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Investigation of pre-service science teachers' attitudes towards laboratory safety

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Abstract

The purpose of the current study is to investigate the pre-service science teachers' attitudes towards laboratory safety in relation to variables such as gender, the state of participating in laboratory applications during their high school education, grade level and the type of graduated high school. The sampling of the study conducted by using survey method consists of 135 first-year and fourth-year students attending Science Teaching Department of Education Faculty at Mugla Sitki Kocman University in 2012-2013 academic year. Based on the scales presented in the literature, the researchers developed the Scale of Attitudes towards Laboratory Safety. At the end of the study it was concluded that the variables of gender, state of participating in laboratory applications in high school, grade level and graduated high school do not have significant effects on pre-service science teachers' attitudes towards laboratory safety.

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Keywords: Science, pre-service teacher, laboratory safety, attitude scala, laboratory

1. Introduction

The most important step to be taken for the formation of information society is to educate new generations so that they can adapt to changes and developments. This can only be achieved by generating student-centered learning environments where the main focus is on learning by doing. One of the environments where learning by doing occurs is Science and Technology laboratories. One of the objectives of science laboratories is to make permanent and effective learning possible, create environments where theoretical information can be turned into practice and teach the importance of systematic, regular and planned working so that students can plan new works (Kirbaşlar et al., 2006). As in any field of natural sciences, the most effective method used to instill scientific attitudes and skills in students, to turn theoretical information into practice, to help students to develop their hand-eye coordination and to improve their creativity and reasoning skills is laboratory method. This method is also of great importance to make permanent learning possible and to provide students with opportunities to work individually and in groups (Sarı, 2011).

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There is a lot of research showing that laboratory applications have significant effects on students' academic achievement and their developing positive attitudes towards science (Renner, Abraham, Birnie, 1985). Yet, for laboratory applications to result in positive outcomes there are some requirements to be met. In order to be able to achieve the objectives set for laboratory applications within the course of science, both students and teachers working in the laboratory should be knowledgeable about laboratory safety and they should be able to put their knowledge into practice.

Laboratory safety is defined as determining the potential threats posed by the use of tools and equipments, machines and devices while conducting experiments and doing preparatory works, taking necessary precautions, adopting scientific approaches to the problems to improve the existing conditions (Bayrak and Ağaoğlu, 1999). The main objective of laboratory safety is to protect the individual himself/herself, his/her colleagues, environment, working materials from accidents and their potential harms. In terms of elementary school science teaching program, the issues of safety and health are as important as the other science subjects. Laboratory safety measures are taken to protect teachers and students from risks such as accidents, diseases etc. The main idea lying on the ground of these measures is elimination or minimization of risks before they pose a threat.

Teacher can assume important roles in the provision of laboratory safety. They should know how to work with chemical matters carefully and safely, they should be able to protect themselves and their students, they should be sensitive to environmental issues, they should be knowledgeable about the laws regulating the use of chemical matters. A science teacher should be informed about the dangers involved in their profession (Bayrak and Ağaoğlu, 1999; Cited. Taşkın, 2008).

The research has revealed that there is a positive correlation between the science and technology teacher's subject are knowledge, experience and perception of laboratory and laboratory safety (Çepni et al., 1994). Erol, Demir and Böyük (2010) reported that science and technology teachers think that they are inadequate at a level that cannot be neglected or partially adequate in these items "having all the information and skills needed to create a secure working environment in laboratory" and "knowing and using all devices and equipments in science and technology laboratory". Yılmaz and Morgil (1999) conducted a study to investigate the present state of the laboratories used by pre-service chemistry teachers in their laboratory applications and students' opinions about secure working". For this purpose, the pre-service chemistry teachers were asked questions to elicit their opinions about the present state of the laboratories they are using and students' opinions about secure working were elicited. And they reported that the students do not have enough information about conducting secure experiments. Hamurcu (1998) conducted a study entitled "Safety in Science Classes" and pointed out that laboratory works are applications that should be carefully planned in relation to dangers they may include. Teachers should be equipped with the necessary laboratory safety information and skills during their pre-service training.

Though the issue of laboratory applications is attached great importance, there is a paucity of research on laboratory safety particularly in our country. Hence, this study is believed to be a contribution to the literature. In this respect, the purpose of the present study is to determine the pre-service science teachers' attitudes towards laboratory safety in relation to variables such as gender, the state of participating in laboratory works during high school education, grade level and type of graduated high school.

For this purpose, answers to the following sub-problems were sought:

1. What is the level of the pre-service science teachers' attitudes towards laboratory safety?

2. Are there significant differences among the pre-service science teachers' attitudes towards laboratory safety based on their gender, state of participating in laboratory works in high school, grade level and type of graduated high school?

2. Method

The current study designed as a survey study was conducted on 135 first-year and fourth-year students from the department of Science Teacher Training of the Education Faculty at Muğla Sitki Kocman University in the spring term of 2012-2013 academic year.

2.1.Data collection instruments

In the study, two different types of data collection instruments were employed. The first one is the information form developed by the researchers to elicit the demographics of the participants and the other one is "The Scale of Attitudes towards Laboratory Safety" developed by the researchers based on the scales of laboratory safety presented in the literature. This scale is designed in the form of 5-point Likert and there are totally 12 items, 3 of which are negative and 9 are positive. The items are scored as 5 "Strongly Agree", 4 "Agree", 3 "Undecided", 2 "Disagree" and 1 "Strongly Disagree" for the positive items and reverse order is followed for the negative items. The Cronbach-alpha reliability of the scale was calculated to be .66. This value shows that the scale is a reliable scale according to alpha coefficient evaluation criteria (Kalaycı, 2005: 405).

2.2. Data analysis

In the analysis of the data, SPSS 14 program package was used. Percentages of the students' opinions elicited with the Scale of Attitudes towards Laboratory Safety were analyzed through descriptive statistics. Whether there are significant differences among the students' attitudes towards laboratory safety based on gender, grade level and state of participating in laboratory applications during high school education was tested with t-test, and whether there is a significant difference among the attitudes based on the type of graduated high school was tested with One-Way Anova.

3. Findings and discussion

3.1. The pre-service science teachers' opinions about the scale of attitudes towards laboratory safety

Frequencies and percentages of the students' opinions about the scale of attitudes towards laboratory safety are presented in Table 1. In Table 1, the options of "Strongly Agree" and "Agree" are classified as positive and the options of "Strongly Disagree" and "Disagree" are classified as negative and the option of "Undecided" is classified as neutral.

In Table 1, it is seen that in general students have positive attitudes towards laboratory safety. The item for which the students have the most positive attitude (85.9%) is the 6th item "When I enter the science and technology laboratory, I wonder what types of experiments are made with which tools and equipments." This shows that pre-service science teachers are interested in laboratory applications. Curiosity and desire are among the basic factors facilitating learning. Moreover, they increase motivation and motivation can make learning more effective. If the interest and desire in these applications are increased, then the students can be more eager to conduct laboratory works so that they can find opportunities to apply theoretical information into practice and to develop their problem solving skills. Yeşilyurt, Kurt and Temur (2005) conducted a study to develop and administer attitude scale for elementary school science laboratory. For this purpose, they investigated the attitudes of elementary school eighth graders towards laboratory experiments conducted in science classes. In light of the findings, they concluded that elementary school students have positive attitudes towards laboratory applications. This finding concurs with the findings of the present study.

The item for which the negative attitude is the highest (44.4%) is the 2nd item "Ventilation system is adequate" and it is followed by the 8th item "There are enough equipments to conduct experiment". So, it can be argued that the pre-service teachers think that ventilation and equipments in the laboratory are not enough. The item for which the pre-service science teachers are "undecided" is the 9th item (60.7%) "Electric system in the laboratory is checked at the beginning of each school year by electricians". This may be because the pre-service science teachers are not informed enough about the tools and equipments in the laboratory or they are not sure of the taken safety precautions. İlhan et al. (2009) investigated the pre-service chemistry teachers' opinions about laboratory applications and found that most of the students are undecided about this item "Precautions taken against the potential accidents in the laboratory are sufficient". This finding is similar to our finding.

Table 1. Distribution of the pre-service science teachers' attitudes towards laboratory safety

Items	Positive		Undecided		Negative	
	n	%	n	%	n	%
1. Laboratory environment frightens me.	110	81.5	2	1.5	23	17
2. Ventilation system in the laboratory is adequate.	34	25.2	41	30.4	60	**44.4**
3. I am afraid of giving harm to laboratory equipments.	56	41.5	9	6.7	70	51.9
4. There are first-aid materials in the laboratory.	80	59.3	30	22.2	25	18.5
5. There is a fire extinguisher in the laboratory.	100	74.1	22	16.3	13	9.6
6. When I enter science and technology laboratory, I wonder what types of experiments are made with which tools and equipments.	116	**85.9**	4	3	15	11.1
7. Conducting science and technology experiments is a very complex process.	84	62.2	22	16.3	29	21.5
8. There are enough materials to conduct experiments.	49	36.3	26	19.3	60	**44.4**
9. Electric system in the laboratory is checked by electricians at the beginning of each school year.	20	14.8	82	**60.7**	33	24.4
10. The cupboards where dangerous materials are stocked are locked.	74	54.8	29	21.5	32	23.7
11. The cupboards where chemical materials are stored are fixed securely.	76	56.3	30	22.2	29	21.5
12. The cupboards where experiment equipments are stored are fixed securely.	84	62.2	27	20	24	17.8

3.2. The effects of the variables of gender, the state of participating in laboratory applications during high school education, grade level and the type of graduated high school on the pre-service science teachers' attitudes towards laboratory

Independent samples t-test was used to test whether there is a significant difference among the students' attitudes towards laboratory safety based on gender variable and the findings are presented in Table 2.

Table 2. T-test results concerning the effects of gender on the pre-service science teachers' attitudes towards laboratory safety

Gender	N	$\bar{X}$	S	sd	t	p
Female	89	40.35	6.23	133	1.44	.151
Male	46	41.95	5.28			

As can be seen in Table 2, out of the pre-service science teachers, 89 are females and 46 are males. The students' attitude scores for laboratory safety do not significantly change depending on gender [$t_{(133)}$= 1.44, p> .05]. This can be interpreted as gender does not have a significant effect on pre-service science teachers' attitudes towards laboratory safety. Though there is no statistically significant difference between the mean attitude scores of male and female students, it is seen that the male pre-service teachers have more positive attitude towards laboratory safety ($\bar{X}$= 41.95) than the female students ($\bar{X}$= 40.35). In the study conducted by Çakmak (2008) to evaluate the correlation between pre-service science teachers' laboratory attitudes and their attitudes towards science it was found that there is no significant difference based on gender. This finding is parallel to our finding.

Independent samples t-test was run to test whether there is a significant difference among the students' attitudes towards laboratory safety based on their state of participating in laboratory applications during their high school education and the findings are presented in Table 3.

Table 3. T-test results concerning the effects of the state of participating in laboratory applications during high school education on the pre-service science teachers' attitudes towards laboratory safety

State of participating in laboratory applications	N	$\bar{X}$	S	sd	t	p
Yes	82	41.69	5.26	133	1.88	.061
No	53	39.67	7.11			

As can be seen in Table 3, 82 of the pre-service science teachers participated in laboratory works during their high school education and 53 of them did not participate. The pre-service science teachers' mean scores for the attitudes towards laboratory safety do not significantly change depending on whether they participated or not in laboratory applications during their high school education [$t_{(133)}$= 1.88, p> .05]. So, it can be argued that participating in laboratory applications during their high school education does not have a significant effect on pre-service science teachers' attitudes towards laboratory safety. Yet, it is seen that, though not significant, the pre-service teachers participating in laboratory works during their high school education have more positive attitudes ($\bar{X}$= 41.69) towards laboratory safety than the pre-service teachers not participating ($\bar{X}$= 39.67) .

T-test was run to see whether there is a significant difference among the students' attitudes towards laboratory safety based on their grade level and the findings are presented in Table 4.

Table 4. T-test results concerning the effects of grade level on students' attitudes towards laboratory safety

Grade level	N	$\bar{X}$	S	sd	t	p
1st year	64	41.31	5.58	133	.736	.463
4th year	71	40.53	6.57			

As can be seen in Table 4, out of the participants, 64 are first-year students and 71 are fourth-year students. The grade level does not have a significant effect on the students' attitudes towards laboratory safety [$t_{(133)}$= .736, p>.05]. There is no significant difference between the mean attitude scores of first-year students and that of the

fourth-year students. This indicates that the attitudes of the pre-service teachers do not vary throughout their undergraduate training. The findings of Çakmak (2008) support this finding of the present study.

T-test was run to see whether there is a significant difference among the students' attitudes towards laboratory safety based on the type of graduated high school and the findings are presented in Table 5 and Table 6.

Table 5. Arithmetic means and standard deviations of the pre-service science teachers' scores of attitudes towards laboratory safety in relation to the type of graduated school

Type of Graduated School	N	$\bar{X}$	S
Anatolian High School	57	3.38	.507
Vocational High School	2	3.37	.530
High School	70	3.44	.528
Others	6	3.27	.304
Total	135	3.40	.509

As can be seen in Table 5, out of the participants, 57 are the graduates of Anatolian High School; 2 are graduates of Vocational School, 70 are graduates of high school and 6 are graduates of others (Super High School etc.). The results of variance analysis conducted to test whether the difference between the arithmetic means is statistically significant or not are presented in Table 6.

Table 6. ANOVA results concerning the pre-service science teachers' attitudes towards laboratory safety in relation to the type of graduated high school

Source of the Variance	Sum of Squares	sd	Mean of Squares	F	P
Between-groups	.239	3	.080	.302	.824
Within-groups	34.537	131	.264		
Total	34.776	134			

The results presented in Table 6 show that there is no significant difference among the attitudes of the participants based on the type of graduated school [$F_{(3-131)}$= .302, p> .05]. Thus, it can be argued that the type of graduated high school does not have significant effects on students' attitudes towards laboratory safety.

4. Results and suggestions

The findings of the study can be summarized as follows:

- In general, the pre-service science teachers' attitudes towards laboratory safety are positive.
- The pre-service science teachers' attitudes towards laboratory safety are not significantly affected by variables such as gender, the state of participating in laboratory applications during high school education, grade level and the type of graduated high school.

Pre-service teachers can make use of the experience and skills they gain in the laboratory in their daily lives. The positive attitudes they have developed towards laboratory safety are believed to contribute to more effective use of laboratory during their professional career.

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