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Evaluation Of Awareness And Safety Among Students And Technicians In UTM Research Chemical Laboratories

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Ester Ndaxuwelao Ndaimbwehafo Kavalela[1], Shreeshivadasan Chelliapan[1,*], Hesam Kamyab[1]

[1] Engineering & Technology Department, Razak Faculty of Technology and Informatics Universiti Teknologi Malaysia, Jalan Sultan Yahya Petra, 54100 Kuala Lumpur, Malaysia

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ABSTRACT

Incidences in chemical research laboratories have been occurring at an alarming rate resulting in chemical-related injuries and illnesses ranging from skin and eye irritation to burns, chronic diseases, or death. Students need to make safety as part of their daily routine when working in chemical research laboratories by understanding particular hazardous characteristics of chemicals they are using in order to prevent accidents. Standards such as OSHA's Occupational Exposure to Hazardous Chemicals in Laboratory standard (29 CFR 1910.1450) can be used by institutions for safe work in research laboratories. The purpose of this study is to assess the awareness and safety of students and technicians in Universiti Teknologi Malaysia (UTM) chemical research laboratories, to identify the type of hazards in chemical research laboratories and propose improvements to existing guidelines. For this study, a qualitative method was used for data collection using a self-administered questionnaire for students and technicians and laboratory checklist. The data collected was analysed using Statistical Package for Social Sciences (SPPS). After various observations and analysis, it is recommended that chemical spillage and handling should be included in the existing guidelines for awareness and safety on hazards caused by chemical and acutement substances in the chemical research laboratories; students should be given safety practices training to create awareness and prevent laboratory accidents when carrying out experiments; and laboratory inspections should be carried out to see whether the students and technicians are adhering to laboratory rules and regulations.

Keywords:
Chemical research laboratories, Hazards, Safety, Awareness

1. Introduction

Science fields can be fun, exciting and amazing but at the same time they can be fatal. Nowadays, laboratory classes are parts and parcel of teaching science subjects throughout the world. One of the main reasons is that students getting exposed to laboratory classes help them to understand theories and abstract otherwise. Laboratory classes also gives opportunities to students to learn on how to handle chemicals safely and with confidence and gain experience in using chemical apparatus [1]. Science students that are working in the laboratories are exposed to hazardous chemicals including

* *Corresponding author.*
E-mail address: shreeshivadasan.kl@utm.my

cancer causing agents (carcinogens), toxins that may affect the liver, kidneys or nervous system, irritants, corrosives, and sensitizers, together with agents that affect the blood system or damage the lungs, skin, eyes, or mucous membranes [2]. Over the past years there have been many records of laboratory incidents in the institutions around the world ranging from minor injuries to major injuries including fatalities.

The rising prevalence of accidents involving students in the science laboratory calls for proficient measures to eradicate, or if not, reduce accident occurrences and one of the measures that can be taken is the development of awareness and practice of laboratory safety [3,4]. Laboratory practices in academic are a major concern worldwide including Malaysia. Therefore, students have to be extra cautious when working in the research chemical laboratory to prevent accidents that can occur. In order for the students to be extra cautious and stay safe when working in the laboratories, they need to have the knowledge on identifying hazards and the dangers they might encounter when working in the laboratory to prevent accidents from occurring. To understand these hazards it requires basic knowledge introduction about toxicology, hazard communication systems [5,6], writing and understanding chemical equations, thermodynamics and release of energy, phase diagrams, chemical structures, and many other chemical concepts [7]. If the students have the knowledge on the hazards, they will understand the risks associated with those hazards and apply control measures to protect themselves from the risks example by wearing eye protection in the laboratory when handling corrosive chemicals. Safety is an essential part of all characteristic of chemistry and it needs to be considered every day in the work when carrying out chemical activity [8,9,10]. Students also need awareness on personal hygiene and proper hand washing when working in the laboratory to specifically prevent contact with the chemicals that can cause burns or irritation to the skin [3,11].

2. Methodology

This study is aimed to assess level of awareness and safety among students and technicians in UTM chemical research laboratories and to identify the type of hazards in chemical research laboratories in order to make improvements to the existing guidelines. The researcher used a mixed mode of qualitative and quantitative approach in this study. Thus, two types of self-administered questionnaires were distributed, one for the students and one for the technicians who work in the chosen chemical research laboratories. A laboratory checklist was also used. The concept of the research methodology is illustrated in Figure 1.

3. Results and Discussion

Based on the results, 30 respondents (27 students and 3 technicians) have participated in this study from the five chosen chemical research laboratories as shown in Table 1.

3.1 Students Demographic Data

Table 2 shows that the majority of the students, 66.7%, that works in UTM chemical research laboratories are females. 25.9% of students are Undergraduate, 59.3% are Master students and 14.8% of the students are PhD students. 96.6% of the students are Malaysia-Japan International of Technology (MJIIT) students while 3.7% are Razak School students.

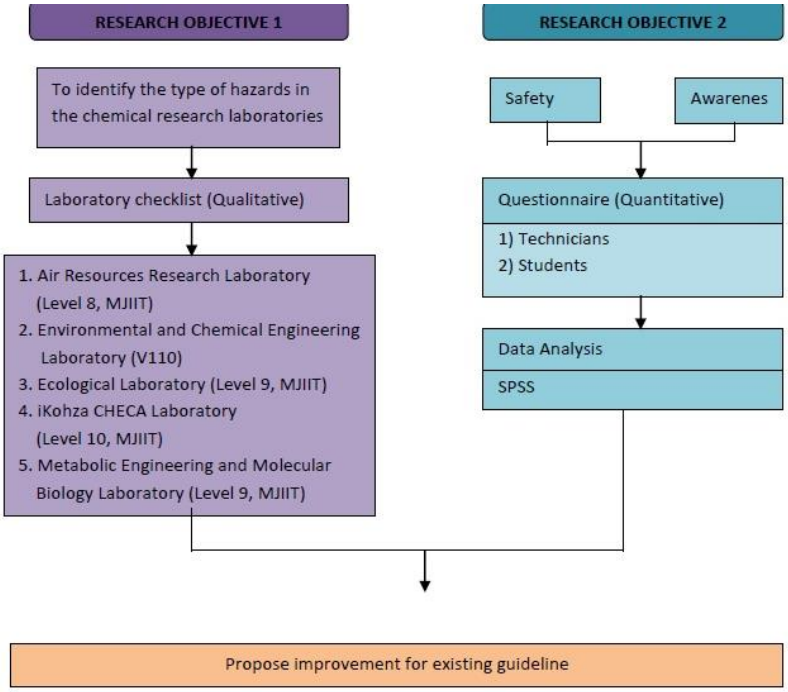

Fig. 1. Research Methodology Concept

Table 1
Number of students and technicians that participated in this study

Name of Laboratory	Number of Students	Number of Technicians
Air Resources Research Laboratory	7	1
Environmental and Chemical Engineering Laboratory	1	0
Ecological Laboratory	6	1
iKohza CHECA Laboratory	6	0
Metabolic Engineering and Molecular Biology Laboratory	7	1

Table 2
Students Demographic Data

SN	Item	Students Response	Frequency	Percentage
1.	Gender	Male	9	33.3%
		Female	18	66.7%
2.	Level of education	Undergraduate	7	25.9%
		Master	16	59.3%
		PhD	4	14.8%
3.	Faculty	Razak School	1	3.7%
		MJIIT	26	96.6%

3.2 Technicians Demographic Data

Table 3 shows that the majority of the technicians, 66.7%, that supervise in the chemical research laboratories are females. 100% of the technicians are PhD students and they all belong to MJIIT.

Table 3
Students Demographic Data

SN	Item	Students Response	Frequency	Percentage
1.	Gender	Male	1	33.3%
		Female	2	66.7%
2.	Level of education	PhD	3	100%
3.	Faculty	MJIIT	3	100%

3.3 Type of Hazards in UTM Chemical Research Laboratories

Table 4 shows that all the chemical research laboratories chosen for the purpose of this study have chemical hazards, electrical hazards and physical hazards. It was only Ecological Engineering Laboratory; Environmental and Chemical Engineering Laboratory, and Metabolic Engineering and Molecular Biology Research Laboratory that have biological hazards. None of the laboratories have ergonomic hazards and mechanical hazards.

Table 4
Type of hazards in UTM chemical research laboratories

Type of hazards	Air Resource Research Laboratory	Ecological Engineering Laboratory	Environmental and Chemical Engineering Laboratory	iKohza CHECA Laboratory	iKohza CHECA Laboratory
Chemical Hazards • Flammable • Toxic • Reactive • Corrosive	✓	✓	✓	✓	✓
Electrical Hazards • Electrical shock • Fire • Burns	✓	✓	✓	✓	✓
Biological Hazards • Microbes	×	✓	✓	×	✓
Physical Hazards • Gas Cylinders • Heating Devices	✓	✓	✓	✓	
Ergonomic Hazards • Standing or seated long time • Uncomfortable working environment	×	×	×	×	×
Mechanical Hazards • Moving machineries	×	×	×	×	×

3.4 Students Safety Knowledge on Hazards and Acutement Substances

Table 5 shows that 81.5% of the students always use the required PPE during their experiments, 14.8% sometimes use the required PPE during their experiments while 3.7% never use the required PPE during their experiments. 77.8% of the students indicated that flammable chemicals are appropriately stored while 22.2% of the students indicated that flammable chemicals are not appropriately stored. 81.5% of the students indicated that acids and basis are stored appropriately separately in acid and basis cabinets while 18.5% of the students indicated that acids and basis are not stored appropriately. 100% stated that chemical containers are clearly labelled. 77.8% of the students stated that they are aware of chemical hazardous substances in the chemical research laboratories while 22.2% stated that they are not aware of chemical hazardous substances in the chemical research laboratories.

Table 5
Students Response on Safety Knowledge on Hazards and Acutement Substances

SN	Item	Students Response	Frequency	Percentage
1.	Usage of required PPE	Always	22	81.5%
		Sometimes	4	14.8%
		Never	1	3.7%
2.	Appropriate storage of flammable chemicals	Yes	21	77.8%
		No	6	22.2%
3.	Appropriate storage of acid and basis	Yes	22	81.5%
		No	5	18.5
4.	Clearly labelled chemical containers	Yes	27	100%
5.	Awareness on hazardous chemical substances	Yes	21	77.8%
		No	6	22.2%

3.5 Students Knowledge on Laboratory safety signs and symbols

Table 6 presents the number of students who correctly matched the laboratory safety signs and symbols with the corresponding pictogram pictograms of hazard signs. As shown in Table 4.8, 100% of the students were able to correctly match toxic, goggles, hand wash and ionizing radiation safety signs. Only 96.3%, 88.9%, 96.3%, 81.5% and 96.3% were able to correctly match explosive, corrosive, flammable, irritant and oxidizing safety signs, respectively. These results indicate that the students have a very high understanding of laboratory safety signs and symbols.

Table 6
Frequency distribution of students who correctly matched laboratory safety signs

Safety signs and symbols	Frequency	Percentage
Toxic	27	100%
Explosive	26	96.3%
Goggles	27	100%
Corrosive	24	88.9%
Flammable	26	96.3%
Irritant	22	81.5
Oxidizing	26	96.3%
Hand wash	27	100%
Ionizing radiation	27	100%

3.6 Technicians Safety Knowledge on Hazards and Acutement Substances

Table 7 shows that 66.7% technicians indicated that flammable chemicals are stored appropriately in flammable cabinets while 33.3% indicated that flammable chemicals are not stored appropriately in flammable cabinets. 66.7% technicians indicated that acids and basis are stored appropriately and separately while 33.3% indicated that and bases are not stored appropriately and separately. 66.7% technicians stated that broken glasses are dumped as garbage while 33.3% stated that broken glass is not dumped as garbage. 66.7% technicians stated that they have the knowledge on the chemical substances that are hazardous while 33.3% stated that they lack of the knowledge on the chemical substances that are hazardous.

Table 7
Technicians Response on Safety Knowledge on Hazards and Acutement Substances

SN	Item	Students Response	Frequency	Percentage
1.	Appropriate storage of flammable chemicals	Yes No	2 1	66.7% 33.3%
2.	Appropriate storage of acid and basis	Yes No	2 1	66.7% 33.3%
3.	Clearly labelled chemical containers	Yes	3	100%
4.	Broken glasses dumped as garbage	Yes No	2 1	66.7% 33.3%
5.	Aware on hazardous chemical substances	Yes No	2 1	66.7% 33.3%

4. Discussion

This study had 30 respondents (27 students and 3 technicians) from chosen UTM chemical research laboratories namely Air Resources Research Laboratory (Level 8, MJIIT); Environmental and Chemical Engineering Laboratory (V110); Ecological Laboratory (Level 9, MJIIT); iKohza CHECA Laboratory (Level 10, MJIIT); and Metabolic Engineering and Molecular Biology Laboratory (Level 9,

MJIIT). The majority of the students and technicians in the chemical research laboratories are females. The majority of the students who participated in this study are Master students followed by Undergraduate students then PhD students. Only 3.7% of the students belong to Razak School while 96.6% are MJIIT students. All the technicians, 100%, are PhD and MJIIT students.

Based on the overall findings, using the laboratory checklist it can be found that all of the laboratories chosen for this study have chemical hazards that are flammable, toxic, reactive and corrosive; electrical hazards (electrical shock, fire and burns) and physical hazards specifically gas cylinders and heating devices. Only Ecological Engineering Laboratory, Environmental and Chemical Engineering Laboratory, and Metabolic Engineering & Molecular Biology Research Laboratory have biological hazards because they use microbes. None of the laboratories have ergonomic hazards due to the fact that students and technicians are not spend much of their time in the chemical research laboratories as they are not carry out experiments every day. When the students are carrying out experiments, during the progress of the experiments they are not in the laboratory. Thus, they are not willing to stand or seat for a long time, do repetitive awkward postures, and be in the laboratory environment. Therefore it is unlikely for the students and technicians to develop musculoskeletal disorders. None of the laboratories have mechanical hazards (moving machineries). According to previous literature by [12,13,14,15], hazards that are found in chemical laboratories are hazards from flammable, explosive, and reactive chemicals; biohazards, and physical hazards which include compressed gases, nonflammable cryogens, high-pressure reactions, vacuum work, radio-frequency and microwave hazards; and electrical hazards.

The study revealed that majority of the students always use the required PPE during their experiments to prevent accidents in the laboratories; appropriately store flammable chemicals, appropriately store acid and basis chemicals; always label chemical containers clearly, know the chemical substances that are hazardous inside the chemical research laboratories and know that broken glasses are not supposed to be dumped as garbage. The majority of the technicians also indicated that flammable chemicals are stored appropriately, acid and basis are stored appropriately, chemical containers are clearly labelled and they are aware of hazardous chemical substances. The majority of technicians are not aware that broken glasses are not dumped as garbage.All the students, 100%, were able to correctly match toxic, goggles, hand wash and ionizing radiation safety signs and symbols. Other safety signs and symbols such as explosive, flammable and oxidizing, 96.3% of the students could match them correctly. This shows that the majority of the students are aware and do understand the hazards found in the chemical research laboratories. However, a few students lack awareness or differentiation between corrosive sign and irritant sign that they mixed them up. Corrosive and irritant signs had the lowest number of students that could match them correctly.

5. Conclusion

The findings of the research project shows that students and technicians are above average aware of the safety, hazardous and acutement substances in UTM chemical research laboratories. However, there still need improvements to be made to the existing guidelines in order to ensure that accidents that can cause injuries or even death are prevented in UTM chemical research laboratories.

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