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Assessment of Familiarity and Understanding of Chemical Hazard Warning Signs among University Students Majoring Chemistry and Biology: A Case Study at Jimma University, Southwestern Ethiopia

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Abstract: The objective of this study was to assess students' familiarity and comprehension of chemical hazard warning signs at the Departments of Chemistry and Biology, Jimma University. Data were collected from randomly selected students using structured questionnaires. The collected data were analyzed using simple quantitative analysis. The results of the study revealed that the majority (56.8%) of the respondents were not familiar with hazard signs of laboratory chemicals. The respondents were also requested to match chemicals properties with the corresponding labels (pictograms). However, only 26.5%, 14.45% and 12% of the respondents were able to correctly match "flammable", "toxic" and "irritant", respectively, with their associated signs. The responses given to the rest of the properties (e.g. explosive, oxidizing, corrosive, harmful and radioactive) were not encouraging. The results also indicate that understanding (comprehensibility) of hazard warning signs is low among the students. This necessitates organization of education/training programs to help students to get familiarized and increase their compressibility about chemical hazard warning signs. Thus, it is recommended that warning students to follow safety rules is not sufficient and thus, they should be educated to understand and recognize the signs in order to avoid the possible happening of chemical accidents on them and the environment.

Key words: Hazard warning signs % Comprehension % Laboratory chemical hazard % Laboratory safety % Hazard communication % Globally harmonized system (GHS) % Chemical labels

INTRODUCTION

Nowadays, laboratory (practical) classes are parts and parcels of teaching science subjects throughout the world. One of the main reasons is that exposure to laboratory classes help students to understand theories and principles of sciences courses which are complex and abstract otherwise. Besides helping students to develop ranges of skills in science knowledge and conceptual understanding, laboratory classes motivate (inspire) students (or potential future scientists) to develop scientific attitude (spirit) toward research in science. These classes also offer opportunities for students to learn to handle chemicals safely and with confidence and gain experience in using chemical apparatus [1-5]. All these facts indicate that laboratory classes (experiments) are integral and essential components of science subjects at secondary school and tertiary level education systems of every country regardless of its stage of development [6].

Most of the laboratories in natural science fields widely use chemicals of different types and hazard levels. Chemistry and biology are two of the fields that intensively and extensively use chemicals for practical laboratory classes and other experimentations. The chemicals are inorganic or organic in their natures and could be in the form of gases, liquids or solids (in powder form, flakes or particulate). Moreover, they could be corrosive, explosive, easily oxidizing, flammable, harmful, irritating, radioactive or toxic to human being and also pollute environment [7]. Thus, students or employees working in these laboratories are exposed to many kinds of chemicals making them more vulnerable to potential hazards and risks caused by these chemicals more than people working elsewhere [7,8]. For example, toxic gases, fumes or liquids may escape from their container or spill while being handled and cause health problems (e.g. poisoning, cancer, allergies and respiratory problems) upon ingestion or prolonged exposure. Acids and bases may cause irritations and burns of eyes or skin and

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respiratory tract. Certain chemicals are known or suspected to harm fetuses or the reproductive health of adults (e.g. anesthetic gases or lead compounds). There are also chemicals that are highly flammable and can easily catch fire and causing fire hazards. Others could be explosive which can explode upon exposure to air or due to mishandling causing explosive hazards. Chemicals also cause catastrophic damages on humans and environment as a result of their release to environment. This occurs as a result of human error or negligence (e.g. the 1986 Chernobyl nuclear disaster, Ukraine and Bhopal CH_3Br factory explosion, India) [9,10,11] or even due to unseen consequences while utilizing chemicals in health and agricultural sectors for other purposes (e.g. DDT and CFCs) [12].

Accidents due to laboratory chemicals are highly likely in the case of inexperienced employees and students who are not well aware of the dangers (risks) associated with the majority of chemicals in their laboratories. Even very experienced laboratory individuals may be at risk, if they fail to follow safety precautions while working with hazardous substances [13]. There are several reports from different parts of the world showing chemical accidents in science laboratories that happened due to mishandling or misusing of chemicals. For instance, chemical accidents in campus have been reported in Malaysia in different times. These include fire in the laboratory at the Department of Chemistry at University of Malaya (2001), engineering laboratory of University Putra (2002) and laboratory of school of applied Physics at University of Kebansoon (2005) [14]. Reports also showed that 49% of campus accidents in Taiwan to be related to improper use of chemicals in laboratories [15]. A fetal chemical accident was happened at Organic Chemistry laboratory of the University California, Los Angeles, that resulted in death of a research assistant [16]. Previous safety inspections of the also revealed several safety lapses in the laboratory. For instance, employees were not wearing protective lab coats and flammable liquids and volatile chemicals were stored improperly. As reported by O’Nell (1975), one major accident per 40 students per year in laboratory settings throughout USA [17]. In another related report, a chemistry professor of Dartmouth College (USA) died from mercury poisoning after a small drop of dimethylmercury apparently seeped through her latex gloves. Investigations showed that the latex gloves were not appropriate for work with dimethylmercury [18]. A postdoctoral fellow at AIHA laboratory (USA) was working with concentrated sulphuric acid. She splashed some of the acid onto her latex gloves and it quickly burned a hole through the gloves and caused a small second-degree burn. If the researcher had been wearing gloves made from polyethylene or butyl rubber, she would not have been burnt by the acid [19]. A UK researcher was testing the pH of a four-liter container of hazardous waste when the bottle fell and burst. The researcher fell in the slippery liquid, hitting his head extremely hard on the floor. The entire side of his body was saturated in the liquid solution. He suffered from lacerations and eye burns [20]. These are some of the typical examples that can serve as sobering remainders for all laboratory chemical users everywhere.

It is wrong to conclude that chemicals are totally hazardous or risky. They are beneficial if they are properly handled or utilized [21]. The benefits of utilization of chemicals in different research activities and laboratory classes in science subjects of higher institutions can be considered as typical examples in this regard. In addition to abide by the “DOs and DONOT” rules, it is very crucial to understand potential hazard of each and every chemical and its associated labels for safe use and handling. Moreover, these hazardous properties (information) of chemicals must be adequately communicated to various groups of people such as chemical transporters, store keepers, distributors, users and/or regulating authorities in order to minimize chemical-related accidents in laboratories, stores and the wider environment [7,22].

Hazard and risk warning signs (labels) of chemicals are something that anyone entering in to laboratories should understand and be familiar with. They are commonly assigned to each chemical in order to draw the attention of users and to classify chemicals according to their characteristics [14,23]. Many of the chemical accidents mentioned above happened either due to lack of proper chemical warning signs (labels) of the chemicals in use or lapses in safety measure [14,15,16,17,18,19,20]. This indicated that knowledge of potential hazards and risks of chemicals and understanding their labels would help to make correct choices and safe utilization and handling of chemicals [12]. These procedures, ultimately, would help to avoid chemical-related accidents on individuals and environment.

There are different approaches to assign hazard warning signs (labels) to chemicals in order to communicate to the user for their safe handling in laboratories and design safety measures to avoid preventable hazards on users [14]. These labels (warning signs) are consist of different colors and pictures and intended to provide information about properties of chemicals such as flammability, toxicity, explosive, corrosive, oxidizing, irritating, radioactivity and harmfulness [7]. Understanding or becoming familiar with the labels of these properties would help to avoid unwanted but preventable hazards of laboratory chemicals. Therefore, for safety reasons, individuals working in Biology and Chemistry laboratories and also in other laboratories that involve use of chemicals are supposed to be aware of the potential hazards of laboratory chemicals and also become familiar with the warning sign of each chemical in use.

There are several reports revealing the results of studies carried out on the assessment of understanding (awareness) of individuals particularly students about chemical hazard and risk communications and hazard signs (labels) [14,24]. For instance, Sarifah *et al.* (2010) conducted a survey to assess understanding of chemical labeling using globally harmonized system (GHS) amongst students of secondary level in Terengganu, Malaysia. The study result of the authors showed that the secondary levels students could not recognize chemical substance labels correctly by using GHS. The understanding would influence attitude, which may further affect the behavior while handling chemical substances. The authors also suggested that incorporation of hazard communication based on GHS into chemistry curriculum for secondary level schools [14].

Ethiopia is one of those developing countries aggressively working on expansion of higher institutes to increase yearly enrollment of students in different fields including natural sciences to meet the demand of skilled human power [25,26]. Similar to their counterparts in other parts of the world, many of these institutes (e.g. institutes/colleges of natural sciences, pharmacy and medical sciences) offer laboratory classes that involve use chemicals of different hazard and risk levels. Moreover, the researches in these institutes widely use varieties of chemicals. Most of the practical classes (especially those in undergraduate level ones) are conducted in a group of students that consisting of up to 5 students/group. Students are usually given brief summaries of specific experiments and then allowed to do experiments following procedures given in manuals. At the beginning of a semester (or on the day of their first experiment) students are briefed about potential hazards and risks of chemicals, how to handle potentially hazardous chemicals, to pay attention to safety precautions and to read/identify labels of chemicals before use or opening containers. However, there are no mechanisms to assess/check how many of the students are actually aware of the potential hazards and risks of laboratory chemicals and -familiar with hazard warning labels of chemicals used in their experiments. Moreover, almost all the students of higher institutes get exposure to chemicals only after they are admitted to colleges and universities. This is a worry that students could face health risks due to mishandling or misuse of chemicals or failures to understand chemical hazard signs (labels) and to comply with safety measures. Though there are no reports on chemical accidents in the histories' of laboratories of higher institutes of the country, it is necessary to carry out a survey to assess situations in order to get preliminary information about the general status of students in higher institutes of the country in this regard.

The objective of this study was to assess awareness of students about hazards and risks of laboratory chemicals and comprehensibility of hazard warning signs of chemicals by undergraduate students majoring chemistry and biology at Jimma University. To the best of our knowledge, there are no similar studies in the university and other universities and colleges of the country. These facts prompted us to carry out the present study. The results of the study would (i) provide information about hazard warning sign comprehensibility of students of chemistry and biology departments; (b) help the respective departments to take correct measures (if there are gaps or problems) in understanding warning symbols (signs) of chemicals which are commonly used in chemical laboratories; (iii) serve as a baseline for other researchers who want to conduct similar studies.

MATERIALS AND METHOD

Description of the Study Area: The study was conducted at Jimma University, Jimma, southwestern Ethiopia, from February to May, 2011. Jimma University is one of the 22 universities of the country. It is known for its mission Community Based Education (CBE). Currently the university has six colleges (College of Medical sciences, College of social sciences, College of Natural Sciences, College of Business, Institute of Technology and College of Agriculture and Veterinary Medicine). Biology and Chemistry departments are two of the six departments at College of Natural Sciences each enrolling about 150 undergraduate students per year.

The Study Population and Sample Size: The population of this study were undergraduate Chemistry and Biology students of year I, II and III. The students of these

Table 1: Profiles of respondents participated in the study (Jimma University, 2011).

	Biology			Chemistry			
Year	No of F(%)	No of M(%)	Total (%)	No of F(%)	No of M(%)	Total(%)	Total No of respondents in year (%)
I	5(6.02)	9(10.84)	14(16.9)	4(4.82%)	10(12.05)	14(16.9)	28(33.74)
II	9(10.84)	4(4.82)	13(15.7)	3(3.61)	9(10.84)	12(14.4)	25(30.13)
III	7(8.43)	8(9.64)	15(18)	2(2.41)	13(15.7)	15(18.07)	30(36.15)
Total (%)	21(25.3)	21(25.3)	42(50.6)	9(10.84)	32(38.55)	41(49.4)	83(100)

F=female; M=male

departments were chosen for present study/survey because of their frequent exposures to different chemicals of various hazard levels during their tenure. During the study period there were 624 students in those departments. A standard method was employed to determine sample size of the study population to 83 [27].

Data Collection and Analysis: Data were collected from randomly selected 83 respondents that consisted of 53 males and 30 females. A structured questionnaire, prepared in English, was used for the data collection (Appendix 1). It was distributed to the respondents who were composed of six group; three groups from Chemistry (year I, II and III) and three groups from Biology (year I, II and III) departments. The respondents were also requested to fill-in the questionnaires immediately without any discussion among themselves. The profiles of the respondents are given in Table 1. Analysis of the collected data was carried out using simple quantitative analysis.

RESULTS AND DISCUSSION

Assessment of Awareness of Students about Hazards of Laboratory Chemicals: Out of the total 83 respondents participated in the survey, 73.5% of them said that they are aware of potential hazards of laboratory chemicals on them and their environment. On the other hand, 25.5% of the respondents said that they are not well aware of hazards of these chemicals (Table 2). Among the respondents who said that they are aware of hazards of laboratory chemicals, the majority of them were year II and year III students. This could be because of the fact that senior students had better laboratory experiences or had attended many practical sessions. However, our observation of the laboratory classes revealed that the students had low motivation to request or use personal protective equipments such as eye goggles and lab jackets. Since it difficult to anticipate the happening of chemical accidents in laboratories, the departments and instructors should take the initiative to enforce student to use or develop the habit of using these equipments. This can be done using different approaches such as (i) encouraging students to feel responsibility to their safety and strictly follow safety rules; and (ii) use of computer game-based training and safety-related visual aids that have been found to be equally effective with that of safety briefing at the beginning of each semester or laboratory session in communicating science safety to students and other visual aids [28,29]; and (iii) the instructors are expected to be good role models in following safety procedures as this has a significant impact on the students' attitude to develop safety behavior [30].

No significant differences were observed among the Chemistry and Biology students with regard to their awareness toward potential hazards and risks of laboratory chemicals (Table 2). Moreover, among the students who said that they were not well aware of potential hazards of chemicals, majority of them were students of year I (14.45%, Table 2). This might be because of their low experience (exposure) to laboratory classes. It is generally expected that senior students to show better awareness due to their repeated exposure or better experience in the university or cumulative effect of study period. However, the results obtained for year I, II and III are very similar to each other (Table 2).

Familiarity of Students with Hazards (Warning) Symbols of Laboratory Chemicals: After getting information on their level of awareness about potential hazards of laboratory chemicals (Table 2), the respondents were also requested about their familiarity with hazard warning signs (labels) of laboratory chemicals. The result of the survey indicated that majority (56.8%) of the respondent claimed that they are not familiar with hazard warning symbols of laboratory chemicals (Table 3). Among this group of respondents, majority of them were Biology students (31.6%) and the remaining (25.82%) were chemistry students (Table 3). This finding demonstrated that chemistry students had relatively a better familiarity with hazard warning symbols (labels) of laboratory

Table 2. The participants' responses to the items "are you aware of potential hazards and risks of laboratory chemicals?" (Jimma University, 2011)

	Biology						Chemistry						
	Year I		Year II		Year III		Year I		Year II		Year III		
Responses	No of F (%)	No of M (%)	No of F (%)	No of M (%)	No of F (%)	No of M (%)	No of F (%)	No of M (%)	No of F (%)	No of M (%)	No of F (%)	No of M (%)	Total (%)
Yes	3(3.61)	4(4.82)	7(8.43)	3(3.61)	6(7.23)	6(7.23)	0(0)	9(10.84)	3(3.61)	8(9.64)	2(2.41)	10(12.05)	61(73.5)
No	2(2.41)	5(6.02%)	2(2.41)	1(1.2)	1(1.2)	2(2.41)	4(4.82)	1(1.2)	0(0)	1(1.2)	0(0)	3(3.61)	22(25.5)

F= female; M= male

Table 3: Participants' responses to an item "Are you familiar with hazard warning signs of laboratory chemicals (Jimma University, 2011).

	Biology						Chemistry						
	I		II		III		I		II		III		
Responses	No of F (%)	No of M (%)	No of F (%)	No of M (%)	No of F (%)	No of M (%)	No of F (%)	No of M (%)	No of F (%)	No of M (%)	No of F (%)	No of M (%)	Total (%)
N o	4(4.82)	7(8.43)	5(6.02)	1(1.2)	4(4.82)	5(6.02)	2(2.41)	7(8.43)	2(2.41)	2(2.41)	1(1.2)	8(9.64)	47(56.8)
Yes	1(1.2)	2(2.41)	4(4.82)	3(3.61)	3(3.61)	3(3.61)	2(2.41)	3(3.61)	1(1.2)	7(8.43)	1(1.2)	5(6.02)	36(43.2)

F= female; M=male

chemicals as compared to Biology students. The possible reason given by these respondents were (i) they don't pay much attention to the labels of chemicals except using the chemicals for specified purposes; (ii) symbols are not displayed in and around the entrances of laboratories; (iii) no orientation have been given to students to pay attention to become familiar with the warming symbols (labels) of chemicals; and (iv) most of the symbols are difficult to understand and remember (Data not given).

The number of year I and Year III students who were not familiar were from both departments were comparable to each other (Table 3). The trend was also similar within the department. The number of year II (8.4% Biology and 3.6% chemistry) students who were not familiar with these symbols were very low (12%) as compared to year I (24.1%) and year III (20.5%) students (Table 3). This data indicated that number of years of stay in the university didn't help students much to get familiarized with hazard warning signs (symbols) of laboratory chemicals.

Of the 43.2% of the respondents who were familiar with hazard symbols were consisted of 21.6% Biology and 21.6% Chemistry students (Table 3). Again no significant differences were observed from year to year and from department to department. The basic reasons that help these groups of respondents, according to their importance, were (i) the departments frequently give warnings to students to pay attention to chemicals and their hazard symbols; (ii) warning signs are displayed in chemistry and Biology laboratory; and (iii) from books and literature (data not given). This finding indicated that regardless of their years of stay and departments, the respondents have similar but low familiarity with the warning symbols.

As discussed above, the respondents claimed that they are well aware of potential hazards of laboratory chemicals but showed low level of familiarity with hazard warning signs. These observations indicate the necessity of a lot of work to be done to help students of the institute in general and Biology and Chemistry students in particular to become familiar with warning symbols (signs) of laboratory chemicals in order to avoid preventable hazards of chemicals on the students and the wider environment. Students in these departments are frequently exposed to chemicals in their laboratories. Therefore, it is recommended that the signs should be displayed in the laboratories as well as cover pages of the manuals and lab note books to help students get familiarized with them.

Assessment of Students' Ability to Comprehend Hazard Warning Symbols of Chemicals: As described in several literature reports, the purpose of classification and labeling of chemicals is to draw the attention of the user, manufacturer, transporter and storekeeper in order to protect human health and the environment [14,31]. They can be designed using symbols (signs), words or a combination of the two given in different background colors [32]. Moreover, they could be national or international (e.g. GHS) [14] where the later approach is being adopted/encouraged for the sake of implementation of chemical control managements. Therefore, understanding or comprehending of these the potential hazard and risk warning signs is mandatory for students and/or employees working in chemical laboratories.

The present survey was carried out on students of Chemistry and Biology, who have frequent exposures to chemicals, in order to assess their understanding of these signs. The respondents were requested to match chemical characteristics with the given hazard warning signs in order to evaluate their knowledge of hazard warning signs of commonly used laboratory chemicals.

Table 4: Number of respondents that correctly matched properties of chemical with the corresponding pictograms of hazard warning signs (Jimma Univeristy, 2011).

Properties of chemicals	Biology	Chemistry	Total (%)
Flammable	8(9.64%)	14(16.87%)	22(26.51)
Toxic	6(7.23%)	6(7.23%)	12 (14.45)
Irritant	3(3.61%)	7(8.43%	10 (12.05)
Harmful	4(4.82%)	3(3.61%)	7(8.43)
Explosive	2(2.41%)	3(3.61%)	5(6.02)
Radio active	1(1.2%)	3(3.61%)	4(4.82)
Oxidizing	1(1.2%)	2(2.41%)	3(3.61)
Corrosive	3(3.61%)	0 (0%)	3(3.61)

However, 56.63% (31.33% Biology and 25.30% Chemistry) replied that they do not know hazard warning signs of chemicals whereas 43.37% (19.28% Biology and 24.10% Chemistry) responded that they know some hazard warning signs of laboratory chemicals (Appendix 2). To confirm how much this information are correct, the respondents were provided pictograms of eight properties of chemicals and requested to match each property with the correct pictogram. The properties of laboratory chemicals presented to the respondents were toxic, flammable, explosive, oxidizing, irritant, harmful, radioactive and corrosive. They were provided a matching item asking them to match each these properties with the correct signs (pictograms). The data indicated that only 12%, 14.45% and 26.5% of them were able to match irritant, toxic and flammable, respectively, with the given pictograms (Table 4). This indicated that the students indeed have low level of understanding (comprehension) towards chemical hazard warning signs. This finding is also in line with previous report by Nicol and Tuomi (2007) who reported comprehensibility of "flammable' and toxic as 80.95% and 90.48%, respectively, among South African illiterate adults [32]. In our survey, the number of respondents who were able to match the rest of the properties with the corresponding symbols/labels was not as such significant (Table 4). Results of similar study by Ta *et al*. (2010) indicated that 'flammable' and 'toxic' pictograms as the most easily identifiable signs and with high comprehensibility rates of 99.3% and 94.7%, respectively [33]. The data obtained from our study also indicated absence of significant differences among students of the two departments with regard to comprehension of warning signs of laboratory chemicals. No correlation was also observed between duration of stay in the university and the students' understanding of hazard warning signs of laboratory chemicals (data not given).

The results of the survey indicated that the overall understanding (comprehensibility) of hazard warning signs of laboratory chemicals by the students is low and is not encouraging. This observation is in line with the report by Karapantsios *et al*. (2008) that states only one student out of four college students was found to correctly match some commonly used laboratory chemicals with the corresponding hazard warning labels (signs) [24]. The low level of hazard sign comprehensibility of students, in the present study, indicates the need for intensive training and education to raise the levels of comprehensibility of students toward the commonly used chemical hazard warning signs. Even it is not possible to be sure that those students who correctly matched the chemical properties with the corresponding labels were based on their knowledge. It could be by luck or chance those students could give the correct answer. As reported by Hill (2006), for better educating students in laboratory, safety is to teach them 'understand and recognize hazards' rather than telling them just to follow safety rules and procedures [34]. This argument is similar to that of Nicol and Tuomi (2007) who suggested training that targets not only hazard sign comprehension but also sign recall and recognition to improve low level of chemical hazard sign comprehensibility of individuals [32]. In their study carried out to assess perception of college students toward GHS classification and labeling of chemicals Su and Hsu (2008) also reported that students who had taken hazard communication training had better perception rates than those without such a training [15]. Similarly, a report by Karapantsios *et al*. (2008) indicated that traditional way of teaching of safe handling and hazard labeling is inadequate and there is a need for more effective teaching methods to improve the awareness of labeling and safe handling of chemical substances [24]. Therefore, to increase hazard sign comprehension of the students, the following steps can be used; (i) students should be given quizzes and trainings by organizing group discussion forums at a regular basis; and (ii) displaying the internationally adopted signs [14] and associated information as well as pictures (cartoons) showing chemical accidents using colorful posters in all laboratories.

Table 5: Preferred ways suggested by respondents to communicate hazard and risk information of laboratory chemicals (Jimma University, 2011).

	Biology						Chemistry						
	I		II		III		I		II		III		
Preferred ways	No of F (%)	No of M (%)	No of F (%)	No of M (%)	No of F (%)	No of M (%)	No of F (%)	No of M (%)	No of F (%)	No of M (%)	No of F (%)	No of M (%)	Total (%)
Color and symbol	4 (4.82)	3(3.61)	4 (4.82)	0(0)	3(3.61)	4 (4.82)	0(0)	4 (4.82)	2(2.41)	6(7.23)	1(1.2)	9(10.84)	40(48.20)
Symbols	1(1.2)	3(3.61)	3(3.61)	2(2.41)	4 (4.82)	0(0)	4 (4.82)	6(7.23)	1(1.2)	2(2.41)	0(0)	2(2.41)	28(33.73)
Colors	0(0)	2(2.41)	0(0)	2(2.41)	0(0)	4 (4.82)	0(0)	0(0)	0(0)	1(1.2)	1(1.2)	2(2.41)	12(14.45)
No idea	0(0)	1(1.2)	2(2.41)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	3(3.61)

F= female; M=male

The respondents were also requested their knowledge about ways for effective communication of the potential hazards and risks of laboratory chemicals. The obtained data indicated that a combination of color and symbol (48.2%) and symbols (33.7%), respectively, can be considered as better ways to communicate information about possible hazards of laboratory chemicals (Table 5).

Consistent with previous reports [32], the data obtained from the survey also indicated that using color or symbol alone are not enough to communicate chemical hazard information (Table 5). The combination of color and symbols could increases comprehensibility of chemical hazard warning signs among students or individuals working in chemical laboratories.

It is clear that managing the process of prevention is much easier and safer and less costly than the process of coping with the consequences of hazards. Based on the findings of the present survey, it can be suggested that the departments (Chemistry and Biology departments) should work together to familiarize their students with these chemical hazard symbols to avoid preventable health hazards on their students and other environmental pollutions. There are reports showing that integration of safety issues into curriculum of undergraduate levels [15,35,36,37] and/or high school levels [38] could increase safety and knowledge base of students. Similarly, the above departments are recommended to integrate chemical hazard communication course (or at least a chapter) to enhance the comprehensibility of hazard warning signs (labels) of laboratory chemicals among their students.

CONCLUSIONS AND RECOMMENDATION

The survey was conducted on undergraduate students of chemistry and Biology departments of Jimma University to assess their (i) familiarity with commonly used hazard signs of laboratory chemicals; and (ii) understanding (comprehensibility) of chemical hazard warning signs. The result indicated that despite their claim saying that they have good awareness about hazards of laboratory chemicals and familiarity with hazard warning signs (Table 2), majority of respondents were not familiar with hazard sings and background colors of these signs.

Moreover, only very few students were able to match hazard names with the corresponding signs (symbols). The main reasons mentioned by the respondents for the observed low hazard sign comprehensibility and familiarity were (i) signs were not displayed in the laboratories (ii) students themselves are not paying attention to hazard signs given in written documents and few displayed symbols on the chemical containers (iii) orientations are not common in these laboratories to raise awareness (or understanding) of students and (iv) difficulties of these symbols to be remembered (comprehend). Further study is also needed to discover other important factors responsible for low level of familiarity and comprehension of students toward chemical hazard warning signs (labels). Thus, the departments and other concerned authorities of the university should take some corrective measures to address these issues (problems). This would help to avoid possible happening of chemical hazards due to mishandling of laboratory chemicals not only in the chemistry and biology departments but also in other departments where chemicals are extensively used.

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Appendix 1

Jimma University

College of Natural Science Department of Chemistry

Dear student the objective of this study is to assess laboratory chemical risk perception under graduate Chemistry and Biology students of Jimma University. The correct response that you provide will largely contribute to the successful completion of the study. Thus, you are kindly requested to provide your genuine response to the items given below. Use "P" mark to indicate your choice.

Thank you

Section I. Profiles of Respondents

Sex: Male _____Female _______

Department: Chemistry _____ Biology _______

Year: I _________II ___________ III _________

Section II. Survey Questions:

1.Are you aware of hazards of laboratory chemicals?

A. Yes B. No C. No idea

2.Are you familiar with hazard warning symbols (signs) of laboratory chemicals?

A. Yes B. No C. No idea

3.If your answer to question No 2 is "Yes", how you came to be familiar with those signs?

A.Hazard warning signs were displayed in the laboratories

B.The departments frequently encourage student to pay attention to chemicals and their hazard symbols (labels)

C.By reading books and other literatures

D.No ideas

4.If your answer to question No 2 is "No", why?

A.The hazard warning signs were not were not displayed in the laboratory

B.I don't give much attention to chemicals except using them for specified purposes.

C.No orientations have been given to student to pay attention and to be became familiar with the commonly used hazard warning symbol of laboratory chemicals

D.They are difficult to understand and remember

E.No idea

5.Do you know some of the hazard warning symbols (signs) of laboratory chemicals?

Yes; __________ No : ____________

6.If your answer is #5 is "Yes", match properties of chemicals properties (Column A) with the corresponding hazard warning symbol (Column B)

Column A (Chemical properties)	Column B (Pictograms)
1. Toxic	A.
2. Flammable	B.
3. Explosive	C.
4. Oxidizing	D.
5. Corrosive	E.
6. Harmful	F.
7. Irritant	G.
8. Radioactive (radiation risk) H.	

9.Which one of the following are the preferred ways of getting information about hazards of laboratory chemicals?

A)Colors (B) Symbols (signs) (C) Colors and signs (D) No idea

Appendix 2

Responses given to the item "Do you know some of the commonly used hazard warning signs of laboratory chemicals?" (Jimma University, 2011).

	Biology						Chemistry					
	Year						Year					
	I		II		III		I		II		III	
Responses	No of F (%)	No of M (%)	No of F (%)	No of M (%)	No of F (%)	No of M (%)	No of F (%)	No of M (%)	No of F (%)	No of M (%)	No of F (%)	No of M (%)
Yes	2(2.41)	3(3.61)	3(3.61)	1(1.2)	3(3.61)	4(4.82)	4(4.82)	1(1.2)	1(1.2)	7(8.43)	1(1.2)	6(7.23)
No	3(3.61)	6(7.23)	6(7.23)	3(3.61)	4(4.82)	4(4.82)	0(0)	9(10.84)	2(2.41)	2(2.41)	1(1.2)	7(8.43)