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Chemistry Teacher-Trainees' Interpretations of Safety Rules and Symbols- A Case Study in Ghana

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Abstract:
The purpose of this paper was to sensitise laboratory instructors and teachers on the need to take seriously the teaching of laboratory rules and safety symbols to students. It reports on the understanding that 34 chemistry undergraduate teacher trainees have about laboratory safety rules and symbols in a study. The research was a mini survey which employed the exploratory design. A questionnaire was used to gather data toassess the situation. Analysis of the data revealed that 23 (67.65%) of the participants had a fair understanding of safety rules while 24 (70%) could interpret safety symbols. The wrong interpretations wee however very bizarre. It is recommended that teacher and lab instructors make the teaching of laboratory procedures a prerequisite topic before the commencement of experimental work in the laboratory.

Keywords*: biohazard, corrosive, radioactivity,safety rules, safety symbols*

1. Introduction

Science is a subject which needs practical experience. It cannot be understood just by classroom training. Students will understand the important concepts in science only if they can apply the knowledge gained in the classrooms during practical activities in the laboratory. Laboratory activities are necessary for understanding many chemistry concepts. Students learn concept, process and manipulative skills for future analytical and research work through laboratory practice. Laboratories provide an enabling environment for students to develop problem solving skills, capacities to design and execute investigations critically as well as to develop problem thinking skills. A chemistry lab will have burette, pipette, titration apparatus, many concentrated and dilute acids, compounds, chemicals, thermometers and other items. The lab has to be a place of regular use by students of science. Yet, Benderly (2010)and Uva (2012)have found out in separate research that dangers associated with school lab work are varied and occur more frequently than those in industrial laboratories. This could be attributed to the fact that laboratory users in industries are given more rigorous training or preparation before the use of laboratories; besides they get compensated for injuries sustained or accidents which occur. These do not happen in academic laboratories. School science teachers, instructors and students do not undergo training nor observe proper code of conduct in academic laboratories. Sheer ignorance of laboratory procedures or ignorance could be contributory factors of these many academic lab accidents. It is therefore important that teachers and their students become aware of the required basic rules and safety symbols and apply them in their laboratories. Hot glassware, broken glassware, caustic chemicals, and open flames are common elements in secondary and tertiarylaboratories which should be managed effectively by informed users. When teachers and students are not prepared to deal with these conditions the occurrence of accidents become rampart. Acquah and Hanson (2013)carried out similar studies among a mixed discipline group of 146 third year undergraduate teacher trainees and found that less than a third of the population could identify and interpret given safety symbols, which is quite unacceptable. Artdej (2012) suggests that innovative ways of teaching this important aspect of laboratory practice could be done through games, videos and computer simulations so that learning of these precautionary rules could become attractive.

2. Purpose

The purpose of this study was to investigate the understanding that chemistry teacher trainees had about laboratory safety rules and safety symbols so that they would be able to work in and provide safe environments for each other.

3. Research question
The question which enabled the collection of data for the study was:
What are first year chemistry teacher trainees' understanding of safety rules and symbols in the chemistry lab?

4. Method
The study adopted the survey approach in order to find out what safety approaches trainees knew and how they interpreted them.

5. Participants
A total of 34 first year major and minor undergraduate chemistry teacher trainees participated in the study. These students had been exposed to safe laboratory procedures in their secondary schools and in the first semester of their university chemistry laboratory work.

6. Instruments
A two-part questionnaire was administered to the sample. Part A of the questionnaire had 15 items on laboratory rules while part B contained 10 questions on the identification and interpretation of safety symbols.

7. Results and Discussion
Data on the interpretation of laboratory safety rules are presented in Table 1.

Item No	Item/Concept Tested	Correct Response	Wrong Response	No Response
1	Proper pipetting method	3	31	0
2	Turning of burner when not in use	31	3	0
3	Dealing with dizziness near fume chamber	34	0	0
4	Catching fire	18	16	0
5	Drinking in the lab	15	18	1
6	Constant observance of lab procedures	27	7	0
7	Experimenting out of curiosity	18	16	0
8	Dealing with unknown chemicals	25	8	1
9	Disposal of mercury	25	7	2
10	Watching out for colleagues in unsafe practice	30	3	1
11	Cleaning stained glass for use	10	23	1
12	Management of chemical spills on body	29	3	2
13	Wearing goggles	9	23	2
14	Dealing with broken glassware	4	27	3
15	Wearing of gloves	34	0	0

Table 1: Teacher trainees' interpretation of laboratory safety rules

From table 1, it is observed that trainees had a good interpretation and adequate knowledge on what to do in situations such as managing lighted bunsen burners in between and at the end of their activities (item 2), feeling dizzy or uncomfortable around the fume chamber (item 3), ensuring other colleagues observe safe practices (item 10) and wearing of safety gloves (item 15) during practical activities. Their interpretation was however abysmal in items 1, 11, 13 and 14 where they had to show knowledge about best methods of pipetting liquids, cleaning of stained glassware, when to wear goggles and how to deal with broken glassware. Items 1, 5, 11 and 13 had the most misconstrued interpretations. In item one, almost all the students (33) stated that *chemicals were best pipetted by mouth* rather than the pipette bulb. In item 11, only 10 trainees knew that acetone was the best chemical for cleaning stained glassware instead of scrubbing them so hard with omo, which could lead to breakages. They again, stated that *goggles were worn only for some activities* instead of wearing them for all activities. Eight (23%) students scored between 4 to 8 out of 15 marks. About 14 trainees (41%) scored above 10 marks. Majority of the trainees (12) got about half of the interpretations of the rules correct. Only two trainees performed creditably well by scoring 13 out of 15 marks. One trainee scored 12, four scored 11 while 19 scored between 9-10 marks. Eight scored between 4-8 marks, which is quite low and suggest that they could work in unsafe conditions which would result in major accidents. Nevertheless, it is at least comforting to learn that trainees are careful about the use of naked flames during activities in the laboratory and wear protective hand equipment. Trainees' understanding of safety symbols is presented in Table 2.

Item	Symbol	Interpretation	Correct Response	Wrong Response	No Response
1		Toxic; danger	30	4	0
2		Ionising radiation	11	22	1
3		Corrosive	26	7	1
4		Biohazard	14	18	2
5		Low temperature hazard	9	22	3
6		Irritant	28	5	1
7		Hot surface	13	19	2
8		Oxidiser	3	29	2
9		No eating/ drinking	25	6	3
10		Radioactivity	21	13	0

Table2: Trainees; identification and interpretation of safety symbols

It is observed from Table 2 that only few students could interpret the safety symbols. Items 2, 4, 5, 7, 8 and 10 were poorly interpreted. Ten (29%) of the trainees out of 34 failed to interpret about two-thirds (60%) of the safety symbols and that is worrisome. Item two, which was the ionising radiation symbol, was interpreted as get out of here as fast as you can by as many as 22 trainees or about two-thirds of the sample. The low temperature hazard (item 5) was interpreted as dangerous when frozen by 15 trainees and as icy condition by 7. Interestingly, the hot surface symbol (item 7) was said to mean high vapour pressure mostly, followed by the noxious vapours option. The oxidiser symbol was the most unrecognised or misinterpreted symbol. 29 out of 34 participants said that it was a fire/flame hazard. Others chose the heat-sensitive explosive option. 10 traineeschose the not a real sign option for the radioactivity symbol while three chose the unguarded fan blade symbol. In all 10 students failed to interpret the safety symbols adequately, and scored 3-4 marks out of a total of 10 marks. 23 students scored between 5 and 7, while only one trainee scored 8 out of 10 marks.Like Vergano (2011)the researcheraffirms in this research that students could be apprehensive about studying science because of the high risk levels as danger of explosions, electrocution and chemical spills which could occur from lack of factual knowledge about safety rules and poor interpretation of safety symbols. If teachers have so little knowledge of danger signs or safety symbols then the fear of practical science among students can be appreciated as their teachers can be of no or little help to them in times of danger.

8. Conclusion

The study assessed the understanding of first year chemistry teacher trainees' understanding of safety rules and symbols in a chemistry laboratory. The findings revealed that trainees were unable to interpret about seven safety rules out of a given total of 15 adequately. This is quite alarming because if about 10% of a population has no or inadequate knowledge about safety measures and procedures then the probability of causing accidents to themselves and the entire population would be quite high.Nevertheless, this sample performed better in their interpretation of safety symbols than another group had done in a prior study (Acquah & Hanson, 2013). This may be because the sample group for this study were basically science students and often had lab practice. It is recommended that safety lab procedures and their implications should be taught as a remedial or refresher course to remind trainees and students in general about the rules and symbols, their meanings and implications if flouted. Like Artdej (2012) suggests, more robust yet interesting means of teaching about laboratory rules and safety should be adopted to ensure that all users of science laboratories know and can interpret all required safety rules and symbols effectively. This would create a safe work environment for all laboratory users.

9. References

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