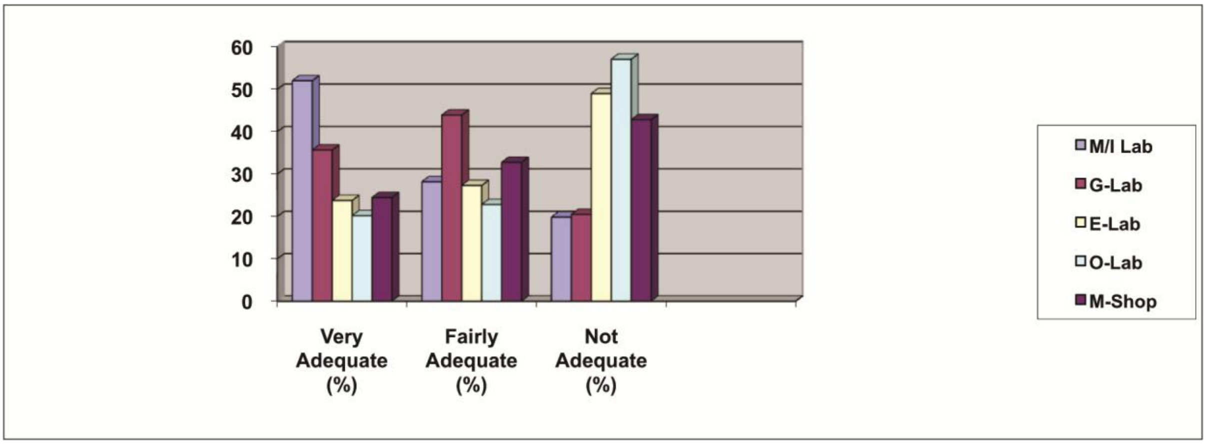

Figure 2. Bar Chart showing percentage of adequacy of equipment/resources

Data in Figure 2 show that more than one-half (52.00%) of the responses indicated that the items available in the measurement/instrumentation physics laboratory are adequate and nearly two-thirds (28.17%) believed it was fairly adequate. Also, more than one-third (35.65%) of the responses believed the items grouped under the general physics laboratory were very adequate and nearly one-half (43.89%) indicated that it was fairly adequate. However, less than one-quarter of the responses (23.74% and 20.15%) indicated that the items in the electronics and optics laboratories, respectively, were very adequate. Also, nearly one-half (42.81%) of the responses agree that the machine shop is not adequate. Inadequate laboratory equipment has long been identified as a factor hindering scientific and technology acquisitions and development in schools. Ivowi (1982) observed that there are not enough facilities for teachers to demonstrate phenomena. However, in making a case for improvisation as an antidote to inadequacy, Marjorie and Brown (1969) as quoted by Umoru and Bake (2007) had warned that teachers should not use inadequate facilities and equipment as an excuse to resort to poor teaching. Instead, they should learn to improvise.

Research Question 3: How often are these laboratory facilities utilised for the teaching and learning of physics in the Universities in Lagos and Ogun States of Nigeria?

Table 4 shows the percentage of responses indicating how often students use the available equipment/resources in the teaching/learning of physics in these universities. The data shows that the most frequently used resources in the teaching/learning of physics are laboratory resources in the measurement/instrumentation group (56.75%) and machine shop equipment (42.81%). Also, the data reveal that sometimes there are teaching/learning using resources within the general physics laboratory (30.98%) to enhance the teaching/learning of physics in the sampled universities. However, the least used teaching/learning resources are the laboratory materials within the optics laboratory group (10.86%).

Table 4. Percentage of the responses indicating how often they use the available resources in the teaching/learning of physics

	Teaching/learning resources	Always (%)	Sometimes (%)	Not at all (%)
1	Measurement/Instrumentation Physics Laboratory	46.75	36.50	16.75
2	General Physics Laboratory	28.31	30.98	40.71
3	Electronics Laboratory	37.87	29.43	32.70
4	Optics Laboratory	10.86	23.74	63.40
5	Machine Shop	42.81	33.78	23.41

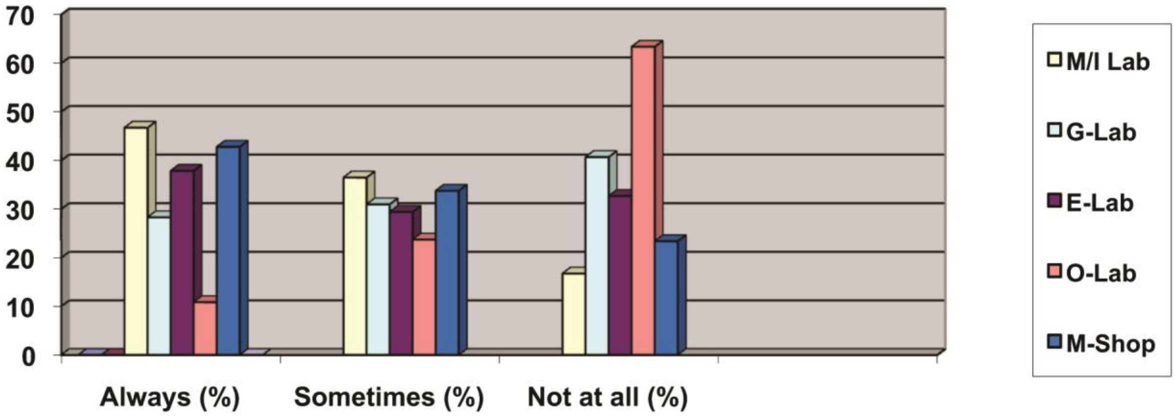

Figure 3. Bar Chart indicating how often they use the available resources in the teaching/learning of physics

In order to authenticate how adequate the available laboratory resources are being used in the teaching and learning of physics in the universities under consideration, the data represented in Table 4 were adopted and subjected to the confirmatory statistical tool using the Chi-square technique, the result of the analysis is shown in the Table 5 below.

Table 5. Result of Chi-Square analysis of adequacy of use of laboratory resources

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	20.000(a)	16	0.220
Likelihood Ratio	16.094	16	0.446
Linear-by-Linear Association	3.959	1	0.047
N of Valid Cases	5		

From the above result of the Chi-square analysis, it is observed that the *p*-value (0.220) is greater than the level of significance (0.05) of the test. Hence, the assumption (hypothesised statement) that the rate of use of the available resources for the teaching and learning of physics is not adequate is accepted.

11. Discussion of results

Eddie (2000) and Obasi (2000) have lamented that lack of facilities is the major problem in Nigeria's educational system, while Hallack (1990) saw these facilities as major determinants of academic achievements in the school system. Anukam (2006) and Mbakwem and Asiabaka (2007) were of the opinion that the cumulative effect of poor facilities results in poor motivation of students and low morale of teachers. The combined effect of these equally results in low quality work output. Many of our primary and secondary schools in most parts of the country today are faced with a lot of problems such as population explosion, overcrowded classrooms, inadequate learning materials and preponderance of unqualified, poorly educated and ill-motivated teachers (Ajayi, 2001). Apart from this, another major problem in our system of education in Nigeria is the erosion of quality. It has been aptly pointed out that the 'hands on experiences' acquired through interactive and practice-oriented programmes are completely lost when learners are denied the opportunity to handle or manipulate laboratory equipment, agricultural tools and other machines (Obanya, 2001).

If the necessary facilities/resources that will facilitate the training of students are not available, then the teaching–learning process cannot be successful.

12. Summary, conclusion and recommendations

This study was designed to assess the resources for the teaching and learning of physics in the universities. The findings of this study revealed the unavailability of some essential and modern teaching and learning resources; inadequate resource situation; and poor utilisation of available resources in the selected universities. From these findings, it can be concluded that government is paying lip service to this very important level of our educational system. It is at this level that teachers are trained who will eventually go to schools to teach physics.

The unavailability of specialised and modern physics laboratory equipment was obvious from the low responses received from the optics and electronics laboratory materials (Table 1) from all the universities. Items in this group include laser systems, optic fibre and digital electronic systems. The implication of this is that most physics graduates from Nigerian Universities will require additional training to effectively understand and handle modern telecommunication equipment that operate on fibre optics and laser technology. The inadequacy of physics teaching and learning resources is typical of the dearth of science laboratory equipment in the tertiary level of education. This problem is compounded by the fact that most physics education students share laboratory facilities with physics students in the Faculty of Science in most of the university sampled.

Furthermore, the findings of this study show that poor utilisation of available laboratory resources in the universities by both teachers and students is equally very disturbing. There is a deliberate recourse to rote learning in a practical oriented subject such as physics, by students, and preference to lecture method of teaching by the lecturers.

In view of the relevance of physics education to the actualisation of our goals in the development of science and technology education in Nigeria, the following recommendations are hereby suggested:

- Physics Education Laboratories should be adequately equipped to avoid their over dependence on the facilities of the Faculty of Science for their practical sessions where these facilities are shared.
- The gap between available and required physics teaching and learning resources should be bridged through regular evaluation of the resource situation by school administrators and the accreditation team of the National University Commission.
- Government should help to provide more funding through the Education Tax Funds, Petroleum Training and Development Fund and other similar subventions or interventions to support in the procurement of laboratory equipment and machine tools for the physics departments of federal and state universities.
- Physics lecturers, laboratory staff and school administrators should endeavour to use their skills and initiatives to explore and exploit their environment and improvise teaching and learning materials and equipment from local materials.
- Obsolete laboratory equipment and machineries should be replaced with modern and up-to-date facilities to guide against producing the twentieth century scientist in the twenty-first century.
- Local and International Physics Journals should be subscribed to by both the school and departmental libraries, and be made readily available to students.
- Physics lecturers and Laboratory staff should be empowered through undergoing regular trainings, seminars and workshops.
- The available resources should be optimally and prudently utilised. Waste and under-utilisation of resources should be minimised or eliminated.

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