Online Science Education Journal *http://dergipark.gov.tr/ofed*
2021; 6(2): 84 - 99.

Qualifications, Problems and Solution Recommendations of Teachers in Science, Engineering and Entrepreneurship Practices[1]

Oğuzhan Köken, *Ministry of National Education, Şırnak, Turkey*
Harun Çelik*, *Kırıkkale University, Faculty of Education, Kırıkkale, Turkey*

*Corresponding Author: haruncelik@kku.edu.tr

To cite this article: Köken, O. & Çelik, H. (2021). Qualifications, problems and solution recommendations of teachers in science, engineering and entrepreneurship practices. *Online Science Education Journal*, *6*(2), 84-99.

Article Info

Article History

Received:
13 June 2021

Accepted:
30 Nov 2021

Keywords

Engineering and entrepreneurship practices
Science education
Science teacher
STEM education

Abstract

The aim of this research is to investigate science teachers` awareness, entrepreneurship levels within the scope ofthe STEM approach and to identify the teachers' competencies, opinions, problems and solution suggestions within the scope of Science, Engineering and Entrepreneurship Practices. In the study, the STEM-Awareness Scale, the Entrepreneurship Scale and a semi-structured interview form developed by the researcher were used as data collection tools. According to the results of the research, it was determined that the STEM awareness levels of science teachers were sufficient, and their STEM awareness did not differ according to gender and professional field. When the entrepreneurship levels of the teachers are evaluated, it is seen that they see themselves as sufficient, and that entrepreneurship does not differ according to gender and professional seniority.In the semi-structured interview results, it was determined that the majority of science teachers did not receive education within the scope of the STEM approach, they found themselves inadequate in the fields of education, encountered many problems while applying STEM, and conditions affected them negatively. The most emphasized situation in the suggestions given by the teachers within the scope of the research is that STEM education should be taken.

INTRODUCTION

Today, rapid progress in fields such as science, technology, mathematics and engineering and the needs of society necessitate a sustainable change on the individual. Bringing 21st-century skills to individuals has become important for countries that want to gain a greater share from science and developing technology. Developed countries 21st-century aim to raise individuals who have critical, analytical and creative thinking skills, who can integrate what they have learned into daily life, who have developed communication skills, who are researching and questioning (National Research Council [NRC], 2009). This process is similar when evaluated on the individual. Because, in the new understanding of education, individuals should be trained with the skills to solve problems, produce information, seek and find information, be creative, use technology significantly, evaluate events with a flexible and holistic perspective, and work as a team. (Hançer, Şensoy, & Yıldırım, 2003). Although traditional methods have a place in education, for example, as a 21st-century skill, it is not active in entrepreneurship education, and therefore new approaches are needed (Berková et al., 2020). Depending on the individual and social developments, different education levels are negatively affected by the changed curriculum. For this reason, it is argued that an interdisciplinary approach is necessary for education reforms, and this need can be fulfilled with STEM (Science-Technology-Engineering-Mathematics) education (Çepni, 2017). The STEM education approach to the current science curriculum may differ from country to country (Ritz & Fan, 2015). The STEM education approach has been included in the science curriculum in Turkey as science, engineering and entrepreneurship practices (MEB, 2018). This study focuses on the practical problems and solution proposals regarding STEM education as a product of the improvement efforts in education that have been continuing since the beginning of the twenty-first century.

Science, Engineering and Entrepreneurship Applications in Science Education

Bybee (2010) defined STEM education as an education system aiming at the integration of science, technology, engineering and mathematics fields with each other. STEM education is not a separate course, but a paradigm in which disciplines such as science and mathematics are blended with technology and engineering-based design applications. Thus, STEM education can be considered an educational process that includes better quality learning by bringing together different and related disciplines and using the information obtained as a result of this learning in daily life, increasing living standards and critical thinking (Yıldırım & Altun, 2015). STEM education is based on interaction through the different disciplines; it contains and aims to develop students' knowledge and life skills through science learning. Therefore, individuals are expected to learn the events related to science within the scope of STEM education, adding better meaning to real life and ensuring permanent learning. The development of countries in scientific and economic fields and its continuity due to this development made it mandatory to support STEM education (Bahar et al., 2018). In order for the student to find a place in life productively in the future, there is a need for active methods that can support entrepreneurship in learning environments (Havlicek et al., 2014). Because STEM education is an approach that aims to train individuals who can produce by following technological and scientific developments (Bray, 2010). Updated curricula and Science in Turkey in 2017, the course "Science and Engineering Applications" unit has been added (Ministry of Education [MEB], 2017). In this context, it is planned to develop engineering skills. In the 2018 curriculum, the term entrepreneurship was added to science and engineering practices, and a joint unit was included under the name of "Science, Engineering and Entrepreneurship Practices" (MEB, 2018). Therefore, the STEM education approach and entrepreneurship be targeted in an integrated process. STEM implementation is planned as a systematic instructional design aiming at an entrepreneurship-oriented learning strategy that integrates entrepreneurship sub-dimensions into learning materials and activities under teacher guidance (Adeyemo, 2009). It is a fact that an individual can develop in entrepreneurship within the scope of STEM education. In this direction, the concept of entrepreneurship also becomes important. Entrepreneurship is the ability to transfer or use knowledge to a new situation and to develop the existing situation by making an effort and carrying out risk activities within the scope of the individual's field. The Ministry of National Education also aimed to gain skills in entrepreneurship and included it in the curriculum. The concept of entrepreneurship in the curriculum in Turkey in 2017, was among the concept to gain life skills considered (MEB, 2017). Entrepreneurship education is defined as a process that allows students to use and develop their skills, take risks and courage, and bring their skills to life. Integration of entrepreneurship into the education system; It is also very important in terms of creating, disseminating, implementing and accelerating new ideas (Çelik, Bacanak, & Çakır, 2015; Özkul & Dulupçu, 2007). Therefore, the concept of entrepreneurship provides new opportunities for both education and the individual. In addition, it should be seen that STEM education understanding, which overlaps many objectives with science education, can develop more entrepreneurial characteristics by indirectly entering the curriculum (Ezeudu, Ofoegbu & Anyaegbunnam, 2013).

Even if the curriculum is fully prepared theoretically (Kubat, 2015), the basic philosophy and vision of the program should be internalized by teachers (Tekbıyık & Akdeniz, 2008), and teachers should contribute to solving the problems that arise during the implementation of the program (Karatepe et al., 2004). Teachers are the ones who will apply whatever changes are made in line with these programs. In this respect, the effectiveness of the renewed science program in practice can be understood from teachers' views (Selvi, 2006). Because for the successful realization of STEM education, it is closely related to the knowledge, skills and experiences of the teachers who provide this education. (Aslan-Tutak, Akaygün, & Tezsezen, 2017).

When the studies on STEM education approach are examined; teachers are unfamiliar with the term STEM (Çevik, Danıştay, & Yağcı, 2017), they want to apply STEM-based courses, but they have problems in procuring time and materials, and that the number of in-service trainings provided is insufficient (Eroğlu & Bektaş, 2016), also they are inadequate to gain engineering and design skills. Sarı and Yazıcı (2019) argue that STEM education is only prone to physics issues, that the cost is high and it creates a limitation proportional to technological insufficiency (Bakırcı & Kutlu, 2018). In studies conducted abroad within the scope of STEM education, it was determined that students studying in schools where STEM education was dominant performed better than students in other schools (Erdoğan & Stuessy, 2015), and STEM education made them eager to teach Mathematics subjects (Elliott et al., 2001). Similarly, McDonald (2016) suggests that a qualified teacher will have a positive effect on student success. On the other hand, teachers practicing STEM education traditionally focused only on science and mathematics teaching (Moore & Smith, 2014), had problems using different disciplines together (Breiner et al., 2012), found the use of engineering design interesting, but it was determined that they did not include them in their classes due to the difficulty (Capobianco, 2011). In addition, the need for teachers to have a comprehensive content knowledge of STEM education (Wang et al., 2011) are important points determined in their overseas studies.

In terms of entrepreneurship, it is stated that the increase of teachers' awareness of STEM will positively reflect on entrepreneurial characteristics, and it is pointed out that there is an important relationship between STEM awareness and entrepreneurial characteristics (Deveci, 2018). One of the important factors in determining entrepreneurial activity in a country is education (Verheul et al., 2002). However, it was stated by the teachers that the activities in the textbooks are not sufficient in terms of developing the concept of entrepreneurship (Bakırcı & Öçsoy, 2017). In this context, one of the closest educational approaches to training individuals with entrepreneurial skills is STEM education (Roberts, 2012; National STEM Education Center, 2014). As a matter of fact, it was stated that the concept of entrepreneurship should be emphasized in STEM education and that the entrepreneurial thinking style complements and improves the knowledge in STEM disciplines (Shahin et al., 2021). In this direction, it is stated that students' entrepreneurial thoughts can be developed with STEM training with first-hand experiences (Jin, Li Yang, & Son, 2015). As Srikoom, Hanuscin, and Faikhamta (2017) stated, teachers' expertise in all areas that make up the STEM training improves the quality of this training. In this respect, it will be beneficial to the literature in terms of evaluating the process from the whole perspective by describing the competencies of teachers about STEM and entrepreneurship skills in science, engineering and entrepreneurship applications through the direct education program and analyzing the findings.

When the studies are classified, it can be seen that the studies are related to STEM education and entrepreneurship. However, Science, Engineering and Entrepreneurship Applications is a new concept in the 2018 curriculum and needs to be examined in detail. Through this change, it is necessary to analyze in detail how 21st-century learning activities will contribute to the individual and how effectively they can be given in line with STEM education understanding.In the study, in line with the ascertainment made, the questions what are the competencies of science teachers in science, engineering and entrepreneurship applications, their problems and their solution suggestions in this context were focused on, and the answers were sought for the following problems:

1. What are the STEM awareness levels of science teachers?
2. Do teachers' STEM awareness differ according to gender and professional seniority?
3. What are the entrepreneurship levels of science teachers?
4. Is there a relationship between gender and professional seniority and teachers' perception of entrepreneurship?
5. What are the competencies of teachers within the scope of Science, Engineering and Entrepreneurship Practices, the problems they face and their solution suggestions for these problems?

METHOD

Study Design

In the study, a mixed method design, in which quantitative and qualitative research designs are considered together, was used. In the research, it was provided to establish a bridge between the two research methods with the mixed research method (Onwuegbuzie & Johnson, 2004). In the study, the sequential explanatory design was preferred among the types of mixed method design. The descriptive method was used as the quantitative research design of the research, and phenomenology (phenomenology) was used as a qualitative research design.

Working Group

The study group of the research consists of 34 Science teachers working in İdil District of Şırnak Province in the 2019-2020 academic year. A convenience accessible sampling method was preferred in determining the research group. A convenience accessible sample brings speed and practicality to the research (Çepni, 2001).

Data Collection Tools

The STEM Awareness Scale (SAS) and the Entrepreneurship Scale were used to collect quantitative data in the study. The STEM awareness scale developed by Çevik (2017) consists of 15 items and is a 5-point Likert type. Çevik (2017) found the general Cronbach Alpha reliability value of the scale 0.82 and the coefficients of each sub-factor 0.70. The Entrepreneurship Scale developed by Deveci and Çepni (2015) has a total of 38 items and is a 5-point Likert type. The Cronbach Alpha reliability coefficient of the study is .77, and the lowest correlation coefficient for Test-Retest reliability is .66 (Deveci & Çepni, 2015).

A semi-structured interview form was used to collect qualitative data. The interview form is used to determine the individual's feelings and thoughts about the subject within the framework of pre-determined questions (Çepni, 2014). The questions were prepared by the researcher and the opinions of the science teachers were taken, and the study was completed by making a pilot application.The final version consisted of 9 questions and the interview period lasted approximately 30 minutes with each participant.

Data Analysis

Descriptive analysis was made in the analysis of quantitative data in the study. The compliance of the data to normal distribution was determined by the Shapiro Wilks test, and a normal distribution was observed. Then, independent samples t-test was used to determine the significant difference for variables. Another criterion that shows whether the difference between the results of the groups in the study is significant is the effect size (Kılıç, 2014). Cohen's d value was calculated for sub-dimensions that differ significantly as a result of the T-Test. Content analysis technique was used in the analysis of qualitative data. In this technique, similar data are brought together within the framework of certain concepts and themes and classified in an order that the reader can understand (Merriam, 2009; Yıldırım & Şimşek, 2011). All forms were given names such as ST1 (Science Teacher 1), ST2, …… and then they were coded by considering the relevant concepts. After these analyzes, themes were determined, categorized, and direct quotations were included.

FINDINGS

The findings obtained from the qualitative and quantitative data determined according to the research problem were given and interpreted separately.

Findings and Interpretation of STEM Awareness Scale

The average and standard deviation results of teachers' STEM awareness scale are given in Table 1.

Table 1. STEM awareness levels of science teachers

Dimensions	N	Mean	SS
Student Effect	34	4.55	.45
Effect on the lesson	34	2.60	.47
Effect on Teacher	34	3.63	.50
STEM (Total)	34	3.59	.36

Table 1. when analyzed, it is seen that the average of the student effect sub-dimension is Strongly Agree, the average of the lesson effect sub-dimension Disagree, the effect on the teacher, and the average of the STEM sub-dimension corresponds to the Agree interval. In order to see the effect of gender on STEM awareness in the study, independent groups t-test was applied and table too presented in.

Table 2. Analysis of STEM awareness scale by gender

STEM Awareness Scale	Gender	N	Mean	SS	SD	t	p	d
Student Effect	Female	16	4.43	.51	32	-1.51	.141	
	Male	18	4.66	.37				
Effect on the Lesson	Female	16	3.76	.42	32	-1.07	.292	
	Male	18	3.93	.50				
Influence on Teacher	Female	16	21.19	.46	32	-2.12	.042	.73
	Male	18	14.2	.49				
STEM (Total)	Female	16	4.09	.34	32	-2.22	.034	.76
	Male	18	4.33	.29				

*p<.05

Table 2. when examined, it was determined that there was no statistically significant difference in the sub-dimensions of the scale in terms of the student effect and the effect on the lesson sub-dimensions according to gender (t (32) = - 1.51, t (32) = - 1.07, p> .05). It was determined that the scores of the science teachers STEM (total) and the effect on teacher sub-dimension show a statistically significant difference according to gender (t (32) = - 2.22, t (32) = - 2.12, p <.05). In Cohen's d calculation made to determine the importance of the difference between the results of this situation, which emerged in these sub-dimensions, it was determined that the difference between the two groups was significant. In order to understand whether the duty years of the group participating in the study coincide with different years and whether this situation differs on STEM, independent groups t-test has been applied and is presented in Table 3.

Table 3. Analysis of STEM awareness scale by professional seniority

STEM awareness scale	Year of duty	N	Mean	SS	SD	t	p
Student effect	1-5	25	4.47	.45	32	-1.83	.076
	6-10	9	4.78	.40			
Effect on the lesson	1-5	25	3.83	.43	32	-.432	.669
	6-10	9	3.91	.58			
Influence on teacher	1-5	25	4.18	.53	32	-.073	.942
	6-10	9	4.19	.45			
STEM (Total)	1-5	25	4.18	.33	32	-1.194	.241
	6-10 Year	9	4.33	.36			

*****p<.05

When the average scores of science teachers in all sub-dimensions of the scale were examined, although it increased as the seniority level increased, this difference obtained was not statistically significant (t (32) = - 1.83, t (32) = -. 432, t (32) = - .073, t (32) = - 1.194, p> .05).

Findings and Interpretation of the Entrepreneurship Scale

Average and standard deviation results within the scope of the responses given to the scale applied to measure the entrepreneurship levels of the study group are given in Table 4.

Table 4. Entrepreneurship Levels of Science Teachers

Dimensions	N	Mean	SS
Risk-Taking	34	3.84	0.66
Seeing Opportunities	34	4.08	0.44
Trust Yourself	34	4.21	0.45
Emotional Intelligence	34	3.90	0.40
Being Innovative	34	3.53	0.51
Entrepreneurship (Total)	34	3,92	0.33

Table 4. when analyzed, the average of risk-taking, seeing opportunities, emotional intelligence, being innovative and entrepreneurship (total) sub-dimensions coincided with the Agree interval. In the self-confidence subscale, the average score is in the range of "Completely

Agree". Within the scope of the research, in order to see the effect of gender on the perception of entrepreneurship, independent groups t-test analysis is given in Table 5.

Table 5. Analysis of entrepreneurship scale according to gender

Entrepreneurship Scale	Gender	N	Mean	SS	SD	t	p
Risk-Taking	Female	16	3.64	.76	32	-1.67	.11
	Male	18	4.01	.51			
Seeing Opportunities	Female	16	3.97	.45	32	-1.34	.19
	Male	18	4.17	.42			
Trust Yourself	Female	16	4.27	.40	32	.66	.52
	Male	18	4.17	.49			
Emotional Intelligence	Female	16	3.94	.36	32	.55	.59
	Male	18	3.86	.44			
Being Innovative	Female	16	3.63	.58	32	1.08	.29
	Male	18	3.44	.45			
Entrepreneurship(Total)	Female	16	3.90	.36	32	-.39	.70
	Male	18	3.94	.31			

*p<.05

When the data were examined, it was determined that all sub-dimensions of the Entrepreneurship Scale did not show a statistically significant difference according to gender (t (32) = - 1.67, t (32) = - 1.34, t (32) =. 66, t (32) =. 55 t (32) = 1.08, t (32) = -. 39 p> .05). Independent groups t-Test was applied to understand the difference of years of duty in the study group and whether this situation differentiated on entrepreneurship. The analysis made is presented in Table 6.

Table 6. analysis of entrepreneurship scale by professional seniority

Entrepreneurship Scale	Year of duty	N	Mean	SS	SD	t	p
Risk-Taking	1-5	25	3.76	.66	32	-1.134	.265
	6-10	9	4.05	.64			
Seeing Opportunities	1-5	25	4.02	.43	32	-1.245	.222
	6-10	9	4.23	.46			
Trust Yourself	1-5	25	4.17	.42	32	-.934	.357
	6-10	9	4.33	.51			
Emotional İntelligence	1-5	25	3.91	.34	32	.189	.851
	6-10	9	3.88	.57			
	1-5	25	3.58	.52			

Being Innovative					32	.932	.358
	6-10	9	3.40	.49			
	1-5	25	3.90	.33			
Entrepreneurship(Total)					32	-.717	.479
	6-10	9	3.99	.33			

*****p<.05

When the analysis was examined, it was determined that there was no significant difference in all sub-dimensions (t (32) = - 1.134, t (32) = - 1.245, t (32) = -. 934, t (32) =. 189, t (32) = bw.932, t (32) = -. 717 p> .05).

Findings of Qualitative Data

In this section, findings obtained from the semi-structured interview questions are included. The problems experienced by the science teachers within the scope of Science, Engineering and Entrepreneurship Practices are given in Table 7.

Table 7. Teachers' views regarding the problems experienced within the scope of STEM education

Theme	Codes	f	%
Problems Encountered in the Application of STEM Education	Lack of material affects application	38	17
	I don't know STEM, and therefore I can't apply	28	12.5
	Lack of laboratory negatively affects the application	20	8.93
	I did not receive STEM training	18	8.04
	Too much class size affects practice	17	7.59
	I cannot associate the curriculum with STEM	12	5.36
	Time problem is affecting the application	12	5.36
	I cannot reflect the (cognitive, affective and psychomotor) skills in line with STEM education	10	4.46
	I cannot apply STEM to every Science subject	10	4.46
	Economic insufficiency affects the implementation	10	4.46
	Physical insufficiency of the school	8	3.57
	I cannot relate between Science and Mathematics	7	3.12
	Students' literacy problem	7	3.12
	Lack of possibilities	7	3.12
	The exam system is a problem	4	1.78
	Family indifference affects practice	4	1.78
	Technological deficiency	4	1.78
	Students' Math problem affects practice	3	1.34
	I did not receive practical training	3	1.34
	I do not apply STEM due to subject density	2	0.89

Table when examined, it was determined that there are many problems teachers have experienced within the scope of STEM education. Some teachers' views on the subject; ST29: “I did not receive any training related to STEM education.” ST16: “I do not consider yourself competent. Because I mostly support the reading, comprehension and writing activities of the students.” ST3: “Although not in every subject, I try to apply especially in physics related subjects. In this context, I think that more time should be given for these applications in the curriculum.”, ST9: “The material and the physical condition of the school affect the practice. Some shortcomings can be compensated, but there are cases where there is no compensation. For example, the class size.”, ST4: “In some schools, teachers cannot find even an empty classroom, in some other schools, the lack of opportunities in our region, the insufficiency of the schools, the situation such as the lack of opportunities of the student affects STEM implementation negatively in the form.” They also provided solutions to the problems of teachers' STEM education. The suggestions stated by the research group are presented in Table 8.

Table 8. Solution suggestions from the working group

Theme	Codes	f	%
Solution Suggestions for STEM Education	STEM training for teachers	20	16
	Establishing technological infrastructure	12	9.6
	Material coverage for STEM should be provided	12	9.6
	Integration of teachers with the STEM approach	11	8.8
	Time should be allowed to apply STEM in lessons	9	7.2
	Planning schools for STEM education	9	7.2
	Classroom integration with STEM	9	7.2
	Ensuring equal opportunity and opportunity	8	6.4
	Achievements are STEM-focused	7	5.6
	Attention should be paid to regional situations with STEM application	7	5,6
	Self-improvement of teachers	5	4
	STEM education being practical rather than theoretical	4	3.2
	The courses are intertwined with STEM education	4	3.2
	Integration of the curriculum with STEM	3	2.4
	Science and Mathematics integration in undergraduate education	3	2.4
	Elimination of teacher shortage	2	1.6

Table 8 when examined, it is the most shared suggestion that teachers should receive STEM education. Teachers' opinions on this subject; ST5: "I think that teachers' deficiencies should be eliminated, teacher shortages should be eliminated, children should receive proper education from the very beginning, equality of opportunities should be ensured." ST24: "The conditions for teachers, schools, the region and even the country should be provided for STEM.", ST33: " According to STEM, it means helping schools for STEM, organizing it, and developing materials that can be used many times.”, ST6: “Since STEM is an applied education after all, situations such as students' teacher shortage should be eliminated, and literacy should be completed will reduce the problems. It would be nice to give education to science teachers to use mathematics while undergraduate education is given.”

DISCUSSION

Within the scope of the research, it was determined that the STEM awareness levels of the teachers were sufficient.There are many studies with similar results (Duygu, 2018; Ciğerci, 2020). Cigerci (2020) found in his thesis that teachers' STEM awareness was high. In the analysis of the gender dimension in The STEM awareness scale, a significant difference was found in the sub-dimensions of "Effect on Teacher" and "STEM".In addition, it was determined that the significant difference was considered significant with Cohen's d calculation made as a result of this significant difference. When studies similar to this study were examined, they found it significant in terms of the gender factor (Karakaya et al., 2018). In other studies, there is no significant difference between the gender factor and STEM awareness (Çevik, Danıştay, & Yağcı, 2017; Kızılot, 2019). It was determined that the STEM awareness of science teachers did not differ significantly in all sub-dimensions according to professional seniority. Cigerci (2020) stated in his thesis that there is no significant difference between the STEM awareness level of teachers and professional seniority. Likewise, Özdemir and Cappellaro (2020) found in their study that there is no significant difference between STEM awareness and professional seniority. Unlike the results of the research, Şahin (2019) stated in his thesis that the STEM awareness of teachers with professional seniority of 1-5 years is higher, while Avcı (2014) stated in his study that the level of technological knowledge generally decreases as professional seniority increases.

It has been determined that science teachers consider themselves competent within the scope of the answers they gave to the Entrepreneurship Scale. Similar to this situation, it has been determined in other studies that teachers' entrepreneurship characteristics are high (Pan & Akay, 2015; Köstekçi, 2016). When the entrepreneurship status is examined in terms of gender variable, it is determined that there is no significant difference. Similarly, in their study, Pan and Akay (2015) stated that there is no significant difference in entrepreneurship by gender. Yılmaz and Sünbül (2009) found a similar result in their study. At the same time, it was determined that there was no significant difference in the entrepreneurship scale in general and in all sub-dimensions according to the years of professional seniority of the teachers. However, in another study, it was stated that the entrepreneurship perceptions of teachers with 1-5 years of professional seniority were composed of standard information, and they were not aware that the concept of entrepreneurship was included in the curriculum (Deveci, 2017).

In this part of the study, the findings of the qualitative data collection tool are discussed and concluded. The majority of the teachers stated that they did not receive any training on STEM, and they were insufficient in knowledge even about how the STEM approach was. Timur and İnançlı (2018) stated that the participants did not have enough information about STEM education. Stohlmann et al. (2012), on the other hand, stated that teachers have problems in STEM practices and they consider themselves inadequate. Most of the teachers stated that they had problems with associating Science, Engineering and Entrepreneurship Practices with science subjects and that they could be done more in physics. Similarly, Eroğlu and Bektaş (2016) think that teachers' activities with STEM mostly fall into the subject area of physics lessons. In addition, it was found that teachers had problems with associating science and mathematics with the STEM interdisciplinary approach. Kızılay (2016), on the other hand, is the result of his study that there is mostly a one-way relationship between science and mathematics. Karaer (2006) stated in his research that the students' lack of mathematics also affects their situation towards science lessons. Yaman et al. (2017) stated that teachers' problems include not knowing the curriculum of other fields within the scope of their studies.

Science teachers stated that the concept of time, lack of laboratories, lack of materials affect the application, and the inadequacy of the economic level of the student and the class size prevent STEM activities. In other studies, it has been stated that there are limitations in terms of STEM (Bakırca & Kutlu, 2018). They stated that they also had problems in acquiring cognitive, affective and psychomotor skills. Teachers in science teaching will also address the individual differences and interests of students by using different disciplines together (Hacıoğlu, Yamak and Kavak, 2016). In fact, they stated that these skills could be gained with STEM education, but they stated that lack of knowledge prevents this. Çavaş et al. (2013) stated in their study that learning science meaningfully and developing these skills will be through STEM-based lesson activities. One of the striking points of the study is that the regional situation affects STEM. In fact, most of these problems mentioned by the teachers are expressions that stem from the regional situation. These are the situations that are dealt with regionally in cases such as family indifference and after-school assistance to the family. Karakaya and Avgın (2016) conclude in their study that the education level of the parents affects the students' attitudes towards STEM. Buschor et al. (2014) stated that individuals who feel the support of family members are more interested in STEM fields.

In addition, they emphasized that they experienced problems with STEM education due to the exam system factor. It is also noteworthy that it is a problem to conduct 8^{th}-grade students with STEM education in terms of the high school entrance exam factor, especially regarding the exam. At the same time, it may be a separate research on how much STEM activities will be performed by teachers who are enrolling in science classes even though they do not have their own branch. The teachers stated that these affected the implementation, and they also stated as a result of the study that they were not familiar with the sample projects. Similarly, Siew, Amir, and Chong (2015) stated in their study that STEM activities are costly, schools should be equipped with technological equipment, and school laboratories need science and technology materials to implement their designed products. Demir et al. (2011) stated that there are no laboratories in many schools in our country and that the materials in schools with laboratories are lacking. Eroğlu and Bektaş (2016) stated in their study that teachers experienced problems in STEM-based lessons. Stohlmann et al. (2012), stated that teachers had problems in STEM practices and saw themselves inadequate. In addition, studies have found that professional development is important in STEM education (Apedoe, Reynold, Ellefson, & Schunn 2008). Within the scope of the study, it can be concluded that most of the problems mentioned here are STEM problems throughout the country. The positive aspects of the study were also determined within the scope of the opinions that some teachers tried to process their lessons with STEM education, paid attention to classroom management and ethical principles, and wanted to learn the STEM approach.

Teachers also provided solutions to the problems they stated within the scope of Science, Engineering and Entrepreneurship Practices. It is one of the suggestions that teachers should receive STEM training and that this training should be more practical than theoretical. They emphasized that equality of opportunity and technology should be ensured, attention should be paid to STEM practices, economic inadequacy should not be reflected in the STEM activities of the students, STEM activities should be brought to the level they can do and materials should be provided. In addition, there were some remarkable solution suggestions that the curriculum should be fully identified with STEM education and that the physical conditions of schools should coincide with STEM, which is the requirement of the age. Similarly; STEM education should be widespread both in schools and in activities outside of school (Yamak et al., 2014), teachers need education covering science and engineering applications (Sarı & Yazıcı, 2019), and that the infrastructure such as financial, human and planning should be sufficient for STEM activities to be efficient. (Thibaut et al., 2018) stated that teachers should develop materials related to science subjects through the engineering process (Marulcu & Sungur, 2012). In addition, Bers and Postmore (2005) draw attention to the necessity of teaching new approaches, methods and techniques to teachers in their studies.

CONCLUSION

This study aimed to determine the competencies of science teachers in Science, Engineering and Entrepreneurship Practices, the problems they experienced in the face of the application and the solution suggestions for those. The results obtained in this context are presented below, taking into account the notable factors.

Science teachers' STEM awareness levels are sufficient regardless of gender and professional seniority. Similarly, it was observed that science teachers were highly positive in their Entrepreneurship skills, without being affected by the variables of gender and professional seniority. Therefore, it can be said that teachers' awareness of both STEM education and Entrepreneurship skills is sufficient for science, engineering and entrepreneurship practices. However, the lack of applied in-service training, the intensity of the curriculum, the lack of materials and exam anxiety, and the learning cultures of students for STEM education have emerged as problems that reduce the efficiency of science, engineering and entrepreneurship applications. On the other hand, designing learning environments in accordance with STEM applications, supporting the content of the curriculum in performing STEM activities, and providing practical vocational training draw attention as solution suggestions.

Limitations and Future Research

This study reflects teachers' experiences and competencies in a limited area as professional experience. Within the scope of Science, Engineering and Entrepreneurship Practices, science teachers should be given training within the scope of the STEM approach and how they can implement STEM with the opportunities in their region. Since the workshop knowledge and application skills of STEM applications are required, teachers should be trained on this subject. Teachers should be informed about how to apply science teaching with STEM. In order for teachers to adopt the STEM approach, regional opportunities to participate in projects and studies should be expanded. In future studies, teachers with higher seniority years can be worked within the scope of STEM education. Within the scope of the effect of regional situations on STEM, different qualitative studies can be conducted that adopt the views of students. Studies in which teachers' opinions are taken to investigate the effect of the situation of schools on STEM application can also be conducted.

REFERENCES

Adeyemo, S. A. (2009). Understanding and acquisition of entrepreneurial skills: A pedagogical reorientation for classroom teacher in science education. *Journal of Turkish Science Education, 6*(3), 57-65. Retrieved from: https://www.tused.org/index.php/tused/article/view/125

Apedoe, X.S., Reynolds, B., Ellefson, M.R., & Schunn, C.D. (2008). Bringing Engineering Design into High School Science Classrooms: The Heating/Cooling Unit, *Journal of Science Education and Technology, 17(5)*, 454-465. Retrieved from: https://www.learntechlib.org/p/166658/.

Aslan-Tutak, F., Akaygun, S., & Tezsezen, S. (2017). Collaboratively Learning to Teach STEM: Change in Participating Preservice Teachers' Awareness of STEM. *Hacettepe University Journal of Education, 32*(4), 794-816. https://DOI : 10.16986/HUJE.2017027115

Avcı, S. (2014). *Ortaokul eğitim yöneticilerinin bilgi yönetimi yeterlilikleri (Bağcılar ilçesi örneği)* [Secondary school administrators' knowledge management competencies (Examples country Bağcılar)], Unpublished master dissertation. Aydın University, Institute of Social Sciences, İstanbul.

Bahar, M., Yener, D., Yılmaz, M., Emen, H., & Gürer, F. (2018). The Changes of Standards in the 2018 Science Curriculum and STEM Integration. *Abant İzzet Baysal* University *Journal of Faculty of Education*, *18*(2), 702-735. https://doi.org/10.17240/aibuefd.2018..-412111

Bakırcı, H., & Kutlu, E. (2018). Determination of Science Teachers' views on STEM Approach. *Turkish Journal of Computer and Mathematics Education*, *9*(2), 367-389. https://DOI: 10.16949/turkbilmat.417939

Bakırcı, H., & Öçsoy, K. (2017). An Investigation of the Activities in Science Textbooks in terms of the Concept of Entrepreneurship. *Adıyaman University Journal of Educational Sciences*, *7*(2), 256-276. https://DOI: http://dx.doi.org/10.17984/adyuebd.322438

Berková K., Frendlovská D., Pospíšil Závodný J., Vojáčková H., & Kolářová D. (2020). Education towards Entrepreneurial Careers in a Czech College: An Empirical Study. *Journal on Efficiency and Responsibility in Education and Science*, *13*(1), 1-9. http://dx.doi. org/10.7160/eriesj.2020.130101

Bers, M. U., & Portsmore, M. (2005). Teaching partnerships: Early childhood and engineering student teaching math and science through robotics. *Journal of Science Education and Technology*, *14*(1), 59-73. https://doi.org/10.1007/s10956-005-2734-1

Bray, J. H. (2010). *Psychology as a core science, technology, engineering, and mathematics (STEM) discipline*. Washington DC: American Psychological Association.

Breiner, M. J., Johnson, C. C., Harkness, S. S., & Koehler, C. M. (2012). What is STEM? A discussion about conceptions of STEM in education and partnerships. *School Science and Mathematics, 112*(1), 3-11. https://doi.org/10.1111/j.1949-8594.2011.00109.x

Buschor, C., Berweger, S., Frei, A., & Kappler, C. (2014). Majoring in STEM—What accounts for women's career decision making? A mixed methods study. *The Journal of Educational Research, 107*(3), 167-176. https://doi.org/10.1080/00220671.2013.788989

Bybee, R. W. (2010). Advancing STEM Education: A 2020 Vision. *Technology and Engineering Teacher*, *70* (1), 30-35.

Capobianco, B. M. (2011). Exploring a science teacher's uncertainty with integrating engineering design: An action research study. *Journal of Science Teacher Education, 22*, 645-660. https://doi.org/10.1007/s10972-010-9203-2

Ciğerci, D. (2020). *Okul yöneticilerinin ve öğretmenlerin FeteMM eğitimine yönelik farkındalıklarının incelenmesi [Investigation of STEM awareness of the teachers and school administrators]*. Unpublished master dissertation, Maltepe University Graduate School, İstanbul.

Çavaş, B., Bulut, Ç., Holbrook, J., & Rannikmae, M. (2013). Fen eğitimine mühendislik odaklı bir yaklaşım: Engıneer projesi ve uygulamaları [An engineering-focused approach to science education: The Engineering project and its applications]. *Fen bilimleri öğretimi dergisi*, *1*(1), 12-22. Retrieved from: https://dergi.fead.org.tr/?page_id=137

Çelik, H., Bacanak, A., & Çakır, E. (2015). Development of science laboratory entrepreneurship scale. *Journal of Turkish Science Education,12*(3), 65-78. doi: 10.12973/tused.10147a

Çepni, S. (2014). *Araştırma ve Proje Çalışmalarına Giriş [Introduction to Research and Project Studies]*. 7. Baskı, Trabzon: Cepheler Yayıncılık.

Çepni,S. (2017). *Kuramdan Uygulamaya STEM (+A/+E) Eğitimi. [STEM (+ A / + E) Education from Theory to Practice]*. Ankara: PegemA Yayıncılık.

Çevik, M. (2017). A study of STEM Awareness Scale development for high school teachers. *Journal of Human Sciences*, *14*(3), 2436-2452. doi:10.14687/jhs.v14i3.4673

Çevik, M., Danıştay, A., & Yağcı, A. (2017). Evaluation of STEM (Science – Technology – Engineering – Mathematics) Awareness of Secondary School Teachers with Various Variables. *Sakarya University Journal of Education*, *7*(3), 584-599. DOI: 10.19126/suje.335008

Demir, S., Böyük, U., & Koç, A. (2011). Views of Science and Technology Teachers on Laboratory Conditions and Use of Laboratory with Their Tendencies to Follow Technological Innovations. *Mersin University Journal of the Faculty of Education*, *7*(2), 66-79. Retrieved from: https://dergipark.org.tr/tr/pub/mersinefd/issue/17378/181450

Deveci, İ. (2018). The STEM Awareness as Predictor of Entrepreneurial Characteristics of Prospective Science Teachers. *Kastamonu Education Journal*, *26*(4), 1247-1256. doi:10.24106/ kefdergi.356829

Deveci, İ., & Çepni, S. (2014). Entrepreneurship in Science Teacher Education. *Journal of Turkish Science Education*, *11*(2), 161-188. doi: 10.12973/tused.10114a

Duygu, E. (2018). *Simülasyon tabanlı sorgulayıcı öğrenme ortamında Fetemm eğitiminin bilimsel süreç becerileri ve Fetemm farkındalıklarına etkisi [The effect of STEM education on science process skills and STEM awareness in simulation based inquiry learning environment]*. Unpublished master dissertation. Kırıkkale University Institute of Science, Kırıkkale.

Elliott, B., Oty, K., McArthur, J., & Clark, B. (2001). The effect of an interdisciplinary algebra/ science course on students' problem solving skills, critical thinking skills and attitudes towards mathematics. *International Journal of Mathematical Education in Science and Technology*, *32*(6), 811-816. https://doi.org/10.1080/00207390110053784

Erdogan, N., & Stuessy, C. (2015). Examining the Role of Inclusive STEM Schools in the College and Career Readiness of Students in the United States: A Multi-Group Analysis on the Outcome of Student Achievement. *Educational Sciences: Theory and Practice*, *15*(6), 1517-1529. DOI 10.12738/estp.2016.1.0072

Eroğlu, S., & Bektaş, O. (2016). STEM eğitimi almış fen bilimleri öğretmenlerinin stem temelli ders etkinlikleri hakkındaki görüşleri [Ideas of Science Teachers took STEM Education about STEM based Activities], *Journal of Qualitative Research in Education*, *4*(3), 43-67. DOI :10.14689/issn.2148-2624.1.4c3s3m

Ezeudu, F. O., Ofoegbu, T. O., & Anyaegbunnam, N. J. (2013). Restructuring STM (science, technology, and mathematics) education for entrepreneurship. *US-China Education Review A*, *3*(1), 27-32. Retrieved from: https://files.eric.ed.gov/fulltext/ED539960.pdf

Hacıoğlu, Y., Yamak, H., & Kavak, N. (2016). Teachers' Opinions Regarding Engineering Design-based Science Education. *Bartin University Journal of Faculty of Education*, *5*(3), 807-830. Doi: 10.14686/buefad.v5i3.5000195411

Hançer, A. H., Şensoy, Ö., & Yıldırım, H. (2003). An Evalatıon about the Importance of Contemporary Scıence Educatıon at Elementary Schools and How This Kind of Science Teaching Must Be. *Pamukkale University Journal of Education*, *13*(1), 80-88. Retrieved from: https://dergipark.org.tr/tr/pub/pauefd/issue/11130/133116

Havlicek, J., Pelikan, M. & Birdthistle, N. (2014). Dreams of the Future: An Examination of Czech and Irish Tertiary Level Students Intention to be an Entrepreneur, In: *Proceedings of the 37th ISBE Conference*, Manchester, p. 12.

Jin, K., Li, H., Yang, L., & Song, Q. (2015). Introducing Entrepreneurship Thinking into STEM Curriculum through Hands-on Projects. *International Conferences New Perspectives in Science Education*, Edition 3, Florence, Italy.

Karaer, H. (2006). Opinions of Science Course Teachers about the Subject Teaching in Primary School (Amasya Sample). *Erzincan University Journal of Education Faculty*, *8*(1), 97-111. Retrieved from: https://dergipark.org.tr/tr/pub/erziefd/issue/5996/79805

Karakaya, F., & Avgın, S. S. (2016). Effect of demographic features to middle school students' attitude towards FeTeMM (STEM). *Journal of Human Sciences*, *13*(3), 4188-4198. Retrieved from: https://www.j-humansciences.com/ojs/index.php/IJHS/article/view/4104

Karakaya, F., Ünal, A., Çimen, O., & Yılmaz, M. (2018). STEM Awareness Levels of Science Teachers. *JRES*, *5*(1), 124-138. Retrieved from: https://dergipark.org.tr/tr/download/article-file/496663

Karatepe, A., Yıldırım, H.İ., Şensoy, Ö., & Yalçın, N. (2004). Teachers' Views About Current Science Curriculum Appropriateness for Acquiring the Aims of Science Education. *Gazi University Kırşehir Journal of Education Faculty*, *5*(2), 165-175. Retrieved from: https://dergipark.org.tr/tr/pub/kefad

Kılıç, S. (2014). Effect size, *Journal of Mood Disorders*, *4*(1), 44-46. DOI: 10.5455/jmood.20140228012836

Kızılay, E. (2016). Pre-Service Science Teachers' Opinions About STEM Disciplines and Education. J*ournal of Academic Social Science Studies*, *47*, 403-417. http://dx.doi.org/10.9761/JASSS346

Kızılot, M. (2019). *Fen Bilgisi Öğretmen Adaylarının Entegre FeTeMM Öğretimi Yönelimlerinin ve FeTeMM Farkındalıklarının Belirlenmesi [Pre-service Teachers' Integrative STEM Teaching Intention and Awareness of STEM]*. Unpublished master dissertation, Onsekiz Mart University Institute of Education Sciences, Çanakkale.

Köstekçi, E. (2016). *Öğretmen adaylarının girişimcilik özellikleri ile yansıtıcı düşünme düzeyleri arasındaki ilişkinin incelenmesi [Examining the Relationship Between Entrepreneurship Characteristics and Reflective Thinking Levels of Pre-service Teachers]*. Unpublished master dissertation, Bartın University Institute of Education Sciences, Bartın.

Kubat, U. (2015). Evaluation of Content and Objectives of fifth Grade Science Curricula in Views of Science Teacher. *Turkish Studies*, *10*(11), 1061-1070. http://dx.doi.org/10.7827/TurkishStudies.8661

Marton, F. (1986). Phenomenography: A research approach to investigating different understanding of reality. *Journal of Thought*, *21*(3), 28-49. Retrieved from: https://www.jstor.org/stable/42589189

Marulcu, İ., & Sungur, K. (2012). Investigating Pre-Service Science Teachers' Perspectives on Engineers, Engineering and Engineering Design as Context. *Afyon Kocatepe University Journal of Sciences*, *12*, 13-23. Retrieved from: https://fenbildergi.aku.edu.tr/1201/012202(13-23)(12-014).pdf

Mcdonald, C. V. (2016). STEM Education : A review of the contribution of the disciplines of science, technology, engineering and mathematics. *Science Education International*, *27*(4), 530-569.

MEB. (2017). Fen Bilimleri Dersi Öğretim Programı [*Turkey Ministry of National Education Science Curriculum*]. Ankara.
MEB. (2018). *Fen Bilimleri Dersi Öğretim Programı* [*Turkey Ministry of National Education Science Curriculum*]. Ankara.
Merriam, S. B. (2009). *Qualitative Research: A Guide to Design and Implementation.* San Francisco: John Wiley and Sons
Moore, T. J., & Smith, K. A. (2014). Advancing the state of the art of STEM Integration. *Journal of STEM Education*, *15*(1), 5-10. Retrieved from: http://mspnet-static.s3.amazonaws.com/Moore_Smith_2014_Advancing_the_Art_of_STEM_Integration.pdf
NRC. (2009). Successful k-12 STEM education: Identifying effective approaches in science, technology, engineering, and mathematics. *Washington* DC: The National Academic Press.
Onwuegbuzie, A. J., & Johnson, R. B. (2004). Mixed methods research. R. B. Johnson, ve L. B. Christensen (Ed.). *Educational research: Quantitative, qualitative, and mixed approaches (s. 408-431)*, Boston, MA: Allyn and Bacon. doi:10.3102/0013189x033007014.
Özdemir, U., & Cappellaro, E. (2020). Elementary School Teachers' STEM Awareness and Their Opinions towards STEM Education Practices. *Fen Bilimleri Öğretimi Dergisi*, *8*(1), 46-75. Retrieved from: https://dergi.fead.org.tr/wp-content/uploads/33.pdf
Özkul, G., & Dulupçu, M. A. (2007). The Effect of Personal Development onto Entrepreneur Types: An Investigation in Antalya-Isparta Provinces. *Girişimcilik ve Kalkınma Dergisi*, *2*, 67-92. Retrieved from: http://gkd.dergi.comu.edu.tr/upload/842f9d86-e749-4e9a-b6a2-7918aa6acb32.pdf
Pan, V. L., & Akay, C. (2015). Examining Teacher Candidates' Entrepreneurship Levels in Terms of Various Variables. *NWSA-Education Sciences*, *10*(2), 125-138. http://dx.doi.org/10.12739/NWSA.2015.10.2.1C063
Ritz, J.M., & Fan, S. C. (2015). STEM and technology education: International state-of-the-art. *International Journal of Technology and Design Education*, *25*, 429–451. https://doi.org/10.1007/s10798-014-9290-z
Roberts, A., & Cantu, D. (2012). Applying STEM Instructional Strategies to Design and Technology Curriculum. *Technology Education in The 21st Century, Proceeding of The PATT 26 Conference*, Linkoping University, Stockholm.
Sarı, U., & Yazıcı, Y.Y. (2019). Science teachers' opinions on science and engineering applications. *International Journal of Social Sciences and Education Research*, *5*(2), 157-167. Retrieved from: https://dergipark.org.tr/tr/download/article-file/689467
Selvi, K. (2006). Developing a Teacher Trainees' Democratic Values Scale: Validity and Reliability Analyses. *Social Behavior and Personality*, *34*(9), 1171–1178. https://doi.org/10.2224/sbp.2006.34.9.1171
Shahin, M., Ilic, O., Gonsalvez, C., & Jon Whittle J. (2021). The impact of a STEM-based entrepreneurship program on the entrepreneurial intention of secondary school female students. *International Entrepreneurship and Management Journal*, https://doi.org/10.1007/s11365-020-00713-7
Siew, N. M., Amir, N., & Chong, C. L. (2015). The perceptions of pre-service and inservice teachers regarding a project-based STEM approach to teaching science. *Springer Plus*, *4*(8), 1-20. https://doi.org/10.1186/2193-1801-4-8
Srikoom, W., Hanuscin, D., & Faikhamta, C. (2017). Perceptions of in-service teachers toward teaching STEM in Thailand. *Asia-Pacific Forum on Science Learning and Teaching*, *18*(2), 1-23. Retrieved from: https://www.eduhk.hk/apfslt/v18_issue2/srikoom/index.htm
Stohlmann, M., Moore, T. J., & Roehrig, G. H. (2012). Considerations for Teaching Integrated STEM Education. *Journal of Pre-College Engineering Education Research (J-PEER)*, *2*(1), Article 4, pp. 28-34. https://doi.org/10.5703/1288284314653
Şahin, B. (2019). *STEM etkinliklerinin Fen Öğretmeni Adaylarının STEM Farkındalıkları, Tutumları ve Görüşleri Üzerine Etkisinin Belirlenmesi [Determination of the effects of STEM activities on STEM awareness, attitudes and opinions of prospective science teachers]*. Unpublished master dissertation, Bartın University Institute of Education Sciences, Bartın
Tekbıyık, A., & Akdeniz, A. R. (2008). Teachers' Views about Adoption and Application of Primary Science and Technology Curriculum. *Necatibey Faculty of Education Electronic Journal of Science and Mathematics Education*, *2*(2), 23-37. Retrieved from: https://dergipark.org.tr/tr/download/article-file/39764
Tezel, Ö., & Yaman, H. (2017). A Review of Studies on STEM Education in Turkey. *Journal of Research in Education and Teaching*, *6*(1), 135-145. Retrieved from: http://www.jret.org/FileUpload/ks281142/File/13.ozden_tezel.pdf
Thibaut, L., Ceuppens, S., De Loof, H., De Meester, J., Goovaerts, L., Struyf, A., . . . Depaepe, F. (2018). Integrated STEM Education: A Systematic Review of Instructional Practices in Secondary Education. *European Journal of STEM Education*, *3*(1), 02. DOI: 10.20897/ejsteme/85525

Timur, B., & İnançlı, E. (2018). Science Teacher and Teacher Candidates' Opinions about STEM Education. *International Journal of Science and Education, 1*(1), 48-66. Retrieved from: https://dergipark.org.tr/tr/download/article-file/549916

Verheul, I., Audretsch, D. B., Thrik, A. R., & Wennekers, A. R. (2002). An eclectic theory of entrepreneurship: policies, institutions and culture, in: D.B. Audretsch, A.R. Thurik, I. Verheul and A.R.M. Wennekers (eds.), Entrepreneurship: Determinants and Policies in a European-US Comparison,. Kluwer Academic Publishers: Boston/ Dordrecht.

Wang, H. H., Moore, T. J., Roehrig, G. H., & Park, M. S. (2011). STEM integration: Teacher perceptions and practice. *Journal of Pre-College Engineering Education Research (J-PEER), 1*(2), Article, 2. https://doi.org/10.5703/1288284314636

Yamak, H., Bulut, N., & Dündar, S. (2014). The Impact of STEM Activities on 5th Grade Students Scientific Process Skills and Their Attitudes Towards Science. *Gazi University Journal of Gazi Education Facult*y, *34*(2), 246-265. https://doi.org/10.17152/gefd.15192

Yıldırım, A., & Şimşek, H. (2008). *Sosyal Bilimlerde Nitel Araştırma Yöntemleri* [Qualitative research methods in the social sciences] *(6. Baskı).* Ankara: Seçkin Yayıncılık.

Yıldırım, B., & Altun, Y. (2015). Investigating the Effect of STEM Education and Engineering Applications on Science Laboratory Lectures. *El-Cezeri Journal of Science and Engineering, 2*(2), 28-40. Retrieved from: https://dergipark.org.tr/tr/pub/ecjse/issue/4899/67132

Yılmaz, E., & Sünbül, A. (2009). Developing Scale of University Students Entrepreneurship. *Selçuk University Journal of Social Sciences Institute, 21*, 195-203. Retrieved from https://dergipark.org.tr/tr/pub/susbed/issue/61797/924383

---

[1] This study was produced from the master's thesis of Science Teacher Oğuzhan Köken, student of Kırıkkale University, Graduate School of Natural Applied Sciences.

Online Science Education Journal *http://dergipark.gov.tr/ofed*
2021; 6(2): 100 - 113.

Student Views on Attitudes towards Chemistry Laboratory Skills

Ayşe Sert Çıbık*, *Gazi University, Gazi Faculty of Education, Ankara, Turkey*
Elvan İnce Aka, *Gazi University, Gazi Faculty of Education, Ankara, Turkey*

*Corresponding Author: sertay@gazi.edu.tr

To cite this article: Sert Çıbık, A. & İnce Aka, E. (2021). Student views on attitudes towards chemistry laboratory skills. *Online Science Education Journal, 6*(2), 100-113.

Article Info

Article History

Received:
31 October 2021

Accepted:
22 Nov 2021

Keywords

Chemistry laboratory
Attitudes towards chemistry laboratory skills
Student opinion

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
Feed back from lectur…	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.

REFERENCES

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

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, Ankara.

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

Ayas, A., Karamustafaoğlu, S., Sevim, S., & Karamustafaoğlu, O. (2002). Genel kimya laboratuvar uygulamalarının öğrenci ve öğretim elemanı gözüyle değerlendirilmesi. *Hacettepe Eğitim Fakültesi Dergisi, 23*, 50-56.

Aydoğdu, C. (1999). Kimya laboratuvar uygulamalarında karşılaşılan güçlüklerin saptanması. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi*, *15*, 30-35.

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

Bal, E. (2012). *5E Modeli merkezli laboratuvar yaklaşımının fizik laboratuvarı dersinde fen bilgisi öğretmen adaylarının tutum ve başarılarına etkisi* (Yayımlanmamış yüksek lisans tezi). Kastamonu Üniversitesi Fen Bilimleri Enstitüsü, Kastamonu.

Batı, K. (2018). Türkiye'de fen eğitimi ve kimya eğitimi laboratuvar uygulamalarına genel bir bakış. *Doğu Anadolu Sosyal Bilimlerde Eğilimler Dergisi*, *2*(1), 45-55.

Berg, C. A. R., Bergendahl, V. C. B., Lundberg, B., & Tibell, L. (2003). Benefiting from an open-ended experiment? A comparison of attitudes to, and outcomes of, an expository versus an open-inquiry version of the same experiment. *International Journal of Science Education*, *25*(3), 351-372. http://dx.doi.org/10.1080/09500690210145738

Cengiz, C. (2017). Fen bilgisi öğretmen adaylarının genel kimya laboratuvarı dersinde aktif öğrenmelerini sağlamaya yönelik bir eylem araştırması. *Dicle Üniversitesi Ziya Gökalp Eğitim Fakültesi Dergisi*, *30*, 574-587.

Çoştu, B., Ayas, A., Çalık, M., Ünal, S., & Karataş, F. Ö. (2005). Fen öğretmen adaylarının çözelti hazırlama ve laboratuvar malzemelerini kullanma yeterliliklerinin belirlenmesi. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi*, *28*, 65-72.

Ekici, G. (2002). Biyoloji öğretmenlerinin laboratuvar dersine yönelik tutum ölçeği (BÖLDYTÖ). *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi, 22*, 62-66.

Gkıoka, O. (2020). Experiments in physics teaching: Towards an approach to laboratory skills development. *Necatibey Faculty of Education Electronic Journal of Science and Mathematics Education*, *14*(1), 1-29.

Hofstein, A., & Mamlok-Naaman, R. (2007). The laboratory in science education: The state of the art. *Chemistry Education Research and Practice*, *8*(2), 105-107.

Hofstein, A. (2004). The laboratory in chemistry education: Thirty years of experience with developments,

implementation, and research. *Chemistry Education Research and Practice, 5*(3), 247-264.
Hofstein, A., & Mamlok-Naaman, R. (2011). High-school students' attitudes toward and interest in learning chemistry. *Educación Química*, *22*, 90-102.
Ibrahim, N. R. M., & Karpudewan, M. (2013). Nanoscience activities improves students' attitude towards learning biology. *Paper presented at the 5th International Conference on Science and Mathematics Education*, CoSMEd 2013, Penang, Malaysia.
Karasar, N. (2004). *Bilimsel araştırma yöntemi* (13. Baskı). Ankara: Nobel Yayın Dağıtım.
Kaya, H., & Böyük, U. (2011). Fen bilimleri öğretmenlerinin laboratuvar çalışmalarına yönelik yeterlikleri. *Erciyes Üniversitesi Fen Bilimleri Enstitüsü Dergisi*, *27*(1), 126-134.
Kozma, R. B. (1982). Instructional design in a chemistry laboratory course: The impact of structure and aptitudes on performance and attitudes. *Journal of Research in Science Teaching, 19*(3), 261-270.
Lang, Q. C., Wong, A. F. L., & Fraser, B. J. (2005). Teacher–student interaction and gifted students' attitudes toward chemistry in laboratory classrooms in Singapore. *Journal of Classroom Interaction*, *40*, 18-28.
Lazarowitz, R., & Tamir, P. (1994). Research on using laboratory instruction in science. In D. Gabel (Ed.), *Handbook of research on science teaching and learning* (pp. 94-128). New York: Macmillan.
Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook*. (2nd ed). Thousand Oaks, CA: Sage.
Millar, R., Tiberghien, A., & Le Maréchal, J. F. (2002). Varieties of labwork: A way of profiling labwork tasks. In D. Psillos, & H. Niedderer (Eds.), *Teaching and learning in the science laboratory* (pp. 9-20). Dordrecht: Kluwer Academic Publishers.
Mutlu, A., & Acar Şeşen, B. (2020). Comparison of inquiry-based instruction in real and virtual laboratory environments: Prospective science teachers' attitudes. *International Journal of Curriculum and Instruction*, *12*(2), 600-617.
Okebukola, P. A. (1986). An investigation of some factors affecting students attitudes toward laboratory chemistry. *Journal of Chemical Education*, *63*(6), 531-532.
Piburn, M. D., & Baker D. R. (1993). If I were the teacher…qualitative study of attitude toward science. *Science Education, 77*, 393-406.
Ramsden, P. (1979). Student learning and perceptions of the academic environment. *Higher Education, 8*(4), 411-427. http://www.jstor.org/stable/3446154
Reid, N., & Shah, I. (2007). The role of laboratory work in university chemistry. *Chemistry Education Research and Practice, 8*(2), 172-185.
Sneddon P. H., & Hill R. A. (2011). Perceptions, views and opinions of university students about chemistry learning during practical work at school. *Chem. Educ. Res. Pract., 12*(3), 312-321.
Sneddon, P. H., & Douglas, R. (2013). The attitudes towards, and experiences of, laboratory teaching in year 1 chemistry and physics university courses. *New Directions in the Teaching of Physical Sciences, 9*(1), 49-54.
Tarhan, L., & Acar Sesen, B. (2010). Investigation the effectiveness of laboratory works related to "acids and bases" on learning achievements and attitudes toward laboratory. *Procedia Social and Behavioral Sciences*, *2*, 2631-2636.
Tobin, K. (1990). Research in science laboratory activities: In pursuit of better questions and answers to improve learning. *School Science and Mathematics, 90*, 403- 418.
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.
Yıldırım, A., & Şimşek, H. (2016). *Sosyal bilimlerde nitel araştırma yöntemleri* (Genişletilmiş 10. Baskı). Ankara: Seçkin Yayınları.
Yücel, E. (2014). *Fen bilgisi öğretmen adaylarının laboratuvar derslerine yönelik öz-yeterlik, tutum ve kaygı puanlarının bazı değişkenlere göre incelenmesi* (Yayımlanmamış yüksek lisans tezi). Sakarya Üniversitesi Eğitim Bilimleri Enstitüsü, Sakarya.