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Student Views on Attitudes towards Chemistry Laboratory Skills

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Abstract

This study aims to examine the views about the attitude towards chemistry laboratory skills of first-year science students taking the General Chemistry Laboratory course. The study sample consists of 33 students studying in the 1st year of the Science Education Department of a state university in Ankara, and the study was carried out in the fall semester of the 2018-2019 academic year. Throughout the work, in which the qualitative research approach was adopted and the survey research model was used, an open-ended question form was used as a data collection tool. As a result of the research, it was determined that the majority of the students were able to define the experiment equipment and chemical substances thanks to their laboratory studies better. Also, taking into account the feedback from their friends and lecturers contributed to them. Furthermore, most of the students' laboratory studies affected their communication with their groupmates and lecturers "Very well" and "Well". Finally, thanks to laboratory studies, they felt ready for chemical substance information, dangerous effects of chemicals, manual dexterity, and naming knowledge. In addition, the majority of the students felt sufficient about the adequacy of knowledge and skills related to the chemistry laboratory.

INTRODUCTION

Laboratory studies are one of the characteristic elements of science education (Reid & Shah, 2007). Laboratory studies, which play a prominent and central role in the science curriculum (Hofstein & Mamlok Naaman, 2007), enable students to gain experience based on observation and experiment, develop social relations, gain cognitive, affective, and psychomotor skills, and teacher-student communication (Ayas, Karamustafaoğlu, Sevim & Karamustafaoğlu, 2002; Lazarowitz & Tamir, 1994; Tobin, 1990). Laboratory applications are important in teaching chemistry from the fields of science. Because in the laboratory, students learn theoretical knowledge through applications with various tools, and they gain practical experience in this regard over time. According to Kozma (1982), learning environments like laboratories improve learning and increase laboratory performance. At this point, the information that students learn is related to how they learn. Laboratory activities are organized in two groups as content and process. The content is about learning scientific facts, concept, relationship, while the process is about how to use a laboratory tool, the duration of a task, the people with whom the student interacts, how to apply a particular method, etc. as such, it is related to the learning of the scientific research process (Miller, Tiberghien & Le Marechal, 2002).

Thanks to the use of laboratories in the field of chemistry, which contains concepts that are difficult to understand and where information is easily accessible through laboratory applications, students understand the method of science, develop problem-solving skills, examine events in daily life, and develop analysis and generalization skills (Coştu, Ayas, Çalık, Ünal & Karataş, 2005). In short, they can perceive things like a scientist and acquire many skills related to the laboratory process. As Alkan (2012) stated, the use of glass materials and chemicals, laboratory safety knowledge, and communication are some of the skills that must be acquired in the chemistry laboratory. In addition, there is the development of other skills such as acquiring manual dexterity, taking into account the feedback from the instructor, and feeling ready for the experimental environment. The literature emphasizes that teachers have the necessary knowledge and skills for laboratory practices (Coştu et al., 2005; Kaya & Böyük, 2011; Kozma, 1982; Ural, 2016). According to Coştu et al. (2005), solution preparation using appropriate laboratory materials is the basis of laboratory practices. In this context, knowledge, and skills related to solution preparation specific to solution concentration types come to the fore. Because chemistry subjects are difficult to understand, concepts need to be concretized for teaching. For this reason, teachers are expected to carry out laboratory activities equipped with these skills.

Affective factors such as attitude and anxiety are very important in making people realize. Attitude is a mental tendency of individuals towards people, objects, subjects, and events, and it is accepted as an important predictor of behavior with its cognitive, affective, and behavioral dimensions (Ekici, 2002). These affective characteristics include understanding scientific concepts, interest and motivation, and practical skills. In short, attitudes can change and develop within the framework of the experiences gained in the laboratory. Sneddon and Douglas (2013) state that university students' attitudes towards laboratory experiences greatly affect their laboratory learning and have an important role in the development of their knowledge and skills. Kaya and Böyük (2011) determined that science teachers have positive attitudes and opinions towards laboratory practices due to the importance and necessity of using laboratories in science lessons. In the literature, it is emphasized that teachers should acquire some knowledge and skills regarding the use of laboratories during their university education (Coştu et al., 2005), and have a positive attitude towards science laboratories while acquiring laboratory skills and science content (Bal, 2012). On the other hand, considering the importance of laboratory applications in learning, there are some problems in laboratory applications due to deficiencies in laboratory equipment and subject matter and getting experience (Batı, 2018; Coştu et al., 2005; Kaya & Böyük, 2011). Although laboratory equipment and supplies are not available in sufficient quantities, it is important to be skillful in laboratory applications. This is possible with better participation in the laboratory and better performance (Okebukola, 1986). In this context, in order to discuss the features that may affect laboratory practices, it is necessary to know the current thoughts of the students about them.

Previous research has shown that students' chemistry laboratory perceptions affect their attitudes towards chemistry (Lang, Wong & Fraser, 2005), and students have a generally positive attitude towards practical work in chemistry (Sneddon & Hill, 2011). However, students' perceptions of the learning environment are different, and these affect how and what they learn (Ramsden, 1979). In this respect, it is important to plan the process of transferring the targeted knowledge, skills, and attitudes to the students through the curriculum effectively and efficiently. Therefore, when the laboratory is considered a complementary element of teaching, it becomes important to determine students' attitudes towards laboratory skills and understand what students' ideas are about the purpose of the laboratory as well as its role in

teaching. In addition, it is thought that knowing the laboratory attitude dimension and source of the students will be effective in directing them to the laboratory and give an idea about what they can achieve in the laboratory.

Teachers may encounter some difficulties during the use of laboratories in their professional life. For this reason, teachers must have sufficient skills in this regard to cope with them and to realize qualified and target-appropriate learning. It is thought that the development of positive attitudes towards these skills will contribute positively to the process in terms of overcoming the difficulties they may encounter during the practices in the future. When the literature is examined, while there are studies on chemistry laboratory attitude or chemistry laboratory skills, few studies on attitudes towards chemistry laboratory skills have been reached (Alkan, 2012; Alkan & Erdem, 2012). In this context, it is thought that determining the attitudes of the students taking the course in this study in line with their knowledge and skills towards the chemistry laboratory will contribute to the field.

The Purpose of Study

This study aims to examine the views about the attitude towards chemistry laboratory skills of first-year science students taking the General Chemistry Laboratory course. Accordingly, the answer to the question "What is the students' opinion about the attitude towards chemistry laboratory skills?" has been sought.

METHOD

Study Design

This research is a descriptive study in which a qualitative research approach was adopted to obtain information about the students' views on their attitudes towards chemistry laboratory skills, and it was carried out according to the survey research model. Survey research aims to describe an existing situation as it is and does not try to change or affect it in any way (Karasar, 2004). Within the scope of this study, students' views on attitudes towards chemistry laboratory skills were presented as they are and analyzed with an interpretive approach.

Study Group

The study was carried out with 33 students (1st grade) studying in the Science Education Department of a state university in Ankara in the fall semester of the 2018-2019 academic year and taking the General Chemistry Laboratory course. An easily accessible sampling method was preferred in the selection of samples. Information on the descriptive characteristics of the samples is given below.

Table 1. Distribution of science students by gender

Gender	f	%
Female	28	84.84
Male	5	15.15

As seen in Table 1, 84.84% of the students are female and 15.15% are male.

Data Collection Tool

An open-ended question form developed by the researchers was used in the study. The questions are about the attitude towards chemistry laboratory skills. It has been prepared to reveal the students' feelings and thoughts about the sub-dimensions that explain the attitude more clearly. In this context, the question items in the sub-dimensions of the Attitude Scale towards Laboratory Skills developed by Alkan and Erdem (2012) were used to develop the

questionnaires. In order to check the consistency of the expressions in the items in terms of language and meaning and whether they serve the purpose, the questionnaires were examined by two science educators other than the researchers. The questions were rearranged after the expert opinion and it was decided that the expressions were sufficiently understandable at the end of the revision. Accordingly, there are eight open-ended questions about the Attitude towards Chemistry Laboratory Skills and the answers they should choose regarding these questions. At the end of these, the students were asked to explain the answer they gave with their reasons and to give written answers to the questions on the form. The main purpose of asking the questions to the 1st year students taking the general chemistry laboratory course is to have in-depth knowledge of these subjects. At the same time, the content of the questions is related to the knowledge and skills of the chemistry laboratory.

Validity-Reliability Check

In qualitative studies, detailed reporting of data and explanations about how the results are reached are important for validity (Yıldırım & Şimşek, 2016). Within the scope of this study, the compatibility of the findings obtained from the study with the dimensions taken into consideration during the development of the interview questions was checked. In addition, the consistency and meaningfulness of the findings were constantly checked by the researchers. Internal validity (credibility) of the findings was ensured with direct quotations. On the other hand, to ensure external validity (transferability), the model of the study, universe and sample, data collection tool, and data analysis were explained in detail.

Some of the measures to be taken regarding reliability in qualitative studies are to clarify the strategies used in the stages of the research and thus allow other researchers to use them in similar ways (Yıldırım & Şimşek, 2016). The data obtained within the scope of this study were coded at different times by two researchers, and the internal reliability (consistency) of the data was tried to be ensured by making comparisons between the codes. The purpose of doing this is to obtain an objective point of view to ensure the integrity of the findings. Since the stages of the research are reported in detail and clearly, and the raw data are stored for future review, it has been tried to contribute to external reliability (repeatability).

Data Analysis

The data collected in the study were analyzed with a qualitative approach. Written answers to open-ended questions were analyzed using the content analysis technique. The purpose of content analysis is to reveal concepts and relationships that can explain the data. In this context, similar data are brought together around certain concepts and themes, and these are arranged and interpreted in an understandable way (Yıldırım & Şimşek, 2016).

The following stages were followed in the content analysis of the data:

1. After the raw data in the interview forms were read independently by the researchers several times, codes were created for each question.
2. Researchers came together to check whether there were differences between the codes. A scoreboard was kept to check the consistency between the codes. In the scoreboard, the evaluation method as “Consensus” and “Dissensus” was followed. The relevant data set was re-examined for codes with a difference of opinion, and a consensus was reached among the researchers. Frequency values were written according to the frequency of the codes.
3. Consensus and dissensus were numerically calculated as Miles and Huberman’s (1994) percentile compliance reliability. Concordance reliability = “Consensus / (Agreement + Disagreement) x 100”. After all these stages, the coding percentage was calculated for each question. According to Yıldırım and Şimşek (2016), reaching a reliability percentage of at least

70% indicates that the codes are reliable. Compliance reliability percentage values obtained in the study are given in Table 2.

4. After ensuring consistency between the codes, the codes that have a similar relationship with each other in terms of meaning were combined under a certain category. Afterward, these relations were tried to be explained under a higher-level theme.

Table 2. Attitude towards Chemistry Laboratory Skill compliance reliability values

Questions	Attitude towards Chemistry Laboratory Skill
First question	87.09%
Second question	90.32%
Third question	93.54%
Fourth question	87.09%
Fifth question	88.88%
Sixth question	90%
Seventh question	83.87%
Eighth question	93.10%

When the values in Table 2 are examined, it can be said that the consistency reliability values between the encoders are sufficient for each question.

FINDINGS

The findings regarding the problem of the study are given below. Student opinions on the question "*What are the students' views on the attitude towards chemistry laboratory skills?"* are given below in tables.

Dimension 1: Recognizing tools and chemicals

Question 1: "Can you define the experiment equipment better thanks to the laboratory studies? Explain the reasons."

Question 2: "Can you identify chemicals better thanks to laboratory studies? Explain the reasons."

The distribution of the answers is given in Table 3.

Table 3. Findings for recognizing test equipment and chemical substances

Dimensions	Theme	Category	Codes	f
Getting to know the test equipment	Process	Practice	– To be practical	5
			– Lack of practice	1
		Equipment	– Mixing some ingredients	2
			– Use of materials in experiments	12
			– Recognizing the substance	5
			– Knowing the use time and purpose of materials	2
		Learning	– Learning by sight and touch	4
			– Learning by doing	3
	Information	Informing	– Informing the instructors	1
Recognizing chemicals	Process	Practice	– To be practical	1
		Equipment	– Consistent use of materials	6
			– Learning the intended use of materials	1
			– Recognizing the substance	9
			– Not recognizing the substance	3
			– Recognizing harmful substances	2

		Learning	– Positive effect on daily life	1
			– Learning by doing experiments	7
			– Permanence of information	2
	Information	Informing	– Informing the instructors	1

*More than one code has been omitted from some descriptions.

The answers "Yes (n=30)" and "Undecided (n=3)" were given in the first stage of the first question and the answers "Yes (n=30)", "No (n=1)" and "Undecided (n=2)" were given in the first stage of the second question. When Table 1 is examined, it is seen that the answers to both questions are gathered mostly in the Process theme (f=34, f=32). When the codes under this theme are examined, it is seen that there are explanations such as being practical, using materials in experiments, learning by doing and experiencing, using materials constantly, recognizing the substance, not recognizing the substance, learning as the experiments are done. All students' names were anonymised and they were called as S1, S2…S10 etc. Regarding the first question, S31 said, "*I identify the materials, I know about them, I also know the places where I need to use them*." while S13 expressed his opinion as, "*Because we always use tools and equipment, we learn better*.". S11 said, "*As we do the experiments, our knowledge about the tools increases*." and S20 said, "*When I work actively in the experiments, I know the materials according to them*.". Regarding the second question, S3 said, "*The more I use the chemical substances, the better I can define them*." while expressing his opinion as, S20 said, "*I understand how harmful chemicals are on the labels and how we should use them*.". S24: "*I do not know anything about the names and effects of some substances*.", and S12: "*I learned how experiments are done with which substances and how data comes out*.".

As a result, it can be said that students have a common opinion that using materials in experiments to identify experimental tools through laboratory studies provides learning by doing, sight and touch, as well as using materials constantly to identify chemicals, recognizing-not recognizing matter, and learning as they conduct experiments, thanks to laboratory studies.

Dimension 2: Considering feedback
Question 3: "Does it contribute to you to consider the feedback from your friends in laboratory studies? Explain the reasons."
Question 4: "Does it contribute to you to consider the feedback from the lecturers in laboratory studies? Explain the reasons."
The distribution of the answers is given in Table 4.

Table 4. Findings to consider feedback from friends and lecturers

Dimensions	Theme	Category	Codes	f
Feedback from friends	Process	Sharing	– Correcting mistakes	9
			– Assisting	2
			– Information sharing	9
			– Teamwork	4
			– Incorrect information of groupmates	3
		Learning	– Learning subjects better	4
			– Making experiments easier	1
		Evaluation	– Clash of ideas	1
			– Self evaluation	1
Feedback from lecturers	Process	Understanding	– Understanding points to consider	3
			– Comprehension of subjects	1

		Evaluation	– True/false detection	4
		Wrong	– Reducing the error rate	3
			– Addressing the errors	1
		Ease	– Making experimentation easier	2
	Information		– Making report writing easier	2
		Enlightenment	– Doing unachievable experiments	2
			– Informing	15

*More than one code has been omitted from some descriptions.

The answers "Yes (n=28)", "No (n=1)" and "Undecided (n=4)" were given in the first stage of the third question and the answers "Yes (n=33)" were given in the first stage of the fourth question. When Table 4 is examined, it is seen that the answers are gathered under the Process theme (f=34, f=18). Within the scope of the feedback from the lecturers, the answers are also seen in the Information theme (f=15). When the codes under the Process theme are examined, it is seen that there are explanations such as correcting mistakes, information sharing, teamwork, learning subjects better, understanding points to consider, true/false detection, reducing the error rate, and making experimentation easier. Regarding the third question, S7 said, "*It contributes when our friends warn us when we do something wrong*.", S20: "*Group work creates a positive effect*.". S10 said, "*I get more productive studies by exchanging information with my friends*." and S24: "*It provides a better understanding of the subjects*.". Regarding the fourth question, S2 said, "*Thanks to the information given, I understand what we need to pay attention to*.", S10: "*I can detect my strengths and mistakes*.". S12 said, "*Checking us reduced our error rate, and we were getting answers to the questions we asked*.". Finally, when the codes in the Information theme are examined, mostly informative explanations are seen. For example, S6 said, "*Assistants and instructors give sufficient information*." and S30: "*They help us with their experience*.".

As a result, students have a common opinion that taking into account the feedback from their friends in laboratory studies, correcting mistakes, information sharing, teamwork, and learning subjects better. In addition, it can be said that there is a common view on understanding the important points to be considered in considering the feedback from the lecturers, understanding points to consider, true/false detection, reducing the error rate, making experimentation, and making report writing easier, doing unachievable experiments and informing them.

Dimension 3: Communication in the laboratory
Question 5: "Did laboratory work affect your communication with your groupmates? Yes, it did ( ). Explain the reasons, including the degree of influence.
No, it didn't ( ). Because….."
Question 6: "Did laboratory work affect your communication with the lecturers? Yes, it did ( ). Explain the reasons, including the degree of influence.
No, it didn't ( ). Because….."
The distribution of the answers is given in Table 5.

Table 5. Findings regarding communication with groupmates and lecturers

Dimensions	Theme	Category	Codes	f
Communication with groupmates	Process	Sharing	– Increase in sharing	4
			– Not sharing information	1
		Teamwork	– Teamwork	10
			– Disagreements in the distribution of tasks	7

	Affective	Sincerity	– Strengthening communication	7
			– Being sincere	3
Communication with lecturers		Issuing the lesson	– Exchanging information	3
			– Explaining in detail without getting bored	1
			– Sharing experiences	1
			– The way of issuing the lesson	1
		Didactic	– Creating consciousness	1
			– Didactiveness of help	1
		Unaltering	– Same as previous communication	1
		Recognition	– Better recognition	2
	Affective	Being thoughtful	– Assisting	12
			– Asking questions comfortably	4
			– Strengthening communication	3
			– Attitude of lecturers	1
			– Thoughtfulness of lecturers	1
			– Asking the topics hard to be done	1
			– Getting answers to the question	1
			– Being positive	1

*More than one code has been omitted from some descriptions.

The answers "Very well (n=12)", "Well (n=8)", "Average (n=6)", "No (n=4)" were given in the first stage of the fifth question and the answers "Very well (n=16)", "Well (n=8)", "Average (n=2)", "No (n=2)" were given in the first stage of the sixth question. When Table 5 is examined, it is seen that the answers are gathered mostly in Process (f=22) and Affect (f=24). When the codes under the Process theme are examined; teamwork, disagreements in the distribution of tasks, and increase in sharing; In the Affective theme, explanations such as assisting, asking questions comfortably, and strengthening communication are seen. Regarding the fifth question S5 said, "*We were able to distribute tasks. We got a better understanding of working in groups*." S20 expressed that "*In general, we were compatible with each other, there was a distribution of tasks. Our communication was good*.". S16 on the subject said, "*Teamwork had a positive impact. We were able to do the distribution of work*.". S18 said, "*The irresponsibility of some friends was inconvenient*." where S8 expressed his opinion as, "*Our communion shares and the number of our common topics are increasing*.". Regarding the sixth question, S30 on the theme of affective said, "*We communicate better, we can ask our questions without hesitation*." where S11 expressed his opinion as, "*As we learn new things, our communication with them improves*.".

As a result, it can be said that the students have common views on teamwork, disagreements in the distribution of tasks, and an increase in sharing, assisting, asking questions comfortably, and strengthening communication.

Dimension 4: Feeling ready

Question 7: "Which of the following knowledge and skills do you feel ready for, thanks to laboratory studies? Explain the reasons"

Chemical substance information ( ) Dangerous effect of chemical substance ( )

Manual dexterity ( ) Naming of what is the substance ( )

Other ( )

Question 8: "Do you think that your knowledge and skills about the chemistry laboratory are sufficient? Explain the reasons"

Yes ( ) No ( ) Undecided ( )

The distribution of the answers is given in Table 6.

Table 6. Findings related to feeling ready

Dimensions	Theme	Category	Codes	f
Feeling ready	Process	Skill	– Being practical	3
			– Being more effective in manual dexterity	2
			– Doing experiments without problems	1
			– Being careful, adjustment of substances	1
		Assist	– Help of lecturer	3
		Learning	– Enlightenment	6
			– Learning in theory and practice	6
			– Learning by doing (experiment effect)	4
			– Missing information on other topics	2
			– Learning by observing	1
			– The importance of knowing the dangerous effect of a chemical substance	5
	Affective	Relevance	– Working, being interested in	1
	Condition	Negativity	– Having difficulty with chemicals	1
			– Inability to convey information	1
Adequacy of knowledge and skills	Process	Warning	– Considering warnings	1
			– Iteration effect	1
		Learning	– Strengthening knowledge with experiments	5
			– Believing that you learned well	2
			– Learning by doing	2
			– Effect of lesson	2
			– Learning the rules	1
			– Having a good time	1
			– Self-development	1
		Skill	– Being competent in performing experiments at the primary level	2
	Affective	Relevance	– Having an interest in chemistry	2
			– Curious	1
	Condition	Negativity	– Experiments are long, groups are large	1
			– Thinking that there are shortcomings	9
			– Differing by experiment	2

*More than one code has been omitted from some descriptions.

The answers "Chemical substance information (n=18)", "Dangerous effect of chemical substance (n=20)", "Manual dexterity (n=24)", "Naming knowledge (n=11)" and "Other (n=3)" were given in the first stage of the seventh question and the answers "Yes (n=22)", "No (n=1)", "Undecided (n=9)" were given in the first stage of the eighth question. When Table 6 is examined, it is seen that the answers were collected mostly in Process (f=34, f=18). When the codes under the Process theme are examined, it is seen that there are explanations such as enlightenment, learning in theory and practice, learning by doing-experience, important to know the dangerous effect of chemical substance, and strengthening knowledge with experiments. However, the code of thinking that there are shortcomings under the theme of the Condition draws attention.

Regarding the seventh question, S4 said, "*I think I have information about the chemical substances*.", S29: "*Since acids and bases are caustic, flammable, damaging, I feel more ready*

in terms of information on their dangerous effects.". On the other hand, S22 said, "*I feel knowledgeable about these topics that I have marked. Because the information of these has already been given to us in the lesson*.". S30 said, "*I have more or less control and knowledge due to the experiments we have done on what I have marked*." while S27 stated that "*The laboratory course helped me both to know the substances and to learn about their dangers*.".

Regarding the eighth question on the Process theme, S1 said, "*Experiments strengthened our knowledge*." while S5 said "*My knowledge about substances and materials has increased*.". Finally, in the Condition theme, S19 said, "*I am not enough yet. There are many things that I am missing*." while S24 expressed his opinion as, "*While I am good at some subjects, I do not know the structure and effects of some substances and their names*.".

As a result, it can be said that students have common views on issues such as enlightenment, learning in theory and practice, learning by doing (experiment effect), the importance of knowing the dangerous effect of a chemical substance, strengthening knowledge with experiments, learning by doing, and they think that they have shortcomings.

DISCUSSION

In the study, students' attitudes towards chemistry laboratory skills were discussed in different dimensions. Thanks to the laboratory studies, the first step of the questions about better recognizing the test equipment and chemical substances was mostly answered with Yes (n=30). This situation can be explained by the fact that laboratory studies in the dimension of recognizing tools and chemicals contribute through different experiences, and therefore they have developed a positive attitude. It is seen that the answers given by the students to both questions are mostly gathered in the Process theme (f=34, f=32). Within the framework of this theme, it has been determined that the students mostly made explanations about the use of materials in the experiments, being practical, learning by doing, sight and touch in recognizing experiment equipment, thanks to laboratory studies. There are studies (Hofstein, 2004; Ibrahim & Karpudewan; 2013; Okebukola, 1986) conducted to investigate the effectiveness of laboratory practices in science education on attitudes towards laboratory and laboratory skills. According to Kaya and Böyük (2011), using a laboratory in science courses is necessary to attract students' attention and ensure effective learning. Practical studies should help students develop their laboratory skills (Gkıoka, 2020).

Within the framework of the Process theme, it has been determined that the students mostly made statements about using the materials continuously in identifying chemical substances, recognizing and not recognizing the substance, learning as they do experiments, thanks to laboratory studies. Some studies show similarities with the results of the research (Berg, Bergendahl, Lundberg & Tiell, 2003; Mutlu & Acar Şeşen, 2020; Tarhan & Acar Sesen, 2010; Ural, 2016). It is possible to realize meaningful and permanent learning thanks to chemistry experiments carried out with the right experiment equipment and appropriate steps. In this context, the importance of gaining more experience comes to the fore. As a matter of fact, Coştu et al. (2005) stated in their study that even pre-service teachers who took laboratory courses could not use laboratory materials correctly and made some mistakes regarding solution preparation. Similarly, in the activity-based study of Cengiz (2017) with pre-service science teachers in the general chemistry laboratory course, the pre-service teachers could not achieve the desired success in solution preparation and solution preparation problems. Alkan (2012) concluded that self-learning did not have a significant effect on the attitude towards the ability to recognize tools and chemicals. In the study conducted by Anılan, Görgülü, and Balbağ (2009), it was determined that pre-service teachers were self-contradictory in their use of

laboratory tools and chemical substances.

In the first phase of the questions about considering the feedback from friends and lecturers in laboratory studies, the answer was mostly Yes (n=28, n=33). This situation can be interpreted in the context of exchanging information about the experiment, confirming the information, and thus making one feel more prepared by evaluating each other. It can be explained as noticing mistakes through informing at the instructor dimension and developing a positive attitude based on the same feeling of confidence in other lessons. It is seen that the answers given by the students to both questions are mostly gathered in the Process theme (f=34, f=18). Within the framework of this theme, explanations were made for the positive effects of taking into account the feedback from friends in laboratory studies. Alkan (2012) concluded that self-learning did not have a significant effect on the attitude towards the ability to consider feedback. In addition, while considering the feedback from the lecturers, explanations were determined for better understanding and facilitating the process. However, in this dimension, the excess of answers in the theme of Information (f=15) draws attention. Within the framework of this theme, it was determined that the students mostly made informative explanations. These results about the contribution of the feedback from the lecturers show parallelism with the findings in the study of Mutlu and Acar Şeşen (2020). In their studies, it has been reported that while the pre-service science teachers were conducting inquiry-based experiments, they were given continuous feedback by the instructor during the learning process. It was emphasized that thanks to these instructions, the candidates were allowed to use different cognitive and affective skills, and they learned by doing and experiencing. The researchers explained the change in the attitudes of pre-service teachers with the feedback given by the instructor.

In the first stage of the questions about influencing the communication with groupmates and lecturers of laboratory studies, the answer was mostly Very well (n=12, n=16). It is also noteworthy that the answer of Well (n=8) was marked too much in the dimension of communication with group mates. This situation can be explained in the context of the emotion and feeling that will occur in the person as a result of the failure of the desired communication. On the other hand, this situation can be evaluated in terms of positive effects such as establishing good relations, being sincere, and sharing that group work will create on individuals. In terms of the instructor, it can be said that the instructors contributed to the development of the students' attitudes as a result of their understanding throughout the process. It is thought that the positive attitudes of the instructors towards the laboratory will guide the knowledge and skills that the students will gain in the laboratory. Coştu et al. (2005) think that the source of teachers' negative attitude towards laboratories may stem from their deficiencies in laboratory practices and using laboratory equipment. Within the framework of the process theme (f=22) in the communication of the students with their group mates, there are mostly teamwork, disagreements in the distribution of tasks, and explanations for the increase in sharing. There are studies that show similarities with this result of the research (Hofstein & Mamlok-Naaman, 2011; Piburn & Baker, 1993). Reid and Shah (2007) emphasized that the university-level chemistry laboratory has an important role in developing of group work skills in students.

In line with the data in the first stage of the question about feeling ready, it can be said that the students mostly feel ready in basic knowledge and skills such as chemical substances and their dangerous effects, manual dexterity, naming substances correctly in the chemistry laboratory. In the dimension of the adequacy of knowledge and skills, the answer was mostly Yes (n=22). This situation can be interpreted as embodying knowledge through experiments, providing easier learning, and allowing them to learn by doing and experiencing, as a result of which they

feel competent in this regard. On the other hand, some students think that they still have deficiencies with the answer of Undecided (n=9). Within the framework of the process theme (f=34, f=18), the students mostly made statements that the experiment had positive effects on them. The finding of Cengiz (2017) that prospective teachers mostly perform permanent and effective learning related to the names and functions of laboratory materials supports this data.

CONCLUSION

The following results were obtained in this study, in which the views about the attitudes towards chemistry laboratory skills of first-year college students studying in science education were examined.

1. It was determined that the majority of the students were able to better define the lab equipment and chemical substances thanks to the laboratory studies and explained this with the Process theme. Being practical, using materials in experiments, learning by doing and experiencing, using materials constantly, recognizing the substance, not recognizing the substance, learning as the experiments are among the prominent explanations.

2. In laboratory studies, it has been determined that taking into account the feedback from their friends contributes to the majority of the students. It has been determined that considering the feedback from the lecturers contributes to all of them. Feedback from their friends was explained as correcting their mistakes, information sharing, teamwork, and learning subjects better. Feedback from the instructors was considered as understanding the points to be considered, making correct/false determinations, reducing the error rate, making experimentation, report writing, performing experiments that could not be done, and informing.

3. The majority of the students stated that the laboratory work affects the communication with their group mates in “Very well” and “Well” degrees. It was determined that they explained this with a common view that group work within the framework of the process theme, disagreements in the distribution of tasks, increasing sharing, and strengthening communication. On the other hand, the majority of students stated that laboratory work affects the communication with the lecturers in “Very well” and “Well” degrees. It was determined that they explained this with common views in the direction of assisting, asking questions comfortably, and strengthening communication within the framework of the theme of feeling.

4. Thanks to the laboratory studies, it has been determined that the students feel ready in the subjects of chemical substance information, the dangerous effect of chemical substance, manual dexterity, and naming knowledge. These are explained with common views such as enlightenment within the framework of the process theme, learning in theory and practice, learning by doing-experimentation (experiment effect), the importance of knowing the dangerous effects of chemicals. On the other hand, it was determined that the majority of the students felt sufficient about the adequacy of knowledge and skills related to the chemistry laboratory. It was determined that they explained this in the theme of the process, such as experiments strengthening knowledge and learning by doing. In the condition theme, it was determined that they explained issues such as thinking that have shortcomings.

As a result, to learn chemistry subjects permanently, it is important that the subjects should be supported by relevant experiments and that they gain first-hand experience. Chemistry is a discipline that allows them to gain knowledge and skills about the subjects because it is based on observation and experimentation and activates all senses. Especially in learning environments where experimental support is provided, comprehension will be easier and thus

the enthusiasm and interest in learning will increase (Ayrancı, 1991). Laboratory environment and opportunities are very important for students to develop positive attitudes towards the laboratory (Okebukola, 1986; Yücel, 2014). For this reason, laboratories should be enriched with sufficient tools and equipment in terms of number and quality, and arrangements should be given importance to take into account the environments that may cause anxiety in students (Ünal & Kılıç, 2016). Aydoğdu (1999) stated that the lack of instructor guidance in chemistry laboratory practices and the difficulties encountered in asking for help from the lecturer are among the difficulties encountered by the students the most.

In line with the results obtained from the study, the following suggestions can be made:

- Students' attitudes towards laboratory skills can be examined by designing an experimental research model.
- By collecting information about other variables that affect attitude and skill variables, the relationship between them or their effects on each other can be examined.
- Attitudes towards chemistry laboratory skills of students from different departments of universities with chemistry laboratory courses with the same content can be examined.
- By designing a qualitative research approach, in-depth information about students' attitudes towards laboratory skills can be obtained through data diversity.

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