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## Assessment of the Integral Role of Laboratory Facilities in the Preparation of Science Teachers for Functional Science Education

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### **Abstract:**

*This study examined the roles of laboratory facilities for functional science education among science teachers in Ondo State, Nigeria. The study employed descriptive research design of survey type. A total of 51 science teachers were sampled from selected 15 public secondary schools in Ondo West Local Government Area of Ondo State. A validated questionnaire tagged Laboratory Facilities and Functional Science Education Questionnaire (LFFSEQ) was used for data collection. The data collected were analysed using mean and standard deviation. The results of the study showed that secondary school teachers perceived that science education is important in improving scientific literacy, understanding the natural world and making crucial decisions on everyday issues. Some laboratory facilities were observed to be available but not adequate for teaching and learning of science. Teachers perceived that laboratory facilities have integral roles to play in preparing science teachers for functional science education. It was recommended that laboratory facilities should be made available and adequate for teaching and learning of science. Science teachers should have access to innovative classroom and scientific equipments. In-service training of science teachers should take cognizance of teachers' knowledge of the integral roles of laboratory facilities.*

**Keywords:** Adequate, available, functional, integral, laboratory facilities, science education

### **1. Introduction**

Science is the study of nature and natural events which are based mostly on empirical observations and quantitative measurement. It is an organized body of knowledge in form of concepts, laws, theories and generalizations. Science education is the field concerned with sharing scientific knowledge and methods with people not traditionally considered part of the scientific community (Aina, 2012). It is a field of study concerned with producing a scientifically literate society (Omorogbe and Ewansiha, 2013). Science education is instrumental to the development of any nation. Science education is the reason behind the success in science and technology in the developing world (Aina, 2013). For proper and effective teaching of the science to be achieved, laboratory must be an integral part of its curriculum.

According to Hamidu and Mohammed (2014), laboratory is a room or a building specially built for teaching and demonstration of theoretical phenomenon into practical terms. Laboratories have been found to be the scientists' workshop where practical activities are conducted to enhance a meaningful learning of science concepts and theories (Adeyemi, 2008). The National Research Council (2000) asserted that laboratory experiences provide opportunity for students to interact directly with the material world (or with data drawn from the material world), using the tools, data collection techniques, models and theories of science.

Secondary school is the base on preparing students for science education. Students at this level are exposed to laboratory equipments necessary to conduct meaningful demonstrations and experiments. Neji, Ukwetang and Nja (2014) emphasized the dependency of effective teaching and learning of science on the furnishment of secondary school laboratories with adequate laboratory facilities. Laboratory practical are dependent on the level of equipping the laboratory with relevant instructional materials and effectively utilizing them (Katcha, 2005; Otive, 2006).

Science teachers are key factors to be considered when talking about the development of science education in any nation. Onasanya and Omosewo (2011) opined that no matter how well-trained a science teacher is, he would be unable to put his ideas into practice if the school laboratory lacks the equipment and materials necessary.

Adequacy of laboratory facilities and students' academic performance, as well as the teaching and learning experience centre on the extent of adequacy of laboratory facilities in secondary schools and the teacher's effectiveness in the use of laboratory facilities with the aim of facilitating and providing meaningful learning experience in the learners. Okafor (2000) and Aburime (2004) in their separate studies on the influence of adequacy of laboratory facilities found out that adequacy of laboratory facilities had significant influence on students' academic performance in secondary school Chemistry teaching.

Akpan (2006) examined adequacy of laboratory facilities using frequency counts and percentages. The results revealed that 61.1% of the respondents agreed that the laboratory facilities for the teaching of Chemistry were adequate in

secondary schools while 38.9% agreed that the laboratory facilities were not significantly adequate. In contrast to this, Mkpanang (2005) and Obioha (2006) reported that there were inadequate facilities for the teaching of science subjects in secondary schools in Nigeria. They further stated that where there were little facilities at all, they are not usually in good condition, while the few that were in good conditions were not enough to go round those who needed them. This is in agreement with the findings of Dahar (2011) that the facilities for teaching science are not up to the standard at secondary and higher secondary school stages.

In the light of the importance of science, laboratory, laboratory activities and science education, a good knowledge of the integral roles of laboratory facilities is expedient in order to achieve a functional science education in Nigeria.

## 2. Statement of the Problem

The researcher observed that in many secondary schools in Ondo State, science teachers do not engage students in practical activities until they are about to write external examinations. This will not allow the teachers and students to be well-prepared for practical activities and be versed in the usage of laboratory facilities.

Some of the problems that are observed to be related to engaging students in practical activities and the utilization of science equipment in teaching and learning of science are under-utilization of laboratory facilities among others. The teacher is often regarded as the most important psychosocial factor that impedes learning. Science teachers can only offer to students what they have, this study therefore intends to assess teachers' understanding of the integral roles of laboratory facilities in the preparation of science teachers for functional science education.

## 3. Research Questions

- What is the perception of science teachers on the importance of science education?
- Are laboratory facilities available and adequate in secondary schools?
- What is the perception of science teachers on the roles of laboratory facilities for functional science education?

## 4. Methodology

### 4.1. Research Design

This study employed descriptive design of survey type. The design solicited information on the opinion, beliefs, perception of science teachers about science education.

### 4.2. Population

The population of the study consisted of all science teachers in all the forty-nine (49) secondary schools in Ondo West Local Government Area of Ondo State.

### 4.3. Sample and Sampling Technique

The sample for the study consisted of 51 secondary school science teachers who were selected using simple random sampling technique from 15 balloted secondary schools.

### 4.4. Research Instrument

A questionnaire titled: Laboratory Facilities and Functional Science Education Questionnaire (LFFSEQ) was used for data collection. It is a 4-point Likert Scale structured questionnaire with rating scale of strongly agree (SA), Agree (A), Disagree (D) and Strongly disagree (SD). The instrument measured the teachers' responses on the importance of science education, availability and functionality of laboratory facilities as well as their perception of the roles of laboratory facilities for functional science education.

### 4.5. Validity and Reliability of the Instrument

The face, content and construct validities of the instrument were carried out by experts in the field of science education and guidance and counselling. A reliability coefficient of 0.86 was obtained using test, re-test method and Pearson Product Moment Correlation Analysis.

### 4.6. Data Analysis

The data collected were collated and analysed using descriptive statistics of frequency count, mean, standard deviation and percentage.

## 5. Result and Discussion

### 5.1. Research Question 1

In order to answer this question, the mean and standard deviation scores of the teachers' perception of the important of science education were computed. The result is presented in Table 1 below

SN	Importance of Science Education	$\bar{X} \pm SD$
1	Knowledge of and about science are integral in preparing people to be actively engaged and responsible citizens	3.39 $\pm$ 0.695*
2	Knowledge about science prepares people to be creative, innovative and able to work collaborate	3.65 $\pm$ 0.483*
3	The complex challenges facing the society can be revealed and solved by science	3.20 $\pm$ 0.872*
4	Science concepts and principles would help students to experience the richness and excitement of knowing and understanding the natural world	3.45 $\pm$ 0.730*
5	Knowledge of science is important in making crucial decisions on everyday issues and problems	3.28 $\pm$ 0.603*
6	Science education improves scientific literacy and technological literacy of citizens	3.67 $\pm$ 0.662*
7	Science education empowers responsible participation in public science conversations, debates and decision-making	3.45 $\pm$ 0.730*
8	Science promotes and nurtures an innovative environment where companies and other stakeholders from around the world want to invest, work and live	3.18 $\pm$ 0.623*
9	Science prepares citizens for an active contribution towards their own culture	3.18 $\pm$ 0.888*
10	Science education inculcates the spirit of scientific thinking in learners	3.73 $\pm$ 0.569*

Table 1: Mean Rating of Science Teachers on the Importance of Science Education

\*Mean Greater Than Cut-Off Point (2.5),  $\bar{X}$  – Mean, SD – Standard Deviation

Table 1 revealed that the mean response of teachers on all items ranged from 3.18  $\pm$  0.555 to 3.73  $\pm$  0.569 and were greater than the cut-off point (2.5). Hence, respondents agreed to all item statements. By implication, this finding showed that the science teachers were not just aware of the core elements and value of science education, but also of its importance.

### 5.2. Research Question 2

In order to answer this question, the frequency counts and percentage of the laboratory facilities that are available and adequate in secondary schools were computed. The result is presented in Table 2 below.

SN	Facilities	Availability		Adequacy	
		Yes	%	Yes	%
1	Clamp and stand	49	96.08	21	41.18
2	Plane mirror	51	100.0	41	80.39
3	Concave mirror	51	100.0	30	58.82
4	Convex mirror	51	100.0	30	58.82
5	Bunsen mirror	26	50.98	22	43.14
6	Optical pin	51	100.0	50	98.04
7	Ruler	51	100.0	39	76.47
8	Drawing board	51	100.0	31	60.78
9	Converging lens	49	96.08	30	58.82
10	Diverging lens	48	94.12	30	58.82
11	Metre rule	51	100.0	25	49.02
12	Screen	32	62.75	28	54.90
13	Lever	36	70.59	16	31.37
14	Pulley	31	60.78	31	60.78
15	Hydraulic Press	29	56.86	10	19.61
16	Wheel and Axle	11	21.57	08	15.69
17	Inc Plane	13	25.49	08	15.69
18	Nut cracker	05	9.80	03	5.88
19	Wheel barrow	13	25.49	07	13.73
20	Semi-circular prism	29	56.86	08	17.65
21	Source of light	36	70.5	26	50.98
22	Wire gauze	27	52.94	20	39.22
23	Ticker-timer/stop watch	38	74.51	12	23.53
24	Forceps	11	21.57	03	5.88
25	Simple pendulum	27	52.94	11	21.57
26	Spiral spring	28	54.90	18	35.29
27	Knife edge	31	60.78	31	60.78
28	Spring balance	33	64.71	21	41.18
29	Beaker	45	88.24	26	50.98
30	Cork or wood	26	50.98	26	50.98

SN	Facilities	Availability		Adequacy	
		Yes	%	Yes	%
31	Thermometer	33	74.51	18	35.29
32	Rectangular prism	45	88.24	40	78.43
33	Triangular prism	13	25.49	08	15.69
34	Ray box	51	100.00	34	66.67
35	Wax burner	31	60.78	22	43.14
36	Force boards	15	29.41	07	13.73
37	Crucible and cover	15	29.41	06	11.76
38	Erlenmeyer flask	06	11.76	02	3.92
39	Evaporating dish	05	9.80	04	7.84
40	Mortar and pestle	23	45.10	13	25.49
41	Test tube	49	96.08	44	86.27
42	Rubber stoppers	38	74.51	38	74.51
43	Flint lighter	14	27.45	05	9.80
44	Stirring rod	33	64.71	33	64.71
45	Scooper/spatula	38	74.51	30	58.82
46	Disposable pipette	30	58.82	17	33.33
47	Glass dropper pipette	37	72.55	31	60.78
48	Burette	48	94.12	32	62.78
49	Graduated cylinder	43	84.31	20	39.22
50	Funnel	49	96.08	46	90.20
51	Round-bottom flask	19	37.25	11	21.57
52	Potentiometer	13	25.48	08	15.69
53	Barometer	11	21.57	07	13.73
54	Hydrometer	06	11.76	04	7.84
55	Hygrometer	05	9.80	03	5.88
56	Voltmeter	48	94.12	42	82.35
57	Ammeter	48	94.12	42	82.35
58	Galvanometer	31	60.78	22	43.14
59	Rheostat	15	29.41	08	15.69
60	Magnet	23	45.10	20	39.22
61	Gold-lead electroscopes	05	9.80	03	5.88
62	Slotted weight/Masses	38	74.51	38	74.51
63	Calorimeter	19	37.25	10	19.61
64	Indicators/Reagents	45	88.34	40	78.43

Table 2: Laboratory Facilities Available and Adequate in Secondary School

Table 2 revealed that many laboratory facilities are available in the schools; however, those that were 100% available in the schools are mirrors, optical pin, rulers, metre-rule, drawing board and ray-box. Other facilities not readily available in the schools are wheel and axle, inclined plane, nut-cracker, wheel barrow, forceps, triangular prism, force board, crucible and cover, Erlenmeyer flask, evaporating dish, flint lighter, round-bottom flask, potentiometer, barometer, hydrometer, hygrometer, rheostat, gold-lead electroscopes and calorimeter.

Table 2 also revealed that mirrors, optical pins, ruler, drawing board, lenses, screen, pulley, source of light, knife edge, beaker, cork, rectangular prism, drawing board, test tubes, rubber stoppers, stirring rod, scoopers, glass dropper pipette, burette, funnel, voltmeter, ammeter, slotted weights and indicators; are the laboratory facilities that are available and adequate for teaching and learning of science. By implication, this finding showed that not all laboratory facilities are available in the schools. Also, most of the available laboratory facilities in the schools are not adequate for teaching and learning of science.

### 5.3. Research Question 3

In order to answer this question, the mean rating of perception of science teachers on the roles of laboratory facilities were compared and computed as shown in Table 3

SN	Importance of Science Education	$\bar{X} \pm SD$
1	It can be used to engage students in open-ended investigative processes, using scientific problem-solving	3.59 $\pm$ 0.853*
2	It provides application of information that students have heard and seen, thereby clarifying scientific principles and concepts	3.71 $\pm$ 0.576*
3	It involves multiple senses in 3 dimensional rather than 2-dimensional learning experiences important for greater retention of concepts and for accommodation of different learning styles	3.43 $\pm$ 0.700*
4	It stimulates students to understand the nature of science including its unpredictability and complexity	3.61 $\pm$ 0.635*
5	It provides opportunities to engage in collaborative work and to model scientific attitudes and behaviour	3.22 $\pm$ 0.783*
6	It develops mastery of techniques and skills needed for potential science, engineering and technology majors	3.39 $\pm$ 0.695*
7	It ensures science course transferability to 4 years schools as well as graduate and professional schools	3.49 $\pm$ 0.784*
8	It enables students to understand in more practical and concrete ways their own physical makeup, the functioning of the natural world around them and environmental issues	3.20 $\pm$ 0.664*
9	It helps students develops many science skills such as making observations, collecting data, recording data, analyzing data, predicting and inferring	3.77 $\pm$ 0.551*
10	It fosters experimental investigations that generate or access appropriate data, display the data and encourage students to form valid conclusion	3.26 $\pm$ 0.717*
11	It can be used to introduce new concepts, and techniques which have a wide application in experimental sciences	3.39 $\pm$ 0.723*
12	It familiarizes students with experimental apparatus the scientific method, and methods of data analysis so that they will have some ideas of the inductive process by which the ideas were originated	3.77 $\pm$ 0.551*

Table 3: Mean Rating of Perception of Science Teachers on the Roles of Laboratory Facilities

\* Mean Greater Than Cut-Off Point (2.5).

Key:  $\bar{X}$  – Mean, SD – Standard Deviation

Table 3 showed that the mean response of the teachers to all items ranged from 3.20  $\pm$  0.664 to 3.77  $\pm$  0.551. All the mean responses were greater than the cut-off point (2.5). Hence, respondents agreed to all item statements. By implication, the science teachers agreed that understanding of the integral roles of laboratory facilities are of immense importance for functional science education.

## 6. Discussion

Findings from the study revealed that teachers were aware of the importance of science education. They agreed that knowledge of science is integral in preparing people to be actively engaged, creative, innovative, work collaboratively and solve complex challenges facing the society by science. Science teachers agreed that science concepts and principles would help students to experience the richness and excitement of knowing and understanding the national world. They also agreed that knowledge of science is important in making crucial decisions on everyday issues and that science education improves scientific and technological literacy of citizen. This is in line with the submission of Aina (2013) and Omorogbe and Ewansiha (2013) that science education is instrumental to the technological development of any nation.

It was revealed from the study that the laboratory facilities that were 100% available in the schools are mirrors, optical pins, rulers' meter-rule, drawing board and ray-max. Many of the listed facilities were sparingly available in the schools such as wheel and axle, inclined-plane, nut-crackers, wheel barrows, forceps, prisms, force board, Erlenmeyer flask, evaporating dish, round-bottom flask, potentiometer among others.

Result from the findings showed that many laboratory facilities are not readily available in the schools. It also revealed that most of the available laboratory facilities in the schools were not adequate for teaching and learning of science.

Findings from the study also revealed that laboratory facilities can be used to engage students in open-ended investigative processes and they involve multiple senses in 3-dimensional rather than 2-dimensional learning experiences. They stimulate students to understand the unpredictability and complexity nature of science. Opportunities to engage in collaborative work, model scientific attitude, develop mastery of techniques and skills, and understand natural world around them, are duly provided by laboratory facilities. In line with this finding, Nije, Ukwetang and Nja (2014) emphasized that secondary school laboratories should be furnished with adequate laboratory facilities for effective teaching and learning of sciences. This aligns with the findings of Okafor (2000) and Aburime (2004) who noted that adequacy of laboratory facilities helps students to perform better in secondary school Chemistry.

## 7. Conclusion

From the findings of this study, it was concluded that secondary school teachers perceived the importance of science education as it prepares people to be actively engaged, creative, innovative work collaboratively improve scientific literacy, understand the natural world and make crucial decisions on everyday issues and problems. Some basic laboratory facilities were observed to be available in secondary schools however, not all the available facilities were observed to be adequate for teaching and learning of sciences. Teachers perceived that laboratory facilities have integral roles to play in development of functional science education as they provide the skills needed for potential science, engineering and technology major and ensure the transfer of science courses to four years schools, graduate and professional schools.

## 8. Recommendations

Based on the findings of this study, it was recommended that:

- Laboratory facilities should be made available and adequate for the teaching and learning of science in the secondary schools.
- Science teachers should have access to innovative classrooms/laboratory and scientific equipments in order to put their acquired knowledge to use
- Science teachers' knowledge of the integral roles of laboratory facilities should be given necessary attention in the preparation and in-services training of science teachers.

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