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Understanding of Chemical Labeling Using Globally Harmonised System (GHS) Amongst Students of Secondary Level in Terengganu, Malaysia

[1]Sarifah Fauziah Syed Draman, [2]Rusli Daik, [3]Kamaruzaman Jusoff and [4]Mohd Lazim Abdullah

[1]Faculty of Applied Sciences, Universiti Teknologi MARA (UiTM), 23000 Dungun Terengganu, Malaysia
[2]School of Chemical Sciences and Food Technology, Faculty of Sciences and Technology, Universiti Kebangsaan Malaysia, 43650 Bangi Selangor, Malaysia
[3]Faculty of Forestry, Universiti Putra Malaysia, UPM Srdang 43400 Selangor, Malaysia
[4]Department of Mathematic, Faculty of Science and Technology, Universiti Malaysia Terengganu, 21030 Kuala Terengganu, Terengganu, Malaysia

Abstract: Chemical substances can be handled safely if properties of the chemical substances are wholly understood and properly managed. From our observation, students at tertiary level in college or university still cannot handle chemical substances correctly due to limitation of their knowledge and training. In Malaysia students start to deal with chemical substances since primary level but they usually handle chemical substances themselves including hazardous substances at secondary level when doing laboratory activities. Therefore, understanding on classification and labeling of chemicals for secondary level students was studied. Globally Harmonized System (GHS) is chosen because this system is expected to be adopted internationally and will replace the relevant laws and regulations used in different countries with worldwide toward implementation started in 2008. Methodology for this study is descriptive quantitative survey. Cluster probability sampling was used for secondary levels students in Terengganu. Results of this study shows that the secondary levels students cannot recognize chemical substance labels correctly by using GHS. The understanding would influence attitude, which may further affect the behavior while handling chemical substances. Therefore, it is suggested to revise the chemistry curriculum for secondary level schools in which the hazard communication based on GHS should be incorporated.

Key words: Chemical labeling · Classification · Hazard · Globally Harmonized System (GHS) · Secondary level

INTRODUCTION

Chemicals are widely used nowadays either in laboratories for research or in industries. Chemicals are inorganic or organic in nature and in the form of gases, liquid or solids (in powder form, flakes or particulate). It may be corrosive, explosive, flammable, radioactive, reactive or toxic [1]. However, chemicals do not have to be dangerous if it are being handled properly. In addition, for industrial chemicals, certain groups of chemicals are regulated separately, for example pharmaceuticals, veterinary medicines, pesticides and radioactive substances [2].

The purpose of classification and labeling of dangerous chemicals is to systematically identify the hazards of chemicals, to draw the attention of the user to those hazards and to enable them to take action to protect them appropriately [3]. At the classification stage, chemical hazards are conventionally divided into the three categories namely physicochemical, toxicological (or health) and ecotoxicological (or environmental) hazards.

There are several hazard communications for classification and labeling chemical substances. All the systems were developed to protect human health and the environment [2]. The hazard communication systems are related to the regulatory system of the country [4]. Different country used different standard of classification, packing and labeling of dangerous substances. In other words, the presence of many chemicals hazard classifications nationally and internationally makes it difficult to implement suitable chemicals control

Corresponding Author: Dr. Kamaruzaman Jusoff, Faculty of Forestry, Universiti Putra Malaysia, UPM Srdang 43400 Selangor, Malaysia. Tel: +60-3-89467176, E-mail: kjusoff@yahoo.com.

management. Therefore, globally harmonized system (GHS) for classification and labeling of chemicals was identified because different countries had different abilities to identify and classify systematically every hazardous chemicals [5]. GHS comprises a total of 27 hazard categories [6]. The basis used to differentiate each hazard is defined in details and a safety data sheet containing 16 items is required. In addition to the identification of chemical products and suppliers, the labeling of GHS includes the hazard pictograms, signal words, hazard statements and precautionary information. The target audiences of GHS include workers, consumers, transporters and emergency responders. GHS facilitates international trading, while simultaneously strengthening the protection of human health and the environment. The system is expected to be adopted internationally and will replace the relevant laws and regulations used in different countries [7].

In Malaysia, chemical accidents in campus were reported too, such as fire in laboratory at Department of Chemistry University Malaya (2001), engineering laboratory at Universiti Putra Malaysia (2002) and laboratory at School of Applied Physics, Universiti Kebangsaan Malaysia (2005) [8]. In Taiwan, it was reported that 49 % of campus accident were related to improper use of chemicals in the last three years [6]. Based on reports in literature [6, 9, 10], lack of hazard communication training is the cause for most of the chemical accidents. This means that knowledge about classification and labeling of chemicals is very important for students to have excellent knowledge in handling chemical substances. According to curriculum specification of chemistry Form 4 [11], students in Malaysia start to deal with chemical substances since primary level but they usually handle chemical substances themselves including hazardous substances at secondary level when doing laboratory activities Therefore, understanding on classification and labeling of chemicals for secondary level students was studied. Globally harmonized system was chosen because this system is expected to be adopted internationally and will replace the relevant laws and regulations used in different countries with worldwide toward implementation started in 2008.

MATERIALS AND METHODS

Methodology for this study is descriptive quantitative survey. A pilot questionnaire was distributed to secondary students, teachers and experts from academic fields for reviewing. A total of twenty-seven multiple-choice questions with pictograms of GHS was designed for correct understanding. Students get one point for correctly answering a question and zero point for incorrectly answering it. Cluster probability sampling was used for secondary levels students who take chemistry subject in Terengganu.

Results from the returned questionnaires were analyzed by SPSS for window 13.0. Descriptive statistic was used to recognize the background of the respondents. The reliability of the designed questionnaires was calculated by Cronbach coefficient, á from 703 samples. Chi-square test was used to distinguish the understanding between students towards chemical labeling using GHS.

RESULTS AND DISCUSSION

Calculations for Cronbach coefficient, α from 703 valid samples was 0.801. This is a very good value for reliability testing. Wu (1985) that being cited in Su & Hsu [6] reported the reliability is poor if $\alpha < 0.6$. Moderate strength association if Alpha coefficient range $0.6 < \alpha < 0.7$. Meanwhile for Alpha coefficient range, $0.7 < \alpha < 0.8$ and $0.8 < \alpha < 0.9$ are good and very good, respectively. The reliability is excellent for $\alpha > 0.9$.

Descriptive Statistics: Table 1 shows the results obtained from analyzing data about the background of students in this study. 92 % of the students have experience with chemical substances and most students were first exposed to handling of chemicals at lower secondary level at school. 72.5 % of the students received the training with hazard chemical substances. Meanwhile, 80 % of students claimed that they paid attention to the signs of chemical labels.

Results from the basic data shows that schools are the most important place to form the understanding of chemical labeling. This finding is in line with the results that were reported by Su & Hsu [6].

Table 2 Presents the results obtained from GHS pictogram recognition testing.

Among the 27 hazards, the percentages of correct answers for the hazards of flammable gases, flammable aerosols, gas under pressure, flammable liquids, flammable solids, self-heating substances and corrosive to metals were over 70 %. This is because the hazard statement is similar to the hazard classification. Results for other 20 pictograms of GHS did not reach the ISO-recommended criteria, which suggest that that graphical design probably cannot deliver information successfully [12].

Table 1: Background of students towards understanding chemical substances labels

		Percentage (%)
Gender	Male	49.8
	Female	50.2
Form	Four	38.7
	Five	61.3
Race	Malay	90.8
	Chinese	8.8
	Others	0.4
Type of school	Boarding	63.6
	Non-boarding	36.4
Cluster of school	*MRSM*	17.8
	Sek Men Sains	16.9
	Sek Men Agama	15.9
	Sek Men Harian	29.6
	Sek Men Teknik	19.8
First contact with	Kindergarten	3.7
Chemical substances	Primary school	36.8
label	Lower secondary school	42.5
	Upper secondary school	16.9

Table 2: Results of GHS pictogram recognition testing

Hazard classification		Correct answer (%)
1.	Explosives	17.2
2.	Flammable gases	82.5
3.	Flammable aerosols	91.3
4.	Oxidizing gases	59.6
5.	Gases under pressure	84.2
6.	Flammable liquids	86.9
7.	Flammable solids	87.8
8.	Self-reactive substances	4.8
9.	Pyrophoric liquids	2.8
10.	Pyrophoric solids	5.1
11.	Self-heating substances	71.3
12.	Substances, which in contact with water, emit flammable gases	59.6
13.	Oxidizing liquids	21.2
14.	Oxidizing solids	19.5
15.	Organic peroxides	6.3
16.	Corrosive to metals	78.0
17.	Acute toxicity	47.7
18.	Skin corrosion / irritation	40.1
19.	Serious eye damage/eye irritation	65.9
20.	Respiratory sensitizer	56.3
21.	Germ cell mutagenicity	46.2
22.	Carcinogens	18.9
23.	Toxic substances to reproductive organs	40.3
24.	Specific target organ systemic toxicity – single exposure	26.6
25.	Specific target organ systemic toxicity – multiple exposure	41.6
26.	Aspiration hazard	4.5
27.	Hazardous substances to aquatic environment	33.4

Table 3: Chi square analysis of understanding chemical labeling using GHS

	Correct answer (%)				
	Read information before matching				
Hazard classification	Not read	Half read	Read	*p*-value*	X^2 value
Explosives	2.1	6.7	8.4	0.158	3.688
Flammable gases	4.7	32.9	44.9	0.000*	25.932
Flammable aerosols	6.1	34.7	50.4	0.000*	29.214
Oxidizing gases	3.3	21.7	34.4	0.000*	15.678
Gases under pressure	5.6	32.0	46.6	0.000*	16.621
Flammable liquids	5.6	32.7	48.6	0.000*	28.579
Flammable solids	6.1	32.9	48.7	0.000*	19.146
Self-reactive substances	0.6	1.7	2.4	0.687	0.751
Pyrophoric liquids	0.1	1.1	1.6	0.872	0.274
Pyrophoric solids	0.4	1.9	2.9	0.928	0.149
Self-heating substances	4.3	26.6	40.3	0.000*	15.943
Substances, which in contact with water, emit flammable gases	2.7	21.0	35.7	0.000*	30.493
Oxidizing liquids	1.0	7.0	13.3	0.018*	8.032
Oxidizing solids	0.6	7.0	12.0	0.014*	8.593
Organic peroxides	0.6	2.7	3.0	0.791	0.469
Corrosive to metals	4.6	28.9	44.4	0.000*	27.145
Acute toxicity	2.4	18.1	27.0	0.009*	9.331
Skin corrosion / irritation	2.9	13.7	23.4	0.098	7.822
Serious eye damage/eye irritation	4.0	24.4	37.4	0.002*	12.893
Respiratory sensitizer	2.4	19.7	34.0	0.000*	30.213
Germ cell mutagenicity	1.7	15.4	28.9	0.000*	30.417
Carcinogens	0.6	6.9	11.2	0.099	7.801
Toxic substances to reproductive organs	1.7	14.0	24.4	0.000*	16.730
Specific target organ systemic toxicity - single exposure	1.0	8.9	16.9	0.001*	13.625
Specific target organ systemic toxicity - multiple exposures	2.6	14.1	24.7	0.023*	11.360
Aspiration hazard	0.3	1.1	3.0	0.342	4.503
Hazardous substances to Aquatic environment	2.6	10.7	19.8	0.175	8.980

* The superscript means statistical significance is reach, $p < 0.05$

Inferential Analysis: Table 3 shows the differences of understanding the correct pictograms using GHS chemical labeling among secondary levels students.

There is no difference in matching correct pictogram for students that read all information in chemical substances labeling for hazard classification of explosives, self-reacting substances, pyrophoric liquids, pyrophoric solids, organic peroxides, skin corrosion/irritation, carcinogen, aspiration hazard and hazardous substances to aquatic environment. This finding indicates that students need training in order to understand further towards chemical labeling using GHS. The information in chemical labeling is not enough for them to understand the chemical labeling using GHS as suggested by Su & Hsu [6].

CONCLUSION

Results of this study shows that the secondary levels students still cannot recognize chemical substance labels correctly by using GHS. Further study should be carried out to discover the most imperative factor that affect the understanding towards chemical labeling for secondary level students using GHS. Since the implementation of GHS by all sectors throughout the world start operational in 2008, it is suggested to integrate the hazard communication courses into the school curriculum since would strongly enhance the understanding in chemical labeling. Again, it is hoped that the system can be implemented in Malaysia soon.

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