

Conceptual Understanding of Science Facilities: A Study benefits for Science Teaching

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Abstract

Science facilities are a very important resource input for teaching science and are an important predictor of academic achievement and effectiveness of teaching science. The proper use of science facilities and demonstration of experiments are the indicators of student performance. Science facilities are important only when they are used in the school setting. If science facilities are provided to schools, there are three possibilities that they remain unused, used inefficiently, and used efficiently. In view of this, the paper presented a conceptual understanding of science, origins of experimental science, the importance of science practical work, production, and utilization of science facilities. The paper described science facilities as crucial for teaching and learning science in secondary and higher institutions. The facilities are an important component in learning science subjects though it depends upon the degree to which it is efficiently used. The proper use of science facilities and demonstration of experiments are the indicators of student performance. Hence, if these facilities are provided to schools, and used efficiently. However, science facilities may contribute a higher level of academic achievement if used effectively and properly with national commitment. Over the years, many have argued that science cannot be meaningful to students without worthwhile practical experiences in the school laboratory.

Keywords: Science, Facilities, Laboratory, Benefits, Understanding

Introduction

Science facilities are a very important resource input for teaching science and are an important predictor of academic achievement. The study of physical science is not possible without science facilities. However, the facilities for teaching science are not up to the mark at secondary and higher secondary stages in the country. Science facilities are an important component in learning science subjects but it depends upon the degree to which it is efficiently used. Only the availability of science facilities is not a guarantee of students' performance until both the teachers and students use Science facilities efficiently (Lewin 2000). The proper use of science facilities and demonstration of experiments are the indicators of student performance. Science facilities are important only when they are used in the school setting. If science facilities are provided to

schools, there are three possibilities that they remain unused, used inefficiently and used efficiently. However, science facilities may contribute a higher level of academic achievement if used effectively and properly with national commitment. Hofstein&Mamluk-Naaman (2007) described the concept of the use science facilities in these words: Over the years, many have argued that science cannot be meaningful to students without worthwhile practical experiences in the school laboratory. Unfortunately, the terms schoollaboratory or lab and practical have been used, too often without precise definition, to embrace a wide array of activities.

Typically, the terms have meant experiences in school settings where students interact with materials to observe and understand the natural world. Some laboratory activities have been designed and conducted to engage students individually, while others have sought to engage students in small groups and in large-group demonstration settings. Teacher guidance and instructions have ranged from highly structured and teacher-centered to open inquiry. The terms have sometimes been used to include investigations or projects that are pursued for several weeks, sometimes outside the school, while on other occasions they have referred to experiences lasting 20 minutes or less. Sometimes laboratory activities have incorporated a high level of instrumentation and at other times the use of any instrumentation has been meticulously avoided. Adesoji and Olatunbosun (2008) cited Raimi (2002), Adeyegbe (2005) and Farounbi (1998). According to Raimi (2002) & Adeyegbe (2005), Science facilities adequacy was reported to affect the performance of students in Science subject. Likewise, about the use of science facilities, Farounbi (1998) argued that students tend to understand and recall what they see more than what they hear. Students see when they actual use science facilities in the teaching and learning of science. Similarly, Adesoji and Olatunbosun (2008) described that science facilities adequacy was also found to enhance achievement through attendance at Science workshop. Many research studies were conducted to investigate the educational effectiveness of science facilities whether these facilitates aid student achievement; According to Tobin (1990), "Science facilities appeal as a way to learn with understanding and, at the same time, engage in a process of constructing knowledge by doing science". This study concluded that the laboratory may facilitates the meaningful learning in the subject of science if students are given opportunities to manipulate equipment and materials in order to be able to construct their knowledge of phenomena and related scientific concepts.

The Concept of Science

There are probably as many definitions of science as there are scientists. The best way to define science is to consider its different aspects. The oxford Advanced learner's Dictionary defines science as the study of the structures and behavior of the physical and natural world and society especially through observation and experiment. According to Ogunniyi (1986), definitions of science vary from one scientist to another. To some, science is an organized body of knowledge, to others science is a search for meanings or explanations of events in nature. Science can also be defined in terms of its methods and processes i. e. what scientists do, in terms of its products i.e. knowledge in the form of facts, concepts, laws and theories. Also science can be defined in terms of its ethics and motives.

Ogunniyi (1986) defines science as an attempt by human beings to organize their experience about nature into meaningful systems of explanations. The term experience includes such things as the discovery of regularities or discrepancies and their effects in nature. Knowledge of human actions on things, events or

situations and the consequences of such actions and understanding derived from control of diverse phenomena in nature etc. Science is a dynamic human activity concerned with understanding the workings of our world. This understanding helps the scientist to probe further in to the nature of the things and events and to control and harness such things and events for the benefit of mankind.

Science has little to do with manufactured goods such as cars, Lorries, aero plane etc. Science is concerned with finding out about nature. Science begin with early man, from his experience with nature he discovered how plant grow, which plants flowers and seeds are edible, why we have night and day among others. From the earliest times, man has concerned himself with the study and interpretations of the universe and the events that occur within.

Cleminson (1990) Have advance new basic tenets claiming that the following assumptions could be used as a foundation in the study of science.

- Scientific knowledge is tentative and should never be equated with truth. It has only temporary status
- Observation alone cannot give rise to scientific knowledge in a simple inductive manner.
- We view the world through theoretical lenses built from prior knowledge
- There can be no sharp definition between observation and inferences.
- New knowledge in science is produced by creative acts of the imagination allied with the methods of scientific inquiry. As such, science is a personal and immensely human activity.
- Acquisition of new scientific knowledge is problematic and never easy. Abandoning cherished knowledge that has been falsified usually occurs with reluctance.
- Scientist study a world which they are a part not a world from which they are part.

Meaning of Science Education

Education has no higher purpose then preparing people to lead personally fulfilling and responsible lives. For its part, science education, meaning education in science, mathematics and technology, should help students to develop the understandings and habits of mind they need to become compassionate human beings, able to think for themselves and to face life head-on. (RytherfurdAhlgre 1990).

Knowledge of science entails knowledge of scientific facts, laws, and theories, and the products of science. Ogunniyi (1986) people confuse science and science education, while science like other subjects has well-defined disciplines such as Biology, Chemistry, Physics and Geology, science education cuts across many fields of human Endeavour such as the natural science mentioned above, sociology, philosophy, psychology, history, art and language among others.

Science education is the bedrock upon which scientific and technological development depends. It is believed by most educators that the giant strides made by the developed countries such as Japan, United State of America (U.S.A) and Britain is not unconnected to the type of science education available in those countries. For example, Ogunniyi (1986) refers to the general view that Japan rose to prominence as a result of the vast investment made by the U.S.A after the second world war (a form of compensation for the large destruction carried out by the latter) as only a half-truth. In reality, the emergence of Japan was based on a sound foundation of a mass literacy program that dates back to the 17th century and even beyond. In other words, Japan's entry into the scientific and technological age is not an accident but a result of a well-planned and implemented science education program- a program inspired and sustained by an intellectual tradition and enlightened

political leadership. Even now, the policies that shaped the Japanese science and technology curriculum points to a well-thought-out science education program. These according to Goto (2000) are: to foster a vibrant student spirit.

- Provide a firm foundation for life and learning.
- Promote quality education that spurs individuality.
- Foster student ability to continuously pursue self-education.
- Inculcate respect for culture and tradition.
- Promote international understanding.

Therefore science education has two basic functions to perform. One is to train specialists for a career in science, while the other is to broaden the horizon of the non-technological citizen by giving them some familiarity with the content and discipline of science.

Science teaching requires attention to both the content of the course and the process of helping the student to move from their initial state of knowledge and good teaching (Seymour and Hewitt in Gyuse 2008). According to Gyuse (2008), one of the practical challenges in science teaching is to discuss real cases in a science classroom situation and how teachers may respond appropriately to them. The class has several opportunities to discuss issues that call for the application of the scientific method.

Ajaja (2008) noted that natural sciences are taught in schools as biology, chemistry, and physics at the secondary level. The product of science, method, and attitudes developed while study science influences an individual's application of scientific ways of doing things. Ajaja (2008) also emphasizes that effective teaching and learning of science required a lot of resources. Those resources included well-trained science teachers, science facilities such as laboratories, reagents, chemicals, equipment, models and teaching aid among others. Science resources make knowledge easily accessible to learners. Ige (2000) noted that science teaching and learning can only be meaningful and effective if backed by the necessary facilities and resources to enrich instruction. Lorsebach and Tobin (1997) found that the use of the senses in laboratories exercises enhances learning. They also noted that it is only through seeing, hearing, touching, smelling, and testing that individual interacts with the environment. Ajaja and Kpangban (2002) submitted that today and tomorrow's children must have to be equipped for the new world that will be dominated by science and technology. Sound science knowledge that can meet the demand of the 21st century. Trowbridge and Bybee (1996) advised that science teaching should be done to facilitate students learning in science and technology as they need to understand science and technology and use the knowledge to live as a functional citizens in their society. They also noted that science teaching should sustain student curiosity, develop an inquiry and design to improve their scientific explanation. Help them develop an understanding and the use of technology. To also contribute to their understanding of the role, limits, and possibilities of science and technology in their society and inform the choices they must make in their personal and social lives.

Science education is relevant to this study by understanding the appropriate processes of teaching science and science teaching facilities. The researcher wants to know whether the facilities in the area of study satisfied the requirement for teaching science.

Origins of Experimental Science

The use of laboratory methods in science teaching originated from the ideas of early scientists. The 17th Century is very significant in this respect. Mendelson (1982) has characterized the Century as the century of "The Scientific Revolution." This characterization is so because, according to Westfall (1971), "it was in the 17th Century that the experimental method... became a widely employed tool of scientific investigation" (p.115). The general feeling of disillusionment among scientists with earlier methods precipitated this trend. (Butterfield, 1957; Westfall, 1971). The feeling of disillusionment had to do with results of scientific investigations that did not match the efforts put into them. The scientists of the time blamed the method of conducting science, for the low output.

Taylor (1963) claimed that "the idea of experimental science began to have to influence about 1590" when scientists started basing their work on deliberately contrived experiments. According to him. "Galileo Galilei (1564-1643) was the first to employ the modern scientific method in the fullness" in physics and astronomy. Before then, Westfall (1971) stated that Galen's writing on physiology contained examples of experimental investigation. Westfall also claimed that Robert Grosseteste of the medieval school. And the logicians based at the University of Padua, Italy, in the 16th Century, also discussed the precursors of the hypothetic-deductive method.

However, it was in the 17th Century that scientists paid the greatest attention to the scientific method that led to a revolution in science. The sheer number of persons that paid attention to the method then indicated the need for an acceptable method of conducting science. Francis Bacon (1561-1626) was perhaps the first in the 17th Century to formulate a series of steps to account for the scientific method in his book *Novum organum* (The New Instruments, 1620), (Taylor, 1963). The book was a reaction to Aristotle's treatise in logic referred to as *Organum*. Bacon based his method on the inductive method of objective observation and experimentation without any preconceptions. Rene Descartes' (1569-1650) *Discourse on Method* based on mathematical reasoning and deduction closely followed Bacon's book. Westfall (1971) has credited Robert Boyle with perhaps the best statement of the experimental method that focused on "the activity of investigation that distinguishes the experimental method of modern science from logic" (p. 115). Pascal, Gassendi, and Newton also wrote on the scientific method (Westfall, 1971). The emphasis on method during this period paid off with the several discoveries and inventions in the 17th Century and beyond, thereby giving the impression, albeit unintentionally, that science is synonymous with its method.

Importance of Science Practical Work

In Shulman and Tamir's (1973) review of research on science teaching, they identified three rationales generally advanced by those that supported the use of science facilities in science teaching. The rationales included:

- (1) The subject matter of science is highly complex and abstract,

(2) Students need to participate in inquiry to appreciate the spirit and methods of science, and

(3) Practical work is intrinsically interesting to students. Shulman and Tamir also compiled a list of objectives of using science facilities in science teaching. The list included the teaching and learning of skills, concepts, attitudes, cognitive abilities, and understanding the nature of science. Also, there is hardly any science method book that does not usually list the objectives of science facilities (Abdullahi, 1982; Collette & Chiappetta, 1984). All science curricula in Nigeria list practical activities that should go with each curriculum item listed. The current West African Examinations Council (WAEC) syllabus (WAEC, 1988) in use in 1996, recommended that the teaching of all science subjects listed in the syllabus should be practical based, perhaps, to demonstrate the importance it attached to practical work in science. Thus, several decades of emphasizing the assumed importance of science facilities in science teaching have elevated the importance to the level of a dogma. Thomas (1972) and White and Tisher (1986) are of this opinion. This position is, perhaps, why Yager (1981) thought that science educators should treat practical work as the "meal-the main course" rather than an "extra" or "the desert after a meal". Also, Bajah (1984) said, "All science teachers and students know that practical work is the 'gem' of science teaching".

This dogma about the importance of Science facilities originated from the views of a few American educationists in the early sixties that extolled the importance of laboratory work in science teaching. Notable among these personalities are Bruner (1961), Gagne' (1963), and Schwab (1960), they all extolled the virtues of teaching science as a process of inquiry or discovery. Before them, Dewey (1938) advocated learning by doing through his "project method" that he considered as a method of organizing the school curriculum on a scientific basis. Another American, Charles Peirce (Peirce, 1877, 1958) who advocated the use of the method of science as a mode of inquiry to satisfy our doubts, in turn, influenced him. The ultimate goal of these advocates of practical work was to train students in the ways of practicing scientists so that students could become good scientists in the future. The surprise by which the former Soviet Union took the Americans, and, perhaps, the world, in launching the Sputnik into space in 1957, motivated their positions. The emphasis in science teaching at this time-shifted from the products of science, what science to teach and learn, to the processes of science, i.e., how we teach and learn science (Bates, 1978). According to Shulman and Tamir (1973), this shift in emphasis lacked empirical evidence because the influence of the educationists mentioned above formed the basis of the shift. As a result of this influence, and the need to match the Soviet feat, the Americans commissioned and executed several curriculum development projects. Such curriculum development projects included the Biological Science Curriculum Study, started in 1959-, Chemical Bond Approach, started in 1958, Physical Sciences Study Committee, started 1956, and Science: A Process Approach, started in 1967, etc. They were all laboratory-based. These curriculum development activities, with emphasis on laboratory work, spread to Nigeria, and elsewhere in the world.

Concept, Nature, and Types of Science Facilities

Schools exist for teaching and learning. Human and material resources are deployed for this purpose. Science facilities are the material resources provided for staff and students to optimize their productivity in the

teaching and learning process. The realization that the transfer of knowledge does not only take place in the four walls of the classroom from the teacher to the students but rather that learning takes place through discovery, exploration, interaction with the internal and external environment has necessitated the creative and innovative development of teaching and learning facilities that reflect these changes. Schools exist to serve the socio-economic and political needs of the ever-changing society; consequently, they are in constant interaction with their external environment. They receive inputs from the external environment in the form of human and material resources, process them, and empty same into the society as finished products and services. The quality of the products bears a direct relationship with the quality of the facilities deployed in the process of production. This demands that state-of-the-art facilities are provided in schools to prepare school leavers for life in the global village. According to Propst (1972), useful types of resources to be contacted by the planners and the management team are acoustical design engineering, audiovisual design engineering, behavioral sciences, building systems design, community and press relations, ecological studies, electronic data processing of hardware specifications, electronic data processing for program development, use of facilities training and financial planning. Others include food service planning, graphic design, health care planning, information management, installation supervision, interior design, laboratory planning and engineering, lighting design, management consulting, project planning, safety engineering, site planning, technical equipment specialization, and urban planning.

This implies that the provision of facilities is a collective responsibility of the federal, state, local government authorities, staff, and students of the individual schools and the community where the school is located. The Federal Government through the Federal Ministry of Education provides the policies that guide the educational system and also oversees the implementation of these policies at the State level. On the other hand, the State Government ensures the actual implementation of the National Policy on Education by providing the enabling environment for effective teaching and learning.

The school plant is a major component of the school facility. Knezevich (1975) described it as “the space interpretation of the school curriculum”. He emphasized that the curriculum finds its physical expression in the construction and arrangement of the school plant, which is a controlled environment that facilitates the teaching and learning process and also protects the physical well-being of the occupants. He further stated that since teaching and learning of science do not take place in a vacuum, science facilities give meaning to the planned curricula and extra-curricular activities. A discussion of the school plan starts with the conceptualization of the educational programs to be offered in the school. The nature and types of the educational program will determine the nature and types of the school plant to be provided. Unruh (1974) emphasized that both teachers and students need places to search, read, write, confer, interact, view, listen, think, experiment, and record. Students need places to transact student affairs or to gather for social purposes. Teachers need office space, conference rooms for team planning, facilities for diagnosis of pupil’s needs, and facilities for preparing an instructional presentations. New views of the teaching-learning process that move beyond memorizing of knowledge toward the involvement of students in applying, analyzing, synthesizing, and evaluating knowledge stress the need for flexibility of space in the schools. The complexity of the learning environment requires flexibility in the design of the school plant. Modern facilities are designed for diverse academic and social activities.

Multipurpose facilities used for academic activities during school hours may be available for community use during or after school hours. Such facilities may be used for continuing education programs, social activities, and recreation. Through appropriate scheduling multipurpose facilities may be accessible to the community during school hours. This will eliminate the burden of duplication of such facilities as conference halls, gymnasium, library, theatre and laboratories facilities. Such integrated effort is cost-effective and brings the community closer to the school. Some buildings are over fifty years and therefore require modern facilities for teaching and learning. Renovation and modernization of old and dilapidated buildings should be carried out to ensure that facilities for team planning areas, office space, clerical space, workrooms, professional development libraries, faculty dining area, storage space, students conference areas, guidance services area for large group instruction, spaces for instructional media, library resource centers, science facilities, arts and music studios, individual study area and physical education facilities. Equipment and supplies are essential for the attainment of educational goals and objectives. Simpson and Anderson (1981) defined equipment as “items that last a minimum number of years or cost more than a certain amount” and supplies as items such as microscope slides, glass tubing, and cotton swabs, that are quickly consumed and that are usually less expensive than equipment items”. Some equipment performs specific functions while others such as computers perform a multiplicity of functions.

Science equipment are available in various forms. The equipment may be fixed or movable and they serve various purposes in the educational system. They are used in the classrooms, laboratories, offices, workshops, cafeteria, toilets, laundry, and library, etc. Furniture is also available in the classrooms, offices, cafeteria, laboratories and workshops, outdoor, residential halls, common rooms, and those designed for the physically challenged. Information and Communication Technology (ICT) facilities also include among others software on classroom management, facility management, inventory control, maintenance management, online procurement, food services, and general management. The application of the software requires that the school managers should be exposed to necessary in-service training to enable them to make maximum use of the soft wares.

Need for Science Facilities.

Science Facilities are materials designed to serve specific purposes in the school system, there are a multiplicity of science facilities, which facilitate teaching and learning. They are used;

- To illustrate concepts
- Provide an opportunity for firsthand experience
- For experimentation and demonstration
- For scientific investigation and discovery
- To provide a diversity of thoughts
- For observation and inquiry
- For the development of scientific attitudes and skills
- To protect the individual and also provide comfort

The indirect or teaching support facilities such as offices, cafeteria, acoustics, toilets, laundry, mowers, residential halls, common rooms, cleaning materials ground, and similar items satisfy the individual's physical and emotional needs. They are used to:

- Increase instructional effectiveness
- Improve the cleanness, orderliness, and safety of facilities
- Reduce the operational cost and life cycle cost of a building
- Extend the useful life of a building
- Increase efficiency and effectiveness of the staff and students
- Improve building appearance

Use data collection and analyses for decision making

Benefits of Science Facilities

Research into the role of science facilities in science teaching has a long history. Blosser (1981) put the beginning date at the 1930s. These research efforts into the role of science facilities in science teaching reached their peak in the 1960s and 1970s during the curriculum development years. Abimbola (1981), Bates (1978), Blosser (1981, 1983), and Shulman and Tamir (1973) carried out reviews of research in this area. All of them concluded that science education researchers failed to provide conclusive evidence to support the view that using science facilities to teaching science is superior to other methods, at least, as measured by paper and pencil achievement tests. This conclusion is perhaps what prompted Leonard (1981) to exclaim that "Laboratory instruction is on trial". Also, the 1980-81 Board of Directors of the National Science Teachers Association (NSTA) in the U-S recognized that there were widespread doubts about the importance of science facilities in the seventies (Klein, Yager, & McCurdy, 1982). The Board thereafter put out a position statement in support for the use of science facilities to teaching science as follows:

The National Science Teachers Association endorses the necessity of laboratory experiences for teaching and learning in science. Adequate support for materials, equipment, and teacher time is available for schools to maintain quality science instruction. Such a quality program is critical in today's age of science and technology (Klein, Yager, & McCurdy, 1982).

Also, the Board commissioned various persons to write position statements to support the use of laboratory work at different levels of education and all the position statements appeared in one issue of *The Science Teacher* 49(2), 20-23. For instance, Tafel (1982) wrote for the Middle/Junior School; Perez (1982) wrote for the high school; Bybee (1982) wrote for the "Basics" movement; Lunetta (1982) wrote from the curriculum perspective; Hurd (1982) wrote from the teaching perspective and Bates (1982) wrote from the research perspective.

The purpose of this section is to briefly provide examples of conclusions from the reviews mentioned above, part of which generated the reactions of the Board of Directors of the NSTA. For instance, in Abimbola's

(1981) review of conceptions of discovery in science held by educators and philosophers of science, he concluded that the conceptions of discovery in science held by major schools of philosophy of science then, did not influence the "teaching by discovery" and "discovery learning" slogans. According to him, "the studies reviewed provided little elucidation about the efficacy of the discovery method of teaching and learning (p. 103). The discovery method of teaching and learning has as its main focus, the use of science facilities in science teaching and learning. Bates (1978), too, in a review of the role of science facilities in secondary school science programs, concluded that despite seventy-five years of studies in this area, the consistent conclusion is that "laboratory experiences neither help nor hinder student achievement - at least as measured by standard paper and pencil tests of subject matter" (p.68). Specifically, he found, among other things, that "lecture, demonstration, and laboratory teaching methods appear equally effective in transmitting science content" (p.74). Nonetheless, he found laboratory experiences to be "superior for providing students' skills in working with equipment" (p.74) and in maintaining students' interest in science. These are important objectives to achieve in science teaching and learning. However, how many of the skills acquired from laboratory work do students use in real-life situations? Put differently, how does the lack of possession of these skills adversely affect the functioning of individuals in their daily life activities?

Production and Utilization of Science Facilities

The school environment has been described as an organization where resources are produced, managed, and organized in such a way that enables the students to acquire desirable learning competencies. The process of managing and organizing resources is called resource utilization. The utilization of resources in teaching brings about fruitful learning since it stimulates students' senses as well as motivating them. Denyer (1998), in his study on science games in National Curriculum in the United Kingdom, reported that games, when used as a resource, enable less able children to stay on task and remain motivated for a longer periods.

There are varieties of resources, which the science teacher can readily use to enrich learning. These resources are wind vane, rain gauge, meter rule, models, charts, preserved specimens of plants and animals, culturing equipment, herbarium, terrarium, vivarium, and microscope (Olagunju, 2000). The resources should be provided in quality and quantity in the classroom for the effective teaching-learning process (Umeoduagu, 2000). Nwoji, (1999) in an empirical study, revealed that essential facilities such as equipment like radio, television, computers, chemicals, specimens, videotape, stove, burners, models, and charts are not available in schools. This inadequacy of teaching material resources, laboratory equipment reagents/chemical, and laboratory space, has been of serious concern to educators. The decline in performance may not be unconnected with the poor learning environment created by the state of infrastructural facilities (Fabayo, 1998 and Farombi, 1998). Mapaderun (2002) and Oni (1995) also emphasized that the availability and adequacy of these facilities promote effective teaching and learning activities in schools while their inadequacy affects academic performance negatively. Several efforts have been extended by Science Teachers Association of Nigeria (STAN) to train secondary school teachers on improvisation techniques in various science subjects Biology, Chemistry and Physics hence there is need to evaluate how far teachers have been able to improvise instructional materials for effective teaching.

Moreover, careful consideration of the statistics of the contribution of gender in Nigeria reveals that participation of women is significantly low. Evidence abound in every science and technology-based

organization to this effect. Sobulo (1998) lamented that this problem has been and is still in existence. Some studies have found gender disparity in achievement in favour of males, (Awoniyi, 1999). Others have found none (Madu, 2004; Ibe, 2004 and Anaekwe, 1997).

The role of Facilities ineffective teaching of Science

The use of Science Facilities in teaching science has become a dogma among science educators and teachers. On the one hand, they extolled the importance of the use of the science facilities in science teaching while on the other hand, they only pay "lip service" to its use in practice. Science teachers do not usually find it convenient to make science facilities work the center of their instruction. They usually complain of a lack of materials and equipment to carry out practical work. At the same time, some of these materials and equipment may be locked up in the school laboratory store without teachers being aware of their existence. The conditions under which many teachers function do not engender any enthusiasm to use the science facilities in teaching science even where they know that these materials and equipment are available. Class size in urban schools is getting larger and this does not usually encourage teachers to use science facilities to teach science. In some states of the country, teachers go for months without salary owing to a shortage of funds. Science teachers who fall in this category cannot reasonably be expected to give off their best to their students.

Higher institutions in Nigeria charged with the responsibility of training science teachers at all levels are increasingly turning out teachers without requisite science facilities/laboratory experience. A common reason usually given is a shortage of facilities. Such trained science teachers usually lack the necessary confidence to conduct practical classes with their students. It is only accreditation exercises that are improving this situation in Colleges of Education and Universities at present.

Governments have given up on their capacity to equip all schools with adequate science facilities. They have therefore resorted to designating selected schools as "science schools" that they equipped with their meager resources. They usually used the traditional help received from the Federal Government in equipping these science schools. The condition of the national economy continues to deteriorate without any sign of improvement in sight. Is it not time to get realistic with our science teaching? I think it is high time we started.

Shulman and Tamir (1973) upheld some of Yager, Englen, & Snider's (1969) conclusions about the need to question the central role of science facilities in science teaching. They thought that science teachers could obtain desirable learning outcomes with limited laboratory experiences. Also, they concluded that a verbal, non-laboratory approach might be best for some teachers and students. Some students may find laboratory activity a sheer waste of their time. They finally emphasized the need to structure some new courses that would deemphasize laboratory work without de-emphasizing the nature of science. We can achieve this restructuring of courses by giving equitable attention to the teaching of science concepts and principles, science process skills, and scientific attitudes without overemphasizing one over the others that were the case in the science programs of the sixties and seventies. All this goes to show that the disillusionment is real.

In any case, studies in Nigeria and abroad have shown, too, that this disillusionment is real. For instance, studies have shown that science teachers themselves did not attach much importance to laboratory work as they usually found the slightest excuse to avoid them. However, if they attach importance to it there is no research evidence to support this importance (Abimbola, 1988; Bajah, 1984; Daramola, 1982, 1985, & 1986; Ndu, 1980: & Weiss, (1978). Important evidence, at least in Nigeria, that many science teachers are either not doing practical work at all or not doing enough practical work to give their students the confidence that they would pass their Senior School Certificate Examinations in science, is the extra-mural laboratory class being established in urban centers in Nigeria. Students that attend these classes must be missing something in their school laboratory work that they think they can find in the extra-mural classes. Also, the importance attached to laboratory activities did not match government provision of laboratory materials and equipment because they are expensive to buy. There is therefore the need to explore alternatives to laboratory activities that would still preserve the nature of science.

Science Facilities Management

The primary purpose of the teaching and learning process is to bring about in the learner desirable change in behavior through critical thinking. This process does not take place in a vacuum but rather in an environment structured to facilitate learning. Stoner, Freeman, and Gilbert (1996) described the environment of an organization as all elements relevant to its operation and they include direct and indirect action elements. Science facilities constitute the major components of both direct and indirect action elements in the environment of learning. Several studies have shown that a close relationship exists between the physical environment and the academic performance of students. Nwagwu (1978) and Ogunsaju (1980) maintained that the quality of education that children receive bears direct relevance to the availability or lack thereof of physical facilities and the overall atmosphere in which learning takes place.

The science facilities consist of buildings for academic and non-academic activities, equipment for academic and non-academic activities, farms, and gardens including trees. Others include laboratory, furniture and toilet facilities, lighting, acoustics, storage facilities, ICT, cleaning materials, food services.

These facilities play a pivotal role in the actualization of the educational goals and objectives by satisfying the physical and emotional needs of the staff and students of the school. Knezevich (1975) emphasized that the physical needs are met through the provision of a safe structure, adequate sanitary facilities, a balanced visual environment, an appropriate thermal environment, and sufficient shelter space for his work and play. His emotional needs are met by creating pleasant surroundings, a friendly atmosphere, and an inspiring environment. The educational system has undergone tremendous changes in the form of its philosophy, broadened goals and objectives, new approaches to service delivery and architectural design, a quantum leap in school enrolment, the multiplicity of curricula programs and extra-curricula activities, the introduction of Information and Communication Technology (ICT) and expanded academic support services such as guidance services to students, teachers and the community, integration of the school and community. The resultant effect of all these changes is the need for creative and innovative steps in the management of facilities. For example, research findings have shown that students learn better when a combination of methods and materials are employed during teaching. Furthermore, emphasis has shifted towards giving individual

attention to students as against teaching large classes which presupposes that all students in a class can learn at the same pace. The implication of the foregoing is that in designing a school plant, provision should be made for individual and small group interaction and large groups for academic and social activities.

Fenker (2004) stated that facilities management is a process that ensures that buildings and other technical systems support the operations of an organization. The International Facilities Management Association (2002) described facilities management as the practice of co-ordination of the physical workplace with the people and the work of the organization; it integrates the principles of business administration, architecture and the behavioral and engineering sciences. Science facilities management is the application of scientific methods in the planning, organizing, decision-making, coordination, and controlling of the physical environment of learning for the actualization of the educational goals and objectives. This involves among other things, collective decision making concerning a selection of a site for the establishment of new schools, design, and construction of new school plants including grounds, renovation, and modernization of old plants, provision of equipment for academic and non-academic activities, maintenance of all facilities and review of management practices and processes.

Planning, as in all management processes is the first logical step in facilities management. According to Dror (1967), planning is the “process of preparing a set of decisions for action in the future directed at achieving goals by optimal means”. A plan for facilities management must be an integral part of the overall Federal, State, and Local Government educational master plan. It is a well-articulated conceptualization of the educational philosophy, goals, objectives, and specifications for short and long-term objectives including implementation of the planned curricula and extra-curricula activities. It also includes budget priorities for facilities management. A facilities management plan starts with the educational philosophy that serves the needs of the individual in a dynamic and knowledge-based economy. The educational system should prepare individuals for life in a constantly changing world. A facility management plan should therefore give meaning to the educational philosophy.

A second step is the development of broad educational goals and specific objectives. These goals and objectives should be comprehensive enough to cover all aspects of the educational program and also make adequate room for flexibility to allow for a specific individual and group needs. Planning cannot meaningfully be carried out without accurate information, which should be collected through facility audits. According to the Planning Guide for Maintaining School Facilities (2003) facility audit is a comprehensive inventory of a school’s facilities that provides a standard method for establishing baseline information about the components, policies, and procedures of a new or existing facility. It provides information on the status of school facilities. It is carried out by assessing buildings, grounds and equipment, documenting the findings and recommending service options to increase efficiency, reduce waste and save money. According to the guide, facility audits are important because they:

- help planners, managers, and staff know what is available, its condition, Service history, maintenance needs, and location
- provide facts not guesswork, to inform plans for maintaining and improving school facilities
- establish a baseline for measuring facilities maintenance progress

- allow in-dept analysis of product life cycles to occur on a routine basis (i.e. measuring actual life versus expected life)

The following information should be collected when a facility audit is being carried out:

- Brand name, model number, serial number
- Quality and product size
- Location
- Age
- Condition
- Working as purchased/designed
- Working as it should
- Working as it needs to be to meet the needs of the users
- Repair history
- Specialized upkeep equipment (e.g. oil and filter types)
- Evidence of future needs
- Recommended services
- Estimated remaining useful life

Brooks and Atkin (2003) outlined the stages in facilities management as follows:

Analysis stage- assembles all relevant facts about the organization's objectives, needs, and policies, a review of resources processes, systems, and the physical assets themselves, together with their attributes in terms of space, functions, and utilization

Solution stage- assembles criteria for judging options, evaluating these against the objectives of the organization, and develops the facility management strategy

Implementation stage- completes the strategy development process through the establishment of an implementable plan that incorporates the key elements of procurement, training, and importantly communication.

The most fundamental problem in facilities management is the lack of policy guidelines for infrastructural development in schools. In some schools, there are inadequate classrooms, staff offices, laboratories and workshops, libraries, study areas while in some, these facilities are adequately provided. This situation arises because the Federal, State and Local Governments have failed to establish policy directives on minimum standards concerning school facilities. While some classes hold under trees and students are exposed to harsh weather conditions, others hold in air-conditioned classrooms. While some others have well-equipped laboratories, workshops, libraries, and other facilities for effective teaching and learning, others have none, and where they exist, such facilities are poorly equipped. It, therefore, becomes imperative that the different levels of government should address the issue of development and implementation of minimum standards for facilities development and management. According to the 21st Century School Fund (2005) policy agenda should entail an increase in public participation in facilities planning, create and support schools as centers of community that offer school-based support to children to eliminate a barrier to success and serve the broader community, improve facilities management including maintenance and improvement program and secure adequate and equitable facilities funding. Policies should direct the actions of the school managers. In the absence of policy, facility management is left to the whims and caprices of the managers. Schools are formal organizations, and all

activities including facilities management should be in line with laid down rules and regulations derived from overall policy guidelines.

Conclusion

Thescience facilities are crucial for teaching and learning science in secondary and higher institutions. The facilities are an important component in learning science subjects though it depends upon the degree to which it is efficiently used. The proper use of science facilities and demonstration of experiments are the indicators of student performance. Hence, if these facilities are provided to schools, and used efficiently. However, science facilities may contribute a higher level of academic achievement if used effectively and properly with national commitment. Over the years, many have argued that science cannot be meaningful to students without worthwhile practical experiences in the school laboratory.

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