

Evaluation of the Science Laboratory Applications Course in a Pre-service Primary School Teacher Curriculum

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ABSTRACT In this study, the Science Laboratory Applications (SLA) course given in a department of Elementary School Teaching in Turkey was evaluated for effectiveness. A triangulation research design, with mixed methods, was employed based on research data collected via a semi-structured interview form, a Science Experiments Evaluation Rubric (SEER) developed by the researchers, and the researchers' diary notes. The study group included 66 preservice teachers in their second year of study. To select the participants, a maximum variation sampling method was used with the qualitative interviews. The SEER scores were analyzed using the packaged software of SPSS, while interview data were evaluated using content analysis, and descriptive analysis was applied to the researcher's diary notes. The quantitative and qualitative results obtained in the study revealed that preservice teachers achieved the course outcomes as well as the objectives of the curriculum. Based on these results, several suggestions are put forward for future researchers and practitioners.

Keywords Elementary school preservice teacher, Curriculum evaluation, Course of science laboratory applications

1. INTRODUCTION

Today, developments in science regarded as the primary criterion for accepting societies to be developed. Examples of these developments could be said to include those in the areas of technology, astronomy, robotics, and engineering (Hodson, 1988; Topsakal, 1999). In other words, it is essential to know and make use of science not only for facilitating daily life but for the development of a country as well. In this respect, it would not be wrong to say that science constitutes the basis of scientific activities that will allow the development of a country (Abruscato, 1988). Science can define as the effort to understand the causes of a phenomenon occurring in our natural environment, to predict the aspects that might happen in the future, and to take related precautions in advance (Aydoğdu & Kesercioğlu, 2005; Chalmers, 2013).

In Turkey, science teaching starts in the preschool period. In this preschool period, simple activities used to help children develop positive attitudes towards science (Çınar, 2013). In the elementary school period, science taught starting from the 3rd class grade within the scope of the course of science. Turkey has frequently given to science experiments in the curriculum. The Science curriculum designed to be taught in the laboratory in the

majority of the courses. Therefore, almost all schools have a science laboratory. However, the lack of sufficient equipment for the teachers to use the laboratory is an obstacle to the use of laboratories in science classes (MoNE, 2018). For high school students, science divided into three areas, such as physics, chemistry, and biology, and science taught to high school students within the scope of these three courses. However, today, students are not considered to be as successful as expected, although science-related courses intensively taught at high schools (Aslan & Erden, 2018). There might be various reasons for this academic failure in science. Yet, related studies conducted in the field demonstrate that this failure mainly occurs due to a lack of adequate and productive use of the teaching methods and techniques applied in the education processes of high school students (Karamustafaoğlu, Bayar, & Kaya, 2014; Taşkaya & Sürmeli, 2014).

In the teaching/learning process of the course of science, a wide variety of methods and techniques can use as in other courses. In science teaching, besides giving theoretical information, making laboratory applications

Received: 25 April 2020

Revised: 08 July 2020

Published: 31 July 2020

and experiment-aided teaching could be said to be indispensable for effective education (Hofstein & Lunetta, 1982). In the study conducted by Wardani & Winarno (2017), it was stated that laboratory activities are useful in learning science.

In science courses taught in the elementary school period, students face basic science concepts for the first time in their educational lives. Therefore, primary school teachers and/or preservice teachers need to become qualified in the field of science. Laboratory activities play an important role in the teaching of science concepts. Laboratory environments, where theoretical knowledge is tested, and various experiments carried out, facilitates the reinforcement of what is learned (Wakeling, Green, Naiker, & Panther, 2017; Lacey, Campbell, Shaw, & Smith, 2020). The ability of classroom teachers to design and carry out laboratory activities depends on the education they receive during the undergraduate period. Laboratory use skills developed in the undergraduate period will make it easier for classroom teachers to teach practical science in their professional life. However, science lessons to be shown in the laboratory will both attract more attention of children and enable them to carry out continual learning through experiments (Ahmad, Shaharim, & Abdullah, 2017).

During their undergraduate education, elementary school preservice teachers take several courses regarding how to teach science courses and how to select the teaching methods and techniques they will use (Çepni, Ayvaci, Bacanak, Özseveç, & Aydın, 2007). When the undergraduate program applied in the department of Elementary School Teaching is examined, it is seen that one of the courses taken by elementary school preservice teachers with science teaching is the course of “Science Laboratory Applications” (CoHE, 2018). The content of the class of “Science Laboratory Applications” should cover the purpose and importance of laboratory in science teaching, safety in the laboratory, scientific methods, scientific process skills, the way these methods and skills are acquired, laboratory experiments for elementary school students (planning and conducting the experiments and evaluating the results of these experiments), preparing experiment-related worksheets and reports, sample experiments to be performed with simple and cheap materials and group work (CoHE, 2018). In this respect, the undergraduate course of “Science Laboratory Applications” has an essential place in the acquisition of the skills in question, and elementary school teachers should develop their related qualifications in line with the objectives of the course. The goals of the program have achieved to understand, and there is a need for studies on program evaluation. Therefore, assessment of the curriculum of the course of “Science Laboratory Applications” is thought to be beneficial for the training of qualified elementary school teachers.

Laboratories have an essential place in science education. In this regard, it can state that the lessons that improve laboratory skills are crucial. Especially the laboratory practice lessons that prospective teachers take during the undergraduate period have a significant impact on the development of these skills (Shapiro et al. 2015). There are many studies on the importance of the laboratory in science teaching in the international literature. Reviews stating that science teaching in the laboratory is more effective than science teaching in the classical classroom were found. Hofstein and Lunetta (1982), Scruggs and Mastropieri (1990), Fraser and McRobbie (1995), Hofstein and Mamlok-Naaman (2007) and Karacop (2017) have demonstrated the effectiveness of the laboratory on science teaching. Laboratory practices in curriculum turkey in this context can be useful to set out the nature of the course.

Program evaluation is an essential process in education. The purpose of program evaluation should be to reveal the value of the program and to judge the related administrative practices besides determining the learning outcomes for students (Ertürk, 2013; Uşun, 2016). While deciding on whether to go on using a program or not, it is necessary to conduct program evaluation studies to get an idea about the effectiveness of the program and to make decisions regarding the program (Demirel, 2016). Erden (1998) defines program evaluation as the process of collecting data regarding the effectiveness of the program with the help of observation and various other measurement tools, interpreting the data via comparisons with the criteria set as the indicators of the effectiveness of the program, and drawing conclusions related to the effectiveness of the program. According to Sanders and Nafziger (2011), program evaluation is done for the following purposes: determining and improving the strong and weak aspects of the program, predicting the probable problems to be experienced within the scope of the program and dealing with them in advance, determining the educational needs and sources, determining the desired educational outcomes, collecting the information necessary for planning and decision making, and gathering the required data to decrease the educational costs. Ornstein and Hunkins (2016) point out that program evaluation is done to identify students’ performance levels, to determine the strong and weak aspects of the program before and after its implementation and to determine its effectiveness by comparing it with other applications.

The common purpose of program evaluation done in various ways is to evaluate the program in several respects, to determine whether the program functions well, and to make the necessary eventual changes in the program. In line with this common purpose of program evaluation, the present study aimed to find answers to the following questions to reveal the effectiveness of the curriculum of the course of “Science Laboratory Applications (SLA)”:

1. What is the distribution of elementary school preservice teachers' scores in the "Science Experiments Evaluation Rubric"?
2. What are elementary school preservice teachers' views about the course of "Science Laboratory Applications"?
3. What are elementary school preservice teachers' behaviors in the process of their taking the course of "Science Laboratory Applications" according to the researcher's diary notes??

2. METHOD

This study was carried out using a mixed-method research design. The methodologies and techniques applied in mixed-method research are specific to the study; therefore, this method provides the researchers with a wide variety of opportunities (Plano Clark & Ivankova, 2018). The reasons for using this method in studies include triangulation, complementary, development, initiation, and expansion (Greene, Caracelli, & Graham, 1989). In the present study, among these reasons, triangulation was considered to be more appropriate. Data triangulation allows viewing the problem from different perspectives by combining the qualitative and quantitative data collection tools (Guion, 2002).

2.1. Study Group

The quantitative part of the study was carried out with 66 2nd grade preservice teachers attending the department of Elementary School Teaching in the Spring Term of the academic year of 2018-2019. The qualitative interviews held with six volunteering preservice teachers among the 66 participants. The preservice teachers interviewed were coded as T₁, T₂, T₃, and so on. These six preservice teachers selected among those who got low, average, and high levels of scores from the rubric. For this purpose, the maximum triangulation sampling method was used.

2.2. Data Collection Tools

In the study, as the data collection tools, Science Experiments Evaluation Rubric (SEER), a semi-structured interview form, and researcher's diary notes were used. The quantitative aspect of the study, SEER, which made up of three dimensions (things to be done before, during, and after experiments), was used as the data collection tool. The participants' scores in SEER constituted the quantitative aspect of the study. The total scores obtained via SEER were evaluated in the following way: the achievement scores ranging between 90-100 referred to "very good"; achievement scores ranging between 80-89 referred to "good" achievement scores ranging between 70-79 referred to "better than average"; achievement scores ranging between 60-69 referred to "average"; and those lower than 60 referred to "unsuccessful" (Altunova & Artun, 2019). In the development process of SEER, the procedural steps determined by Andrade (1997) were followed. These steps taken in the process of developing SEER were as follows:

1. Step 1: A related literature review for the evaluation of science experiments.
2. Step 2: The criteria, definitions, and score ranges in the rubric were determined.
3. Step 3: The draft rubric prepared.
4. Step 4: The draft rubric piloted.
5. Step 5: Feedback for the rubric was taken (from the students and the faculty member).
6. Step 6: The draft rubric was revised, and the necessary changes made.
7. Step 7: Content and face validity studies conducted.
8. Step 8: The rubric was finalized and made ready for use.

As the data collection tool used for the qualitative dimension of the study, a semi-structured interview form developed by the researchers and researcher's diary notes used. An interview is a data collection technique in which participants respond verbally to a series of questions (Fraenkel, Wallen, & Hyun, 2015).

The researcher's diary notes were the researcher's written statements regarding what he saw, heard, experienced, and thought during the qualitative data collection process. In this diary, the researcher takes notes regarding contextual information about the place, time, data, and focus; descriptive information about the characteristics, attitudes, and behaviors of the individuals observed; descriptive index; observer's comments; and overall comments (Uzuner, 1999). All the in-class observations were noted down in the researcher's diary on each day when the preservice teachers taught for 12 weeks. While taking notes related to the situations in class, the preservice teachers' behaviors examined from different perspectives. In the study, the researcher's diary notes were coded as RD1, RD2, RD3, and so on.

2.3. Data Analysis

The quantitative data collected via the rubric within the scope of the study were analyzed using the packaged software of SPSS 22. For the analysis, descriptive statistics like percentage, frequency, and mean score used to evaluate the preservice teachers' academic achievement. The data collected via the interviews were subjected to content analysis. Content analysis is defined as organizing the data reason following the concepts obtained via the conceptualization of the data and as getting the themes explaining the data accordingly. The researcher's diary notes were analyzed using the descriptive analysis method. Descriptive analysis is a data analysis technique that allows drawing the picture of a current situation or phenomena (Yıldırım & Şimşek, 2013).

2.4. Validity and Reliability

To achieve validity and reliability in scientific studies, Lincoln (1995) suggests using particular strategies like negative situations, obtaining sample information, long-time participation, constant observation, and participant's approval. According to the results of the reliability analysis

Table 1 Preservice teachers' mean scores in SEER

Dimensions	Items	X
Pre-experiment	Wears clothes appropriate to the laboratory (uniforms, gloves, hair restraints, shoe covers, masks, etc.)	4.89
	Brings all the tools to be used for the experiment	4.85
	Presents the report at the beginning of the lesson	4.82
	Writes down the report using his/her own statements	4.62
	Writes legibly and neatly	4.38
	Writes accurately considering Turkish language grammar and spelling/punctuation rules	4.36
	Introduces the materials to the students before the experiment and explains for what purposes the materials will be used	4.35
	Writes a thorough report including all sections	4.08
	Makes comprehensible, satisfactory and full explanations of the subject	3.80
	Makes definitions based on students' views instead of providing direct definitions	3.73
During the experiment	Behaves attentively and carefully while using the materials	4.86
	Conducts the experiment according to the order of the related procedures	4.53
	Tells the students what s/he has done during the experiment	4.17
	Involves the students in the experiment and makes them active in the process	4.15
	Directs questions to the students and informs them about the experimental process	3.77
Post-experiment	Uses the time effectively and productively	5,00
	Cleans the experimental materials and stores the items appropriately	4.82
	Encourages students to speak and tries to learn to what extent they have understood the subject	3.91
	Tests whether or not the students have understood the experiment	3.52
	Tests whether the product obtained is appropriate to the purpose of the subject of the experiment	1,61

conducted using the packaged software of SPSS 22 for the rubric used as the quantitative data collection tool in the study, the Cronbach's Alpha reliability coefficient was calculated as 0.74. In the process of developing the semi-structured interview form, first, the related literature was reviewed to see what kind of questions could be directed concerning science teaching. Following this, three experts in the field asked for their views about the draft interview form prepared. In line with the experts' opinions, the interview form was finalized in a way to include five questions. The validity of the interview form, a female and a male preservice teacher were interviewed within the scope of a pilot application. In order to reveal what participants understand from the questions prepared, it is essential to conduct a pilot application first, which will allow ensuring the validity of the participants' responses to the questions (Türnüklü, 2000). As a result of the pilot application, the interview form was found to be understandable and applicable as a data collection tool, and the research process started.

Before the analysis, the interview forms to be analyzed were read thoroughly, and the internal consistency of the views reported by the same participant was examined. It is seen that all the responses to the questions were consistent and that the participants did not make any contradictory statements. Therefore, the data collected were found to be reliable. After the content analysis was conducted on the data, the codes and themes were formed in order to ensure the reliability of these codes and themes, the reliability

formula suggested by Miles and Huberman (Baltacı, 2017). The analysis of the qualitative data, and the fit value among the three different coders was calculated as 0.81. The reliability ratio found to be higher than 0.70 revealed that the analyses conducted were valid. In order to ensure the reliability of the researcher's diary notes, the audit trail method, another data collection tool used in the study, was used. In this method, the decisions, designs, procedures, and questions used in the analysis process are written down and reflected wholly and attentively. This method involves keeping records of the operations/activities so that future researchers can make use of them. The purpose here is to show the evidence and process that help obtain detailed results (Başkale, 2016).

3. RESULT AND DISCUSSION

This part presents the quantitative and qualitative results in line with the sub-problems.

3.1. Results Related to the Quantitative Data

The scores obtained via SEER constituted the quantitative data in the study. Table 1 shows the mean scores of the preservice teachers regarding the items in SEER.

When table 1 examined, it's seen that the preservice teachers' mean scores were highest for the "pre-experiment" and lowest for the "post-experiment." Concerning the sub-dimension of "pre-experiment," the preservice teachers got the highest mean score for the item of "Wears clothes appropriate to the laboratory (uniforms, gloves,

Table 2 SEER distribution of the preservice teachers' scores

Score Range	Total Score	f	Level
Between 90-100	97	1	*Very good
	94	1	
	93	1	
	92	1	
	91	1	
	90	3	
	Between 80-89	89	
88		3	
87		9	
86		5	
85		2	
84		3	
83		5	
82		6	
81		8	
80		4	
Between 70-79	79	4	***Better than average
	78	3	
	76	1	
Between 60-69	63	1	****Average

*Achievement score between 90-100; ** achievement score 80-89; *** achievement score between 70-79; **** achievement score between 60-69

hair restraints, shoe cover, mask, etc.)" ($\bar{X}=4.89$), the average mean score for the item of "The report has been written legibly and neatly" ($\bar{X}=4.38$) and the lowest mean score for the issue of "Makes definitions based on students' views instead of providing direct definitions" ($\bar{X}=3.73$). In relation to the sub-dimension of "during an experiment," the preservice teachers got the highest mean score for the item of "Behaves attentively and carefully while using the materials" ($\bar{X}=4.86$), the average mean score for the item of "Tells the students what s/he has done during the experiment" ($\bar{X}=4.17$) and the lowest mean score for the item of "Directs questions to the students and informs them about the experimental process" ($\bar{X}=3.77$). In relation to the sub-dimension of "post-experiment," the preservice teachers got the highest mean score for the item of "Uses the time effectively and productively" ($\bar{X}=5.00$), the average mean score for the item of "Encourages students to speak and tries to learn to what extent they have understood the subject" ($\bar{X}=3.91$) and the lowest mean score for the item of "Tests whether the product obtained is appropriate to the purpose of the subject" ($\bar{X}=1.61$). The preservice teachers' total scores in SEER regarded as their general achievement scores. Table 2 presents the distribution of the preservice teachers' scores at the end of the academic term.

When table 2 is examined, it is seen that the preservice teachers' total mean score in the rubric was calculated as 84.18. The preservice teachers mostly got scores in SEER within the range of 80-89 (good; $n=48$). An equal number of preservice teachers ($n=16$) got scores within the fields of 90-100 (excellent) and 70-79 (better than average). Also,

Table 3 Preservice teachers' views about SLA

Codes	General	Evaluation	f
	Regarding SLA		
	Learning by experience		3
	Being permanent		3
	Allows concretizing		3
	Being entertaining		1
	Being interesting		1
	Developing the ability to do experiments		1
	Increasing sociality		1
	Allowing group work		1

only one preservice teacher got a score within the scope of 60-69 (average). The maximum score the preservice teachers got was 97, while the minimum score was 63. Lastly, the most frequent score was 87.

3.2. Results related to the qualitative data

In the study, the qualitative data were collected via the interviews held with the preservice teachers and the diary notes taken by the researcher. The data collected via the observations and the interviews were used together in a blended manner. The preservice teachers were first asked for their views about the course of Science Laboratory Applications (SLA). Table 3 presents the preservice teachers' overall views about SLA.

According to table 3, the preservice teachers reported views about such benefits of SLA as allowing students to learning via experience ($n=3$), increasing permanency ($n=3$), allowing concretizing ($n=3$), making lessons entertaining ($n=1$), increasing students' interest with the help of experiments ($n=1$), developing the ability to do experiments ($n=1$), increasing sociality ($n=1$) and allowing group work ($n=1$). It is seen that the preservice teachers mostly emphasize such characteristics of SLA as its being practice-based and its supporting learning via experience. Among the participants, T₂ claimed that the experiments concretized what they had learned within the scope of the science course, saying, "It concretized the abstract points for me. If we concretize these points, then our students will understand them more easily and make better use of them in their future lives."

When the diary notes taken via the in-class observations by the researcher for program evaluation were examined, it is seen that the researcher's diary notes were consistent with the data obtained via the interview forms. The researcher's diary notes demonstrated that the preservice teachers learned by doing and experiencing science experiments. Some of the researcher's observations in the process were as follows:

"Another skill that the students developed was the ability to use tools. The preservice teachers teaching today are more skilled in using tools when compared to the past when they did their first teaching (RD₆)".

In the study, all the preservice teachers interviewed believed that elementary school teachers should do experiments within the scope of the course of science.

Table 4 Preservice teachers' views about the need for doing experiments in science teaching

Main Theme	Views about Doing Experiments	f
Codes	Allows concretizing	2
	Allows trying practical applications	2
	Allows doing effective teaching	2
	Associating theoretical knowledge with daily life	1
	Being permanent	1

Table 4 presents the reasons why preservice teachers supported the need for doing experiments in science teaching.

When Table 4 was examined, it was seen that the preservice teachers reported views about the need for doing experiments in science teaching. All the preservice teachers interviewed believed in the necessity of doing experiments in science teaching. According to the preservice teachers, the reasons for education via experiments included the following: experiments allow concretizing in science teaching (n=2), allow making practical applications (n=2), make teaching effective (n=2), allow associating theoretical knowledge with daily life (n=1) and increase permanency. The preservice teachers interviewed agreed on the need for doing experiments within the scope of the course of science. One of the preservice teachers coded as T₃ stated that doing experiments in science teaching allowed concretizing, saying, "Science is generally an abstract course, and that's why it is necessary to do experiments to concretize the lessons." Another preservice teacher coded as T₅ reported that the course of science is more related to daily life than other classes are,

Table 5 Preservice teachers' views about teaching SLA

Main Theme	Views about Teaching SLA	f	
Codes	Positive	Efficient tools	4
		Individual experiments	2
		Students' selecting the experiments	2
		Lessons taught via applications	2
		Useful measurement and evaluation tools	1
	Negative	Lessons taught in a laboratory	1
		Experiments related to daily life	1
		Feeling relaxed	1
		Lack of experiments	3
		Lack of methodological knowledge	2
Inefficient class management	2		
Lack of content knowledge	1		
Use of a plain language	1		

and s/he pointed to the importance of doing experiments, saying "science is more related to daily life, and it is thus necessary to do experiments so that students can understand the lessons better."

When the researcher's diary notes taken for program evaluation were examined, the preservice teachers thought to do experiments made teaching more effective. The preservice teachers stated that the course was suitable for making practical applications. In relation to this, some of the diary notes taken by the researcher were as follows:

"In addition, the preservice teachers came to the laboratory before the lessons on the day they would teach, and they had the opportunity to do experiments in a laboratory environment before their teaching (RD₇)."

The preservice teachers' views about the way of teaching the course were gathered under two sub-themes: positive views and negative views. Table 5 presents the preservice teachers' views about teaching the course of SLA.

Table 5 shows the preservice teachers' views about teaching the course of SLA. It was seen that the preservice teachers reported more positive aspects of teaching the course of SLA than negative views. The preservice teachers had positive views about the following points related to teaching the course of SLA: The number of tools used in teaching the course was sufficient (n=4); the experiments were individual (n=2); the students had the opportunity to select the experiment they would do (n=2); the lessons included practical applications (n=2); a rubric was used as a measurement and evaluation tool (n=1); the lessons were taught in a laboratory environment (n=1); the experiments were related to daily life (n=1), and the preservice teachers were relaxed while teaching (n=1). On the other hand, the preservice teachers reported negative views about those who taught the course of SLA in following respects: lacking experience (n=3), lacking methodological knowledge (n=2), lacking class management skills (n=1), inefficient in using tools (n=1), lacking content knowledge (n=1) and failing to use an understandable language (n=1).

Some of the preservice teachers' positive views about the flow of the lessons were as follows:

"To me, the evaluation method was quite good. Now, we don't have any doubts or question marks in our minds. Also, we no longer question why we got a lower mark than we had expected. I mean, we now know our mistakes. That was quite beneficial for us because we can see our weaknesses (T₂)."

Besides the preservice teachers who had positive views about the way the course was taught, some others were reporting negative views. The participants' views about the negative aspects of the way the course was taught were as follows:

"In fact, we do the planning, and we think a lot in advance about what to do, but while teaching, we may face difficulties because we are really novice teachers (T₂)."

When the teachers' ways of teaching were examined, it was seen that they mostly had weaknesses in terms of

Table 6 Suggestions to make the SLA course more effective

Main Theme	Suggestions	f
Codes	Number of microscopes should be increased	3
	Number of dynamometers should be increased	1
	Number of visual materials should be increased	1
	There should be a U-shape seating plan	1

professional knowledge and skills. During the interviews, the preservice teachers pointed to their lack of professional knowledge and skills. Some of the observations regarding this issue were as follows:

“While teaching an experiment, the preservice teachers were quite excited. When they fail to involve the class in the lesson, students’ attention is distracted. Thus, the number of students interested in the lesson is decreasing (RD₁)”.

The preservice teachers put forward suggestions to make the course of science laboratory applications more productive, as can be seen in Table 6.

According to Table 6, the suggestions put forward by the preservice teachers to make the course of science laboratory applications more productive were mostly related to the physical sub-structure. It was seen that the preservice teachers’ suggestions were about increasing the numbers of microscopes (n=3), dynamometers (n=1), and visual materials (n=1). Among all the preservice teachers, one thought that a U-shape seating plan could be more effective. One of the preservice teachers put forward the following suggestions to make the course of SLA more productive:

“Also, there were not enough microscopes. Say there are 35 students in one classroom, and you divide these students into four groups. Therefore, almost 6 or 7 students have to use the same microscope, and to me, this decreases the effectiveness of the lesson. In addition, there are no interesting visuals on classroom walls at all. Also, the desks should be organized in U-shape (T₆)”.

3.3. Discussion

At the end of the study, it was seen that the highest mean score of the preservice teachers regarding the things to be done before the experiment belonged to the item related to laboratory tools and clothes appropriate to laboratory conditions (gloves, hair restraints, shoe cover and so on). Getting a high score in this item shows that the preservice teachers paid attention to the safety rules. Besides, the preservice teachers could be said to be efficient in preparing reports. Studies carried out by Duru, Demir, Önen, and Benzer (2011) and by Uluçınar, Cansaran, and Karaca (2004) demonstrate that students have difficulty in writing reports. In the present study, the fact that the students were good at writing reports could be because there were several sample reports written at the beginning of the research process and that they were already used to

writing reports in other courses. The item for which the preservice teachers got the lowest mean score was related to the teaching skills.

According to the results obtained in the study, the highest score of the preservice teachers regarding the sub-dimension of things to be done during the experiment belonged to the item related to the use of tools. Kılıç, Keleş, and Uzun (2015) report that the ability to use laboratory materials develops depending on the frequency of using tools. In the present study, the preservice teachers could be said to become proficient in using tools since they frequently did experiments during the lessons. As mentioned in the researcher’s diary notes, the students who were initially novice at using tools became better at using the correct tools towards the end of the research process. In this respect, the preservice teachers could be said to develop themselves in time. They got an average mean score for the item related to teaching the students in class what they had done during the experiment. In a study conducted by Aslan and Tekin (2015), the researchers pointed out that doing experiments developed the ability to teach. In the present study, the fact that the preservice teachers developed themselves in this respect while doing the experiments might have caused them to get a good score for this item. Therefore, this situation could be the reason why the preservice teachers got low scores in this item of the rubric.

In the study, the highest mean score that the preservice teachers got in the dimension of the post-experiment process belonged to the item related to time management. In one study carried out by Arslan and Umdu-Topsakal (2019), it was revealed that the preservice teachers were quite good at time management. The fact that similar findings were obtained in the present study shows that the preservice teachers were proficient in time management. In addition, for the sub-dimension of post-experiment, the preservice teachers got an average level of the mean score in the item related to giving students the right to express themselves. The lowest score that the preservice teachers got for the sub-dimension of post-experiment and the whole rubric belonged to the item related to testing whether the product obtained as a result of the experiment served the purpose of the subject or not. In one study, Demir, Büyük, and Koç (2011) found that the preservice teachers experienced difficulties in evaluating the product they obtained at the end of the research process. In the present study, this situation might have occurred because the preservice teachers had not taken any course related to measurement and evaluation.

In the present study, based on the elementary school preservice teachers’ scores in SEER, on their views determined via the interviews and on the diary notes taken by the researcher in the process, it could be stated that all the preservice teachers developed their qualifications to a great extent. Depending on the researcher’s diary notes, it

could indicate that the course of science laboratory applications developed the preservice teachers' ability to do experiments and thus helped them. Not only teach the subjects via experience but also concretize the topics for permanency. According to Avery and Mayer (2012), teachers' effective science teaching depends on their field knowledge to a great extent. Similarly, Jacobs, Martin, and Otieno (2008) point out that teachers' skills have an important place in science teaching. In one study conducted by Yao and Guo (2018), it was found that the effective application of a science curriculum is closely related to teachers' qualifications. Therefore, the researchers emphasize the importance of science teaching in teacher training programs. In another study, Davis, Janssen, and van Driel (2016) reported that teachers' knowledge and skills influenced the frequency and way of their using the materials included in the science curriculum. Based on all these findings obtained in different studies, it could be stated that during their undergraduate education, developing the laboratory usage skills of elementary school teachers who will teach science is essential for effective science teaching.

In the study, the preservice teachers' views about the course of science laboratory applications mostly focused on such issues as learning via experience, permanency, concretizing, being interesting, developing the ability to do experiments, and doing group work. In one study, Levinson (2018) found that learning via experience developed the ability to do experiments, which was, in turn, reflected positively onto science teaching. In another study conducted by Molefe and Stears (2014), the researchers concluded that the experiment-doing skills of teachers who would teach science were influential in their science teaching. In the present study, the results obtained via the rubric, interviews, and researcher's diary notes demonstrated that the course of science laboratory applications developed the preservice teachers' teaching skills. Based on the fact that the preservice teachers got high scores in SEER; that during the interviews, they reported they became more proficient in science teaching; and that positive development was observed according to the researcher's diary, it could be stated that the goals of the course of Science Laboratory Applications were achieved. In this respect, preservice teachers taking the course of laboratory applications could be said to become proficient in the field of science teaching.

In the study, it was seen that all the preservice teachers agreed on the necessity of doing experiments in science teaching. According to the preservice teachers, the reasons for doing experiments in science teaching were as follows: allowing concretizing, facilitating association of what has been learned in class with daily life, contributing to effective science teaching, and increasing permanency. Jacobs, Martin, and Otieno (2008), who claimed that science teaching should be supported with laboratory

activities in teacher training programs, stated that science teaching without doing any experiments would always be short of something. Therefore, the researchers emphasized the need for developing laboratory skills during teacher training. In one study conducted with elementary school students, Eren, Bayrak, and Benzer (2015) reported an increase in the permanency of what the students had learned within the scope of a science course supported with experiments. In the present study, it was also found that the experiments helped the students develop positive attitudes towards the science course.

In the study, it was found that the preservice teachers had positive views about the course in following respects: the number of evaluation tools was sufficient; the experiments were individual; the students had the opportunity to select the experiments themselves; there were several practical applications; a rubric was used as a measurement and evaluation tool; the course was taught in the laboratory, and the experiments were related to daily life. Studies conducted by Arias, Bismack, Davis, and Palincsar (2016), Wardani and Winarno (2017), and Kaya and Büyük (2011) demonstrate that a sufficient number of tools in science laboratories is important for doing experiments. In other studies, Arias, Davis, Marino, Kademian, and Palincsar (2016) and Güneş, Dilek, Topal-Germi, & Nesrin (2013) point out that practical application is important in science teaching and that experiments should thus be included in science teaching. Similarly, in another study carried out by Kelly and Erduran (2019), the researchers reported that doing experiments was necessary for science teaching. In one study, Chan, Rollnick, and Gess-Newsome (2019) found that the use of a rubric had a positive influence on the teaching skills of the participants, which was a finding supporting the results of the present study. In the present study, the evaluation of the in-class activities using SEER helped the students know what they would do. The preservice teachers made great efforts to meet the criteria in SEER and eventually obtained good scores. In this respect, the use of a rubric as a measurement and evaluation tool could be said to be beneficial.

In the study, the preservice teachers had negative views about the way the course of science laboratory applications was taught in the following respects: lack of experience, lack of methodological knowledge, lack of an ability to use tools, and lack of content knowledge. When these negative views were taken into account, it could be stated that the preservice teachers mostly focused on teaching skills. In one study, Yeigh et al. (2016) point out that professional knowledge and skills are important for the profession of teaching and that it is important to acquire these skills and knowledge during preservice training. In another study, Harris and Farrell (2007) found that the teachers who taught science had not been trained well during undergraduate education and that their ways of teaching were not thus sufficiently effective. In one other study, Alt

(2018) reported that the science teachers lacked certain professional qualifications, and the researcher suggested that these deficiencies could be overcome with the help of such methods as distance education and in-service pieces of training. In the present study, the researcher's diary notes, and the interviews revealed that the preservice teachers were not efficient in making practical applications in science teaching. When the items in SEER were examined, it was seen that the preservice teachers got low scores, mostly in relation to professional knowledge and skills. This result could be associated with the fact that they were almost on the halfway of their whole undergraduate education. In addition, this situation might have occurred due to the fact that the preservice teachers participating in the study did not make enough practical applications. This problem could be overcome via more practical applications to be done by preservice teachers.

4. CONCLUSION

When the SEER scores obtained by the preservice teachers were taken into account, it could be stated that they achieved the objectives of the course. For this reason, the overall goals of the program could be said to be achieved to a great extent. In one study conducted by Luft (1999), it was found that the science lessons taught using a rubric developed the preservice teachers' skills in doing experiments. Also, the results obtained via the interviews held with the preservice teachers participating in the present study revealed that following the research process, they developed positive attitudes towards doing experiments in science teaching. Moreover, the diary notes taken by the researcher during the 12-week teaching process revealed that the preservice teachers developed themselves in terms of doing experiments in science teaching. In this respect, it was seen that doing experiments in science teaching developed the preservice teachers with respect to making practical applications, associating with daily life, and teaching effectively. Based on these results, the following suggestions can be made:

1. Within the scope of science course, if students select the experiments themselves that they are interested in and if they do these experiments in class, then the way of teaching becomes more effective. Thus, preservice teachers could be provided with the opportunity to select the experiments to be done.
2. In the study, the rubric used for the evaluation of the in-class activities was found effective in experiment evaluation. In this respect, faculty members teaching science courses could be encouraged to use a rubric in their courses.
3. At the end of the study, it was seen that supporting scientific subjects with experiments in laboratories increased permanency. Therefore, laboratory applications should be used more frequently in science teaching.

4. Laboratory tools should be enough in number for crowded groups. Thus, increasing the number of such tools could be beneficial for teaching science more effectively.

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