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The state of science and technology infrastructure in secondary schools in Nigeria

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ABSTRACT

Science and technology (S&T) education is crucial to the achievement of socio-economic development of any society and also a critical element in the attainment of the Millennium Development Goals (MDGs). Standard laboratories and equipments as well as reagents are S&T infrastructures essential for providing qualitative education for producing national technological manpower. This study evaluates the condition of S&T infrastructures in the Nigerian secondary schools. The study utilises primary data collected from public and private secondary schools across the six geo-political zones in the country. Findings show that there are inadequate teachers, laboratories and necessary equipment for teaching S&T related subjects in most of the secondary schools in Nigeria. Also, electricity supply from the national grid to secondary schools is poor because only 3[illegible] of them have light at most 4hours a day. The study therefore recommends the provision of adequate funds and electricity generators for these institutions to enhance the teaching and overall development of S&T education in Nigeria. In addition, adequate and qualified personnel (teachers and laboratory technicians) should be provided while good maintenance culture and improved security of laboratories and equipment in secondary schools should be imbibed by all secondary schools in the country.

Keywords: Science and technology; infrastructure; Nigeria

1. INTRODUCTION

1. 1. Background to the Study

Science and technology (S&T) has been globally recognised as major instrument of economic development and social transformation. As a result, every nation has continued to pursue S&T knowledge in order to remain relevant in a globalised world economy. A major source of S&T knowledge and skills are educational institutions at all levels. The purpose of education is to generate and apply knowledge resulting in improvements in science and technology, while the S&T infrastructures required for knowledge generation and the attendant learning processes are the lifeline of the educational system. The state of available S&T infrastructures in educational institutions is a determinant factor of the capacity of the educational system to produce the requisite human capital necessary for achieving competitive economy and social transformation.

The production of adequate and competent technological manpower is a major challenge in Nigerian education industry. The education industry in the country has been battling with various aspects of infrastructure development challenges for improving the quality of education and expanding access. The various government efforts to improve infrastructure in educational institutions include construction of classrooms, lecture halls, laboratories and staff quarters as well as supply of water and electricity to improve quality of education and manpower production.

This study examines the condition of S&T infrastructure in secondary schools in Nigeria. The study aims to contribute to the attainment of Nigeria's Vision 20:2020 and socio-economic transformation agenda currently pursue by the Federal Government of Nigeria (FGN).

1. 2. Problem Statement

It is generally acknowledged that the delivery of education in Nigeria has suffered from many years of neglect. This led to frequent industrial actions by trade unions in education institutions and students unrests caused by discontent arising from poor state of educational infrastructure.

Again, the various efforts to address the challenges of educational infrastructure include establishment of model schools, creation of specialised colleges, establishment of new public and private secondary schools. Other efforts included the establishment of specialised funding support for infrastructure from donor agencies and local institutions such as the Education Trust Fund (ETF) and the Universal Basic Education Commission (UBEC) among others. The extent to which these mechanisms support or contribute to the development of S&T infrastructure in the educational system has been unclear.

In addition, investment in S&T infrastructure still remain a factor not raised to the forefront when considering issues of educational development in Nigeria, and where it does, such investment is often subsumed under general infrastructure items. Currently, the quality of education provided remains grossly deficient and unable to build the human capital required for a competitive economy.

1. 3. Research Questions

The research questions addressed by this study are:

a) What is the current state of S&T infrastructure in secondary schools in Nigeria?
b) What are the constraints and opportunities for the development of S&T infrastructure in secondary schools in the country?
c) What are the necessary policies that will enhance the development of S&T infrastructure in secondary schools in Nigerian?

1. 4. Research Objectives

The broad objective of this study is to examine the state of S&T infrastructure in secondary schools in Nigeria. The specific objectives are to:

a) examine the current state of S&T infrastructure in secondary schools in Nigerian;
b) identify the constraints and opportunities for the development of S&T infrastructure in secondary schools in Nigerian; and
c) Make policy recommendations on how the develop S&T infrastructure in Nigerian secondary schools.

1. 5. Justification for the Study

Nigeria is technologically poor due to poor investment in human capacity development and necessary infrastructure. Presently, the 60:40 ratio of students' admission into science and art disciplines in tertiary institutions is yet to be achieved in the country.

This study becomes necessary in order to foster national technology capability building. Besides, it is unknown whether any study has examined the state of S&T infrastructure in secondary schools in Nigeria. This study aimed at bridging this knowledge gap and also proffers policies and actions that will enhance availability of S&T infrastructure in Nigerian secondary schools.

2. LITERATURE REVIEW

2. 1. The Meaning and Role of Science and Technology Infrastructure

Science and Technological Infrastructure can generally be defined as intermediate inputs that provide the basis for the functioning of other technologies or provide essential services to other sectors of the economy. Technology infrastructure thus consists of science, engineering and technical knowledge available to industry. Such knowledge can be embodied in human, institutional, or facility forms. More specifically, technology infrastructure includes generic technologies, technical information, and research and test facilities, as well as less technically explicit areas including information relevant for strategic planning and market development.

Science and Technology infrastructures amongst others are some of the minimum requirements that feed into technological and industrial development of any economy. Tassey (1992) describes Science and Technological Infrastructures in much wider terms, as 'science, engineering and technological knowledge available to private industry … embodied in human, institutional or facility forms'. He concludes that at national and firm levels respectively, there is an increasingly dependence on service delivery of Science and Technology Infrastructure.

The role of Science and Technology Infrastructure as an engine of development is an emerging issue that is beginning to feature prominently on the Nigerian scene. This is being demonstrated aptly in the National Education and also National S & T policies and in subsequent economic developments and reform framework of the country. The current economic reform framework is the Vision 20:2020 (NV20:2020), and it features S & T infrastructure as a cross-cutting issue that has to be promoted in order to achieve economic development objectives (NPC, 2007).

The state of poverty in the country and the challenge of meeting the Millennium Development Goals in this respect, in particular have drawn attention to the role of S & T infrastructure for solutions of technological adaptation and diffusion based on local conditions and knowledge, for example those that can boost agricultural productivity and food storage capacity, reduce post-harvest losses, promote renewable energy (including bio-fuels and solar), develop rainwater harvesting systems, deliver potable water to rural villages, and improve basic health care.

2. 2. The Role and Importance of Science Laboratories

At every level of science education, laboratories are perceived as a vehicle for curriculum enhancement. Studies including Hadley & Rheingold, 1992; McDaniel, Melnerney & Armstrong, 1993; Hannafin & Saverye, 1993) have indicated that a properly equipped and functional science laboratory has the potential for enhancing science learning. Science laboratories have a central and distinctive role in S&T education, and science educators suggest that there are rich benefits in learning from using laboratory activities.

In many African countries, research has revealed shortages in the number of laboratories in schools. A study by Jones (1990) found that 45 % of the schools surveyed in selected African countries indicated insufficient laboratories. Alebiosu, 2000 and Onipede, 2003 reported that many schools in Nigeria do not have laboratory with minimum standard facilities. This finding agreed with Barrow`s (1991) findings in Saudi Arabia which also indicated inadequacy in the provision of laboratory facilities in schools.

The findings were also consistent with those of Black *et al*. (1998) who found in Uganda that science education is faced with the problem of lack of resources with half the schools having no real laboratory. Leister, (1992) observed that shortages of laboratory facilities could have serious implications on the quality of schools` output.

3. METHODOLOGY

3. 1. Primary Data Collection and Scope of Study

This study covered both the private and public secondary schools in selected states in the six geopolitical zones of Nigeria. The choice of the secondary schools is anchored on the fact that it is at these levels that education become profound and learning is tailored to breeding future physicians, scientists, engineers, technicians and other professionals. The choice of states for the study is based on investment in S & T infrastructure in the educational sector, and availability of the frame/list of public and private tertiary institutions in 2010.

3. 2. Sample Selection

One state was selected in each of the six geo-political zones for the study. Based on perceived performance on investment in education with focus on S & T infrastructure in 2010, one state was selected from each of the geo-political zones as follows:

(i) Edo State - South-South
(ii) Enugu State - South-East
(iii) Katsina State - North-West
(iv) Kwara State - North-Central
(v) Lagos State - South-West
(vi) Bauchi State - North-East

The Ministries of Education in the selected states were contacted for the list and location of secondary schools in their respective states. The lists provides sample frame from which twenty secondary schools that participated in the survey were chosen in each of the states selected. The secondary schools were stratified into public and private secondary schools, and urban and rural secondary schools. Secondary schools located in the state capital and local government headquarters were generally regarded as urban schools while those elsewhere were regarded as rural schools.

There are two types of semi-structured questionnaires employed as instruments for eliciting the primary data/information from respondents. One questionnaire was designed for secondary school principals and one for teachers of S&T related subjects. In each secondary school, five questionnaires were administered. Altogether, 600 questionnaires were administered in secondary schools while 438 questionnaires were retrieved representing 73 %

retrieval rates. For the primary data collection, field research assistants were recruited and trained in each state served as enumerators.

The questionnaire aimed at collecting data on S&T related issues such as nature of S&T related investments in the educational sector, availability of teachers in S&T related subjects, number and quality of S&T laboratories available in the institutions, capability to use laboratory equipment, availability and adequacy of chemical reagents in the institutions, the availability and adequacy of S&T equipment in the schools, the age and functionality of the available S&T equipment and materials, the adequacy or otherwise of S&T teaching materials and personnel and level of availability of water and electricity. To gain deeper insights into the constraints on S&T infrastructure development and how to overcome them, interviews of directors of research, planning and statistics in each of the selected state's ministry of education were carried out.

3. 3. Data Analysis

The Statistical Package for Social Science (SPSS) was used to analyze the questionnaires, following which descriptive statistics such as frequency counts, charts and tables were used as appropriate to explain the features of science and technology infrastructure in the sampled secondary schools. Chi-square was calculated to measure the difference in significance between private and public educational institutions.+

4. FINDINGS

4. 1. State of Science and Technology Infrastructure in Nigerian Educational Institutions

4. 1. 1. Human Capital Outlay

An important determinant of economic growth and development is human capital outlay. The quality and nature of education determine the knowledge and skills available for human capital upgrading. From the findings of the study, three elements of the results provide some insights to the human capital outlay in the Nigeria educational sector. These are qualification of teachers of secondary schools; quantity and level of experience of teachers; and ratio of teachers to students.

4. 1. 2. Qualification of Teachers

Table 1 shows the distribution of the highest qualifications of teachers in the sampled secondary schools. 82 % of the teachers have at least a bachelor degree in their subject areas, while the rest have HND or NCE in S&T related subjects. In fact, about 91 % of the teachers have at least HND or B.Sc.

It thus appears that very high proportion of teachers in S&T related subjects have appreciable requisite qualifications in S&T subjects. It is often advocated that teachers in S&T subjects should also possess training in education. From the results in Table 1, only 8.4 % of the teachers have a postgraduate diploma in education and only 8.7 % have national certificate in education.

Table 1. Highest qualification of teachers in Nigerian secondary schools.

Highest Qualification	Frequency	Percent
NCE	38	8.7
HND	41	9.4
B.Sc.	272	62.1
M.Sc.	50	11.4
PGD	37	8.4
Total	**438**	**100.0**

Source: Field Survey, 2011

4. 1. 3. *Quantity and Experience of Teachers*

Table 2 shows the teacher to students' ratio. The Table shows that, there are 4,793 teachers in S&T related subjects and 90,672 students. This implies a teacher to students' ratio of 1:19. Except for wood work and metal work, the teacher to students ratios are very poor in all the S&T related subjects the most affected subjects being computer science and introductory technology with teacher to students ratios of 1:251 and 1:201 respectively. This shows that the quantity of teachers for S&T related subjects in the sampled secondary schools is inadequate.

Table 2. Teacher to students' ratio for S&T related subjects in the research sample.

Subject	No. of teachers	No. of students	Teacher to students ratio
Chemistry	292	31124	1:107
Physics	269	32897	1:122
Biology	364	60636	1:167
Introductory Technology	124	24881	1:201
Integrated Science	217	26938	1:124
Computer Science	164	41125	1:251
Agricultural Science	337	53725	1:159
Basic Electronics	19	2241	1:118
Metal Work	28	594	1:21
Wood Work	93	588	1:6

Source: Field Survey, 2011

From Table 3 showing the distribution of the subject areas of teachers' qualification, the vast majority (71 %) of the teachers are in the traditional science subject areas of chemistry,

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physics and biology. The remaining 31 % of the teachers are distributed over other S&T related subjects as shown in Table 3. These results indicate that secondary school teachers' experiences are still mainly in basic science subjects comprising of chemistry, physics and biology.

Table 3. Subject area of teachers' qualification.

Subject	Frequency	Per cent
Chemistry	104	24.4
Physics	91	21.2
Biology	110	25.6
Introductory Technology	18	4.2
Integrated Science	12	2.[illegible]
Computer science/mathematics	22	5.1
Agriculture/ Animal Science/Home Mgt/Food & Nutrition	59	13.8
Basic Electronics	4	.9
Metal Work	2	.5
Wood work/carpentry	3	.7
Education/ Guidance & counselling	2	.5
Environment/Geography	2	.5
Total	**438**	**100.0**

Source: Field Survey, 2011.

4. 2. Science and Technology Hardware

Science and technology hardware in educational institutions is very crucial to the advancement of practical teaching and learning. It includes the science laboratories, equipments, and teaching aids such as ICT facilities (computers, the Internet) as well as the support infrastructure (electricity and water supply) which are expected to aid the best functioning of the science and technology hardware. Science laboratories, in particular have been found to be central to the teaching of science.

These laboratories are the workshops where practical activities are conducted to enhance a meaningful learning of science concepts and theories (Seweje, 2000; Olubor and Unyimadu, 2001).

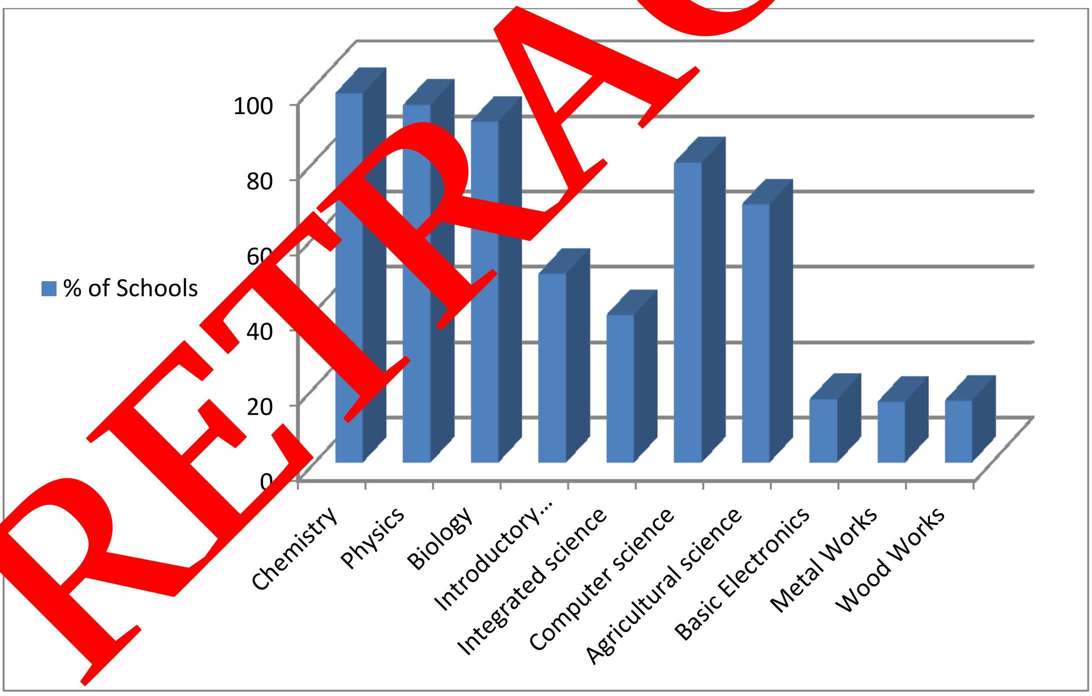
4. 2. 1. Science Laboratories

The results of our survey showed that 82.5 % of schools in our study have between one and five science laboratories, while the remaining 17.5 % have over five science laboratories.

The minimum age of these laboratories is one year; while the maximum age is 30 years. About 55 % of schools have laboratories within the age range 1 and 10 years old, while the remaining 45 % are above 10 years old.

For each of the three core science subjects, which are Chemistry, Physics and Biology, over 90 % of schools, claim to have separate laboratories. Furthermore, while 68.4 %, and 50 % have laboratories for agricultural science and introductory technology respectively. It was observed that integrated science and introductory science are often taken as the same subjects in many schools, and this may explain why only 39 % claim to have a separate laboratory for integrated science. Figure 1 shows the responses received on the specific types of laboratories that exist in the schools in our sample. In addition to having specific laboratories, almost [illegible]0 % of the schools attested to the fact that their schools have at least one science laboratory, which may be classified as multipurpose laboratory used for practical sessions for a combination of subjects. The four most common combinations of subjects for which these multipurpose laboratories were used for, are as follows:

a. Chemistry, Physics, Biology Agriculture, Animal Science, Home Management, Food and Nutrition
b. Chemistry, Physics, Biology, Agriculture, Animal Science, Home Management, Food and Nutrition and Basic Electronics
c. Chemistry, Physics, Biology , and Introductory Technology/Integrated Science
d. Chemistry, Physics, Agriculture , Animal Science, Home Management, Food and Nutrition



Source: Field survey, 2011.

Figure 1. Types of laboratories in Nigerian secondary schools.

4. 2. 2 Quality of Science Equipment

Respondents were asked to rate how they perceived the quality of science equipments in the laboratories on a likert scale reported as poor = 1, fair = 2, good = 3, very good = 4 and excellent = 5. The perception of respondents (see Table 4) show that about 35 % perceive the equipment as good, while 12 % perceive the equipments to be excellent, and 17.10 % perceive them as poor.

Table 4. Perception on quality of science equipments.

Quality of science equipment	Secondary Schools %	Average
Poor	13.10	17.10
Fair	25.60	18.05
Good	34.80	35.80
Very Good	18.40	17.[illegible]0
Excellent	8.10	11.95

Source: Field survey 2011.

Further analysis was done based on the computation of the level of significance of the perception levels on quality of equipments by teachers in the public and private secondary schools. The results show that there is a significant difference in the perception on quality of equipment at secondary school level (p = 0.0000).

4. 2. 3. Sources of Laboratory Reagents/Consumables in Secondary Schools

The main sources of laboratory reagents and consumables in the secondary school surveyed are the school (68.5 %) and the State Government (70.9 %). The PTA has not been active in this line of activity with only 7.[illegible] % of schools reporting this trend.

4. 3. Electricity Supply

Electricity supply is one of the factors that are likely to influence the functionality of science laboratories, as it an essential input to many scientific processes. The regularity of electricity supply from PHCN (national grid) to educational institutions is generally very poor. As shown in Table 5, about [illegible]0 % of schools have light for not more than 4 hours, and only 21.0 5 % of respondents at secondary education claim to have electricity from PHCN for more than 6 but not more than [illegible] hours per day.

Table 5. Regularity of electricity supply from PHCN.

Regularity	Secondary schools
Not more than 2 hrs	29.9
More than 2 but not more than 4hrs per day	29.9
More than 4 but not more than 6 hrs per day	21.0

More than 6 but not more than 8 hrs per day	7.6
More than 8 but not more than 10 hrs per day	8.9
More than 10 hrs per day	2.7
	100 %

Source: Field Survey, 2011.

With the results obtained on the regularity of electricity, it is therefore also not surprising to report that 74.1 % of schools and 85.7 % of faculties surveyed attest to the fact that they have alternative sources of electricity power supply to their laboratories. The alternative sources include electric generators, solar panels and inverters, as shown on Table 6.

Table 6. Alternative sources of energy supply in Nigerian institutions

Sources	Secondary Schools
Electric Generator	83.7
Solar Panel	4.8
Inverter	4.0

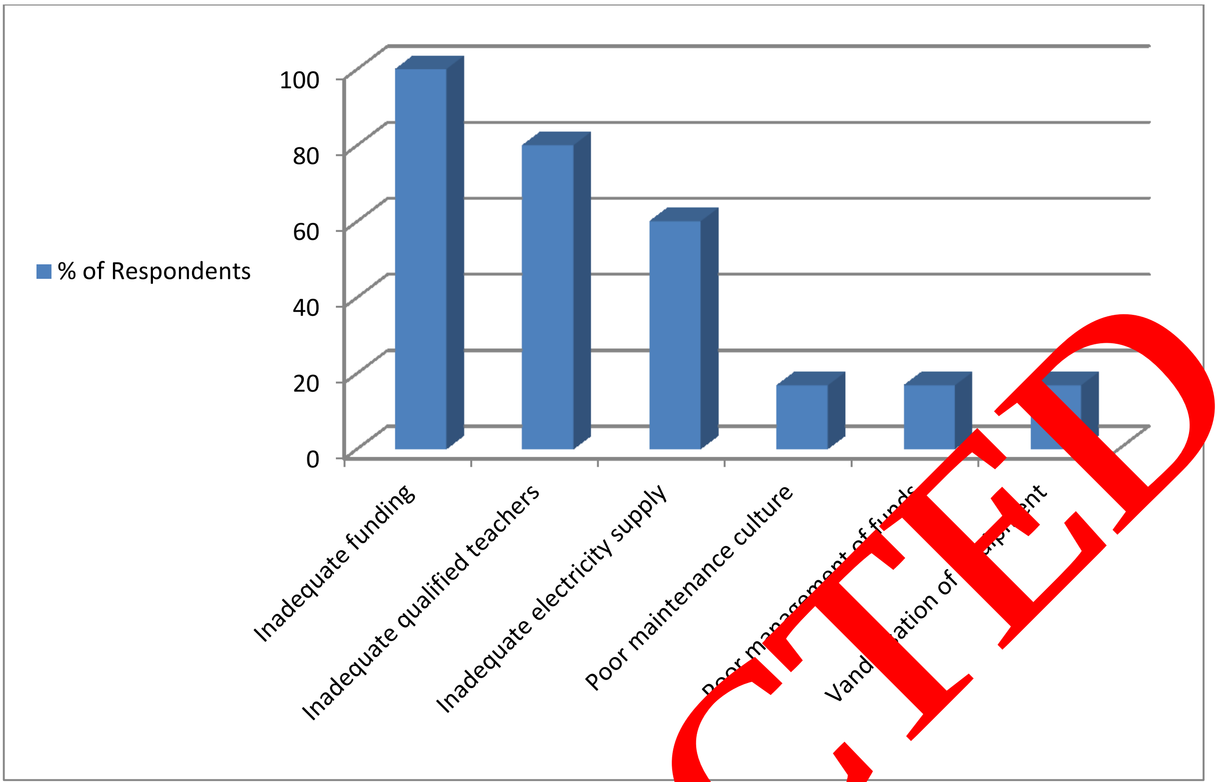
Source: Field Survey, 2011 (Multiple responses and therefore add more than 100 %).

4. 4. Constraints To The Development Of S&T Infrastructure In Nigerian Educational Institutions

All impediments to the availability of viable and adequate S&T infrastructure in the educational institutions are referred to as *constraints* in this study. The general constraints identified to the development of S&T infrastructure in secondary schools include lack of qualified laboratory technicians, inadequate laboratory equipment, poor to high quality reagents, poor electricity supply and poor funding among others.

Analysis of the interviews conducted on selected key officials in the respective State Ministries visited also highlighted some concerns on the constraints and suggestions for improvement of Science and Technology Infrastructures.

These responses are presented in Figure 2 and it shows that inadequate fund (100 %) was considered as the major constraint to the development of S&T infrastructure in the education sector. The inadequate number of qualified teachers (80 %) and poor electricity supply (60 %) were reported by these officials as second and third constraints respectively. Other constraints were poor maintenance culture, poor management of funds and vandalisation of equipment (16.8 % respectively).



Source: Field Survey, 2011.

Figure 2. Constraints to S&T infrastructure development identified by government officials.

Results of the analysis carried out on the suggestions made by government officials to remove the constraints show that all respondents (100 %) suggested improvement in the level of funding of education as a strategic way for improving S&T infrastructure development. This was followed by the suggestion on training and re-training of teachers (80 %), procurement of electricity generating sets (60 %) improved security, proper management of funds and good maintenance culture (about 20 % respectively).

5. CONCLUSIONS / RECOMMENDATIONS

- *Improved Funding*: To move Nigeria forward technologically, there is need to provide adequate funds to provide all the necessary S&T infrastructures like laboratories, reagents and equipment for secondary schools.
- *Provision of Necessary Amenities*: There is a need for adequate and regular electricity supply and water supply to run the S&T infrastructure in Nigerian Educational institutions. Electricity generators should be provided for the schools to complement power supply by the Power Holding Company of Nigeria (PHCN). All educational institutions should be provided with regular water supply from a well or borehole.
- *Production of Qualified Personnel:* Adequate and qualified personnel (teachers, laboratory technicians) should be provided in the Educational institutions. In addition, there is need to train and retrain these personnel to perform effectively.

- *Good Maintenance Culture and Proper Management of Funds*: Good maintenance culture and improved security of school properties should be imbibed by all educational institutions. In addition, the provision and proper management of funds to source Science and Technology Infrastructure should be taken as a collective responsibility of the educational institutions, the state government, parents, and private individuals/organizations.

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