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A Survey On The Pre Service Chemistry Teachers’ Lab Safety Education

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Abstract

A chemistry lab is a place of learning. However, in the absence of proper safety procedures it can become a dangerous environment. To ensure that students remain safe while they are engaged in experimentation, teachers must offer safety instructions. The purpose of this study is to find the effective factors of safety education in chemistry lab for teachers. The research method is exploratory survey. The population includes iranian chemistry teachers who have completed the graduate courses. One hundred and five teachers were selected by cluster sampling. Data was collected through an open-ended questionnaire, a closed-ended questionnaire and an open-ended questionnaire again. The reliability of the closed-ended questionnaire yielded a cronbachs alpha coefficient of 0.942. The results shows necessity of labeling primary, secondary and waste containers. Other requirements include public storage, chemicals arrangement, storing of chemicals and purchasing primary containers. These factors should be applied in content design for the chemistry teachers’ safety education.

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1. Introduction

Science is one of the few subjects in which providing the most pedagogically sound learning environment that results in potentially dangerous situations for students and teachers in the school environment (National Research Council 1996). Every day, students at all grade levels from kindergarten to seniors in high school participate in science instruction involving hands-on science activities. Many of these activities include heat, electricity and/or chemicals, thus presenting potentially dangerous or unsafe conditions (Linda M. Stroud, 2007). Fear is driving many school districts to cyber labs. This is robbing chemistry students off lab experience

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that restricts authentic thoughts. Although laboratory accidents occur, they are not unavoidable. We must attack this safety crisis by providing fundamental training to build teacher’s knowledge. At a minimum rate, the training should include chemical hygiene, potential hazards and risks. Proper storage and handling, stock records and safety audits, safe physical, facilities and equipment, chemical waste, management and how to select experiments for students while knowledgeably considering both educational impact and safety risks should also be considered (Sarquis, 2003).

Standard 9 of the National Science Teachers Association Standards for Science Teacher Preparation is designed to ensure that science teachers’ preparation programs provide pre service science teachers with the knowledge and skills to understand and successfully engage students in a safe and ethical manner. This standard contains four components describing science teachers’ legal and ethical responsibilities, appropriate use of instructional materials (chemicals in particular), emergency procedures and safety equipment (Allan, et al, 2009). It is not a necessity but an obligation for the science teachers to be competent on safety since they need the laboratory applications more because of the characteristics of the lesson. A Science teacher is competent when he/she knows the dangers and takes precautions in his/her occupation (West, et al., 2002). The teacher candidates do not know how to operate safely in laboratories and they will not be able to provide their students in the future with safety. However, it is essential for the individuals to recognize the chemicals and their hazard symbols not only for their own health and safety but also for the safety and health of the laboratory and environment in the laboratory operations allowing practical applications (Osmangazi, 2010).

Chemical safety has evolved into more than a skill and deserves to be recognized as a valid curriculum topic. Instilling a culture of safety into the next generation of chemists is a worthy goal and safety professionals should advocate for this sub-discipline to have a place in the chemistry curriculum. Not all graduating chemistry majors must have the skills and knowledge of a chemical hygiene officer, but every student that graduates with a degree in chemistry should have some basic chemical safety coursework under their belt (Sigmann, 2011). The results of the study at the Department of chemistry, Jimma University, revealed that the majority 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. 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 results also indicate that understanding 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 sign (Adane, et al, 2012). In an effort to explore the necessity for laboratory safety training, results indicate that there is a general lack of formalized safety training for in service chemistry teachers, most self-report following safety guidelines analogous to the OSHA Lab Standard Assistance with disposal of chemical waste was the most requested form of help. Overwhelmingly, in-service teachers recommend inclusion of chemical safety training as part of the collegiate educational experience. However, neither the traditional nor non-traditional paths to science teacher certification include a focused effort in chemical laboratory safety. Current in-service teachers are receptive to enrolling in a chemical safety online course especially if continuing education credits are offered (Michelle, 2010). Since most of the lab accidents occur due to the of lack of labelling on chemical materials, the aim of this project is finding an effective ways in labelling and categorizing of chemical materials so that we can find a curriculum for syllables of safety lesson in chemistry lab.

2. Research Questions

- What are the important factors in relation with labelling of chemical materials in the chemistry lab?
- What are the important factors in relation with storing of chemical materials in the chemistry lab?

3. Methodology

The present study was done through a survey method. This method has been used to study ideas and attitudes of large groups of people and its advantages in obtaining more information than other methods. Two sample
groups were included. The first was composed of all lab administrators and M.A and PhD students of chemistry in state universities of Tehran. The experts and chemistry instructors in state universities of Tehran and Kerman comprised the second sample. The sampling was done in twofold. The cluster sampling was used for the administrators and chemistry students and 105 people from universities of Tehran, Shahid Beheshti and the Sharif University of Technology were included in the survey. The experts and chemistry instructors were the available sample to the researchers and 4 instructors from the universities of Tehran and 3 instructors from the universities of Kerman commented on the subject of the study. In order to gather information for the literature review, the library method (books, papers and research projects on related topics) was used. To collect data on the participants view, a research-made questionnaire was used. The questionnaire assessed the degree of agreement of the respondents with items concerning the arrangement & labeling of chemicals. Also, the professionals were interviewed in two stages for their views. The first step was using an open questionnaire for collecting experts’ attitude about content of a closed questionnaire and in the next step their attitudes have gathered by interview.

4. Results

Factor analysis is one of the various ways of validating an instrument. As seen in table 2, the KMO index is 0.606 which is higher than the 0.60 suitability criterion. This shows that the size of the selected sample is suitable for conducting factor analysis. Furthermore, the null-hypothesis is rejected in Bartlett's test of sphericity with 1847.192 and the degree of freedom of 861. This result indicates that the items in the questionnaire for validating necessities of arrangement & labelling of chemicals in the lab have sufficient correlations for factor extraction.

Table 1. Result of the size related to the KMO & the Bartlett's test of Sphericity

| Level of significance | Degree of freedom | Chi-square of the Bartlett's test of Sphericity | KMO size |
|-----------------------|-------------------|-----------------------------------------------|----------|
| 0.000                 | 861               | 1847.192                                      | 0.606    |

According to the information obtained from the varimax rotation, twelve factors were extracted. Factors which were significant, as well as being obtained by the factor analysis were considered. Five factors were excluded from the study since the researchers didn't consider them as significant. Seven factors were significant: the necessity of labelling primary containers, the necessity of labelling waste containers, necessity of labelling secondary containers, public storage requirements, requirements of chemical arrangement, requirements of storing chemicals & requirement of purchasing primary containers. The information (mean, media, standard deviations and variances) of which is presented in the Table 2.

Table 2: The necessities & their information

| The degree of correspondence to the necessity | The degree of correspondence | Median correspondence | Unacceptable data | mean | median | S.D. | variance |
|---------------------------------------------|------------------------------|----------------------|------------------|------|--------|------|----------|
| necessity of labelling primary containers   | 81%                          | 4%                   | 15%              | 88.87| 90     | 11.19| 125.43   |
| necessity of labelling waste containers    | 92%                          | 3%                   | 5%               | 88.68| 90     | 10.29| 105.96   |
| necessity of labelling secondary containers | 91%                          | 1%                   | 8%               | 91.85| 95     | 17.62| 310      |
| public storage requirements                | 89%                          | 1%                   | 10%              | 90.64| 91.66  | 8.26 | 68.21    |
| requirements of chemical arrangement       | 87%                          | 6%                   | 7%               | 90.82| 91.66  | 11.63| 135.34   |
| requirements of storing chemicals           | 96%                          | 1%                   | 3%               | 90.74| 93.75  | 9.21 | 84.87    |
| requirement of purchasing primary containers| 94%                          | 1%                   | 5%               | 92.43| 93.75  | 9   | 90.19    |
5. Discussion

According to the information obtained, figure 1 organized seven factors, into three main groups as follow:

**Part 1**
- **Public storage requirement is:** attending to material of the shelves and their height from the floor, appropriate air conditioning for the lab environment, low temperature, low light, and the availability of fire control equipments based on the NFPA standards and the prohibition of entering people other the staff into the storing department. The mean of agreement for this requirement was 96.64.

**Part 2.**
- **Chemical storage requirements:** attending to storing alkali metals under oil, storing peroxide- generating compounds in air light and flexible containers, and storing chemicals which are sensitive to waterproof cup boards. The mean of agreement for this requirement was 90.74.
- **The requirement of chemicals arrangement involves:** attending to the arrangement manner of chemicals including separation of acids & bases, arranging chemicals according to homogeneous organic & inorganic groups, and keeping toxic chemicals in locked hooded cup boards. The mean of agreement for this requirement was 90.82.

**Part 3.**
- **The necessity of purchasing primary containers:** these containers must have a label warning about the required safety and focusing on the most important danger. The mean of agreement for this requirement was 92.43.
- **The necessity of labeling primary container is:** putting the code of NFPA, the shelf number that the chemicals belong to, the number of waste container of the chemical & its solvent on the label. The mean of agreement for this requirement was 88.87.
- **The necessity of labeling secondary containers includes:** putting the name, chemical formula, the density of the chemicals, and information about its danger on the label. The mean of agreement for this requirement was 91.85.
- **The necessity of labeling waste containers:** this label must include the chemical name, its amount, the data of beginning collection and the probable dangers. The mean of agreement for this requirement was 88.68.

Then in one of the interviews the experts have been asked to express their ideas about the heading and title of necessity and elements of them. All experts agreed with necessity of labeling but they consider very important cases such as writing the date of opening the container of peroxide (In the necessity of labeling on primary containers) clarifying the exact distinction of oxidative and flammable and using unbreakable covers for bottles (necessity of categorizing of chemicals chemistry).
Fig. 1. Theoretical Profile
6. Conclusion

Safety must be of upmost importance in teaching and research laboratories, and an integral part of chemical and laboratory-based education programs. The results show necessity of labelling primary, secondary and waste containers. Also requirements of public storage, chemicals arrangement, storing of chemicals and purchasing primary containers. These factors should be applied in content design for chemistry teachers’ safety education.

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