Awareness and Perceptions of Biological and Chemical Safety in Laboratories by Polytechnic Students; Implications for Professionalism

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Abstract- This study examines the awareness and perceptions of biological and chemical safety in laboratories among Polytechnic students at the Delta State Polytechnics at Ozoro and Otefe-Oghara, Nigeria. The research design employed was cross-sectional survey. The study population comprises science laboratory students the Polytechnics in Delta state. A random sample size of 240 students from the Department of science laboratory Technology was selected. A questionnaire was designed to obtained responses from participants on their level of awareness and Perceptions of Biological and chemical safety in school science laboratories. Descriptive statistics was employed in data analysis. Pearson Correlation tested the research hypothesis. The findings reject the null hypothesis. There was positive correlation in the perception of relevance of compliance to basic Laboratory rules for safety by male and female science laboratory students. Turning off power, water and gas sources, after laboratory experiments is one of the cardinal safety measures in a science laboratory. Over seventy nine percent of the students (79.17%) admit that they usually forget to turn these sources off after completion or termination of laboratory experiments. The study recommends that trainers such as laboratory technologists and lecturers ensure that students obey safety procedures and practices while conducting laboratory experiments in school laboratories. This is imperative as graduates from the science laboratory technology departments are expected to be competent as professionals in handling of laboratory works. The government should also ensure proper monitoring of Laboratories within the State and ensure periodic provision of professional safety education to laboratory staff.

Index Terms- Awareness; chemical safety, school laboratory; hazards; compliance; professionals

I. Introduction

A typical laboratory functions as suitable environment for research and teaching of science (Collins and O'Brien, 2008). In typical biology or Chemistry laboratories, there are stocks of materials that can be classified as potentially flammable and explosive in nature. Others may be irritants to the human skin and radioactive in nature. In essence, most science laboratories have chemicals and materials that can be health hazards to the users and require care and knowledge of these materials on their utilization and storage.

The science laboratory is also designated as facility suited for teaching Science in academic institutions. It facilitates the achievements of scientific education for students in diverse scientific disciplines. There are however challenges inherent in the use and management of laboratories. These challenges may be linked to infrastructure decay or faults as well as human activities and behaviour when using the laboratory.

Generally, there are measures that can be adopted to ensure enhanced or improved Safety in school laboratories. , It is imperative that the users have relevant knowledge of Laboratory risk Management and basic laboratory safety rules and regulations. This will prevent or reduce the risks of accidents and minimize damages to facilities and harm to users.

Statement of the problem: Science laboratory staff must be trained to acknowledge and apply safety practices when working in the laboratory. All types of devices, equipment and experimental procedures must only be used after due consideration to safety implications associated with them (Jo et al., 2002). Laboratory experiments should have defined procedures, precautions and instructions regulating them. Non-compliance to scientific procedures can lead to accidents. Often, this had been linked to users performing experiments in haste, without proper training on the use of equipment or adequate knowledge of the properties of the biological or chemical materials involved in the experiment.

Some empirical studies had highlighted the increasing levels of laboratory accidents occurring as a result of negligence in compliance to laboratory safety ethics and rules (Julius and Thomas , 2014; Ahlin & Weiss, 2007).

Other reasons deduced for laboratory related accidents and injuries, damages and losses include non-usage of personal protective equipment (PPE) in the laboratory, inadequate experience by laboratory staff or students, wrong use of chemicals, and wrong handling of emergency cases resulting from laboratory accidents (American Chemical Society, 2012; Schroder et al., 2016).). Ensuring availability and effective utilization of First aid in the laboratory by laboratory mangers is crucial to a safety in the Laboratory.

Some of the identified factors responsible for laboratory accidents include indifference to set down rules, lack of experience in experimental procedures, disregard for

manufacturers' instructions equipment or chemical. Others factors include incidences of mistakes or errors in carrying out bench works or operating a machine. Understanding the labeling and codes associated with categorization of materials (biological and chemical) is needed to avoid consequences of wrong use of substances. Correct identification of established symbols and labels of substances found in the laboratory especially chemical labels is thus very crucial for forestalling laboratory accidents (Karapantsios et al., 2008).

Aim of study: The research seek to assess the knowledge, practices and attitudes of science laboratory students of the School of Applied Sciences at the two state owned Polytechnics located at Ozoro and Otefe –Oghara towns in Delta state. It also seek to examine students' ability to identify potential biological and chemical hazards in the laboratory

Research questions: The research seek to answer the following research questions

1). what are the Science Laboratory Students' Attitudes to and compliance with basic rules and safety procedures in the laboratory?

2). what are the reasons or factors responsible for Science Laboratory Students' non-use of Personal Protective Equipment (PPE) in the Laboratory?

Research Hypothesis: The following null hypothesis is formulated for the research

Ho: There is no significant difference in the mean perception of relevance of compliance to basic Laboratory rules for safety by male and female science laboratory students

Significance of the study: The outcome of this study will be useful to policy makers and Regulatory body Polytechnics in Nigeria as they design and implement curriculum for the training of science laboratory technicians and technologist in Nigeria. The findings could be relevant to the Delta State government. They can also adopt and implement suitable safety measures from the research output for use in all the Science laboratories in institutions of higher learning in the State.

II. MATERIALS AND METHODS

The study period lasted from August to October 2020. The study Population includes all science laboratory students in the two Delta State Polytechnics located in Ozoro and Otefe towns. The participants due to the curriculum content and training requirements for the award of National Diploma in Science Lobotomy Technology do have exposure to potential biological and chemical materials during their class work and laboratory practical activities. A sample size of 240 students was obtained by random sampling technique. All the participants received assurances of keeping their responses in the study confidential. The return rate of the completed questionnaire was a ninety six percent. A total of 240 out of 250 questionnaires were successfully retrieved from participants.

Stratified random sampling technique was employed in selecting 165 male and 75 female science laboratory students from the two Polytechnics in the study. schools, giving the sample size 240 students Instruments of Data collection

Instrument for data collection: for this research was a rating scale and a structured questionnaire administered to science laboratory students from the two Polytechnics in the study. The questionnaire was divided into two parts; part A and B. Part A consists of general information of the respondents such as gender, school, One of the rating scale items were structure as 'YES' and 'NO' while the other questionnaire items were structured in 4-point rating scale of Strongly Agreed (SA) = 4, Agreed (A) = 3, Disagreed (D) = 2 and Strongly Disagreed (SD) = 1 respectively to elicit information on perception of relevance of compliance to basic Laboratory rules for safety by male and female science laboratory students in the State owned Polytechnics. Statistical means of 2.5 and above are regarded as responses indicating 'relevant', while responses receiving mean score less than 2.5 are regarded as responses indicating 'not relevant'

III. RESULTS AND DISCUSSION

Table 1: Science Laboratory Students' Attitudes to and compliance with safety procedures in the laboratory

Attitude/ compliance in the Lab	Yes		No	
	Frequency	%	Frequency	%
Always handling samples with hand gloves	100	41.67	140	58.33
Washing of hands before and after any laboratory process	75	31.25	165	68.75
covering of cuts , abrasions and injuries with waterproof plaster before engaging in Laboratory experiments	198	82.50	42	17.50
Use of laboratory coats in the laboratory	110	45.83	130	54.17
Eating, drinking, in the laboratory	170	70.83	70	29.17
Always using facemasks and goggles in the laboratory as required in experiment	72	30.00	168	70.00
Turning off power sources after laboratory experiments	50	20.83	190	79.17
Turning off water sources after use in laboratory experiments	50	20.83	190	79.17
Turning off gas sources after use in laboratory experiments	50	20.83	190	79.17
Always Reading equipment instructional manual before using them	95	39.58	145	60.42
Always checking the expiry date of chemicals and reagents before using them	58	24.17	182	75.83

Always ensuring the exit door during emergency is free from encumbrances during laboratory work	94	39.17	146	60.83
Always checking for prescribed precautions for each experiment in the laboratory	120	50.00	120	50.00
Ensuring hygiene/ alcoholic disinfectants after handling laboratory animals	80	33.33	160	66.67
Ensuring hygiene/use of alcoholic disinfectants after handling dishes with microbial contents in the laboratory	80	33.33	160	66.67
Ensuring a fully equipped first aid box in available during laboratory experiments	110	45.83	130	54.17
Ensuring a functional fire extinguisher is available in the lab during experiments	48	220.00	192	880.00

The attitudinal disposition of the Polytechnic students towards safety precautions and compliance with basic rules in the laboratory is relatively poor and a cause for safety concerns. The results show that 70.83% of them formed the habit of eating or drinking in the laboratory. The implication of this finding is that they lack knowledge of the health hazards posed by eating or drinking inside the laboratory. Food and drinks can have risk of chemical exposure in the lab leading to possible food poisoning (Hardy, 1999). Turning off power, water and gas sources, after laboratory experiments is one of the cardinal safety measures in a science laboratory. Over seventy nine percent of the students (79.17%) admit that they usually forget to turn these sources off after completion or termination of laboratory experiments. This is a potential risky attitude that can lead to fire incidents as well as electrical accidents such as electrocution or damage to equipment. However, findings indicate that 82.50% of the students would always remember to cover of cuts, abrasions and injuries with waterproof plaster before engaging in Laboratory experiments. This health related attitude is positive and needs to be encouraged among all the students and laboratory staff. Covering of cuts in the lab is recommended as this prevents possible infections of the wounds by pathogens or cut getting in contact with irritant chemicals (Percival et al., 2012; Izegbu et al., 2006; Odusanya, 2003).

Over seventy five percent (75.83%) of the students do not bother to read the equipment instructional manual before using them and 60.83% do not consider checking the expiry date of chemicals and reagents before using them. This attitude can be potentially risky as manufacturer's manual is crucial to proper handling of equipment in the laboratory. This would prevent accidents and faulty results etc.

Table 2: Participants responses to Reasons for non-Use of Personal Protective Equipment (PPE) in the Lab

Factors /Reasons for non-use of PPE	Frequency	Percentage
Was not made compulsory by Lecturer./Technologist in charge of the Lab	168	70.00
PPE is expensive	195	81.25
Hinders free movement and activities in lab	110	45.83
Make the user Uncomfortable	45	18.75
Not made available by school	200	83.33

Analysis of the factors or reasons put forward by the students for non-use of PPE in the laboratory show that most of them (70%) do so because the use of PPE was not made mandatory by the staff in the laboratory all the time. This highlights the need for enforcement of basic laboratory rules in the school science laboratories. This will ensure the students ultimately imbibe in the need to be safety conscious as professionals and scientists.

Economic reasons were also put forward by the students as 81.25% of them consider PPE as expensive. The students also expected the Polytechnic authorities and the State government to provide PPE for students in the labs. About 83.33% of the students say they have not being using PPE regularly because the school did not make them available in the school laboratories. The use of personal protective equipment as revealed by this study is unsatisfactory. These finding are similar to those of Okebukola, et al (2020) that identified poor chemical safety in Nigerian secondary schools. It emphasized the need for training of the teachers and the need to ensure enforcement of laboratory safety regulations.

Table 3: Participants response on relevance of compliance to basic Laboratory rules for safety by male and female science laboratory students

S/N	Questionnaire item	Respondents	4 SA	3 A	2 D	1 SD	total	mean $\overline{X}$
1	Laboratory rules and regulations are necessary and relevant for safety in the laboratory	Male students	139	22	4	-	165	3.80
		Female students	62	8	5	-	75	3.74

The mean value of 3.80 and 3.74 indicates that the science laboratory students consider Laboratory rules and regulations as necessary and relevant for safety in the laboratory environment. The study regards Statistical means of 2.5 and above are as responses indicating 'relevant', while responses receiving mean

score less than 2.5 are regarded as responses indicating 'not relevant' The implications of this findings underpins the need for enforcement and training of the students on compliance with safety rules.   The students know that the rules are relevant. However, they need enforcement mechanisms to ensure they do the right thing.

The null hypotheses formulated for the research were tested using Pearson Correlation analysis at 0.05 level of significance Table 4: Pearson Correlation analysis results on relevance of compliance to basic Laboratory rules for safety by male and female science laboratory students

Gender	N	Mean	SD	DF	r - cal	r-cri	Remarks
Male	165	3.82	0.44	238	0.688	0.195	Significant
Females	75	3.74	0.57				

The calculated r-value of 0.688 is greater than the r-critical value of 0.195 at degree of freedom of 238 and 0.05 level of significance. This implies that the null hypothesis (H_0) is rejected, and alternative hypothesis (H_1) accepted. The findings show that there is a significant and strong positive relationship between Male and female science laboratory students' perception on relevance of compliance to basic Laboratory rules for safety in the Laboratory environment.

IV.   CONCLUSION

This study examined science laboratory students' awareness and perceptions of Biological and Chemical Safety in science Laboratories. The findings indicate that students' general perception and awareness for compliance to laboratory rules and regulations needs to be improved upon. It is imperative as it underpins the implications for their practice as technicians and/or technologist when they graduate and the need to uphold professionalism in the laboratory environments.

V.   RECOMMENDATIONS

The present study recommends:

1) The Federal government of Nigeria should conduct a broad review of the National Board for Technical Education (NBTE) curriculum for Science laboratory technology training and certifications in Polytechnics in Nigeria. This is to ensure the curriculum provides for improved students' awareness and compliance with laboratory safety measures while still at school.

The government should create multiple avenues for awareness and education on laboratory safety, ethics and best global practices. The social media, targeted advertisements and news channels can be harnessed to accomplish this goal.

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APPENDIX

PART A

DEMOGRAPHIC DATA

Please mark [✔] in the boxes to answer any of the corresponding questions below.

Gender:	Male[ ]	Female [ ]
School	[ ]	[ ]

PART B

Please mark [✔] in the boxes to answer any of the corresponding questions below

Attitude/ compliance in the Lab	Yes	No
Always handling samples with hand gloves		
Washing of hands before and after any laboratory process		
covering of cuts , abrasions and injuries with waterproof plaster before engaging in Laboratory experiments		
Use of laboratory coats in the laboratory		
Eating, drinking, in the laboratory		
Always using facemasks and goggles in the laboratory as required in experiment		
Turning off power sources after laboratory experiments		
Turning off water sources after use in laboratory experiments		
Turning off gas sources after use in laboratory experiments		
Always Reading equipment instructional manual before using them		
Always checking the expiry date of chemicals and reagents before using them		
Always ensuring the exit door during emergency is free from encumbrances during laboratory work		
Always checking for prescribed precautions for each experiment in the laboratory		
Ensuring hygiene/ alcoholic disinfectants after handling laboratory animals		
Ensuring hygiene/use of alcoholic disinfectants after handling dishes with microbial contents in the laboratory		
Ensuring a fully equipped first aid box in available during laboratory experiments		
Ensuring a functional fire extinguisher is available in the lab during experiments		

Please mark [☐] in the boxes to answer any of the corresponding questions below

Factors /Reasons for non-use of PPE	Yes	No
Was not made compulsory by Lecturer./Technologist in charge of the Lab		
PPE is expensive		

Hinders free movement and activities in lab		
Make the user Uncomfortable		
Not made available by school		

Please mark [□] in the boxes as appropriate

S/N	Questionnaire item	4 SA	3 A	2 D	1 SD
	Laboratory rules and regulations are necessary and relevant for safety in the laboratory				-
					-

SA= STRONGLY AGREE
A= AGREE
D= DISAGREE
SD= STRONGLY DISAGREE