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SAFETY IN SCHOOL LABORATORY: AN ASSESSMENT OF LABORATORIES IN PUBLIC SECONDARY SCHOOLS IN OBIO/AKPOR LOCAL GOVERNMENT AREA OF RIVERS STATE

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ABSTRACT

The study adopted a descriptive survey design in order to access safety in Laboratories in public secondary schools in the research area where sixty three (63) science teachers were randomly sampled to provide information based on the laboratory. Research findings revealed that in spite of students guided inquiry through experimentation, 60.9% are ignorant of the potential danger associated with storage of chemicals with worn-out labels. 95.7% of the assessed laboratories do not have fire extinguishers and 62.2% had no safety sign posts. 91.3% of the laboratories have inadequately equipped First Aid facilities, Therefore, there exists high susceptibility of student's and teachers to chemical burns and fire accidents. Based on these findings, it is recommended that teachers should provide operational safety rules and signs to guide practice in various laboratories and in order to encourage students guided inquiry in practical works. The government should assist in redeeming the poor condition of the laboratories in the research area.

KEYWORDS: Safety in School Laboratory, where Sixty Three (63) Science Teachers

INTRODUCTION

Secondary school education curriculum emphasizes the study of Physics, Chemistry and Biology as core Science subjects which are compulsory for science students, in order to give them a more rounded, and functional education with high utility value. Ekwueme (1991) asserted that these objectives are yet to be fully achieved in the face of a depressed economy. Very recently, due to the financial input for national development especially in the south-south geopolitical zone of the nation, there have been sporadic and immeasurable strides towards infrastructural development in schools. One centre of attraction in Rivers State, for instance is the construction of modern buildings (classroom blocks and laboratories) to encourage active learning by experimentation. Although Hund (1971) points out that the new science curriculum does not list understanding technology or its relationship as a goal, the early exposure of students to this science learning process shall instill the right scientific attitude of inquiry, observation, co1lection of data, inferring or prediction of phenomena and foster in students the curiosity to explore the nature around their environment. According to Alamina (2001), science programmes should be based on experimentation which is advantaged in training of students to acquire high level of rational and critical thinking. When the student is acculturated with skills pertinent for laboratory practice, he excels in professional courses like Physical and Analytical Biochemistry, medicine, as well as engineering. The benefits also includes knowledge of the problem solving skills, mastering the concepts, by experimentation and discovery.

According to Achenold, Jenkins and Robinson-wood (1977), Laboratory safety is best regarded as a positive undertaking which is an integral part of every activity in which the science teacher is engaged with his pupils. In order to curb incidence of accidents in secondary schools, the teacher has a lot of duties. Each laboratory lesson plan should indicate precautionary measures against accident, instill in pupils the acquisition of safety conscious attitudes and design of experimental set ups that minimizes all safety hazards.

Purpose of the Study

The purpose of the study is to ascertain the state of safety in school laboratories in public secondary schools in Obio/Akpor Local Government Area of Rivers State

Design Consideration in Secondary School Laboratory

In design consideration for school laboratories, Archenhold, Kenkins, and Robinson-wood, (1977) enumerated the followings.

- **The Setting of Laboratories**

No two schools will be identical in terms of size and needs but there are several advantages when setting laboratories close together to the science block to reduce movement of staff, mutual facilities and apparatus availability of technical assistance is increased. Environmental consideration should also be made, North-South orientation of laboratories in which window areas to wall area should increase with blinds to control sunlight in Biology and Chemistry this is dangerous to non-luminous Bunsen flames. Lewis (1972) also strongly warned against preventing direction of prevailing wind especially in hot days.

- **Provision of special facilities**

The planning of special indoor and outdoor science facilities should be considered at an early stage in the design process.

a. **Indoors:** In addition to an adequate science section in general, a science library containing background readers, periodicals and variety of textbooks, where audio-visual equipment, are stored.

b. **Outdoors:** It is suggested that biology and rural science laboratories should be at ground-floor level. Nuffield Advanced Biology (1971) posited that access to specialist facilities such as green houses, animal houses, ponds and experimental plots in which the animal home should be kept at a temperature between 18°C and 26°C should be restricted from direct sunlight in as much as possible.

- Laboratory design criteria which involves basically meeting the needs of present and future students' organization for science learning and management of resources. It is also possible to consider non-specialist laboratory for study activities and practical work by individuals or group works. Lecture and demonstration hail with movable tables, audio-visual activities, display and exhibition centers are also possible inclusion in facility provision.

1.2 Safety and Laboratory Design

Accidents in schools' laboratories involving learners and teachers who engage in domestic laboratory practices may not have been quantified in recent times. But the level of risk to teachers and students are potent due to students increased engagement in experimentation, changes in teaching methods where experiments are now open-ended in nature and pupils do not have the appropriate skill to distinguish between project, experimentation and hazardous exploration. Again, there are ranges of equipment and techniques used in schools such as lasers, x-ray sources, high-voltage power outlets and microbiological materials, which are very common in secondary schools (Jenkins, Archenold and Robinson-wood, 1977).

Apart from observing safety precautions in schools, familiarity of instruments, increased ignorance of hazards and laboratory design are other factors which effects level of risk in use of schools' laboratories.

One salient issue of industrial and medical importance to students, teachers and laboratory personnel as active users of the laboratory is safety. The essence of the co-operative exercise between the architects and those engaged in science education and administration is not only to provide the curriculum content for those subjects but to effect designs of science laboratories that is capable of tolerating less than 0.05 incidence of accident. The paper intends to investigate the safeness of our schools' laboratories vis-ã-vis the design, consideration, safety and design fire accident in schools' laboratories, safety work Act, 1974; overview of safety in secondary school among others.

Some LEA's have suggested draft laboratory rules and insists that copies of the laboratory rules be given to the students in their laboratory work books. Rules are not to be rented but should form part of the routine practice of teachers and students.

The science teacher should therefore be consulted in the design of the laboratory and should allow for:

i. Large space to accommodate demonstration bench and sitting arrangements that can allow for adequate supervision of pupils during laboratory seasons, according to the ASE recommendation of a safe distance (6ft away) from demonstration experiments conducted by the teacher.

ii. The floor should also be resistant to minor spillage and non slippery.

iii. Provision like cupboards made for storage of teachers sachets and bags, jackets and clothing.

iv. Wall fittings should not protrude outwards to occupy walking space.

v. One fume cupboard or hood for unpleasant gases and vapours.

vi. Design to incorporate adequate collection of waste materials with separate and clearly labeled waste containers.

vii. Provision of adequate fire fighting equipment which is suitably located.

viii. First aid kits must be provided in adequate numbers and kept in areas accessible to the teachers, technical staff and pupils. Such kits should include safety pins, forceps, eye bath, sterilized guaze, Adhesive plaster and strings or triangular bandage, scissors, methylated spirits, pain relief drugs etc.

ix. Caution or use of plastics as laboratory fittings e.g. bench tops, fume cupboard, waste pipes.

Common areas of hazard in the laboratory includes the glassware. Chipped and cracked glassware should not be used in the laboratory. Pipettes and burettes are dangerous if not properly used. Mouth pipettes must never be used for volatile liquids like liquid ammonia, always bring down burette clamped before the eye level. All hazardous and concentrated chemicals should not be used in titrimetric analysis.

Toxic reagents should be handled with care, they permeate the body through inhalation, ingestion or absorption, with inhalation most common. Hence it is important to use proper experimental technique, to have adequate natural and mechanical ventilation, and to give conscious thought to minimizing or overcoming the hazards associated with the particular procedure (Achernold, Jenkins and Robinson-wood, 1977).

Asbestos, (use under DES. Administrative memorandum), Carcinogens, caustic and corrosive materials, plastics and polymers and uncontrolled chemical reactions, x-ray radiations, Electrical hazards, noise, lasers and microbiological hazards, contaminations in fieldwork, fire accidents are potent-areas of laboratory accidents.

1.3 Fire Accident in School Laboratories

The gas cylinders are sometimes connected through various gas pipes to Bunsen burners for various organic and inorganic synthesis in the laboratory in which heat is required. Teachers are to control the students use of the gas cylinders. No more than four terminals (not as a rule) should be ignited at a time to avoid sudden rise in temperature of the environment. It is important, to stabilize control of burning points by the teacher (misuse of gas cylinders).

Sources of fire in school laboratories are:

i. Ignition of reactive materials such as alkali, metals, white phosphorus. Avoid powerful oxidizing agents like HNO_3(aq).

ii. Ignition of solvent vapours: Do not store flammable, volatile liquids in free cylinders but they are better stored in domestic refrigerators.

iii. Uncontrolled chemical reactions including release of hydrogen. Hydrogen gas should be ignited only when reduced volume is released. (hydrogen explosion is common when large volume of hydrogen is ignited in air.

iv. Inadequate maintenance of electrical equipment or circuiting.

v. Inadequate laboratory design can set-in static electricity.

1.4 Safety Work Act for School Science Teachers (Review of Safety Act, 1974)

Laboratory practice and safety at work are important aspects of school science programme. The provision of the safety work act is to direct man and materials towards a common goal of safe practice and instruction in the laboratory. The Act requires all employers to prepare and where necessary to revise written statements setting out their policy for the health and safety of employees and the procedures for effecting that policy. According to Archenhold, Jenkins and Robinson-Wood (1977), the following rules are of general acceptance among safety conduct:

- That teachers and employees be trained on safety issues.
- Materials supplied to schools for practical teaching lessons should be ensured safe by designers, manufacturers, importers and suppliers.
- Teachers should ensure safe teaching period in laboratories ensuring injury free work and to co-operate with employers and others in meeting statutory requirements.
- Operators and employers should realize that the Act should cover risks to students in schools and give them appropriate safety training. The Act therefore places an obligation on teachers and administrators to develop and publicize appropriate safety education procedures. (Archenhold, Jenkins and Robinson-wood, 1977).

1.5 Overview of Safety in Secondary Schools

The researchers agree with the views of Abdullahi (1979) and Daramola (1985) that progress made in the learning of science, historically, created impetus for generation of scientific instruments for which science is studied in order to cater for reliability, concept relatedness and safety. Very recently, innovation is also made in the labless laboratory skill G project of the Federal Ministry of Science and Technology to develop adequately safe experimental kits which can be used to explain, or interpret or prove with simplicity basic phenomena in science. Historically, despite the efforts of Liebig, (1803-1873), Priestley (1733- 1804), Cavendish (1731-1810) in changing their homes to laboratories and demonstrated teaching of concepts in science, modern science teachers, are encumbered with struggles of the inadequacy of laboratory equipment, inadequate supply of essential reagents for experiment, teacher welfare, students response to teaching which are necessary pre-instructional characteristics than the curiosity to engage in improvisation. A lot of problems are associated with effective science teaching through laboratory work. One main advantage of laboratory science teaching is that it allows students to have experience that are consistent with the goal of scientific literacy (Omosewo, 2010). Unfortunately, and pitiably, science practical work is difficult to organize as a result of lack of apparatus Ogunniyi (1977), Ojo (1981).

For instance, in Kwara State of Nigeria, Onawala (1982) and Oyelere (1983) reported that poor management of laboratory equipment and materials as well as inadequate equipment supply has created difficulty in the teaching and learning of practical in science.

However, another problem could be the inactivity of students and teachers in their roles in practical work session. Safety in the secondary school laboratory practice involves the students' and teachers' ability to manipulate the apparatus, make observations, record them, interpret results on planned experiment, ability to plan and positive attitude to work (Omosewo, 2011).

Although the planning of a practical class session involves teachers skills, cognitive ability, concept-readiness, and attitude, work experience reveals that the poor renumeration attached to science teacher and non- insurance policy formulated to assure science teachers against laboratory hazards are completely discouraging and defeatist.

There is another salient issue linked with waste and technological obsolescence which affects science laboratory practice in schools. Most labels placed on reagent bottles, apparatus and chemicals wears away, burns off or carelessly removed when touched with the chemicals and since the chemicals now have no identity, they become a source of worry. An unknown chemical is a potential danger, hence care has to be taken to discard content into earth (danger soil pollution) or waste drain. Most apparatus are out of use due to technical problems such as lack of man Power trained in use of those equipments or loss of operational manual. The idea of lack of fund in assisting and realizing educational development in most part of the states especially the south-south geopolitical zone, vis-ã-vis the much acclaimed free education, modernization and rehabilitation of our school systems without considering instructional equipments and verbose laboratories will render teaching in science theoretical and scientific literacy cannot be achieved as a matter of fact without the basic experimental knowledge and application of science. Where the commitment, motivation and relevance of the teacher cannot be over-emphasized.

1.6 Methodology of Research

The research is a descriptive survey research design in order to describe the sate of safety of school laboratories in the research area. Using the Laboratory Safety Resources Assessment Sheet (LSRAS) as questionnaire. The state of the art assessment of the safety of the laboratories in public schools in Rivers state, is carried out using the Safety Resources Assessment Sheet (LSRAS) designed by the researchers. The LS1AS is a 30 item questionnaire consisting of two sections.

Section A-consist of 6-items seeking demographic information whereas section B consist of 24-items sub-divided into safety in Biology, Chemistry and Physics laboratories which is re-considered for general and in depth study as susceptibility to fire hazard, susceptibility to chemical hazard, susceptibility to physical accidents such as electric shocks and utility of school laboratories/post accident cares. The questionnaire Laboratory safety Resources Assessment Sheet (LSRAS) was disseminated to three science teachers (Physics teacher, Chemistry teacher and Biology teacher) in twenty-one-schools in the research area. The questionnaire were retrieved after two days and their responses and used in the providing answers to the research questions. Descriptive analysis by use of percentages and mean were used in handling of the data.

1.7 Research Questions

The following research questions were stated to enable the researcher delve into this study.

Research Question I

Are the public schools' laboratories in the research area susceptible to fire accidents?

Table 1.1: Response of Teachers on Susceptibility of the Laboratories (Biology, Physics and Chemistry) To Fire Accidents

S/No	Questionnaire	Response		%x	%y	Mean x	Mean y
	Item	Yes	No				
1	Do you have fire extinguishers in your laboratory	15	54	21.74	78.26	0.708	0.44
2	Do you have lamped gas cylinders	57	12	82.61	17.39		
3	Do you have inflammable chemicals like kerosene, aromatic amines aerosols etc	69	-	100	0.00		
4	Do you have plastics in your laboratory	69	-	100	0.00		
5	Do you have knowledge of flash points of chemicals in your stores	6	63	8.7	91.3		
6	Do you give instruction on how students should conduct themselves in the laboratory	39	30	56.5	43.5		

Table 1.1 revealed that 100% of schools laboratories have potentials dangerous chemicals (concentration reagents) kept in stands in the laboratory despite the teachers ignorance of flash points of these chemicals, (only 8.7% have knowledge of flash points of displayed chemical reagents). There are presence of plastics and 78.26% of these laboratories do not have fire extinguishers installed in them. There is therefore a potent for fire accidents in most laboratories in the research area with only 21.7% with fire extinguishers although 17.39% of the laboratories lacked gas cylinders only 32.69% are fitted with gas cylinders at strategic positions in the laboratory. The mean value of more potency for fire hazard = 0.708 is greater than the less potency for fire hazard = 0.44 in the research area.

Research Question II:

Are the public schools' laboratories susceptible to causing chemical hazards such as burns and corrosion?

Table 1.2: Response of Teachers on Susceptibility of the Schools' Laboratory to Chemical Hazards (Burns and Corrosion)

S/No	Questionnaire	Response		%x	%y	Mean x	Mean y
	Item	Yes	No				
7	Do you wear goggles in your eyes to protect against accidental splash of chemicals into your eyes?	6	63	8.7	91.3	0.308	0.842
8	Is your windows sufficiently and regularly opened for temp. regulation and ventilation?	39	30	55.5	43.5		
9	Do you have hand gloves, dissecting sets?	6	63	8.7	91.3		
10	Do you prepare N02 or mercury in large quantities?	-	69	-	100		
11	Are you abreast with the table of potential hazardous chemicals in our laboratory?	-	69	-	100		
12	Do you have caustic and corrosive chemicals on the stands	60	9	86.96	13.04		

Table 1.2 indicates that, the mean value for more potency for accidents due to chemical hazards y = 0.842 is greater than the less potency for chemical hazards x= 0.308. Laboratories of public for chemical hazards due to burns, corrosion and this resulted from about 91.3% of technician and teachers in the schools doing practical without the use of goggles to protect their eyes. 100% of the respondents do not have the table of potential hazardous chemicals in their laboratory but have identified 86.96% of the caustic and corrosive chemicals kept openly in stands in the laboratory.

Research Question III

Is the condition of electrical installations in the laboratories in public schools in the research area susceptible to electric shocks and explosion?

Table 1.3: Indicates Teachers Response on State of Electrical Installation and Other Physical Conditions in the Laboratories in Public Schools in the Research Area

S/No	Questionnaire	Response		%x	%y	Mean x	Mean y
	Item	Yes	No				
13	Do you have electricity supply? (lighting in lab).	24	45	34.8	65.24	0.375	0.775
14	Do you have adequate space for keeping of stools cupboards and tables	54	15	78.26	21.74		
15	Do you have plants like butter cups, snowberry, potato	—	69	-	100		
16	Do you have lasers and uv lights produced during experimentation	6	63	8.6	91.3		
17	Do you have separate laboratories for physics, chemistry and biology	27	42	39.12	60.86		
18	Do you have electrical equipments above IMA, 50Hz	24	45	34.28	65.22		

Mean value y = 0.775 > x = 0.375. Although 65.22% of the schools laboratories do not have electricity 34.78% do make use of installations having current above IMA and frequency of 50Hz. More than 65.2% of the schools in the research area do not have the potency for electrical hazards like snowberry, buttercups planted. The production of laser lights and uv is also limited to about 8.6%.

Research Question IV

Are there available working laboratory for teaching science safety in public schools in the research area?

Table 1.4: Responses of Teachers on Utility of Laboratory for Experimentation and Post-Accident Care in Public Schools in the Research Area

S/No	Questionnaire	Response		%x	%y	Mean x	Mean y
	Item	Yes	No				
19	Do you have first aids box with accessories?	6	63	8.7	91.3	1.74	3.26
20	Do you have waste collections containers for broken glasses etc?	60	9	86.95	13.05		
21	Do you actually make use of the laboratory at least twice weekly	27	42	39.1	60.9		
22	Do you have sign posts at strategic positions in your laboratory to regulate man and materials	3	66	4.30	95.7		
23	Do you engage in experimental field work?	24	45	34.8	65.2		
19	Do you have first aids box with accessories?	6	63	8.7	91.3		
		120	225				

The table indicate that 91.3% of the laboratories in the research area do not have equipped first aid box but 86.96% had waste collection containers for broken glasses among others teaching of subjects (physics, chemistry and biology) are not regular up to about 39.1% of the schools, twice weekly. Whereas 60.9% of schools do not carryout experiments in the laboratory at least bi-weekly. 95.7% of the laboratories do not have sign posts indicating danger and free zone commands in their laboratories and only 34.8% of teachers in the schools in the research area, engage their students on field work.

In summary the mean value of high potency for accident due to lack of preventive measures and post-accident care Y = 3.26 against less potency for accident due to provision of safety instruments and measures is 1.74.

1.8 RESULTS AND DISCUSSIONS

Although, Obome et al; (1996), Reiss S (2000) and Osborne & Collins, (2000) in independent research exploring pupils' attitudes to science, consistently reveals that one of the major points of engagement with science is practical work which has afforded the students opportunity to engage in hands-on manipulation of the material world, current practices in schools in the research area limits the opportunities for students to engage in empirical enquiry. Research findings indicated that laboratory practices are rarely conducted among schools in the research area. 100% of schools in the research area are ignorant of the potential danger associated with storage of chemicals with worn-out labels, 78.26% do not have fire extinguishers and kept concentrated acids and alkalis in the stands. The flash points and table of hazardous chemicals of these chemicals storage precisions were neglected.

Hence possibility of having fire incidence is therefore high. Secondly, 65.2% of the schools do not have the potency for electrical accidents.

The study revealed that 91.3% of the surveyed laboratories do not also have equipped first aid box. This means that first aid attendance of accidental cases is not possible in such schools and against laboratory regulation practices.

CONCLUSIONS

Based on the research findings there is no safety regulation among the teachers and laboratory technologist in schools in the research area. The potency of teachers and students and technologists to hazards due to chemical burning, fire incidence lack of trained personnel in the laboratory are observed in the schools in the research area.

Recommendation

The following recommendations are made based on the findings of this research.

- Teachers should produce a network of safety symbols, and instruction to control movement of man and materials in the laboratory in order to reduce the incidence of accident.
- The government should redeem the poor condition of our laboratories which are vulnerable to accident by providing safe materials and equipment for science teaching and learning.
- Education supervisors should emphasize compulsory practical work for students in secondary schools this would enhance their performance in the subject matter.

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