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RESEARCH ARTICLE

Knowledge, Attitude, and Practices about Chemical Laboratory Safety of the Faculty, Staff and Students of Kalinga State University

Melanie Santos Manuel[1]*, Bernadette Colangan Aggabao[2], Cherry Ann Doctor Bona[3]

1 Prk.1 Bulanao, Tabuk City, Kalinga
2 Calanan, Tabuk City, Kalinga
3 Magsaysay, Tabuk City, Kalinga

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* **Corresponding author**.

msmanuel@ksu.edu.ph

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Abstract

Objectives: This study investigated the perception of the students, faculty members, and staff of Kalinga State University about chemical safety in the laboratories, including their familiarization with chemical hazards and warning symbols. **Methods**: A sample size of 124 respondents, primarily females, were 10 faculty members, a University Official, and one hundred thirteen (113) students. A questionnaire was used to collect data which were analyzed using descriptive statistics. In the questionnaire, at least 32 questions were used with five sections: demographic data, different GHS pictograms, and approach to safety in chemical laboratories, the practice of students within the laboratory, and knowledge and familiarity with emergency equipment and procedures to assess their knowledge, attitudes, and practices on their familiarity and understanding of chemical hazards in the laboratories. In addition, a semi-structured interview was done after answering the questionnaires to gain deeper insight from the respondents on their knowledge, attitudes, and practices about safety while working in the laboratory. **Findings:** Descriptive statistics conveyed that students, faculty, and staff demonstrated poorly on familiarity and understanding of chemical hazards and warning symbols. Students displayed a poor attitude towards chemical safety but demonstrated fair responses to chemical safety practices. Though faculty and staff displayed fair attitudes towards chemical safety and practices, educational reinforcement and conduct of safety ethics and risk management in the chemical laboratory are recommended for the subjects in charge. The study concluded and recommended that an in-depth education and training need to be implemented for all university students on testing facilities, chemical safety devices, and other standard protocols encountered in the laboratory parallel to the suggestions and recommendations of fellow researchers in the field[(1)]. (Ejilemele & Ojule, 2005)

Keywords: Chemical safety; chemical hazards; emergency equipment; safety devices; standard protocols

1 Introduction

In March 2017, a national newspaper published in the Philippines that several students and personnel of the Manila Science High School have been accidentally exposed and believe to be contaminated with heavy metal mercury. The accident that took place early in March was reported to the school principal ten (10) days after worsening the scenario and angered many of the victims' relatives and friends. If only it were written early, an intervention should have been conducted by the administration. In every subject with laboratory, as included in the course syllabus, the subject teacher discussed safety and precaution before conducting any laboratory activities. Despite the educators' effort to discuss and highlight the safety and the conduct of safety procedures in the laboratory, many studies concluded the deficiency and inadequacy of the student's readiness and comprehension regarding chemical laboratory safety.

Ecumenical injuries have been reported in chemical laboratories for various reasons, such as lack of personal protective equipment (PPE), insufficient training, mishandling of chemicals, and lack of knowledge of the effective measures to be taken in emergencies. In an investigation conducted by Walters in 2017 (Walters et al., 2017)[(2)] showed shortcomings in emergency response and danger recognizing. Results coincides with Allied Health Sciences students that showed that laboratory safety precautions are inadequate[(3)]. Jimma University's Departments of Chemistry and Biology tested the familiarity of students and comprehension of chemical hazard warning signals, and later conclude that the findings support the inference and showed that hazard warning signs are low in understandability[(4)].

Lunar[(5)] and her group discovered in the Philippines that students participating in De La Salle Lipa's Chemistry and Biology Laboratory classes have low levels of experience and knowledge of warning signs of risk.

Studies conducted in the past showed that though awareness was high, there were deficiencies in the areas of hazard identification and emergency response. Attitudes and practices were acceptable but needed improvement, with a weak correlation existing between these two variables. It was concluded that more education and training need to be implemented for improvement.[(2,6)]

On the other hand, a fellow researcher mentioned that a safety climate may also emerge in informal groups and that to improve safety conditions in college laboratories, a more careful analysis of the safety perceptions of the laboratory users other than faculty and staff is required to develop targeted safety interventions since teachers are master orchestrator in the laboratory.[(7)]

Hazardous prevention and management mechanisms for laboratory procedures must be easily communicated with the laboratory staff, their colleagues, and the laboratory supervisors. For such a control scheme to be successful in a transferable and reliable manner, appropriate communication tools for risk assessment must be in place.

Despite the efforts of the researchers to study its status for law and regulations-making, it lacks systems of enforcement here in our country[(8)].

This research was therefore proposed to assess the capacity of faculty, staff, and students to recognize GHS (Globally Harmonized Scheme of Naming and Marking of Chemicals) pictograms and to define the behaviors of faculty, staff, and students engaged in laboratory safety protocols, safety activities, and awareness of acceptable responses to emergencies and the use of related equipment to evaluate the status of Chemical Laboratory safety procedures and achieve an environmentally friendly institution.

Lastly, the present study would initiate and complement the institution in its application to the statutory and regulatory requirements and continuous monitoring

and evaluation to improve the effectiveness of its Quality Management System.

2 Objectives of the Study

The study aims to achieve the following objectives

1. to measure the ability of the faculty and students to comprehend GHS (Globally Harmonized System of classification and labeling of chemicals) pictograms
2. to identify the attitude of the faculty and students in undertaking safety procedures in the laboratory, safety practices, and knowledge about the appropriate responses to be taken in emergency cases and the use of related equipment.

3 Significance of the Study

The study was designed to assess and identify the knowledge, attitude, and practices of faculty and students of Kalinga State University to identify appropriate action of the administration and the Central Science laboratory for an efficient and safe laboratory environment.

4 Scope and delimitation of the study

The study included the faculty, staff, and students at the University enrolled in Chemistry, Biology, and Physics subjects for the academic year, 2019-2020.

Their comprehension of GHS and appropriate responses in emergency cases, attitudes, and practices in the chemical laboratory was considered in this research proposal.

5 Methodology

A. Locale of the Study

All information needed to answer the objectives was conducted solely at Kalinga State University for the period of the academic year 2019-2020. The faculty, staff, and students were asked to answer the prepared questionnaire during their vacant time to minimize the disturbance of classes.

B. Research Design

The study was a survey-based study where a questionnaire used was adapted and modified from the study of Al-Zyoud and his group in 2019 [3] (pp 15-18).

The first part consists of ten demographic questions that included various variables: gender, age group, major, academic year, previous laboratory experience, and previous laboratory safety training. Part 2 comprised nine different Globally Harmonized System (GHS) pictograms, and the respondents were asked to match each pictogram with the corresponding danger it represents.The third part consisted of four Likert scale questions to determine students' practices to safety in chemical laboratories. The fourth section examined the practice of students within the laboratory, that consisted of four questions, of which three were on the Likert scale, and a multiple-choice The fifth part consisted of five multi-choice questions that measured students' knowledge and familiarity with emergency equipment and procedures.

In some of the multiple-choice questions, students were allowed to write their responses under "other" options.

For the faculty and staff, a modified version of the questionnaire was used, with adjustments to the questions in Sections one (1) and four (4).

C. Respondents of the Study

The survey population included students who were enrolled for the Academic Year 2019-2020 and have subjects that include but are not limited to a chemical, biological, and physical laboratory. Said students were not enrolled for the on the Job-Training. One hundred and fourteen (114) respondents took the questionnaire from April 2020 to August 2020. The majority comprised 90.3 % of students, and the rest is composed of a university official, and 10 Faculty members who teach subjects with laboratory. These faculty members came for the different Colleges of the University such as the College of Criminal Justice Education (CCJE), College of Engineering and Information Technology (CEIT), College of Health and Natural Sciences (CHNS), College of Education (CoED), and the College of Public Administration and Indigenous Governance (CPAIG).

D. Instrumentation

The questionnaire was adapted and modified from the study of (Al-Zyoud et al., 2019). After due consultation with the Office of the Central Laboratory and Office of the Director of Research with slight modification, the questionnaire was then utilized to identify the Knowledge, Attitude, and Practices about Chemical Laboratory Safety of College Students, Faculty, and Staff of Kalinga State University.

D. Data Gathering Procedure

Before the questionnaires were distributed to the different respondents, permission was first sought from the office of the Director for Research with the approval of the VPRDET. After the request was approved, the researchers personally administered the distribution of the questionnaires so that they could explain fully the parts that could not be understood well by them.

Personal interviews likewise were conducted to ascertain that the questions were clearly understood and to prove the authenticity and correctness of the responses.

F. Data Analysis

The data obtained were interpreted using descriptive statistics, which involved the measurement of central tendency (means and medians), standard deviations, and frequency counts, which were shown using frequency tables and bar charts.

A score was given for each answer To evaluate the responses to Sections 2–4 of the questionnaire, which can be measured, which included the following variables: familiarity and understanding (knowledge), attitude, and practice. In Section 2, which evaluated the participants' knowledge in GHS, nine symbols were tasked to identify. A score of each correct answer was awarded '1' and "zero" for incorrect. The maximum achievable score was 9.

In Section 3, the answers to statements used the five-point Likert scale, and the attitude score was determined by giving a score of '2' for strongly disagree, '1' for disagreeing, 'zero' for neutral, '−1' to agree, and '−2' to strongly agree. The highest attainable score was 8. A three-point Likert scale was used for the evaluation. Section 4 and the answers were scored as follows: always assigned '2' and sometimes assigned '1' and never assigned 'zero'; thus, the highest possible score was '6.' After calculating the scores, they were categorized into good, fair, or poor, based on a modified version of the original Bloom's cut-off points. Categories was as follows: Knowledge (0 to 4 = poor, 5 to 6 = fair, 7 to 9 = good), Attitude (−7 to 2 = poor; 3 to 5 = fair; 6 to 7 = good) and Practice (0 to 3 = poor; 4 = fair; 5 to 6 = good).

Sections 2, 3, and 4 of the Faculty Survey were examined in the same way as the explanation given above for the students. The highest possible score was '8.' After calculating the practice ratings, each of them was classified into good, fair and poor based on the following criteria: 0 to 4 = poor; 5 = fair; 6 to 8 = good.

6 Results and Discussion

One limitation encountered in the study's conduct is the unprecedented rise of the COVID-19 pandemic, limiting the researchers to interview face to face the students and faculty members. Majority of the 124 respondents were female, 43 of them were female, and the rest chose not to say their gender preference as shown in Table 1.

Table 1. Frequency distribution of Respondents by demographics

Variable	Frequency	Percent
Overall		
Gender	114	
Male	57	50%
Female	43	37%
Prefer not to say	14	12.3%
Prior to your undergraduate studies, did you have any experience in the laboratory?		
Yes	52	46%
No	45	39.8%
Maybe	16	14.2%
Have you ever received training about chemical laboratory safety rules and procedures?		
Yes	52	46%
No	45	39%
Maybe	16	14%

Continued on next page

Table 1 continued

Where did you receive the training?		
School	32	80%
Attended chemical laboratory safety workshop	2	5%
Course in the BSc Curriculum	2	5%
Internet (e-learning, webinar)	4	10%

However, using technology, the researchers were able to reach out to the respondents through Google forms and other social media forms like messenger and Facebook in administering the questionnaire. The respondents were asked about their experience in a laboratory environment. Results showed that majority of them (46%) have encountered or experienced working in a laboratory. However, 69.8 % did not receive training in Chemical Laboratory Safety. The school's trained respondents who received training while few answered others listed as one of the enumerated limitations since they did not specify where they received the training. Half of the Faculty and staff did not receive training in the school. The highest level of Chemistry laboratory course of the respondents from the CCJE is General Chemistry (Nat Sci 13), for the College of Health and Natural Sciences, Microbiology and Biochemistry (Chemical Biology 3) while for the CEIT listed Chemistry for Engineers (Engg Chem 11).

However, majority of the respondents did not list any subject with laboratory activities given to them. The faculty and staff named General Chemistry and Organic Chemistry courses to the highest level of chemistry lab courses they attended. On the other hand, the faculty listed none.

In this study, both students and faculty members demonstrated poor knowledge in chemical warning signs which included the symbols of the health hazard, irritant, toxic, explosive, corrosive, flammable, oxidizing, compressed gas, and environmental hazard. Majority of the respondents were students enrolled in the previous academic year (2019-2020, 2nd semester) who were affected by the current pandemic. Due to the imposition of blended learning and no face-to-face instruction, laboratory activities were replaced by virtual laboratory sessions.

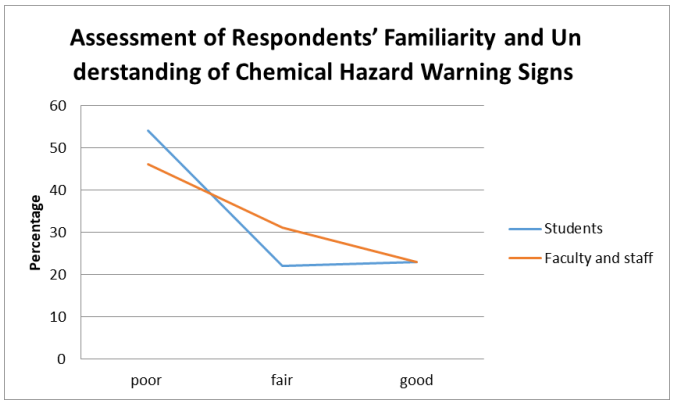

Fig 1. Assessment of Respondents' Familiarity and Understanding of Chemical Hazard Warning Signs

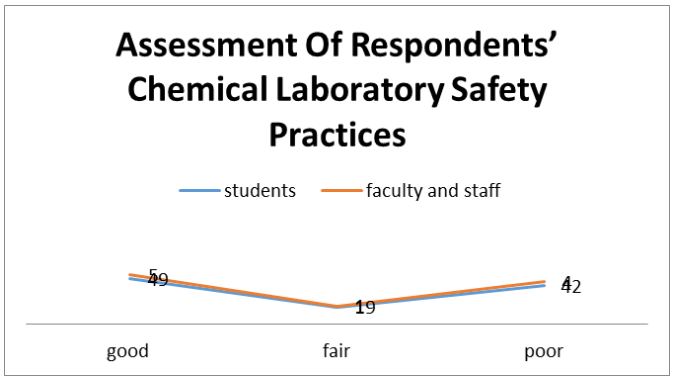

Fig 2. Assessment Of Respondents' Chemical Laboratory Safety Practices

Laboratory exercises reinforce the material learned in class and give learners a chance to apply their knowledge. They will learn some of the essential experimental techniques required to become an effective professional in the future. Laboratory activities will allow learners to gain insight into an array of subjects.

6.1 Assessment of Respondents' Attitude Towards Chemical Laboratory Safety

In general, students' attitude towards Chemical Laboratory safety is poor, while the faculty members demonstrated a fair attitude as described in Table 2.

Table 2. Assessment of Respondents' Attitude Towards Chemical Laboratory Safety

Variable	Frequency	Percent	Mean	Description
Overall	114		1.25	poor
Students	103	90	1.055	poor
Faculty & Staff	11	10	3.27	fair

Results have shown that students have reacted negatively to chemical laboratory safety. The potential reason for this outcome is that students appear to underestimate the importance of compliance with safety regulations.

This is consistent with the present study. Drama et al. have also shown that the correct attitude to safety while working in chemistry laboratories arises from being aware of potential chemical hazards in the laboratory.

Since half of the faculty and staff attended training either in e-learning through a webinar or sent for a seminar, the said group scored well towards chemical laboratory safety attitude. This finding is consistent with that of other studies that showed that the correct attitude towards safety comes from being aware of various possible chemical hazards when operating in chemical laboratories.

6.2 Assessment of Respondents' Chemical Laboratory Safety Practices

Both students and faculty and staff scored well in the assessment of Chemical Laboratory safety. However, although most of the students did not undergo training or hands-on activity in the laboratory; they know the importance of PPE and the utilization of fume hoods for the safe execution of the experiment.

However, in the management of waste disposal of discarded and used chemicals, it has been found that there is uncertainty in the response of the respondent to the removal of chemicals, as shown in Figure 3. The outcome of the analysis agrees with the previous findings Al-Zyoud and his group [3]. This will also underscore the Central Research Laboratory's role in managing and evaluate the waste disposal process in the laboratory.

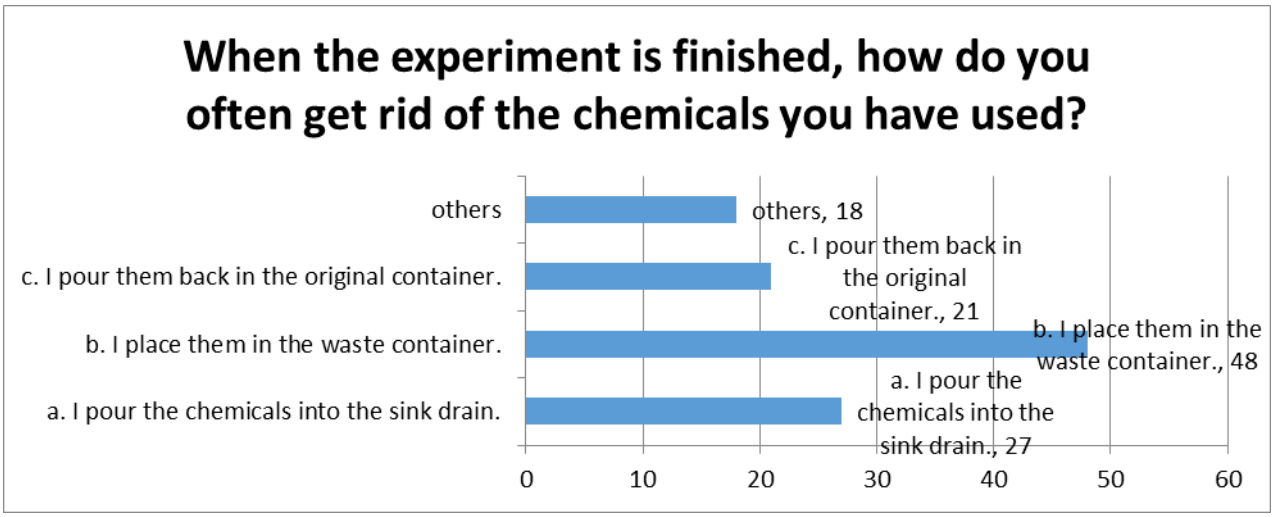

Fig 3. Summary of responses in question regarding waste disposal

Furthermore, the lack of knowledge of the respondents on potential environmental risks linked to the inadequate handling of chemical waste should also be addressed in the curriculum.

6.3 Emergency Equipment and Procedure

More than half of the population of Kalinga State University knows the safety equipment location while 14% answered no for question No.1 in Section 5. All of the mentioned safety equipment in the questions were available at the Central Science Laboratory of Kalinga State University. Moreover, the sandbox is situated at every entrance or exit of the laboratory rooms for fire precautionary measures.

Responses for Question No.2 for Section 5 coincide with answers from Question No.1. Knowing the location of this safety equipment has a high percentage that they are also knowledgeable in using this equipment. Almost 80% of the respondents distinguish the use of some safety equipment. Some equipment is not recommended for demonstration during subject-laboratory orientation, like the fire extinguisher. Separate training is mandatory for such.

Figure 3 showed the equipment the respondents comprehensively identified that they know how to use. Among these, first aid kit (82%) ranked first, followed by fire extinguisher (37%) and safety shower (31%). However, the eyewash unit ranked last since it's the least technical safety equipment to use. In some subjects, improvised eyewash bottles are included in their laboratory kit. An eyewash bottle is described as water inside a PET or easy-squeeze bottle that can be punched once an emergency arises, e.g., a chemical spill in the eye. Besides, a pail of water is also nearby each station that would serve as an emergency water splash in case the water source is out. This improvisation might contribute to the extent of use of the students and faculty to the mentioned safety equipment.

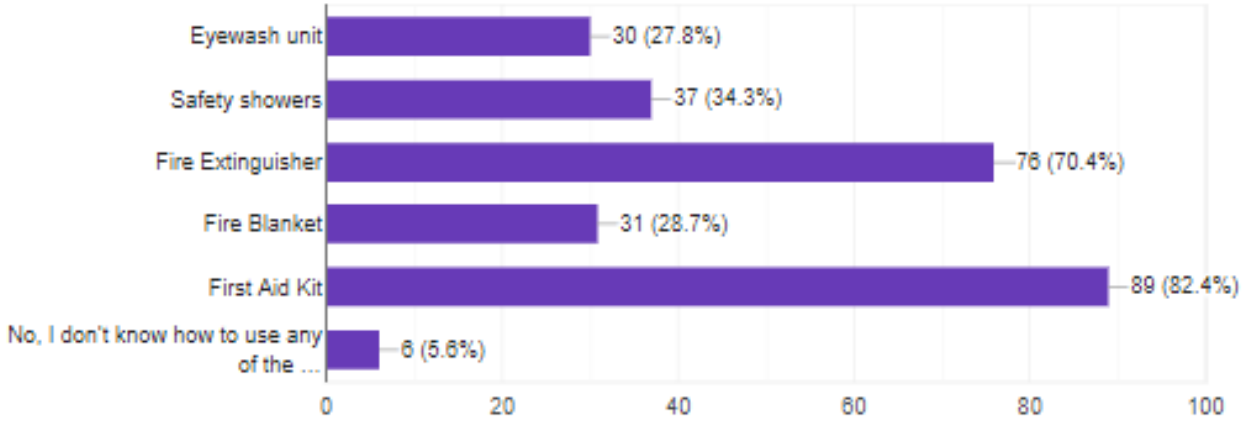

Fig 4. Summary of the Respondent's Use of Safety Equipment

Questions No. 3, No. 4, and No. 5 measure the precautionary activities of the respondents in case of emergencies like a chemical spill on lab benches, skin, and in the eyes while experimenting. Almost half of the respondents answered correctly for the question re chemical spill in lab benches (43.4%), while others answered wiping the spilled chemical with a towel and rinsing it in the sink. This would later result in acid/base burn and incorrect waste disposal.

In the case of chemical spills both on the skin and the eyes, most of the respondents replied correctly. This indicates that respondents look at the well-being of themselves and the people in the laboratory and know-how to cope with crises when survival was at risk.

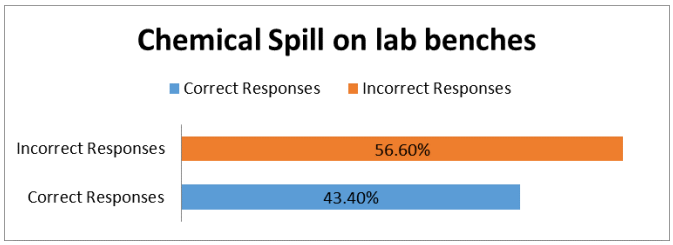

Fig 5. Responses for QuestionNo. 3 on Section 5 Re- Chemical Spill

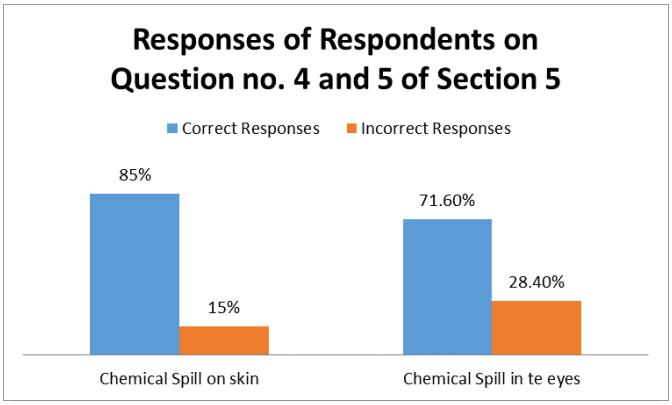

Fig 6. Responses of Respondentson Question no. 4 and 5 of Section 5

7 Summary

One hundred twenty-four (124) respondents participated in the study from March 2020 until September 2020. Questionnaires were given to those students enrolled in either Chemistry, Biology, and Physics. The same set of questionnaires was given to the subject in charge, including staff for the academic year 2019-2020. About 90.3% of the population were students, and the rest were faculty and a university official. They were randomly chosen from the CCJE, CHNS, CEIT, and the CPAIG. Six (6) Grade 12 students from STEM Strand also participated in the survey. Majority of the respondents were female from the CCJE. Almost half of the respondents have received training from their respective schools. Faculty and staff have indicated that they've received training sponsored by the institution. The highest chemistry course that they've attended included General Chemistry and Organic Chemistry at either freshman or sophomore year.

Overall, respondents scored poorly in identifying the warning signs of chemical hazards included in the study. Both students, faculty, and staff scores were deemed poor. However, faculty and staff showed a fair attitude towards chemical laboratory safety and safety practices. It showed that some of the training they've received were effective and still of use to them. Students, on the other hand, scored poorly on chemical laboratory safety but responded positively (fair) on safety practices. Majority of the respondents also know some of the safety equipment in the laboratory. Considering this, it was shown that students answered correctly on emergency responses on a chemical spill on the skin and in the eyes. However, majority of them didn't know the precautionary measure in case of a chemical spill on laboratory benches.

Results also showed that most of the faculty members and staff are informed of the precautionary measures, be it for chemical spills on lab surfaces, on the skin, and in the eyes. The precautionary measures are essential since all required laboratory activity is headed and supervised by the subject in charge. More than half of the respondents also reported that they know how to use the first aid kit and the fire extinguishers. The said result is good as it shows that the respondents can react to emergencies that may arise in the laboratory that would use the said safety equipment.

8 Conclusion

Amidst the present situation, the online administration of questionnaires was done through google forms. But not everyone is entitled to a good internet connection, thus included as one of the limitations of the study are the students who do not have the means to access the questionnaire online. The study population included one hundred and twenty-four (114) Respondents who were students (90.3%) enrolled in either Chemistry, Biology, Physics and six (6) grade 12 students from STEM Strand. For faculty and staff, ten (10) faculty from the different colleges and a university official of the university participated in the study. They were from the different colleges of the university. The majority of them were female and from CCJE. Half of the Faculty confirmed that they had received training sponsored by the institution based on the study. The highest chemistry course that the respondents attended included General Chemistry and Organic Chemistry at either freshman or sophomore year. The same with the responses of the faculty. This indicates that these subjects' subject-in charge should highlight the standard laboratory procedures and orientation in the laboratory of the said courses.

The research results showed the strengths and limitations of respondents' understanding of Chemical Hazards, including Chemical laboratory safety and attitude. Familiarity and awareness of chemical warning signals both for students and faculty were poor.

Faculty and staff responded fairly when attitude and practices on Chemical laboratory safety were measured. However, students showed poor attitudes though displayed fair laboratory safety practices. Other limitations of the study include respondents who didn't answer the latter parts of the questionnaire due to connectivity issues and sometimes missed the questions. To add, the option 'other' as well as chosen by respondents, didn't specify their responses in the specific question.

9 Recommendation

Based on the results, there is a need for reinforcement and conduct of safety ethics and risk management in the chemical laboratory of the University, especially students and subject-in charge with the laboratory. It is imperative to develop a crash course or lecture-seminar on Chemical Hazard identification, hazardous waste, and risk management with safety rules and procedures to equipped students and faculty, and staff with knowledge, the right attitude, and practices in all laboratories.

It is also recommended being made obligatory for all university students to attend orientation on the use of the laboratory, chemical safety equipment, and other standard procedures observed in the laboratory.

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