Macrothink Institute™

Journal of Educational Issues
ISSN 2377-2263
2018, Vol. 4, No. 1

The Level of Awareness of Safety Measures Practiced in School Laboratories among Pre-Service Science Teachers at Najran University

Yahea Ali Fagihi (Corresponding author)

Associate Professor of Curricula & Teaching Methods of Science

College of Education, Najran University

King Abdulaziz Road, P.O. Box 1988, Najran, Saudi Arabia

E-mail: yahyafaqihi@hotmail.com

Received: March 27, 2018 Accepted: May 1, 2018 Published: May 4, 2018

doi:10.5296/jei.v4i1.12908 URL: https://doi.org/10.5296/jei.v4i1.12908

Abstract

This study is an attempt to identify the level of awareness of safety measures practiced in school laboratories among pre-service Science teachers at Najran University. It also aims to identify the sources of safety measures awareness and the statistically significant differences among the sample responses due to specialization and grade variables. To achieve the study objectives, a scale of (43) questions prepared and applied to a sample of (49) students. The scale covers the following aspects: Laboratory risk management, proper laboratory practices and first aid for laboratory injuries, in addition to a question about the sources of safety measures awareness. Results concluded that the awareness level of safety measures among pre-service Science teachers was low. There were statistically significant differences among the sample responses due to specialization, in favor of chemistry, and grade in favor of higher grades. The sources of safety measures awareness include undergraduate courses, faculty members, the laboratory safety manual, and websites.

Keywords: Awareness, Safety measures, School laboratory, Pre-service science teacher

1. Introduction

Scientific education is concerned with the application of knowledge and information, as well as the acquisition of experience through the practice of science activities. The school laboratory is one of the most important fields of practice where practical experiments are carried out to transfer knowledge from concepts, principles, and theories to tangible results that can be observed, measured, controlled and re-tested in different conditions and according

to new variables. As a result, the student may understand the subject under study in many ways.

Despite the contemporary development of learning sources and the variety of its means, the statement "the laboratory is the heart of science education" is true and unchangeable. The laboratory has maintained its status as the most important characteristic of teaching Science than other fields of knowledge. It also plays a clear and tangible role in advancing this field of knowledge and making it more interesting and enjoyable for students, teachers, and researchers alike.

Since the school laboratory is the most important learning environment and the most widely used in teaching Science, the attention of specialists in scientific education has been drawn up to study how to activate it and utilize its contents in order to effectively contribute to achieving the goals of scientific education. However, its use is shrouded in many difficulties and problems that hinder its activation appropriately including the risks caused by the improper use of laboratory equipment or tools, poor storage and preservation of certain materials, or errors resulting from the improper practices in handling materials or implementing some operating procedures. Therefore, the concern in activating the role of laboratory was integrated with an equal concern in providing safety and security precautions, accident and injury prevention measures, and providing first aid skills to whomever works or exists there.

In order to ensure safety and security in science laboratories, the following requirements must be met:

1) Risk Management: It is the preventive aspect of laboratory work and is intended to prevent or reduce the risks to individuals and facilities, to minimize losses, and to avoid the recurrence of accidents (Abdel Moneim, Kashef, & Kasab, 2008). Therefore, school laboratory staff should introduce to those who use the laboratory including teachers, students, and technicians with the practices, tools, materials, and devices that may be dangerous and make them aware of the expected injuries resulting from the misuse of such materials and devices (Jo et al., 2002). Despite the importance of the preventive aspect, field studies such as Al-Abdalatif (2011), Julius and Thomas (2014), Hackling (2009), and Mogopodi, Paphane, and Petro (2015) revealed a clear decline in the level of preventive awareness among school laboratory users in several countries including Saudi Arabia.

2) Laboratory practices: It is the practical aspect that covers all practical activities associated with Science course. It is necessary that these activities are sound and performed properly in accordance with the instructions regulating them. Failure to perform tasks due to the lack of knowledge, negligence or haste may cause accidents. Thus, achieving awareness of the safety measures of students and teachers and abiding by the instructions when performing laboratory practices serve as a moral charter that should be observed when performing laboratory experiments (American Chemical Society, 2012).

3) First aid: It represents the therapeutic aspect, which is no less important than the preventive and practical ones as for the measures of safety in the laboratory. In many cases,

good behavior in emergency situations and providing first aid to those who get injured inside the laboratory may be crucial. Therefore, first aid can be described as the immediate primary care provided to the injured prior to the arrival of medical assistance (Mansoura University, 2009). As laboratory accidents are expected to occur at any time, it is necessary to qualify laboratory users to provide the necessary assistance to themselves and others when required. Consequently, an adequate scientific knowledge and special skills of how to behave when an accident occurs and ways to handle the various laboratory injuries are a must.

Reviewing the reality of these fundamental aspects of education illustrates that they receive less attention than it should be. For example, Schroder et al. (2015) conclude that the rate of compliance with the rules and safety requirements in academic laboratories is lower than industrial and governmental laboratories and that (25%) of the users of the academic laboratories do not receive any training on safety measures. Other studies show that safety precautions are few and below expectations in some aspects (Almodifer, 2005; Julius & Thomas, 2014). Furthermore, there is a set of laboratory malpractices (Nasim et al., 2010) which can be attributed to low level of awareness and skills of the staff due to poor training (Al Habeel & Aish, 2012; Zaveri, 2012).

The reports prepared and studies conducted by the competent bodies and research centers on laboratory accidents may justify this concern and emphasize the need to give greater attention to this aspect. For example, a report made by the Science Education Section and Manpower Bureau (2013) revealed that (97%) science laboratory accidents in secondary schools were mainly caused by the ignorance of safety measures and the indifference of users to the problems that may result from misuse. In the same context, The American Chemical Society (2012) reports that since 2001 there have been incidents in more than (120) university laboratories resulting in deaths, human injuries, and material and financial harm of millions of dollars including students, teachers, researchers, and staff. Locally, Balkhoyor (2011) argued that there is a lack of safety requirements in laboratories, including the lack of emergency exits, unavailability of a storage mechanism, as well as lack of emergency and evacuation plans. Additionally, the laboratory staff has a low level of knowledge of the rules of safety and first aid and how to extinguish fires.

It is known that the prevention or reduction of accidents in laboratories is a collective responsibility that requires exerting efforts by the staff and users. That is, everyone is responsible for reducing the accident, especially those who carry out the experiment. Accidents usually occur because of apathy, lack of common sense, failure to implement instructions or errors in carrying out experiments.

The prevention of laboratory accidents requires a set of measures including applying safety awareness requirements after adequate training, using personal safety tools such as wearing glasses and lab coat during the laboratory period, using as little chemicals as possible to conduct the experiment, using non-hazardous or less hazardous substances whenever possible, and predicting the sequence of events while working (The American Chemical Society, 2010).

It is the responsibility of science teacher and the technician to mainly manage the laboratory

and orient work towards achieving the objectives of the practical lessons while maintaining their, as well as others' including the students and the whole school community. They also bear the most important burden of emergency action, providing medical assistance and first aid to those in need, in addition to the related tasks as the provision of safety in the school, training students and teachers on the use of safety means and how to act in case of disasters, fires, or crises, methods of dealing with emergency cases, raising awareness of the whole school community, and disseminating the culture of school safety through paying attention to safety precautions in the laboratory. In this regard, The American Chemical Society (2010) reports that Science teacher plays a vital role in achieving safety in the laboratory and that pre-university teachers in America have recognized the importance of this role. Therefore, they incorporate the topic of chemical safety in teaching.

Science teacher preparation programs are an important aspect of safety measures awareness, as well as of forming an outcome of knowledge and skills which prepares the teacher for his role in laboratory management and dealing properly with emergency situations in the laboratory. After passing the theoretical courses and gaining practical experience which the program includes to prepare him for graduation as a science teacher, the student is described as a "pre-service teacher" or a "student teacher". Therefore, the author is motivated to identify the level of awareness of safety measures practiced in school laboratories among pre-service Science teachers at Najran University.

1.1 Statement of the Problem

The specialists in scientific education realized the importance of school laboratory and its relationship with Science courses that represent a key to the students' knowledge in the years of preparation as these courses are based on stimulating thinking, analyzing phenomena, and dedicating the scientific methodology in research and gaining knowledge. Therefore, effective science teaching is linked to a stimulating and practical laboratory environment by ensuring its human and material requirements in any school belonging to the age of knowledge and technology (Aldandani, 2010). Trowbridge et al. (2004) argue that laboratories are essential for the study of science and modern science courses in most development programs and projects.

Despite the importance of the role of Science teacher in terms of safety in the laboratory and the provision of first aid to laboratory injuries, many studies, *e.g.* Almodifer (2005), Alshuaile and Almaamari (2006), Al-Abdalatif (2011), Al Habeel and Aish (2012), Zaveri (2012), Ali (2013), Julius and Thomas (2014), Schroder et al. (2015), and Alahmadi (2016) showed that the level of safety measures awareness and knowledge of first aid among Science teachers is low.

In the Kingdom of Saudi Arabia, education undergoes a process of development covering all domains. Natural science curricula have received a large share of this development effort as the American McGraw Hill series is being taught after its translation and adaptation to the Saudi environment. It focuses on the practical aspect of information through the activation of the laboratory, intensification of laboratory activities, and allocation of books for the practical activity of all science courses in the intermediate and secondary stages. To keep in line with

this approach, the Ministry of Education paid increased attention to school safety, through creating a special department within its administrative structure, issuing manuals, and holding seminars and workshops on safety precautions in school, in general, and in school laboratories, in particular.

Because of the results of the aforementioned studies and the nature of teaching Science courses, the author is motivated to identify the level of awareness of safety measures in laboratories and the ability to provide first aid to laboratory injuries among pre-service science teachers.

Accordingly, the problem of the present study has been defined in asking the following major question:

What is the level of awareness of safety measures practiced in school laboratories among pre-service Science teachers at Najran University?

It is divided into the following minor questions:

1) What is the level of awareness of safety measures (*i.e.* laboratory risk management, proper laboratory practices, and first aid for laboratory injuries) among pre-service science teachers at Najran University?

2) Are there statistically significant differences in the degree of awareness of safety measures practiced in school laboratories among the participants due to specialization (chemistry or physics) at the level of ($\alpha \leq 0.05$)?

3) Are there statistically significant differences in the degree of awareness of safety measures practiced in school laboratories among the participants due to grade (excellent, very good, good, or pass) at the level of ($\alpha \leq 0.05$)?

4) What are the most important sources of information about safety measures practiced in the laboratory among pre-service Science teachers at Najran University?

1.2 Objectives

The study seeks to:

1) Identify the level of awareness of safety measures among pre-service Science teachers at Najran University including laboratory risk management, proper laboratory practices, and first aid for laboratory injuries.

2) Highlight the statistically significant differences among the responses of the participants according to specialization and grade.

3) Define the sources of information about safety measures practiced in the laboratory among pre-service Science teachers at Najran University.

1.3 Significance

It is a significant study because:

1) It reveals to those concerned with the programs of Science teacher preparation the level of awareness of safety measures practiced in the laboratory in a group of pre-service Science teachers.

2) The results of the study may help develop science teacher preparation programs regarding safety measures practiced in the laboratory.

3) It highlights the role of the different sources of information about safety measures practiced in the laboratory among pre-service Science teachers.

1.4 Limitations

The study has been limited to:

1) Objective limitations: The study specifically handles the following two topics:

a) Defining the level of the sources of information about safety measures practiced in the laboratory among pre-service Science teachers at Najran University.

b) Identifying the most important sources of information about safety measures practiced in the laboratory among pre-service Science teachers at Najran University.

2) Human limitations: The study was applied to the students of chemistry and physics at the College of Science and Arts who spend the period of practical training. They are known as "student teachers" or "pre-service teachers".

3) Temporal limitations: The study was applied in the first semester of the academic year 1438-1439 H/2017-2018 AD.

1.5 Definition of Terms

1.5.1 School Laboratory

Ali (2013) defines laboratory as "a room designed in an appropriate manner in which students learn some skills, concepts, and principles associated with a certain course, through laboratory interaction with some concrete examples to identify the concepts and processes of certain chemical and physical phenomena in order to acquire knowledge based on abstract and concrete concepts".

According to Collins and O'Brien (2008), a laboratory is "a room or a building equipped to conduct practical experiments, investigate procedures, or teach science using specific equipment and procedures.

1.5.2 Safety

It is defined as a set of approved procedures and methods to ensure the protection of life and property before the incident (Aldandani, 2010). It also means "avoiding damage and losses that may occur as a result of not taking care much in a work" (Ali, 2013).

According to Aldandani (2010), safety in school laboratories is "a set of procedures and rules aiming at keeping laboratory staff from injuries, preserving the property from damage and

loss, and providing safe work environments".

1.5.3 Safety Measures in School Laboratories

Procedurally, the author defines them as the precautions aiming to maintain the users of the laboratory including students, teachers, and technicians, as well as devices, tools, and equipment. They cover everything related to laboratory risk management, proper laboratory practices, and first aid for laboratory injuries.

2. Procedures

2.1 Methodology

The descriptive (survey) method, which is based on studying the phenomenon as it exists in reality, describes it accurately, and expresses it quantitatively or qualitatively, was adopted (Thuqan et al., 2003).

2.2 Population and Sampling

The population of the study comprised (56) pre-service Science teachers in the eighth level of physics and chemistry at the College of Science and Arts, Najran University in the first semester of the academic year (2017-2018), while the sample comprised (49) female students because of the absence and the exclusion of the incomplete cards.

2.3 Tool of the Study

After reviewing literature, the scale prepared by Alahmadi (2016) was adopted as a proper scale for the present study because:

1) It was prepared for the same objective that author seeks to achieve in the present study.

2) It was developed and applied to the same environment; the Saudi environment.

3) It has high validity and reliability, indicating its applicability.

4) The simplicity and clarity of its items.

5) The scale designer agreed to reuse and apply it to the present study.

It consists of (43) multiple choice questions that each of which has four choices (one choice only is correct), covering three domains:

1) Laboratory risk management; questions (1-18).

2) Proper laboratory practices; questions (19-32).

3) First aid for laboratory injuries; questions (33-43).

The scale also included a question about the sources of safety measures awareness practiced in school laboratories. The choices consisted of (12) potential sources.

2.4 Validity and Reliability

Based on the results of validity and reliability measures carried out by the scale designer

(Alahmadi, 2016), its items were presented to specialists in education, science, and laboratories to verify its validity in terms of the integrity of content and relevance to the main domains. The scale was finalized in (43) items after taking the reviewers' notes and making the proposed modifications.

Furthermore, its reliability was verified by applying it to a pilot sample of (30) participants. Cronbach alpha for the whole scale reached (0.82), indicating that it has an appropriate degree of reliability. Since the scale was prepared and codified in the Saudi environment, it was applied, in the present study, to the same environment and on a category similar to that of the original study. Consequently, the author adopted the previous values.

In addition, the criterion score of the scale was set to (75%) that is equal to (32.25) after reviewing similar studies and consulting some specialists.

2.5 Statistical Methods

Based on SPSS, the arithmetic averages and the standard deviations were calculated to identify the level of safety measures awareness in the school laboratory. The T-test, ANOVA, and Scheffé test were applied to highlight the significance of the differences in the sample's performance and their attitudes according to the variables. Additionally, frequencies and percentages were estimated to identify the importance of knowledge sources as perceived by participants.

3. Results

3.1 Answer to the First Question

What is the level of awareness of safety measures (*i.e.* laboratory risk management, proper laboratory practices, and first aid for laboratory injuries) among pre-service science teachers at Najran University?

To answer this question, arithmetic averages and standard deviations were calculated, to identify the level of safety measures awareness in the school laboratory, for the domains and the total scale, as shown in Table 1.

Table 1. Arithmetic averages and standard deviations of the participants' performance

Domain	Number	Arithmetic average	Standard deviation	Criterion score	Level
Laboratory risk management	49	11.27	2.370	32.25	Low
Proper laboratory practices	49	7.90	1.817		Low
first aid for laboratory injuries	49	5.78	1.403		Low
Total	**49**	**24.96**	**5.358**		**Low**

Table 1 shows that the arithmetic average of the whole scale regarding the degree of safety measures awareness in the school laboratory scored (24.96) with a standard deviation of (5.36). While laboratory risk management scored an arithmetic average of (11.27) and a standard deviation of (2.37), proper laboratory practices domain scored an arithmetic average of (7.90) and a standard deviation of (1.817), and first aid for laboratory injuries scored an arithmetic average of (5.78) and a standard deviation of (5.358).

It is noted that all values indicate that the level of safety measures awareness in school laboratory among the pre-service Science teachers at Najran University is low, as the arithmetic average was lower than the specified criterion score (*i.e.* 32.25) for each domain and the total scale.

This finding matches the findings of Al-Tarawneh (2005), Almodifer (2005), Alshuaile and Almaamari (2006), Al-Abdalatif (2011), Zaveri (2012), Julius and Thomas (2014), Schroder et al. (2015), and Alahmadi (2016).

This finding can be explained by linking it to the results of literature. Despite the differences between these studies regarding community, environment, and spatial and temporal dimension, they all matched the present one that the level of safety measures awareness in the laboratory was weak and did not achieve the educationally acceptable limit. Thus, the present study could conclude that the level of pre-service Science teachers at Najran University did not very different from that of the other groups to which similar studies were applied. Accordingly, the mechanisms and programs of developing safety measures awareness in the laboratory in the different educational institutions shall be developed.

3.2 Answer to the Second Question

Are there statistically significant differences in the degree of awareness of safety measures practiced in school laboratories among the participants due to specialization (chemistry or physics) at the level of ($\alpha \leq 0.05$)?

To answer this question, arithmetic averages and standard deviations were calculated to identify the level of safety measures awareness among the sample study according to specialization (chemistry or physics). To highlight the significance of the differences between the arithmetic averages, T-test was applied, as shown in Table 2:

Table 2. Arithmetic averages, standard deviations, and T-test of the participants' performance according to specialization

Specialization	Number	Arithmetic averages	Standard deviations	T	Freedom degree	Significance level	Difference in averages
Physics	27	22.67	5.02	-3.740	47	0.000	-5.106
Chemistry	22	27.77	4.39				

Table 2 shows that there are statistically significant differences in the degree of awareness of safety measures practiced in school laboratories among the participants due to specialization (chemistry or physics) at the level of ($\alpha \leq 0.05$) where the significance level of (0.00) is less than (0.05) for students of chemistry. There were statistically significant differences on the total scale in favor of chemistry.

This finding is partially in line with the findings of Julius and Thomas (2014), Ali (2013), and Al-Tarawneh (2005) concerning covering various specialization. However, they differ in that their differences were in favor of Physics, while those of the present study favored Chemistry. This result differs from the findings of Alahmadi (2016) that did not identify statistically significant differences due to specialization.

3.3 Answer to the Third Question

Are there statistically significant differences in the degree of awareness of safety measures practiced in school laboratories among the participants due to grade (excellent, very good, good, or pass) at the level of ($\alpha \leq 0.05$)?

To answer this question, arithmetic averages and standard deviations were calculated of the level of safety measures awareness in the school laboratory, according to grade (excellent, very good, good, or pass).

Table 3. Arithmetic averages and standard deviations of the participants' performance according to grade

Grade	Number	Arithmetic averages	Standard deviations
Excellent	9	29.33	4.66
Very good	13	27.54	2.54
Good	18	24.50	4.29
Pass	9	17.78	3.31
Total	49	24.96	5.36

Table 3 shows that there are apparent differences at the significance level of (0.05) for the level of safety measures awareness in the school laboratory according to grade on the total scale. To highlight the significance of the differences between the arithmetic averages, ANOVA analysis was applied, as shown in Table 4.

Table 4. ANOVA of the sample performance according to grade

Source	Sum of squares	Freedom degree	Sum of squares	F	Level
Between groups	726.63	3	242.21	16.73	000
Within groups	651.28	45	14.47		
Total	1377.91	48			

Table 4 shows that there are statistically significant differences between the averages of the participants' performance in the level of safety measures awareness in the school laboratory. In order to identify the direction of the statistically significant differences between the levels of the variable, post-hoc comparisons of the Scheffé's method was applied, as shown in Table 5:

Table 5. Post-hoc comparisons of the Scheffé's method to identify the direction of differences of grade

Grade (I)	Grade (J)	Difference in averages	Significance level
Excellent	Very good	1.795	.757
	Good	*4.833	.031
	Pass	*11.556	.000
Very good	Excellent	-1.795	.757
	Good	3.038	.201
	Pass	*9.761	.000
Good	Excellent	*4.833	.031
	Very good	-3.038	.201
	Pass	*6.722	.001

Table 5 shows statistically significant differences between those students who obtained "excellent" and those who obtained "good "in favor of "excellent" grade. Additionally, there are statistically significant differences between those students who obtained "excellent" and those who obtained "pass", in favor of "excellent" grade. There are statistically significant differences between those students who obtained "very good" and those who obtained "pass", in favor of "very good" grade. There are statistically significant differences between those students who obtained "good" and those who obtained "pass", in favor of "good" grade.

Thus, there are statistically significant differences between the averages of the participants'

performance due to grade variable, in favor of the higher grade. This result can be interpreted that the awareness of laboratory safety measures among pre-service Science teachers is part of the general educational achievement. Generally, those with a better academic achievement, their knowledge and skills in the field are better than those with less academic achievement. This explanation is supported by the fact that university courses are the most important source of information for the study sample regarding safety measures in the laboratory as illustrated by the answer to question 4.

3.4 Answer to the Fourth Question

What are the most important sources of information about safety measures practiced in the laboratory among pre-service Science teachers at Najran University?

To answer this question, frequencies and percentages were calculated to identify the most important sources for providing students with information about safety measures practiced in the school laboratory, as shown in Table 6.

Table 6. Frequency and percentage of sources of information about safety measures practiced in school laboratories among the participants

No.	Source	Frequency	Percentage	Ranking
1	Studying undergraduate courses	28	57%	1
2	A manual of laboratory safety	25	51%	3
3	Faculty members	27	55%	2
4	Classmates	12	24%	7
5	Laboratory technician	20	41%	5
6	Training courses offered by the department	6	12%	9
7	Awareness brochures distributed by the department	7	14%	8
8	Further (self) reading	13	27%	6
9	Radio and TV	6	12%	9
10	Press	1	2%	12
11	Social media	3	6%	11
12	Websites	21	43%	4

Table 6 shows that the most important source that provides students with information about safety measures practiced in school laboratory are studying university courses (57%), faculty members (55%), a manual of laboratory safety (51%), and websites (43%), respectively. Meanwhile, the lowest sources of information were the press, social media, training courses offered by the department, and radio and TV with (2%), (6%), (12%), and (12%), respectively.

Studying university courses is integrated with the role of faculty members and the contribution of the manual of laboratory safety in providing pre-service Science teachers with the required knowledge of laboratory work and how to cope with the relevant risks, having the skills of handling laboratory tools, methods of dealing with laboratory injuries, and first aid for laboratory injuries. The results also highlight the importance of websites as a source of knowledge and education in various aspects of contemporary life, including safety in school laboratories.

This result can be interpreted that the participants are still students. Naturally, their most preferable information sources in the various fields, including laboratory safety, are the university environment with its courses, faculty members, books, and the specialized websites.

This finding is consistent with Ali (2013) regarding the importance of university study and Alahmadi (2016) in relation to the role of university studies, websites and social networks. It differs with Daclan (2013) on the role of social networks in disseminating knowledge related to safety in laboratories as his study revealed a positive impact of (Facebook) in improving safety awareness in the laboratory, while the current study indicates that this network is not one of the main sources to the participants regarding laboratory safety measures.

4. Recommendations

The present study recommends:

1) Conducting a comprehensive review of the program of Science teacher preparation at Najran University to include continuous activities in order to increase students' awareness of the safety measures practiced in school laboratories.

2) Giving the practical aspect of laboratory practices and first aid skills a special attention to be acquired and evaluated through the process of teaching in lectures and while making experiments.

3) Incorporating activities in the practical education study plan to develop pre-service Science teachers' knowledge and skills in safety measures in school laboratories.

4) Overcoming the shortcomings of pre-service Science teachers in relation to work skills and safety in the laboratory through appropriate in-service training and preparation programs.

5) Diversifying the sources of awareness and education for laboratory safety and benefiting from social media and new media channels.

6) Coordinating efforts between the university and the concerned authorities such as the Red Crescent and Civil Defense to disseminate and promote safety measures awareness in school laboratories.

7) Conducting further scientific studies including:

a) The reality of safety measures in the educational laboratories in general education schools and universities.

b) Safety measures awareness in the laboratory among pre-and-in-service Science teachers (a comparative study).

c) Designing and testing a safety skills development program in school laboratories.

References

Abdel Moneim, A., Kashef, M., & Kasab, S. (2008). *Risk assessment and management* (1st ed.). Cairo: Faculty of Engineering, Cairo University.

Al Habeel, W., & Aish, A. (2012). Evaluating the effectiveness of occupational and health safety procedures in scientific laboratories at the Palestinian universities from the staff perspective. *Journal of the Islamic University for Economic and Administrative Studies, 20*(2), 83-143.

Al-Abdalatif, E. (2011). Preventive security awareness in school laboratories. *Security and society: Security awareness in education curricula*. Symposium at King Fahad Security College, Riyadh.

Alahmadi, A. H. (2016). Level of awareness and knowledge sources of safety measures in school laboratories among Science teachers and laboratory technicians in general education schools. *Journal of Information Security, 64*(25), 117-167.

Aldandani, A. (2010). *Safety and first aid manual in school laboratories*. Riyadh: Ministry of Education.

Ali, R. (2013). Concepts of laboratory safety for school teachers in Algeria. *Jordanian Journal of Educational Sciences, 3*(9), 255-261.

Almodifer, F. (2005). *The effectiveness of implementing occupational and technical security and safety systems: A survey study on the laboratory of scientific departments at Girls' Colleges* (Unpublished M.A. thesis, Naif Arab University for Security Sciences, Riyadh).

Alshuaile, A., & Almaamari, A. (2006). The level of understanding of Omani students in the faculties of education for safety precautions in chemistry laboratories in light of some variables. *Educational Sciences Studies (Jordan)*, 1(33), 156-180.

Al-Tarawneh, F. (2005). *The level of safety measures awareness in Chemistry laboratories among the students of scientific colleges at Mutah University* (Unpublished M.A. thesis, Mutah University, Jordan).

American Chemical Society. (2010). In A. A.-A. Akram (Trans.), *Safety in educational Chemistry laboratories* (7th ed.). Washington, DC: American Chemical Society.

American Chemical Society. (2012). *Creating safety culture in academic institution* (1st ed.). Washington, DC: American Chemical Society.

Balkhoyor, M. A. (2011). Evaluation of the status of safety in some university laboratories. *King Abdul Aziz University Journal*, *Faculty of Meteorology, Environment, and Arid Land Agriculture, 22*(1), 217-228.

Collins, J., & O'Brien, N. (2008). In K. Hanan (Trans.), The *Greenwood- Dar El Ilm dictionary of education* (1st ed.). Beirut: Dar El Ilm.

Hackling, M. (2009). *The status of school science laboratory technicians in Australian secondary schools*. Perth, Australia: The Department of Education, Employment and Workplace Relations.

Jo, L., Kenneth, M., Patricia, I., & Linda, W. (2002). *Safety in Science teaching*. Virginia: Virginia Department of Education.

Julius, A., & Thomas, O. (2014). Analysis of hazard and safety in science laboratories in Ekiti State, Nigeria. *British Journal of Education, Society & Behavioral Science, 3*(4), 403-414.

Mansoura University. (2009). *First aid manual*. Mansoura, Egypt: General Administration for Community Development and Environmental Services, Mansoura University.

Mogopodi, M., Paphane, B., & Petro, S. (2015). Assessment of chemical management practices and safety in junior secondary school laboratories in Gaborone. *Journal of Chemical Health and Safety, 22*(5), 17-27. https://doi.org/10.1016/j. jchas.2015.01.001

Nasim, S., Shahid, A. Ayaz, M., Kazim, S., Ruba, T., Mohi, S., … Usman, S. (2010). Practice and awareness regarding biosafety measures among laboratory teaching working in clinical laboratories in Karachi, Pakistan. *Applied Biosafety, 4*(15), 172-179.

Schroder, I., Huang, D., Ellis, O., Gibson, J., & Wayne, N. (2015). Laboratory safety attitudes and practice: A comparison of academic, government, and industry research. *Journal of Chemical Health and Safety, 23*(1), 12-23. https://doi.org/10.1016/j Jchas.2015.03.001

Science Education Section and Manpower Bureau. (2013). *Survey of laboratory accidents in secondary schools*. Hong Kong: Science Education Section and Manpower Bureau.

Thuqan, E., Rahman, A. A., & Kayed, A. H. (2003). *Scientific research: Concept, tools and methods*. Riyadh: Dar Osama for Publishing & Distribution.

Trowbridge, L., Bape, R., & Powell, J. (2004). In A. H. Muhammad, et al. (Trans.), *Teaching secondary school science: strategies for developing scientific literacy* (1st ed.). Al Ain: University Book Centre.

Zaveri, J. (2012). Knowledge, attitudes, and practice of laboratory technicians regarding universal work precautions. *National Journal of Medical Research, 1*(2), 113-115.