International Journal of Progressive Education, Volume 17 Number 5, 2021

Investigation of Pre-service Science Teachers' Attitudes towards Laboratory Skills and Chemistry Laboratory Anxieties According to Selected Variables

Ayşe Sert Çıbık [i]
Gazi University

Elvan İnce Aka [ii]
Gazi University

Abstract

The aim of this study was to determine the attitudes towards laboratory skills and chemistry laboratory anxieties of pre-service science teachers who were currently registered to general chemistry laboratory course and who had taken this course previously. To evaluate candidates' attitudes and anxieties in line with this purpose, they were examined in terms of gender, year of study, and the type of high school. The sample of the study consisted of 202 candidates studying in the 1st, 3rd, and 4th years of the Science Education Department of a state university in Ankara. A survey research model was used, and the Attitude Scale towards Laboratory Skills and the Chemistry Laboratory Anxiety Scale were applied. It was determined that candidates' attitudes were generally scored as "agree" and their anxieties were generally scored as "disagree" in terms of average scores. It was also determined that there was a statistically significant difference in the attitudes and anxieties in terms of gender in favor of males. It was determined that there was no statistically significant difference between attitudes and anxieties in terms of year of study and type of high school. A moderate, negatively significant correlation was found between the average attitude and anxiety scores.

Keywords: Attitude Towards Laboratory Skills, Chemistry Laboratory Anxiety, Gender, Year of Study, Type of High School Graduated From

DOI: 10.29329/ijpe.2021.375.5

---

[i] **Ayşe Sert Çıbık,** Assoc. Prof. Dr., Science Education, Gazi University, ORCID: 0000-0001-9648-3593

[ii] **Elvan İnce Aka,** Research Assist Dr., Science Education, Gazi University, ORCID: 0000-0003-2013-1035

Correspondence: elvanince@gazi.edu.tr

INTRODUCTION

In the science curriculum in Turkey, it is aimed to shape individuals who research and question, can solve problems, are self-confident, are able to communicate effectively, and learn lifelong. One of the important features of science is that it requires learning by doing and experiencing. In this respect, laboratories that provide a bridge between daily life and scientific knowledge have an important place (MEB, 2018). Science educators have suggested that learning using laboratory activities has many benefits and they have emphasized that laboratories have a central and distinctive role in science education (Hofstein & Lunetta, 1982). Laboratories are environments that enable students to work individually or in groups, where students are taught by creating or being shown science phenomena, concretizing the questions formed in the mind as a result of observation or abstract perceptions, and developing cognitive, affective, and psychomotor skills (Ceylan, Güzel Yüce & Koç, 2019; Yılmaz & Morgil, 1999). Science courses taught through experiments enable students to become better equipped in terms of knowledge and skills (Lunetta, 1998; Tamir, 1991).

In addition, one of the goals of science education is to ensure that students acquire affective domain behaviors (Ekici & Hevedanlı, 2010). Affective factors such as motivation, attitude, and anxiety are very important in making people aware (Alkan & Koyuncu, 2017). Attitude is a positive or negative emotion about a person, object, or subject (Koballa & Glynn, 2007, p. 78). Students' interest in the subject in the laboratory environment and doing experiments fondly and willingly improve their attitudes towards the laboratory and their interest in the lesson. Students' attitudes towards the laboratory may vary depending on many factors such as previous knowledge and experience, learning method, teacher, laboratory environment, communication and teamwork, and the materials and safety information provided in the laboratory. Another affective variable addressed in the present work is anxiety. Anxiety is a variable that negatively affects learning, and it is a situation in which the individual cannot form a clear behavioral pattern to change a threatening situation (Power & Dalgleish, 1997). According to Bowen (1999), there are five categories that help explain laboratory anxiety: i) working with chemicals, ii) using and experimenting with laboratory equipment, iii) collecting data, iv) collaborating with other students, and v) time management in the laboratory. Laboratory anxiety causes students to feel stressed and uncomfortable while working in the laboratory (Eddy, 2000). It is important for students to learn about glass materials, tools, and chemicals used during laboratory studies and to have knowledge about safety information in terms of gaining laboratory skills.

In a study conducted by Ceylan et al. (2019), it was determined that the majority of pre-service teachers focused on learning goals in practice and did not include the purpose of the affective domain. If an individual lacks knowledge and skills, the related feelings and values may negatively affect the permanence and effectiveness of learning (Senemoğlu, 1989). When a student who is not interested in science classes enters the laboratory environment, he or she may develop anxiety with the effect of different stimuli (Azizoğlu & Uzuntiryaki, 2006).

A lack of emphasis in the literature on laboratory practices in universities where teachers have studied (Ayvacı & Küçük, 2005; Balbağ & Anılan, 2014) is the reason why laboratory applications are not applied sufficiently in primary and secondary education institutions. Reasons such as not taking related courses are stated. However, prospective science teachers need to learn by doing and living, both during their university education and throughout their teaching careers. Therefore, the laboratory courses that teacher candidates take during their university education create opportunities for learning by doing and living in real environments as predicted by constructivism theory and they play an important role in future success. In addition, affective dimensions such as attitude and anxiety affect students' success and performance in the laboratory (Bowen, 1999). Considering that attitudes affect the process and success of the lesson, it should be ensured that individuals develop a positive attitude towards the laboratory and laboratory skills first (Alkan & Erdem, 2012).

In this context, knowing the extent and source of students' concerns about the laboratory will be effective in determining the ways to relieve that anxiety and direct the students back to the

laboratory. For this reason, it is thought that reducing stress in laboratory conditions and developing a positive attitude towards laboratory skills will make a significant contribution to the science education literature in order to train individuals and qualified science teachers as targeted by the Turkish Ministry of National Education.

Aim

The aim of this study is to determine the attitudes of teacher candidates studying in the Science Education Department towards laboratory skills and their chemistry laboratory anxieties. To evaluate candidates' attitudes and anxieties in line with this main purpose, they were examined in terms of gender, year of study, and the type of high school that they graduated from. Accordingly, answers to the following questions were sought:

1. How are pre-service teachers' attitudes towards laboratory skills and levels of chemistry laboratory anxiety distributed?

2. Do pre-service teachers' attitudes towards laboratory skills differ significantly in terms of gender, year of study, or the type of high school that they graduated from?

3. Do pre-service teachers' levels of chemistry laboratory anxiety differ significantly in terms of gender, year of study, or the type of high school that they graduated from?

4. Is there a significant relationship between pre-service teachers' attitudes towards laboratory skills and their level of anxiety in the chemistry laboratory?

METHOD

Sample Group

The study was carried out with 202 teacher candidates studying in the Science Education Department of a state university in Ankara in the spring semester of the 2017-2018 academic year and the fall semester of the 2018-2019 academic year. These individuals were pre-service science teachers who were currently registered to general chemistry laboratory course in the 1st year of their studies and who had taken this course previously (currently 3rd and 4th year candidates). An easily accessible sampling method was preferred in the selection of samples. Information on the descriptive features of the participants is given below.

Table 1. Distribution of Pre-Service Science Teachers by Gender

Gender	f	%
Female	179	88.6
Male	23	11.4

As seen in Table 1, 88.6% of the participants were female and 11.4% were male.

Table 2. Distribution of Pre-Service Science Teachers by Year of Study

Year of study	f	%
1st	71	35.1
3rd	78	38.6
4th	53	26.2

As seen in Table 2, 35.1% of the participants were in the 1st year of the academic program, 38.6% were in the 3rd year, and 26.2% were in the 4th year.

Table 3. Distribution of Pre-Service Science Teachers by the Type of High School that They Graduated From

High school type	f	%
Anatolian high school	130	64.4
Science high school	16	7.9
General high school	11	5.4
Other	45	22.3

As seen in Table 3, 64.4% of the participants graduated from an Anatolian high school, 7.9% from a science high school, 5.4% from a general high school, and 22.3% from other types of high schools.

Research Pattern

In this study, a survey research model, as a descriptive research type, was used. In such cases, researchers deal with a large group of people to address a particular issue or problem. They ask a series of related questions to find the answers (Fraenkel, Wallen & Hyun, 2012, p. 393). In this study, the survey model was used to examine prospective teachers' attitudes towards laboratory skills and chemistry laboratory anxieties according to the variables of gender, year of study, and the type of high school that participants had graduated from.

Data Collection Tools

Quantitative data collection tools were used in the study.

Attitude Scale towards Laboratory Skills (ASLS)

The Attitude Scale towards Laboratory Skills, developed by Alkan and Erdem (2012), was prepared in a five-point Likert-type format (I strongly agree, agree, indecisive, disagree, and strongly disagree) and it consists of 25 items. Points given for positively scored items are Strongly disagree = 1, Disagree = 2, Indecisive = 3, Agree = 4, and Strongly agree = 5, while points are given to negatively scored items in the reverse order. Accordingly, the maximum score that can be obtained from the overall scale is 125 and the minimum score is 25. As a result of the validity studies of the scale, a structure with four factors was determined. Factor 1 is recognizing materials and chemicals (14 items), factor 2 is considering feedback (four items), factor 3 is communication in the laboratory (three items), and factor 4 is feeling ready (four items). The four-factor structure of the scale explains 54.34% of the total variance. As a result of reliability analysis, while the Cronbach alpha reliability coefficient of the scale was .91, the Cronbach alpha reliability coefficients of the four factors were .916, .774, .809, and 0.643, respectively.

Looking at the reliability values of the scale for this study, the Cronbach alpha reliability coefficient for the overall scale was .88, for equipment and chemicals recognition it was .89, for feedback consideration it was .74, for communication in the laboratory it was .75, and for the factor of feeling ready it was .66.

Chemistry Laboratory Anxiety Scale (CLAS)

The Chemistry Laboratory Anxiety Scale, developed by Bowen (1999) and adapted to Turkish by Azizoğlu and Uzuntiryaki (2006), was prepared in a five-point Likert-type format (I strongly agree, agree, am indecisive, disagree, and strongly disagree) and it consists of 20 items. The scores given to the positively scored items (supporting anxiety) are Strongly disagree = 1, Disagree = 2, Indecisive = 3, Agree = 4, and Strongly agree = 5, while negatively scored items (not supporting anxiety) are scored in reverse order. Accordingly, the maximum score that can be obtained from the overall scale is 100 and the minimum score is 20. As a result of the validity studies of the scale, a structure with four factors was determined. Factor 1 is using laboratory tools and chemicals (six items), factor 2 is

working with other students (four items), factor 3 is collecting data (six items), and factor 4 is using laboratory time (four items). The four-factor structure of the scale explains 66.714% of the total variance. As a result of the reliability analysis, the Cronbach alpha reliability coefficients of the four factors of the scale were .88, .87, .86, and .87 respectively.

Looking at the reliability values of the scale for this study, the Cronbach alpha reliability coefficient for the overall scale was .92. For the use of laboratory equipment and chemicals, it was .84, while it was .83 for the factor of working with other students, .80 for the data collection factor, and .80 for the factor of using laboratory time.

Data Analysis

The collected data were analyzed with a quantitative approach according to the four sub-problems prepared in line with the main purpose of the study.

Before the quantitative analysis of the data, it was checked whether the data obtained from the ASLS and CLAS were normally distributed. In a normal distribution curve, the principal arithmetic mean, mode, and median values overlap and correspond to the midpoint of the horizontal line of the bell curve. The skewness and kurtosis values are 0 (Taşpınar, 2017, p. 32). Equality of central tendency measurements indicates normal distribution. If the mean is greater than the median, it indicates right skewness, and if it is smaller, it indicates left skewness. The fact that the mean, mode, and median values are close to each other is considered an indicator that the distribution does not deviate too far from normality (Büyüköztürk, Çokluk, & Köklü, 2017, p. 59). In other words, the closer these values are to each other, the more the distribution exhibits characteristics of normal distribution (Can, 2014, p. 82). However, if the skewness and kurtosis values are within certain rates (Taşpınar, 2017, p. 33), it is decided that the distribution is normal. The fact that the Z value calculated by dividing the skewness and kurtosis values by their standard errors was within the ±1.96 limits indicated that the distribution was normal at a 0.05 confidence level (Can, 2014, p. 85; Taşpınar, 2017, p. 33). The analysis of the sub-problems, based on the control of normal distribution of the data as a descriptive method, was performed according to Z scores with arithmetic mean, mode, and median values. SPSS 22.0 was used in evaluating the distribution of the candidates' scores for the overall scales and in the analysis of the distribution of these scores by gender, year of study, and type of high school that participants graduated from. For the data of all sub-problems of the study, except for the comparison of attitudes towards laboratory skills and the gender variable, it was determined that the Z scores of central tendency measurements were equal or close to each other and within the limits of ±1.96. Values related to Z scores are presented in Table 4.

Table 4. Z Score Values of Attitude towards Laboratory Skills and Chemistry Laboratory Anxiety Score Averages According to Variables

Variables		ASLS					
		Skewness	Standard Error of Skewness	Skewness Z value	Kurtosis	Standard Error of Kurtosis	Kurtosis Z value
Gender	Female	-.004	.182	-.022	-.016	.361	-.044
	Male	1.190	.481	2.474*	.256	.935	.273
Year of study	1	.278	.285	.975	.471	.563	.836
	3	-.002	.272	-.003	.652	.538	1.211
	4	-.191	.327	-.584	-.484	.644	-.751
High school	Anatolian	.026	.212	.122	.339	.422	.803
	Science	.096	.564	.170	.350	1.091	.320
	General	.351	.661	.531	-.827	1.279	-.646
	Other	-.059	.354	-.166	.221	.695	.317
ASLS (overall scale)		.050	.171	.292	.147	.341	.431

		CLAS					
Gender	Female	.040	.182	.219	-.033	.361	-.091
	Male	-.137	.481	-.284	-.318	.935	-.340
Year of study	1	.112	.285	.392	-.490	.563	-.870
	3	.153	.272	.562	.487	.538	.905
	4	-.270	.327	-.825	.087	.644	1.350
High school	Anatolian	-.060	.212	-.283	-.003	.422	-.007
	Science	-.114	.564	-.202	-.416	1.091	-.381
	General	.552	.661	.835	-.273	1.279	-.213
	Other	.069	.354	.194	.224	.695	.322
CLAS (overall scale)		.020	.171	.116	-.053	.341	-.155

*Skewness Z=2.474 value does not show normal distribution.

The data with normal distribution were analyzed with the independent groups t-test, single factor analysis of variance (ANOVA), and the Pearson correlation test, while non-normally distributed data were analyzed using the Mann-Whitney U test, one of the nonparametric tests. In addition, analyses of frequency (f) and percentage (%) were performed for descriptive statistics. The results were evaluated and interpreted at the 0.05 significance level.

For the analysis of data obtained from the ASLS and CLAS, in the calculation of the interval width of the scales, the formula of "sequence width/number of groups to be made" (Tekin, 1993) was taken into consideration, and the main arithmetic mean weights in the evaluation of the findings are given below.

For ASLS	For CLAS
1.00–1.80=Strongly disagree	1.00–1.80=Strongly disagree
1.81–2.60=Disagree	1.81–2.60=Disagree
2.61–3.40=Indecisive	2.61–3.40=Indecisive
3.41–4.20=Agree	3.41–4.20=Agree
4.21–5.00=Strongly agree	4.21–5.00=Strongly agree

Effect size is a useful statistical value in determining the size of the difference between two average scores (Taşpınar, 2017, p. 65). In this context, the effect size was calculated according to Cohen's d for the variables with a statistically significant difference between them.

RESULTS

The findings obtained as a result of determining the attitudes of teacher candidates towards laboratory skills and chemistry laboratory anxieties and examining the distribution of these variables according to the variables of gender, year of study, and the type of high school that participants graduated from are as follows.

1. How are pre-service teachers' attitudes towards laboratory skills and levels of chemistry laboratory anxiety distributed?

Distributions of the descriptive statistics of pre-service teachers' attitudes towards laboratory skills and chemistry laboratory anxiety scores are shown in Table 5.

Table 5. Distribution of Descriptive Statistics of Pre-Service Teachers' Attitudes towards Laboratory Skills and Chemistry Laboratory Anxiety Scores

	Dependent variables	Descriptive values										
		N	X	Median	Mode	SD	Variance	Skewness	Kurtosis	Range	Min	Max
ASLS	1st factor	202	3.92	3.85	3.79	.447	.200	.142	.781	2.71	2.29	5.00
	2nd factor	202	4.20	4.00	4.00	.490	.240	-.446	.971	2.50	2.50	5.00
	3rd factor	202	3.86	4.00	4.00	.764	.585	-1.190	2.051	4.00	1.00	5.00
	4th factor	202	3.16	3.25	3.50	.771	.596	-.319	.105	3.75	1.00	4.75
	ASLS (overall scale)	202	3.79	3.80	3.88	.399	.159	.050	.147	1.94	2.90	4.84
CLAS	1st factor	202	2.36	2.33	2.00	.737	.543	.159	-.165	3.33	1.00	4.33
	2nd factor	202	2.05	2.00	2.00	.727	.529	.644	.114	3.00	1.00	4.00
	3rd factor	202	2.20	2.16	2.00	.601	.361	.253	-.017	2.83	1.00	3.83
	4th factor	202	2.27	2.03	2.00	.750	.563	.385	-.034	3.75	1.00	4.75
	CLAS (overall scale)	202	2.22	2.16	2.00	.546	.299	.020	-.053	2.46	1.00	3.46

When Table 5 is examined, the highest score obtained by the candidates from the overall ASLS is 4.84 and the lowest is 2.90. In addition, the mean score is 3.79, the median value is 3.80, and the standard deviation is .399. The skewness coefficient calculated for the distribution is .050 and the kurtosis coefficient is .147. On the other hand, when the distribution of scores for the four factors is examined, the lowest score for the 1st factor is 2.29 and the highest score is 5.00. The average score is 3.92, the median value is 3.85, and the standard deviation is .447. The skewness coefficient calculated for the distribution is .142 and the kurtosis coefficient is .781. For the 2nd factor, the lowest score is 2.50 and the highest score is 5.00. The average score is 4.20, the median value is 4.00, and the standard deviation is .490. The skewness coefficient calculated for the distribution is -.446 and the kurtosis coefficient is .971. For the 3rd factor, the lowest score is 1.00 and the highest score is 5.00. The average score is 3.86, the median value is 4.00, and the standard deviation is .764. The skewness coefficient calculated for the distribution is -1.190 and the kurtosis coefficient is 2.051. Finally, for the 4th factor, the lowest score is 1.00 and the highest score is 4.75. The average score is 3.16, the median value is 3.25, and the standard deviation is .771. The skewness coefficient calculated for the distribution is -.319 and the kurtosis coefficient is .105. It was determined that the pre-service teachers' attitudes towards laboratory skills in terms of the average scores of the 1st and 3rd factors and the overall scale were in the range of "agree." On the other hand, it was determined that the mean scores of the 4th factor were in the "indecisive" range, and the mean scores of the 2nd factor (X = 4.20), although they were in the "agree" range, showed a tendency towards the "strongly agree" range.

When Table 5 is further examined, the highest score obtained by the candidates from the overall CLAS is 3.46 and the lowest is 1.00. In addition, the mean score is 2.22, the median value is 2.16, and the standard deviation is .546. The skewness coefficient calculated for the distribution is .020 and the kurtosis coefficient is -.053. On the other hand, when the distribution of scores for the four factors is examined, the lowest score for the 1st factor is 1.00 and the highest score is 4.33. The average score is 2.36, the median value is 2.33, and the standard deviation is .737. The skewness coefficient calculated for the distribution is .159 and the kurtosis coefficient is -.165. For the 2nd factor, the lowest score is 1.00 and the highest score is 4.00. The average score is 2.05, the median value is 2.00, and the standard deviation is .727. The skewness coefficient calculated for the distribution is .644 and the kurtosis coefficient is .114. For the 3rd factor, the lowest score is 1.00 and the highest score is 3.83. The average score is 2.20, the median value is 2.16, and the standard deviation is .601. The skewness coefficient calculated for the distribution is .253 and the kurtosis coefficient is -.017. Finally, for the 4th factor, the lowest score is 1.00 and the highest score is 4.75. The average score is 2.27, the median value is 2.03, and the standard deviation is .750. The skewness coefficient calculated for the distribution is .385 and the kurtosis coefficient is -.053.

It was determined that the chemistry laboratory anxieties of the pre-service teachers in terms of average scores for all factors and the overall scale were in the "disagree" range.

2. Do pre-service teachers' attitudes towards laboratory skills differ significantly in terms of gender, year of study, or the type of high school that they graduated from?

For pre-service teachers' attitudes towards laboratory skills, the Mann-Whitney U test was used to compare significance in terms of gender, while one-way ANOVA was used for comparisons according to year of study and the type of high school that participants graduated from. The results are given in Table 6 and Table 7.

Table 6. Mann-Whitney U Test Results for the Gender Variable in Pre-Service Teachers' Attitudes towards Laboratory Skills

Variable	ASLS score distributions (overall scale)					
		N	Rank average	Rank sum	U	p
Gender	Female	179	97.91	17525.50	1415.500	.015*
	Male	23	129.46	2977.50		

*p<.05

When Table 6 is examined, it is determined that the candidates' attitudes towards laboratory skills differed significantly in terms of gender (U=1415.500, p<.05). Considering the average rank, it is seen that the attitudes of male candidates were more positive than those of female candidates.

Table 7. One-way ANOVA Results of Pre-Service Teachers' Attitudes towards Laboratory Skills for the Variables of Year of Study and the Type of High School That They Graduated From

Variables		ASLS score distributions (overall scale)					
		N	X	SD	df	F	p
Year of study	1	71	3.79	.401			
	3	78	3.77	.371	199	.196	.822
	4	53	3.81	.439			
High school	Anatolian	130	3.80	.399			
	Science	16	3.72	.380	198	.168	.918
	General	11	3.80	.515			
	Other	45	3.78	.386			

When the average scores of the overall ASLS are examined in terms of year of study and high school type in Table 7, it is determined that the scores show close distribution and there is no statistically significant difference. Furthermore, scores fall within the range of "agree."

3. Do pre-service teachers' levels of chemistry laboratory anxiety differ significantly in terms of gender, year of study, or the type of high school that they graduated from?

For pre-service teachers' chemistry laboratory anxiety scores, the independent groups t-test was used to determine significance in terms of gender, while one-way ANOVA was used in comparisons regarding significance in terms of year of study and type of high school. Results are given in Table 8 and Table 9.

Table 8. Independent Groups T-Test Results for the Gender Variable in Pre-Service Teachers' Chemistry Laboratory Anxiety Scores

Variable	CLAS score distributions (overall scale)							
		N	X	SD	df	F	p	Effect (d)
Gender	Female	179	2.25	.543	200	.059	.049*	0.44
	Male	23	2.01	.541				

In Table 8, when the average CLAS scores (overall scale) are analyzed in terms of gender, it is seen that the scores of female pre-service teachers are X (female)=2.25 and the scores of male pre-service teachers are X (male)=2.01. It was determined that the score ranges of the candidates were at the level of "disagree." It was also determined that the participants' score ranges do not agree in terms

of gender. There is a statistically significant difference between female and male participants and this difference is in favor of male participants. In line with these findings, it can be said that male pre-service teachers' anxieties about chemistry laboratories are lower than those of female pre-service teachers. In addition, it can be said that the significant difference between the average anxiety scores of male and female participants about the laboratory has a moderate effect (d=0.44).

Table 9. One-way ANOVA Results for Pre-Service Teachers' Chemistry Laboratory Anxiety Scores For the Variables of Year of Study and Type of High School That They Graduated From

Variables		CLAS score distributions (overall scale)					
		N	X	SD	df	F	p
Year of study	1	71	2.23	.549			
	3	78	2.20	.533	199	.126	.881
	4	53	2.25	.572			
High school	Anatolian	130	2.22	.525			
	Science	16	2.28	.733	198	.099	.960
	General	11	2.23	.642			
	Other	45	2.20	.526			

When the average CLAS scores (overall scale) are examined in terms of year of study and high school variables in Table 9, it is determined that the scores show a close distribution and there is no statistically significant difference. The ranges of the scores are at the level of "disagree."

4. Is there a significant relationship between pre-service teachers' attitudes towards laboratory skills and their levels of anxiety in the chemistry laboratory?

In order to determine whether there is a meaningful relationship between pre-service teachers' average ASLS and CLAS scores (overall scale), Pearson correlation analysis was performed and the results are given in Table 10.

Table 10. Correlation Values Between Pre-Service Teachers' Average ASLS and CLAS Scores

Variables		ASLS	CLAS
ASLS	Pearson correlation (r)		-.580
	Sig. (2-tailed) (p)		.000**
	N		202
CLAS	Pearson correlation (r)	-.580	
	Sig. (2-tailed) (p)	.000**	
	N	202	

**p<.001, N: Number of students

The correlation coefficient (r), which is used to determine the amount of relationship between two variables is defined to be of high level if it is between .70-1.00; medium level if it is between .70-.30 and low level if it is between .30-.00 (Büyüköztürk et al., 2017, p. 87). When Table 10 is examined, a moderate, negatively significant correlation (r=-.580, p<.001) is seen between the candidates' average ASLS and CLAS scores. This negative relationship between the variables indicates that as the attitudes towards laboratory skills become more positive/more negative, anxieties about the chemistry laboratory decrease/increase. This confirms the expected results.

DISCUSSION

In this study, the attitudes towards laboratory skills and chemistry laboratory anxieties of teacher candidates studying in the Science Education Department were determined and examined in terms of gender, year of study, and the type of high school that the participants graduated from.

When the findings of the study regarding the scores for attitudes towards laboratory skills were examined, it was determined that the pre-service teachers' attitudes towards laboratory skills in

terms of the 1st and 3rd factors of the scale and the average scores of the overall scale were in the range of "agree". On the other hand, it was determined that the mean scores for the 4th factor were in the "indecisive" range. The mean scores of the 2nd factor (X = 4.20), although they were in the "agree" range, showed a tendency towards the "strongly agree" interval.

These results show that teacher candidates' attitudes towards laboratory skills are generally positive. This finding is similar to those of other studies in the literature (Dilber, Sönmez, Doğan & Sezek, 2006; Henderleiter & Pringle, 1999; Karatay, Doğan & Şahin, 2014). In studies conducted according to experimental designs on the scores for the laboratory skills attitudes of pre-service teachers in different departments of universities, the results are also consistent with our results (Alkan & Erdem, 2013; Bilen-Kaya, 2012). In line with the results of this study, it can be said that teacher candidates are generally positive towards laboratory activities and related situations and they are aware of their goals and needs. With these results, it is noteworthy that the candidates were hesitant about feeling ready for laboratory activities. In this factor, there are items concerning the knowledge of chemical substances and their dangerous effects during the individual studies of teacher candidates. These items also contain their sufficiency of knowledge on identifying chemical substances and necessary manuel skills of realizing experiments (Alkan & Erdem, 2012). The psychological perceptions that individuals create in their minds about actions or situations can be defined as feeling ready for a task. This shapes the behaviors related to the work to be done, causing the individual to act accordingly. When this situation is generalized to the laboratory environment, it is seen that teacher candidates can easily apply the knowledge and skills that they will obtain from all experiences related to the laboratory in other lessons. In short, this can be called the readiness of individuals for laboratory activities. Laboratory studies are usually carried out in groups. It can be said that factors such as not making an equal distribution of tasks during group work, undertaking the work with just one person, and lack of communication between groups may be effective in preventing development in this factor. Indeed, Reynders, Suh, Cole and Sansom (2019) found that teamwork and communication are the most common skills used as evidence for behavioral change. According to these researchers, teamwork and process management skills have a role in planning and conducting experiments. If team roles are to be required in the lab environment in which a group will work, the roles should be clearly defined in terms of the specific tasks to be performed (Ott, Kephart, Stolle-McAllister & LaCourse, 2018). For this reason, it is important to follow individuals closely during such applications and to ensure their equal participation in the process. In short, their learning should be followed. This may contribute to the reduction of negative effects on the 4th factor. However, individuals should also have considerable experience in matters such as the use of chemicals and the selection of appropriate chemicals for experiments. In order to turn this skill into a positive benefit, environments that encourage individual studies can be created, information about laboratory applications can be given both in theory and practice, and it can be ensured that students experience the experiments to be done beforehand. As Alkan (2012) stated, university students manage their activities in the process of conducting an experiment themselves, which results in having the necessary equipment for future studies and feeling ready in this regard.

When the findings regarding the chemistry laboratory anxiety scores were examined in this study, it was found that the pre-service teachers' average scores for all factors and the overall scale were in the "disagree" range for chemistry laboratory anxieties. These results show that the pre-service teachers' anxieties about the chemistry laboratory are generally low. It can be said that the situations that these teacher candidates generally encounter in the chemistry laboratory do not cause much anxiety for them, and they have developed some strategies in terms of overcoming difficulties.

It was furthermore determined that the candidates responded in the "disagree" range in terms of using laboratory tools and chemicals, working with other students, collecting data, and using laboratory time. It is important to know the emotional components of learning and performance in the laboratory environment, one of which is anxiety. Reducing the anxieties that may arise in laboratory environments can improve complex laboratory problem-solving skills (Bowen, 1999). Anxiety is an affective state that shows the person's discomfort from the situation that he or she is in. The chemistry lab offers opportunities to learn skills beyond specific chemistry domain knowledge, such as how to

use scientific tools appropriately, how to collect and analyze data, and how to work in a group (Reynders et al., 2019). It is common for students to feel anxious about what needs to be done in such a setting, and it is important for them to take steps that will support their cognitive and psychomotor skills, to develop a sense of value in their work, and to do their work willingly. When individuals value or enjoy something, their attitude towards it improves, and this, of course, contributes to the development of other skills. It is a natural result that their worries decrease with improved attitude. The results of this study support these explanations. According to Kaya and Çetin (2012), students should not only be supported in designing experiments and making observations in laboratory environments, but also in developing a more positive attitude and decreasing their anxiety.

In the literature, it is seen that studies conducted with teacher candidates on this subject have involved experimental designs (Alkan, 2012; Alkan & Koçak, 2015; Can, 2013; Ercan, 2014; Erökten, 2010; Güven, Çam & Sülün, 2015; Seçkin & Yılmaz, 2014; Ural, 2016) and have also been performed according to relational/general survey models (Anılan, Görgülü & Balbağ, 2009; Kaya & Çetin, 2012; Kurbanoğlu & Akın, 2010; Rummey, Spagnoli & Clemons, 2017; Sharpe, 2012; Veyisoğlu, 2013). In studies in the literature, the relationship between chemistry laboratory anxiety behaviors and other behavioral dimensions such as self-efficacy, attitude, and achievement was investigated. Studies showed that individuals who have positive feelings about the laboratory have low laboratory anxiety. The reasons for this are the increase in the experience that they gain during laboratory courses (Erökten, 2010; Rummey et al., 2017), the negative relationship between self-efficacy and anxiety as stated by Bandura according to social learning theory (Kurbanoğlu & Akın, 2010) and the laboratory applications in which the students participated actively (Ural, 2016). Kurbanoğlu and Akın (2010) stated that self-efficacy has an indirect effect of reducing chemistry laboratory anxiety through attitudes towards chemistry courses. The explanations stated above may similarly explain the results of the present study. Ünal and Kılıç (2016) stated in their study that university students' anxiety about the use of chemicals in the laboratory was less than that measured for the use of equipment and achievement, evaluation, and sensory dimensions. However, they stated that anxiety about this issue still affected students. As a result, it is important to conduct interventions to reduce chemistry laboratory anxiety and to determine the factors that may cause students' anxiety in laboratory environments while preparing effective laboratory content (Rummey et al., 2017).

When the results of the teacher candidates' attitude and anxiety scores in terms of the gender variable are examined, it is seen that the attitudes of the male candidates are better and their anxieties are lower than those of the female candidates. According to the results obtained from both scales, it was determined that there is a statistically significant difference between male and female candidates in favor of male candidates. While there are studies in the literature that are compatible with the present chemistry laboratory anxiety results (Akgün, Gönen & Aydın, 2007; Çakmak & Hevedanlı, 2005) and chemistry course attitude results (Cheung, 2009; Kurbanoğlu, 2014), findings about teacher candidates' chemistry laboratory anxieties in favor of females (Anılan, Görgülü & Balbağ, 2009) and results that do not differ according to gender (Karatay et al., 2014; Kaya & Çetin, 2012; Kurbanoğlu, 2014; Veyisoğlu, 2013) can also be seen.

According to our results, when the variables of anxiety and attitude are evaluated together, it can be said that male teacher candidates' feelings and thoughts about the chemistry laboratory are more positive than those of female candidates. When this situation is evaluated within the framework of the learning environment of the chemistry laboratory, it can be explained by the fact that males may be better able to control themselves in issues such as the use of equipment, selection of chemicals, and safety. In contrast to our results, it is possible to mention literature results that are more positive about females' perceptions of the classroom environment in the chemistry lab (Quek, Wong & Fraser, 2002) and science labs in general (Wong & Fraser, 1997). The literature also suggests that females express their self-confidence about techniques and skills in chemistry laboratories more easily and make more positive statements (Henderleiter & Pringle, 1999) compared to males. In light of these results, learning environments, course contents, and students' prior knowledge and past experiences may guide their feelings and thoughts about the chemistry laboratory and may also cause gender differences. Chemistry laboratory experiments involve the use of chemicals by nature, and sufficient

knowledge of their correct and safe use should be ensured. From this point of view, in order for students to work individually in the laboratory, knowledge about chemical substances, their dangerous effects, the necessary manual skills for using them, and the knowledge of naming substances must have been successfully obtained via prior education. This may contribute to the reduction of gender differences in the chemistry laboratory environment.

On the other hand, when the results of the ASLS were examined in terms of year of study and type of high school, it was found that the scores showed a close distribution and there were no statistically significant differences, with score ranges being at the level of "agree." It was determined that the overall scores of the CLAS also showed close distribution with no statistically significant differences, and the score ranges were at the level of "disagree." These results show that pre-service teachers' attitudes towards laboratory skills and their anxieties about chemistry laboratories are similar in terms of the variables of year of study and their previous type of education level (high school) during their university education. In terms of both variables, it can be said that the candidates have positive attitudes and low anxiety. It is thought that evaluating the attitude and anxiety of teacher candidates in terms of the type of high school that they graduated from can give information about the activities carried out in the chemistry laboratories of different types of high schools in Turkey, as well as the general feelings about the current and future laboratory activities in university education. In the literature, it is seen that the findings of studies examining students' chemistry laboratory anxiety in terms of year of study (Kaya & Çetin, 2012, Veyisoğlu, 2013) and high school type (Veyisoğlu, 2013) are similar to our results. Within the scope of these findings, it is thought-provoking that there is no significant difference in either sensory state, especially for the high school type variable. Among the types of high schools that provide education at the secondary level in Turkey, science high schools follow a different curriculum than others. According to the Ministry of National Education's Regulation on Science High Schools (1999), "In science high schools, lesson schedules and education programs approved by the Ministry are applied. In science programs, emphasis is placed on laboratory and application studies."

In addition, science teaching programs consist of very rich instructional program materials such as detailed teachers' guides, supplementary publications, instructive films, specially prepared laboratory tools, student experiment guides and auxiliary books, tests, and other assessment tools. Science lessons are mostly taught by experimental methods (Turgut, 1990). From this point of view, it is expected that graduates of science high schools will have good knowledge and skills thanks to laboratory lessons. However, Günbayı, Yücedağ and Emir Yücel (2015), among authors who have conducted relevant studies in recent years, found that science high school students were not sufficiently prepared to participate in scientific activities and that they complained about not using laboratories. One of the major problems of science high schools has been stated as moving away from an understanding of education that is based on research and experimentation and that produces science. On the other hand, it is possible to note study findings in which graduates of science high schools have more positive attitudes towards chemistry lessons and lower anxiety towards the chemistry laboratory compared to graduates of other high school types (Kurbanoğlu, 2014).

A moderate, negatively significant correlation ($r=-.580$, $p<.001$) was found between these pre-service teachers' mean ASLS and CLAS scores. The negative relationship between these variables was an expected result. In the literature, there are studies investigating the relationship between chemistry laboratory anxiety and attitudes towards chemistry lessons (Ercan, 2014; Kurbanoğlu & Akın, 2010; Kurbanoğlu, 2014). On the other hand, there are limited studies on attitudes towards laboratory skills and anxiety in the chemistry laboratory, which were examined in the present work (Alkan, 2012; Alkan & Erdem, 2013). The results of those studies are in line with our own results. However, a negative relationship was found in studies examining the attitude towards chemistry laboratories and chemistry laboratory anxiety states (Ural, 2016; Veyisoğlu, 2013). Laboratories are places where theoretical knowledge learned in a course is applied in practice. It can be said that in terms of development and follow-up of knowledge and skills, the laboratory and theoretical courses are related. In line with these explanations, it is thought that students can reflect their attitudes towards chemistry courses in their attitudes towards laboratory skills. In this context, when the relevant

literature results are examined, the existence of a negatively significant relationship between the students' scores for chemistry laboratory anxiety and attitude towards chemistry courses can be considered compatible with our results.

In conclusion, in order for students to learn chemistry topics permanently, it is important that subjects be supported by related experiments and that students gain first-hand experience. Chemistry is a discipline that requires students to gain knowledge and skills related to the subjects, as it is based on observation and experimentation and it activates all senses. Especially in learning environments where experiment support is provided, comprehension will be facilitated and thus the enthusiasm and interest in learning will increase (Ayrancı, 1991). Laboratories should be enriched with equipment of adequate numbers and quality, and attention should be paid to regulations that take into account environments that may cause anxiety among students (Ünal & Kılıç, 2016).

CONCLUSION

As a result of the research, it was determined that pre-service teachers' attitudes towards laboratory skills were generally scored as "agree" and their chemistry laboratory anxieties were generally scored as "disagree" in terms of average scores for the overall scales. Laboratory activities are organized in order to reach science learning outcomes. It is of utmost importance to recognize that affective variables, such as anxiety, affect learning and performance in laboratory situations (Bowen, 1999). When the laboratory is considered as a complement to science teaching, it is also necessary to determine the laboratory anxiety of the students. When a student who is not worried about science courses enters the laboratory environment, he/she may develop anxiety by the influence of different stimuli (Azizoğlu & Uzuntiryaki, 2006). Knowing the size and the origin of the anxiety will be instrumental in directing the students to the laboratory. For this reason, the identification of chemistry laboratory anxiety of students is gaining importance.

Attitude is very important among the factors that affect the knowledge and skills of students at all educational levels (Bennett, Green, Rollnick & White, 2000). Attitude is an acquired internal condition that affects a person's choice of individual activities against events and various situations (Senemoğlu, 2000). As a result of the research, a moderate, negatively significant correlation was found between the average attitude and anxiety scores of these teacher candidates. For this reason, developing positive attitudes towards learning environment and decreasing anxiety are important subjects.

RECOMMENDATIONS

In line with the results obtained from this study, the following recommendations may be made:

• By designing an experimental research model, pre-service teachers' attitudes towards laboratory skills and chemistry laboratory anxieties can be analyzed comparatively.

• By collecting information about other variables that affect attitude and anxiety variables, the relationship among them can be investigated or their effects on each other can be examined.

• The variables of attitude and anxiety towards the chemistry laboratory skills of students in different departments of universities with the same content of chemistry laboratory courses can be analyzed comparatively.

• By designing a qualitative research approach, in-depth information about teacher candidates' attitudes towards laboratory skills and chemistry laboratory anxieties can be obtained.

REFERENCES

Akgün, A., Gönen, S., & Aydın, M. (2007). İlköğretim fen ve matematik öğretmenliği öğrencilerinin kaygı düzeylerinin bazı değişkenlere göre incelenmesi. *Elektronik Sosyal Bilimler Dergisi*, *6*(20), 283-299.

Alkan, F., & Erdem, E. (2012). Laboratuvar becerilerine yönelik tutum ölçeği geliştirme çalışması. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi*, *Özel Sayı 1*, 22-31.

Alkan, F., & Erdem, E. (2013). Kendi kendine öğrenmenin laboratuvarda başarı, hazırbulunuşluk, laboratuvar becerileri tutumu ve endişeye etkisi. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi, 44*, 15-26.

Alkan, F., & Koçak, C. (2015). Chemistry laboratory applications supported with simulation. *Procedia - Social and Behavioral Sciences*, *176*, 970-976.

Alkan, F., & Koyuncu, N. (2017). Analyzing the relationship between chemistry motivation with chemistry laboratory anixety through structural equation modeling. In The Eurasia Proceedings of Science, Technology, Engineering & Mathematics (EPSTEM) (p. 83-89), 26-29 October, Antalya,Turkey.

Alkan, F. (2012). Kendi kendine öğrenmenin kimya laboratuvarında öğrenci başarısına, öğrenme hazırbulunuşluğuna, laboratuvar becerilerine yönelik tutumuna ve endişesine etkisi. *Yayımlanmamış Doktora Tezi*. Hacettepe Üniversitesi, Fen Bilimleri Enstitüsü, Ortaöğretim Fen ve Matematik Alanları Eğitimi Ana Bilim Dalı, Ankara.

Anılan, B., Görgülü, A., & Balbağ, M. Z. (2009). Öğretmen adaylarının kimya laboratuarı endişeleri. *e-Journal of New World Sciences Academy Education Sciences*, *4*(2), 575-594.

Ayrancı, H. (1991). Kimya eğitiminde deneysel yöntemin avantajları. *Dokuz Eylül Üniversitesi Buca Eğitim Fakültesi 1. Ulusal Eğitim Sempozyumu, Bildiriler Kitabı, s: 281-284, İzmir*.

Ayvacı. M. Ş., & Küçük. M. (2005). İlköğretim okulu müdürlerinin fen bilgisi laboratuvarlarının kullanımı üzerindeki etkileri. *Milli Eğitim Dergisi, 32*(165), 150-161.

Azizoğlu, N., & Uzuntiryaki, E. (2006). Kimya laboratuarı endişe ölçeği. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi*, *30*, 55-62.

Balbağ, M. Z., & Anılan, B. (2014). Fen bilgisi ve sınıf öğretmen adaylarının fen bilgisi laboratuvar uygulamaları derslerine yönelik görüşlerinin bazı değişkenler açısından incelenmesi. *Eğitim ve Öğretim Araştırmaları Dergisi, 3*(4), 309-320.

Bennett, J., Green, G., Rollnick, M., & White, M. (2000). Freshman South African students' views on the study of chemistry, *Paper presented at the Annual Meeting of the National Association for Research in Science Teaching*, April 28- May 1, New Orleans, LA.

Bilen-Kaya, D. (2012). Temel kimya laboratuvar dersinin web ortamı ile desteklenmesinin öğrencilerin başarısına ve derse yönelik tutumuna etkisi. *Yayımlanmamış Doktora Tezi*. Dicle Üniversitesi, Fen Bilimleri Enstitüsü, Kimya Anabilim Dalı, Diyarbakır.

Bowen C. W. (1999). Development and score validation of a chemistry laboratory anxiety instrument (CLAI) for college chemistry students. *Educational and Psychological Measurement, 59*(1), 171-187.

Büyüköztürk, Ş., Çokluk, Ö., & Köklü, N. (2017). *Sosyal bilimler için istatistik* (19. Baskı). Pegem Akademi.

Can, A. (2014). *SPSS ile bilimsel araştırma sürecinde nicel veri analizi* (3. Basım). Pegem Akademi.

Can, Ş. (2013). Pre-service science teachers' concerns about chemistry laboratory (Case of Muğla University-Turkey). *Procedia - Social and Behavioral Sciences*, *106*, 2102-2111.

Ceylan, E., Güzel Yüce, S., & Koç, Y. (2019). Öğretmenlik yolunda fen öğretimi laboratuvar uygulamaları dersi: Bir durum çalışması. *Atatürk Üniversitesi Kazım Karabekir Eğitim Fakültesi Dergisi*, *39*, 22-47.

Cheung, D. (2009). Students' attitudes toward chemistry lessons: The interaction effect between grade level and gender. *Research Science Education*, *39*, 75-91.

Çakmak, Ö., & Hevedanlı, M. (2005). Eğitim ve fen edebiyat fakülteleri biyoloji bölümü öğrencilerinin kaygı düzeylerinin çeşitli değişkenler açısından incelenmesi. *Elektronik Sosyal Bilimler Dergisi*, *4*(14), 115-127.

Dilber, R., Sönmez, E., Doğan, S., & Sezek, F. (2006). Fizik bölümü öğrencilerinin laboratuarlara karşı tutumlarının değerlendirilmesi ve karşılaştıkları sorunların tespit edilmesi üzerine bir çalışma. *Çukurova Üniversitesi Eğitim Fakültesi Dergisi, 1*(31), 102-109.

Eddy, R. M. (2000). Chemophobia in the college classroom: Extent, sources, and students characteristics. *Journal of Chemical Education*, *77*(4), 514-517.

Ekici, G., & Hevedanlı, M. (2010). Lise öğrencilerinin biyoloji dersine yönelik tutumlarının farklı değişkenler açısından incelenmesi. *Türk Fen Eğitimi Dergisi, 7*(4), 97-109.

Ercan, O. (2014). Effect of 5E learning cycle and V diagram use in general chemistry laboratories on science teacher candidates' attitudes, anxiety and achievement. *International J. Soc. Sci. & Education*, *5*(1), 161-175.

Erökten, S. (2010). Fen bilgisi öğrencilerinde kimya laboratuvar uygulamalarının öğrenci endişeleri üzerine etkisinin değerlendirilmesi. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi, 38*, 107-114.

Fraenkel, J. R., Wallen, N. E., & Hyun, H. H. (2012). *How to design and evaluate research in education* (Eight Edition). New York: McGraw-Hill.

Günbayı, İ., Yücedağ, F., & Emir Yücel, B. (2015). Fen lisesinde yaşanan sorunlara ilişkin öğretmen, öğrenci ve yönetici görüşleri: Bir durum çalışması. *Eğitim ve Öğretim Araştırmaları Dergisi*, *4*(2), 396-412.

Güven, G., Çam, A., & Sülün, Y. (2015). Effectiveness of case-based laboratory activities on chemistry laboratory anxiety of pre-service science teachers. *Uluslararası Avrasya Sosyal Bilimler Dergisi*, *6*(18), 211-228.

Henderleiter, J., & Pringle, D. L. (1999). Effects of context-based laboratory experiments on attitudes of analytical chemistry students. *Journal of Chemical Education*, *76*(1), 100-106.

Hofstein, A., & Lunetta, V. N. (1982). The role of the laboratory in science teaching: Neglected aspects of research. *Review of Educational Research*, *52*(2), 201-217.

Karatay, R., Doğan, F., & Şahin, Ç. (2014). Öğretmen adaylarının laboratuvar uygulamalarına yönelik tutumlarının belirlenmesi. *Eğitimde Kuram ve Uygulama, 10*(3), 703-722.

Kaya, E., & Çetin, P. S. (2012). Investigation of pre-service chemistry teachers' chemistry laboratory anxiety levels. *International Journal on New Trends in Education and Their Implications*, *3*(3) Article: 09, 90-98.

Koballa, T. R., & Glynn, S. M. (2007). Attitudinal and motivational constructs in science learning. In Abell, S. K., Lederman, N. G. (Eds), *Handbook of Research on Science Education.* (pp. 75-102). Mahwah, NJ: Lawrence Erlbaum Associates.

Kurbanoğlu, N. İ., & Akın, A. (2010). The relationships between university students' chemistry laboratory anxiety, attitudes, and self-efficacy beliefs. *Australian Journal of Teacher Education*, *35*(8), 48-59.

Kurbanoğlu, N. İ. (2014). Lise öğrencilerinin kimya laboratuvarı kaygı ve kimya dersi tutumlarının cinsiyet ve okul türü değişkenlerine göre incelenmesi. *Eğitim ve Bilim*, *39*(171), 199-210.

Lunetta, V. N. (1998). The school science laboratory: Historical perspectives and centers for contemporary teaching. In B. J. Fraser & K. G. Tobin (Eds.), *International handbook of science education*. Dordrecht: Kluwer

Milli Eğitim Bakanlığı [MEB]. (2018). *Fen bilimleri dersi öğretim programı (İlkokul ve Ortaokul 3, 4, 5, 6, 7 ve 8. Sınıflar).* Ankara: Millî Eğitim Bakanlığı Temel Eğitim Genel Müdürlüğü.

Ott, L. E., Kephart, K., Stolle-McAllister, K., & LaCourse, W. R. (2018). Students' understanding and perceptions of assigned team roles in a classroom laboratory environment. *Journal of College Science Teaching*, *47*(4), 83-91.

Power, M. J., & Dalgleish, T. (1997). *Cognition and emotion: From order to disorder.* Hove: Psychology Press.

Quek, C. L., Wong, A. F. L., & Fraser, B. J. (2002). Gender differences in the perceptions of chemistry laboratory classroom environments. *Queensland Journal of Educational Research*, *18*, 164-182.

Reynders, G., Suh, E., Cole, R. S., & Sansom, R. L. (2019). Developing student process skills in a general chemistry laboratory. *Journal of Chemical Education*, *96*, 2109-2119.

Rummey, C., Spagnoli, D., & Clemons, T. D. (2017, September). Trends in level 1 chemistry students' laboratory anxiety and self-efficacy. *Australian Conference on Science and Mathematics Education: Science and Mathematics Teaching and Learning for the 21st Century.* Monash University, Clayton, Australia. pp. 54-55.

Seçkin, M., & Yılmaz, S. (2014). Örnek olay yönteminin öğretmen adaylarının kimya laboratuvarı dersine karşı endişelerine etkisi. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi*, *29*(29-2), 215-227.

Senemoğlu, N. (1989). Öğrenci giriş nitelikleri ile öğretme-öğrenme süreci özelliklerinin matematik derslerindeki öğrenme düzeyini yordama gücü. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi, 5*(5), 259-270.

Senemoğlu, N. (2000). *Gelişim, öğrenme ve öğretim: Kuramdan uygulamaya*. Gazi Kitabevi.

Sharpe, P. C. (2012, September). Who's afraid of the chemistry lab?. *In Proceedings of the Australian Conference on Science and Mathematics Education*. Sydney, Australia: The University of Sydney, UniServe Science.

Tamir, P. (1991). Practical work in school science: An analysis of current practice. In B. E. Woolnough (Eds.). *Practical Science: The Role And Reality of Practical Work in School Science* (pp. 13-20). Milton Keynes: Open University Press.

Taşpınar, M. (2017). *Sosyal bilimlerde SPSS uygulamalı nicel veri analizi*. Pegem Akademi.

Tekin, H. (1993). *Eğitimde ölçme ve değerlendirme*. Ankara: Yargı Kitap ve Yayınevi.

Turgut, M. F. (1990). Türkiye'de fen ve matematik programlarını yenileme çalışmaları. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi*, *5*, 1-14.

Ural, E. (2016). The effect of guided--inquiry laboratory experiments on science inquiry laboratory experiments on science education students' chemistry laboratory attitudes, anxiety and achievement. *Journal of Education and Training Studies*, *4*(4), 217-227.

Ünal, A., & Kılıç, M. (2016). Fen bilgisi öğretmen adaylarının laboratuvara yönelik kaygı durumlarının incelenmesi. *Batı Anadolu Eğitim Bilimleri Dergisi*, *7*(14), 21-32.

Veyisoğlu, A. (2013). Öğretmen adaylarının kimya laboratuarına karşı tutumlarına etki eden değişkenlerin incelenmesi. *Yayımlanmamış Yüksek Lisans Tezi*. İstanbul Üniversitesi, Eğitim Bilimleri Enstitüsü, İlköğretim Anabilim Dalı, İstanbul.

Wong, A. F. L., & Fraser, B. J. (1997). Assessment of chemistry laboratory classroom environments. *Asia Pacific Journal of Education*, *17*(2), 41-58.

Yılmaz, A., & Morgil, F. İ. (1999). Kimya öğretmenliği öğrencilerinin laboratuvar uygulamalarında kullandıkları laboratuvarların şimdiki durumu ve güvenli çalışmaya ilişkin öğrenci görüşleri. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi*, *15*(15), 104-109.