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A Case Study on the Efficacy of Technical Laboratory Safety in Polytechnic

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***Abstract*—**Technical laboratories are typically considered as highly hazardous places in the polytechnic institution when addressing the problems of high incidences and fatality rates. In conjunction with several topics covered in the technical curricular, safety and health precaution should be highlighted in order to connect to few key ideas of being safe. Therefore the assessment of safety awareness in terms of safety and health about hazardous and risks at laboratories is needed and has to be incorporated with technical education and other training programmes. The purpose of this study was to determine the efficacy of technical laboratory safety in one of the polytechnics in northern region. The study examined three related issues that were; the availability of safety material and equipment, safety practice adopted by technical teachers and administrator's safety attitudes in enforcing safety to the students. A model of efficacy technical laboratory was developed to test the linear relationship between existing safety material and equipment, teachers' safety practice and administrators' attitude in enforcing safety and to identify which of technical laboratory safety issues was the most pertinent factor to realize safety in technical laboratory. This was done by analyzing survey-based data sets particularly those obtained from samples of 210 students in the polytechnic. The Pearson Correlation was used to measure the association between the variables and to test the research hypotheses. The result of the study has found that there was a significant correlation between existing safety material and equipment, safety practice adopted by teacher and administrator's attitude. There was also a significant relationship between technical laboratory safety and safety practice adopted by teacher and between technical laboratory safety and administrator attitude. Hence, safety practice adopted by teacher and administrator attitude is vital in realizing technical laboratory safety.

***Keywords*—**Polytechnic, Safety attitudes, Safety practices, Technical laboratory

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I. Introduction

TECHNICAL laboratory activities and demonstrations represent an essential part of effective science teaching. Although there are many science activities that present potential hazards, reasonable and prudent safety practices are greatly reduced the likelihood of accidents [1]. Table I shows the common hazard in technical laboratory. When students adhere strictly to the standard safety precautions, they are unlikely to encounter any risk greater than those they might encounter in physical education or home economics classes. Knowing about possible hazards, taking precautions are the bases for creating a safe learning environment.

TABLE I
COMMON TECHNICAL LABORATORY HAZARD

Hazard	Sources
Physical hazard	Heating device, noise, projectiles, fire, cold, etc
Electrical hazard	Fire and electrical shock
Mechanical hazard	Moving Machineries
Airborne hazardous materials	Vapors, dust, etc
Ergonomic factors	Standing, repetitive motion

Recognition of laboratory safety and health problems had identified since the passage of the Occupational Safety and Health Act 1994 (Act 514). This Act requires that certain precautions have to observe to protect the safety and health of employees on the laboratory job. Cases of this nature might arise where the required protective devices are not provided on machinery used by students or others, under the supervision. Other situations of potential liability might arise from failure to comply with standards as to individual protective equipment, chemicals and electrical apparatus. It seems that it will be the advantage of teachers to familiarize themselves with OSH Act as well as other state and municipal regulations pertaining to instrumentalities and activities under their control [2]. Technology teachers and science leadership are being challenged to meet both academic and safety concerns with the advent of renovations and new construction of technical laboratories. Technical teachers, since they work with individuals in a laboratory setting, are required to provide a much higher standard of caring than history, math or English teachers [3]. According to USW guideline safety, the responsibility for implementation of the laboratory safety guidelines primarily rests with the administrator [4]. It is recognized that OHS Consultation Committees are well placed to provide advised and feedback on the appropriateness of the material. Thus, the material must contains in the guidelines, effectiveness of the risk control measures outlined in the guidelines when applied to the work that being carried out within a laboratory setting, practicalities of implementing the guidelines within laboratories, and how well these constructive recommendations improve workability and layout of a laboratory and associated facilities.

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Open Science Index, Humanities and Social Sciences Vol:5, No:5, 2011 publications.waset.org/6763/pdf

Technical laboratory has earned a reputation of being highly hazardous place in the institution because of the high incidence and fatality rates. This is because technical laboratory dealt with numerous chemicals, electrical, mechanical, procedures and operations that required safety precaution, laboratory safety, fire safety and other safety related issues. Furthermore, according to Schulte et al., the safety practice has not been widely recommended into technical education and other training programmes, and the extent to which this occurrence has not been assessed [5]. In a technical laboratory setting, where students experiences new activities, the likelihood of incidents, injury and damage is high. Therefore, it is essential that the students to be taught what can go wrong of an emergency. Safety practice in the technical laboratory will increase career knowledge, safer work behaviors, increases competence when dealing with high-risk occupational situations, and reduces incidence of occupational injuries and illness. It is essential for all involved in the program to develop a positive approach to a safe and healthful environment in the laboratory. For this reason, this research explores the effectiveness of technical laboratory safety on three related issues; (a) availability of safety material and equipment, (b) safety practices adopted by technical teachers and (c) safety attitudes of the administrators in enforcing safety.

II. Methodology

A. Theoretical Framework

A theoretical framework as shown in Fig. 1 describes the relationship between existing safety material and equipment, teachers' safety practices, and administrator attitude towards laboratory safety. The primary variable of interest in the study was the dependent variables such as laboratory safety. The model also suggested that existing safety material and equipment, teacher safety practice and administrator attitude are independent variable or factors that have been identified associate with laboratory safety.

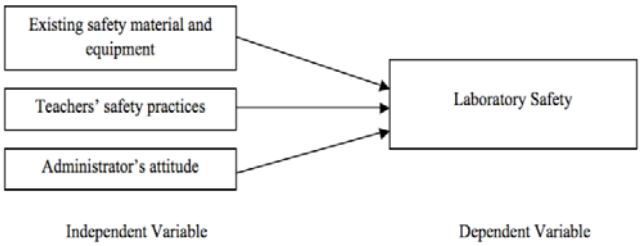

Fig. 1 Research framework for laboratory safety

B. Descriptive Study

This study was conducted in descriptive nature, especially to justify information about the efficacy of technical laboratory safety in one of the polytechnic in northern region of Malaysia. A cross-sectional research design was a research method in which groups of participants of different chronological ages were observed and compared at a given time. Essentially, data were collected from the research participants at a single point in time or during a single, relatively brief time period. The advantage of cross-sectional research was more economical, with respect to time and cost, than other design. For the participant, there was only one period of data collection. The inability to direct assess intra-individual change was a significant disadvantage of cross-sectional design. This study was conducted with data being gathered just once in order to answer research questions.

C. Quantitative Research

This study has adopted a type of research method called quantitative study, where the researcher has to determine the relationship between one variable and another variable [6]. The aim was to classify features, counted them and constructed statistical models in an attempt to explain what was observed. The selection of quantitative method was chosen because of the research conducted in relation to the research question and which was the most suitable for the topic under consideration. Therefore, the quantitative research was used because the objective of this study was to examine the efficacy of technical laboratory safety which could be defined as the process of measuring the existing of safety material and equipment, teachers safety practice and administrator attitude in enforcing safety in laboratory using numerical data. In addition, hypothesis testing was performed to test the relationship that existed among variables.

D. Data Collection Procedures

The sample in forms of students was selected randomly and the questionnaire was distributed to the engineering students within civil, mechanical and electrical department depending on their classes in which 5 questionnaires were distributed to each class. This study managed to obtain the involvement of 210 students. For the purpose of this study, all students were asked to reply the questionnaire in one week and gathered in one pigeonhole.

E. Technique of Data Analysis

All data were analyzed using the Statistical Package for the Social Sciences, Personal Computer Version (SPSS Version 13.0). All data were analyzed using the Statistical Package for the Social Sciences, Personal Computer Version (SPSS Version 13.0). Appropriate statistical procedures for description (frequencies, percents, means, standard deviations, Pearson correlations) were used. Descriptive statistics was applied in order to examine the profile of the respondents in the study. More precisely, frequency counts and percentage were taken to obtain data regarding the demographic characteristics of the respondents. Pearson Correlation statistical method was suitable to determine how strongly the scores of two variables were associated with each other and to determine whether a linear relationship between two variables existed. Thus, in this study, a Pearson Correlation was taken into consideration as the statistical tool in testing the hypothesis.

Open Science Index, Humanities and Social Sciences Vol:5, No:5, 2011 publications.waset.org/6763/pdf

III. Results

The total respondents were 210 of students consisting of 131 males and 79 females. The majority of respondents were in the aged group of 17 to 21 years (74.3%), followed by age group of 22 to 26 years (23.8%) and 27 to 31 years (1.9%). The respondents were from different courses of study level, where 74.8 percent was studied in diploma course, while 25.2 percent were studied at certificate level. Among them, 96 percent had no accident experienced in the laboratory and the rest had such accident experienced. Another group of student consisted of 7 respondents that had accidents or near miss experienced in the laboratory, 71.4 percent from them experienced laceration and 28.6 percent experienced burned and scalded. With regarded to how serious of the injury was, all of them only received first aid treatment.

A. Perception on Laboratory Safety

Section two of the questionnaire had gathered information about students' perception on the laboratory safety. The statement "lecturers are the persons responsible in students' safety while doing work at laboratory," had scored the highest mean rating of 4.20, where 84.3 percent of the total respondents ranked the statement as agreed or strongly agreed. The high percentage rating showed that those students in polytechnic had set responsibility on lecturers while doing job in laboratory.

B. Existing Safety Material and Equipment

Section three of the questionnaire had collected information about respondent knowledge on existing safety material and equipment in the technical laboratory. The statement "is the laboratory has a first aid kit" had scored the highest mean rating of 4.20 with the total percentage of strongly agreed and agreed was at 79.6 percents. This statement indicated that majority of the students aware and knew about the presence of the first aid kit in the laboratory.

C. Safety Practice Adopted by Technical Teacher

With regarded to the safety practice adopted by technical teachers, section four of the survey was developed in order to obtain information about respondents perception towards safety practice that adopted by the technical teachers. The statement "make sure students tidy up work area and clean up work surface at the end of every laboratory session" had scored the highest mean rating of 4.37, which consisted of 91.9 percent of the total respondents perceived either agreed or strongly agreed. In other words, the majority of student alerted that their teachers took care of a good housekeeping, always used a tidy and systematic method of working.

D. Administrator's Attitude

According to the items measuring administrator attitude, the statement "student must aware of the laboratory regulation" had scored the highest mean rate at 4.27, which consisted of 89.1 percent of the total respondents perceived either agreed or strongly agreed. Only minority that was one percents of the total respondents indicated the statement either strongly agreed or disagreed. The result indicated that most of the students aware of their responsibility related to safety and health in the laboratory.

E. Comparison Mean between Variables

The mean of the three independent variables as shown in Table II demonstrates that "safety practice adopted by teacher" had scored the highest mean at 4.159, followed by "administrator's attitude" at 4.157, and lastly variable of "existing safety material and equipment" with mean at 3.833. In other words, among the three independent, variables teacher played an important role to ensure the safety and health of the students in the laboratory. This statement was also consistent with the statement made by Kigin. He emphasized that teacher was responsible for promoting desirable attitudes that assisted students in developing a proper respect for safety regulations [7]. However, the teacher alone cannot complete the safety programmes. Therefore, administrator's attitude in enforcing safety is one of the requirements for succeeding safety proggrammes. The programmes will happen when the administrator supports them and will cease when the interest and attention have been eliminated or became lax. Existing safety material and equipment are also important towards the safety laboratory. Safety material and equipment such as first aid kit, fire extinguisher can reduce the consequences of the accident.

TABLE II
MEAN OF THE VARIABLES (n=210 STUDENTS)

Variables	Mean
Existing safety material and equipment	3.833
Safety practice adopted by teachers	4.159
Administrator's attitude	4.157

F. Testing the Hypothesis

Table III shows the research hypotheses of the survey instruments and relationship between the independent variables that exists i.e. safety material and equipment, safety practice adopted by technical teacher and administrator attitude in enforcing safety to the student and dependent variable that was technical laboratory safety.

TABLE III
RESULT OF PEARSON CORRELATION BETWEEN EXISTING SAFETY MATERIAL AND EQUIPMENT AND LABORATORY SAFETY (n=210 STUDENTS)

H	RESEARCH HYPOTHESIS
H_1	Existing safety material and equipment will increase the safety and health of students working in technical laboratory.
H_2	Safety practices adopted by technical teachers will increase the safety and health of students working in technical laboratory.
H_3	Administrator attitudes in enforcing safety among students will provide positive relationship to the safety in technical laboratory

1) Relationship between Existing Safety Material and Equipment and Laboratory Safety.

Open Science Index, Humanities and Social Sciences Vol:5, No:5, 2011 publications.waset.org/6763/pdf

Hypothesis H_1 was tested for a significant correlation between existing safety material and equipment and laboratory safety, thus a Pearson Correlation test was performed to test the direction and strength or any linear relationship between the two variables. Table IV shows the actual value of the correlation coefficient along with its p-value. The mean numbers for both laboratory safety and safety material and equipment were 3.771 (std. deviation = 0.504) and 3.833 (std. deviation = 0.381), respectively. The correlation coefficient (r) was 0.113 and the p-value was 0.05. Therefore hypothesis H_1 was accepted since p = 0.05, while the null hypothesis was rejected. It could be concluded that, from the analysis using the Pearson Correlation it was proven that existing safety material and equipment has positively effect on the safety and health of students working in technical laboratory. However, the correlation effect was rather weak (r = 0.113).

TABLE IV
RESULT OF PEARSON CORRELATION BETWEEN EXISTING SAFETY MATERIAL AND EQUIPMENT AND LABORATORY SAFETY (n=210 STUDENTS)

Variables	Descriptive Statistics		Correlation	
	Mean	Std Deviation	Pearson Correlation	Sig. (1-tailed)
Laboratory safety	3.771	0.504		
Safety material & equipment	3.833	0.381	0.113	0.05

2) Relationship between Teachers' Safety Practice and Laboratory Safety.

Hypothesis H_2 was tested for a significant correlation between teachers safety practice and laboratory safety as shown in Table V. The Pearson Correlation was used to test for any significant correlation for both variables. The mean numbers for both laboratory safety and teacher safety practice were 3.771 (std. deviation = 0.504) and 4.158 (std. deviation = 0.615), respectively. The correlation coefficient (r) was 0.564 and the p-value was nil. The results showed that safety practice adopted by technical teachers was positively correlated with laboratory safety. Since the average score was $p < 0.01$, hypothesis H_2 was accepted and the null hypothesis was rejected. It could be concluded that, the Pearson Correlation (r = 0.564) had proven that there was a significant positive relationship between safety practice adopted by technical teacher and laboratory safety. A positive correlation meant that as safety practice adopted by technical teacher increased, laboratory safety also increased. Conversely, as safety practice adopted by technical teacher decreased, safety in laboratory also decreased.

TABLE V
RESULT OF PEARSON CORRELATION BETWEEN SAFETY PRACTICE ADOPTED BY TEACHER AND LABORATORY SAFETY (n=210 STUDENTS)

Variables	Descriptive Statistics		Correlation	
	Mean	Std Deviation	Pearson Correlation	Sig. (1-tailed)
Laboratory safety	3.771	0.504		
Safety practice adopted by teacher	4.159	0.615	0.564 **	0.000

** Correlation is significant at 0.01 level (2-tailed)

3) Relationship between Administrator's Attitude and Laboratory Safety.

Hypothesis H_3 was tested for significant positive correlation between administration attitude in enforcing safety to the students and technical laboratory safety. Table VI shows the Pearson Correlation. The mean numbers for both technical laboratory safety and administrator attitude were 3.771 (std. deviation = 0.504) and 4.157 (std. deviation = 0.636), respectively. The correlation coefficient (r) was 0.526 and the p-value was nil. The results showed that the technical laboratory safety was positively correlated with administrator's attitude at 0.01 of confidence level. Since the average score was lower than 0.01 ($p < 0.01$), hypothesis H_3 was accepted and the null hypothesis was rejected. It could be concluded that the Pearson Correlation (r = 0.526) had proven that there was rather a strong significant positive relationship between technical laboratory safety and administrator's attitude in enforcing safety to the students. A positive correlation meant that as administrator's attitude in enforcing safety to the students increased, technical laboratory safety also increased. In other words, as administrator attitude in enforcing safety to the students decreased safety in technical laboratory also decreased.

TABLE VI
RESULT OF PEARSON CORRELATION BETWEEN ADMINISTRATOR'S ATTITUDE AND LABORATORY SAFETY (n=210 STUDENTS)

Variables	Descriptive Statistics		Correlation	
	Mean	Std Deviation	Pearson Correlation	Sig. (1-tailed)
Laboratory safety	3.771	0.504		
Administrator's attitude	4.157	0.636	0.526 **	0.000

** Correlation is significant at 0.01 level (2-tailed)

IV. DISCUSSION

The discussion was basically in line with the achievement in the objectives that had been set at the beginning of the study. This study was done in descriptive nature and the data from 210 respondents were collected through standardize questionnaire that distributed to all respondents with the help of the person in charge in 82 engineering classes at polytechnic. Stratified random sampling was used to obtain sample of the study, and Statistical Package for Social Science (SPSS) Version 13.0 was used to analyze the data. Frequency and percentage were used to describe the demographic characteristics of the respondents and several items measuring the technical laboratory safety. Pearson Correlation analysis was used to test linear relationship between independent variables and dependent variable. Regression analysis had proven that the model was fit together with the independent variables and contributed at 35.3 percent variance in the

Open Science Index, Humanities and Social Sciences Vol:5, No:5, 2011 publications.waset.org/6763/pdf

laboratory safety.

With regarded to the relationship between technical laboratory safety and existing safety material and equipment, the Pearson Correlation found that the relationship between the two variables was weak at $p = 0.05$, where $r = 0.113$. The finding showed that existing safety material affects the technical laboratory safety. However, there was a stronger significant positive relationship between safety practice adopted by teacher and administrator's attitude towards technical laboratory safety, where both of r-values were $r = 0.564$ and $r = 0.526$, respectively. The strong relationship between the two variables indicated that technical laboratory needed teachers to champion the safety and health among students as well as a strong commitment from the administrator. This relationship implied that the greater safety practice adopted by teachers, as well as administrators, the greater safety and health for students in the laboratory.

Several researchers had noted on some justification on the issues of responsibility with regarded to the safety and health of the students. For instance, Gliem & Miller in their study on administrators' attitudes, policies and procedures regarding safety in vocational education laboratories, had found that safety was important to the administrators and they overwhelmingly agreed that it should be an integral part of the instructional program in vocational education. Furthermore, teachers should be aware of the expectations that administrators have regarding safety in vocational education [8]. Similarly, Science Safety Handbook noted that science teachers were in a unique position to orient school administrators to the attitudes, skills, rational thinking processes and knowledge resulting from laboratory activities [1].

Research finding also showed that the existing safety material and equipment had significantly correlated with safety practice adopted by teacher and administrators' attitude, with r-values were at 0.226 and 0.16, respectively. It was indicated that although existing safety material and equipment were weakly affected directly to the efficacy of technical laboratory safety, however there was a linked between safety practice adopted by teacher and administrator attitude. It seemed that without adequate safety material and equipment, teacher could not adopt their safety practice to the students. Administrator also could not take any enforcement to the students because of inadequate safety material and equipment.

The Pearson Correlation analysis demonstrated that there was a significantly positive correlation ($r = 0.694$) between safety practice adopted by teacher and administrator attitude. The finding had shown that teachers and administrator must work together and co-operated in order to make sure the efficacy of technical laboratory safety.

V. Conclusion

The results obtained from this study revealed that all objectives had been achieved. Technical laboratory safety is an important to administrators, and it is an integral part of the instructional program in the polytechnic education. Technical teachers are aware of the expectations that administrators have regarding safety in polytechnic education. Beside awareness, technical teachers have also provided effective supervision, present a proper safety and laboratory instruction, and maintain equipment and facilities, to make sure the safety and health of the students.

With regarded to the research finding, the administrators' attitudes toward safety and teacher safety practice were significantly related to the technical laboratory safety. Administrators must be convinced of their legal and moral obligation to provide for the safety of students and teachers under their supervision. Teachers and teacher-aides shall lead by example such as wear personal protection equipment, and follow and enforce safety rules, procedures, and practices. Furthermore, they shall demonstrate safety behavior and promote a culture of safety. They shall also be proactive in every aspect of laboratory safety by making safety a priority.

In addition, it was found that existing safety material and equipment are essential in the technical laboratory. However, those material and equipment are a waste without enforcement from the administrator and guidance from the teachers. Level of OSH awareness among students is still considered as an immature. For this reason, administrator shall make a possible step to enhance the level of OSH among students. Therefore, it is recommended that the results of this study to be shared with technical teachers so that they can understand and aware about the importance of safety in the technical laboratory.

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