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PRESERVICE CLASSROOM TEACHERS' VIEWS OF DISTANCE EDUCATION SCIENCE LABORATORY ACTIVITIES

Research article

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Abstract

This study investigated preservice classroom teachers' views of distance education science laboratory (lab) activities (DESLA). The study adopted a phenomenology design, which is a qualitative research method. The sample consisted of 34 students (25 women and nine men) from the department of classroom teaching of the education faculty of a public university. Participants were recruited using convenience sampling. Data were collected online (Google Forms) via Google Drive using an open-ended question form developed by the researcher based on a literature review and expert feedback. The data were analyzed using content analysis, a qualitative data analysis method. The results showed that participants had positive and negative opinions about DESLA. They had numerous academic, social, and professional experiences but also faced some challenges. They pointed out the pros and cons of DESLA. Most participants stated that they preferred face-to-face science lab activities to DESLA. The results also showed that DESLA improved participants' attitudes towards science lab activities in general.

Keywords: Science laboratory activities, preservice classroom teachers, distance education

1. Introduction

Novel Coronavirus 2019 (COVID-19) is one of the biggest pandemics that has taken hold of the whole world. It has taken its toll on all aspects of our lives, including education. Most countries have shut down schools and suspended face-to-face education. More than 91 percent of students and about 1.6 billion children and young people worldwide have been adversely affected by the pandemic (Miks & McIlwaine, 2020). Most administrations have taken economic measures and implemented emergency programs that shifted face-to-face education to distance education via digital technologies (Angoletto & Queiroz, 2020). The Turkish Ministry of Education and the Council of Higher Education (CHE) have also suspended face-to-face education, ushering in novel educational models (Eroğlu & Kalaycı, 2020). There has been a sudden transition from classroom-based teaching to distance education all over the world. Most universities have the infrastructure to provide different types of distance education. However, there has been a demand for a structure called "emergency distance education" to adapt to the new situation and find new solutions to the challenges it has presented since the onset of the pandemic (Keskin & Kaya, 2020). Emergency distance education involves implementing solutions for education that will return to face-to-face when the crisis or emergency is over (Hodges, Moore, Lockee, Trust & Bond, 2020). Distance education is a model that expands communication and interaction beyond the limits of time and space and allows teachers and students to conduct virtual live classes via information technologies (Horzum, 2003). Distance education is an innovative system that allows teachers and students to communicate using digital virtual platforms anywhere and anytime. Distance

education is used at all levels, from preschool to higher education, and students prefer it to traditional classroom teaching (Enfiyeci & Filiz, 2019). The pandemic has caught the education systems of most countries off guard because none of them had ever faced such a crisis before (Sangster, Stoner, & Flood, 2020). Digital technologies are used for effective distance education worldwide (Bakioğlu & Çevik, 2020). Ankara University was the first to implement distance education in Turkey in 1956 (Kaya, 2002). The 1970s witnessed rudimentary efforts put into distance education at the secondary education level, and those experiences allowed us to make progress, albeit to a limited extent. The Open Education Faculty of Anadolu University, which was established after 1980, was the first to provide distance education at the higher education level (Bozkurt, 2017). Law No. 2547, which entered into force in 1981, authorized universities to carry out open education activities. The decision in 1982 authorized Anadolu University to carry out open education activities. In the following years, Sakarya University, Fırat University, and Middle East Technical University put in much effort to making distance education widespread in Turkey (Gürer, Tekinarslan & Yavuzalp, 2016). Today, most distance education activities in Turkey are carried out through Educational Informatics Network (EIN), which has various modules, such as my page, lectures, live classes, quizzes, and library. It is a social education platform that brings students/parents and teachers together. Through EIN, teachers can communicate, cooperate, and share educational materials with students and set up a learning environment at home (live lessons) (Pınar & Dönel Akgül, 2020). The pandemic has led to a drastic transformation in education and paved the way for significant progress in distance education worldwide. Today, EIN offers online distance education to students at four levels (primary school, secondary school, high school, and kindergarten). The Council of High Education demanded that all universities improve their infrastructure to provide distance education for all courses synchronously or asynchronously. Most universities set up their infrastructure in a very short time and started to offer online courses. Although this rapid transformation is seen as an educational innovation, it has caused numerous problems. Distance education has been ideal for theoretical courses both before and during the epidemic. However, it has been pretty challenging to perform applied courses online (Kahraman, 2020). The pandemic has dealt a blow to science lab activities in particular because lab activities ordinarily provide students with the opportunity to interact with materials to make observations and put theory into practice (Hofstein & Lunetta, 1982). Lab activities turn abstract concepts into concrete visual representations and allow students to construct new knowledge. Labs are the backbone of the visual and complex structure of science courses (Bozkurt, 2008). Besides, students have to do experiments to understand nature and solve technological problems (Soylu, 2004). Visualization ensures learning retention, and experiments promote learning by living and doing (Sarıoğlan, Altaş & Şen, 2020). It is argued that the quality of education in Turkey has been declining since the onset of the pandemic, mainly because the curricula used for distance education are the same as those designed for face-to-face education. This assertion is corroborated by the fact that online applied courses (lab, internship, and workshop) are imbued with challenges with which teachers and learners must cope (Devran & Elitaş, 2017). It is already hard to organize and use labs effectively in traditional face-to-face education, and distance education makes it all the more difficult (Kennepohl, 2013). It is mainly because students are deprived of the materials and opportunities available in labs. According to Çivril (2018), authorities should design materials that encourage self-study because open and distance education depends largely on individual effort. We should identify students' demographic characteristics and their interests and attitudes towards distance education in order to design effective and efficient distance education activities that respond to their needs (Şenel & Kutlu, 2015). Preservice teachers are the ones who can take advantage of the opportunities provided by lab activities or have to deal

with their challenges because they perform those activities themselves. Therefore, it is important to determine how they perform distance education activities for applied courses and what kind of challenges they face during the process and what kind of attitudes they have towards those activities. We think that we can use preservice teachers' feedback to further improve the distance education process for applied courses. Lab activities are an integral part of undergraduate science education. This paper focused on the opportunities and challenges of online science education and investigated preservice classroom teachers' views of distance education science lab activities (DESLA). We think that our results and recommendations will help authorities revise applied science courses and adjust them to distance education.

2. Research Objective and Questions

This study addressed preservice classroom teachers' views of DESLA. The research questions are as follows:

1. What do preservice classroom teachers think about DESLA?
2. What are preservice classroom teachers' experiences with DESLA?
3. What do preservice classroom teachers think are the challenges of DESLA?
4. What do preservice classroom teachers think are the advantages of DESLA?
5. What do preservice classroom teachers think are the disadvantages of DESLA?
6. In what way do preservice classroom teachers think that DESLA helped them design activities?
7. Which one do preservice classroom teachers prefer: DESLA or face-to-face science lab activities (FESLA)? Why?
8. In what way do preservice classroom teachers think that DESLA affected their attitudes towards science lab activities?

3. Method

This section includes information about the research model, study group, data collection tools, data analysis and applications.

3.1. Research Model

The study adopted a qualitative phenomenology design, which is used to identify people's subjective experiences and perceptions of a phenomenon (Ersoy, 2016) and to provide a more general perspective on the phenomenon (Yıldırım & Şimşek, 2013). The most important criterion of this design is that all participants should experience the same phenomenon (Patton, 2014). The primary objective of phenomenology is to bring a universal explanation to individual experiences with a phenomenon. Researchers aim to provide a holistic description that reveals the essence of those experiences (Moustakas, 1994). This study adopted a phenomenological design because it addressed preservice teachers' experiences and views on the phenomenon of distance education science lab activities (DESLA).

3.2. Study Group

The research was conducted in the fall semester of the 2020-2021 academic year. The study population consisted of all students taking the DESLA course. The sample consisted of 34 students (25 women and nine men) studying in the 2nd class from the department of classroom teaching of the education faculty of Muş Alparslan University. Participants were recruited using convenience sampling.

3.3. Data Collection Tools

Data were collected using an open-ended question form developed by the researcher based on a literature review and expert feedback. The form consisted of eight clear and easy-to-understand items. The data were collected online (Google Forms) due to the nationwide school closures and restrictions. The form was prepared on Google Forms, and the data were collected via Google Drive. The form was emailed to all participants, whose responses were then transcribed verbatim.

3.4. Data Analysis

The qualitative data were analyzed using content analysis. In content analysis, researchers identify recurrent concepts or words in a text and then determine what they mean and what kind of relationship they have with one another in order to make inferences about the meaning the text aims to convey (Büyüköztürk, Kılıç Çakmak, Akgün, Karadeniz & Demirel, 2010). The data were analyzed using Kuckartz's (2014) qualitative data analysis. The researcher and an expert randomly selected seven interview forms (20% of the total) and coded them. The researcher identified the similarities and differences between the codes and developed a codebook. The expert then completed all the codes according to the codebook. In the second stage, themes and categories were created and all codings were completed. After the coding, themes were created and categories and codes were created for each theme. In the third stage, the researcher and expert developed themes and categories and grouped the codes under them by reaching a consensus on points in common. For example, they changed the name of the theme "socially" to "social." They also rearranged the codes of "being fun, building self-confidence, removing prejudices, and taking up responsibility" under the theme of "social" to "fun, self-confidence, prejudice, and responsibility." The researcher and the expert coded the data to increase consistency and credibility. All participants were assigned pseudonyms, such as (Ayşe, Veli, Zeynep, etc.) for anonymity. The researcher created a codebook during the theme and coding stages. The researcher and the expert discussed the codes on which they disagreed until they reached a consensus. In this context, the data were reviewed three times. The data concerning the themes and codes were tabulated and interpreted in the "Results" section. Explanations and direct quotations were made to provide a coherent picture of participants' views and to increase reliability.

3.5. Procedure

The university offers the DESLA course two hours a week in the third semester of an eight-semester undergraduate education within the scope of the teacher training program (CHE, 2018). However, DESLA has been carried out online since the onset of the pandemic. The research procedure consisted of five stages:

1. The researcher, who was the course instructor, opened up a Google Classroom, where she informed participants of DESLA before the onset of class.

2. During online classes, the researcher provided theoretical information on experimental topics and presented experiment reports and materials.
3. The researcher gave participants open-ended instructions for experiments and asked them to design experiments and videotape and report them. Figure 1 shows some visuals from experiments.
4. After the experiments, participants held discussions, received feedback, and asked questions in online classes.
5. The researcher interviewed all participants.

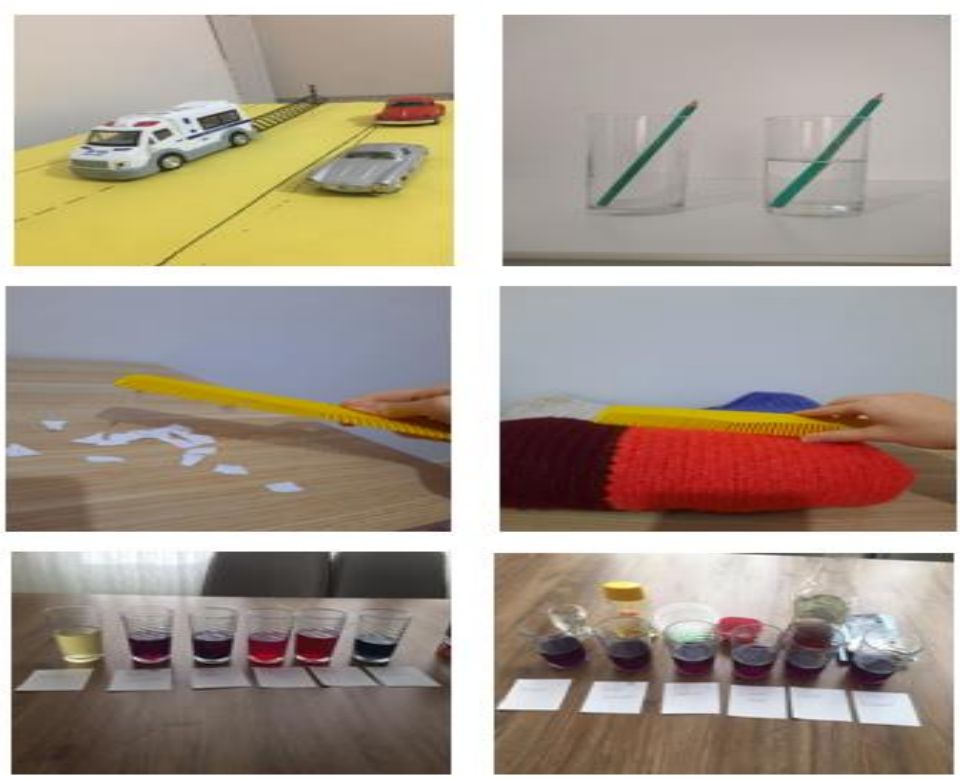

Figure 1. Visuals from Experiments

4. Results

This section addressed the participants' responses to the interview questions.

Table 1 shows the codes and themes concerning the first research question.

Table 1. Participants' Views of DESLA

Theme	Category	Code	Participants
Positive	Useful	One to one application	Cem, İpek, Çiğdem, Ezgi
		Personal development	Cem
		Multidimensional thinking	Cem
		Effective learning	Derya, İpek
		Doing research	Çiğdem
		Drawing up reports	Cem, Çiğdem, Ezgi, Esra
		Applying at home	Sibel
	Efficient		Burcu, Filiz, İpek, Öykü, Esra, Çiğdem
	Convenience		Rüya
Negative	Unfavorable	More efficient when face to face	Canan, Mehmet, Murat, İnci, Seren, Cemal
		Being away from the lab	Ömer, Zeynep, Selim, Gaye
	Challenging	Accessing materials and tools	Faruk, Zeynep
		Applying at home	Faruk, Zeynep
		Applied course	Ela, Ece, Merve, Gamze,
	Reduced quality		Mert
	Not understanding the topics		Mert
	Reduced efficiency		Özge, Melek
	Lack of interaction		Seda
	Lack of exchange of ideas		Seda
	Passiveness		Ömer
None	Applicable at home		Betül, Ayşe, Ebru, Veli

Participants' views of DESLA were categorized under three themes: *"Positive," "Negative,"* and *"None"* (Table 1). Most participants had "Negative" views, especially under the code of "Unfavorable." Some participants elaborated on why they found DESLA unfavorable. Their views were categorized under the codes of "More efficient when face to face" and "Being away from the lab." The code of "Challenging" was also prominent. Under the theme of "Positive," most participants emphasized the code of "Useful." Under the theme of "None," most participants made statements grouped under the code of "Applicable at home." The following are some quotes from participants:

İpek: I think DESLA was as good as it got if it'd been face to face. I think it is pretty effective and efficient. You learn something for good when you get the chance to put it into practice. We got to put all topics to use during experiments, so it was pretty efficient.

(Efficient, useful, one to one application, effective learning)

Cem: It was by far the most useful class that I had since we got on with distance education. The teacher was very attentive. She answered all our questions and did her best to help us. We did experiments and drew up reports on them, which helped us develop multidimensional thinking skills.

(Useful, one to one application, personal development, multidimensional thinking)

Can: DESLA has been more challenging than other courses because it was pretty hard to find lab tools and materials to do the experiments at home.

(Challenging, Accessing materials and tools, Applying at home)

Mert: Science is an applied course, so DESLA reduces the quality of the class and prevents us from understanding the subjects and concepts.

(Reduced quality, not understanding the topics)

Table 2 shows the codes and themes concerning the second research question.

Table 2. Participants' Experiences with DESLA

Theme	Code	Participants
Academic	Using simple materials to do experiments	Ayşe, Canan, Cem, Derya, Esra, Faruk, Seda, Öykü, Zeynep, Çiğdem, Gamze, Veli
	Doing various experiments	Derya, Mehmet, Cem, İnci, İpek, Seren, Merve, Melek
	Understanding the topics	Ela, Sibel, Canan, Gaye
	Doing research	Selim, Cem, Gaye
	Problem-solving	Cem
	Creative thinking	Ezgi, Zeynep, Özge, Çiğdem
	Scientific thinking	Cem
	Multidimensional thinking	Seda, Cem
	Drawing up reports	Selim, Melek, Seren, Filiz, Cem, İpek, Cemal
	Getting different and new information	Cem, Derya, Mert, İnci
	Learning retention	Filiz, Esra
	Concepts of the experimental process	Ömer, Ela, Ece
	Turning home into a lab	Esra, Mehmet, Veli
Social	Fun	Ezgi, Betül, Canan, Faruk
	Self-confidence	Ebru, Burcu
	Prejudice	Çiğdem
	Responsibility	Çiğdem
Professional	Getting students to use simple materials to do experiments	Gamze, Betül, Ela, Öykü, Zeynep
	Gaining experiment	Seda, Özge, Seren, Murat, Melek, Çiğdem, Zeynep
	Instructive lectures	Filiz
	Fun lectures	Sibel, Filiz
	Having a sound grasp of primary school science subjects	Betül, Seren, Ömer, Ela, Rüya
	Preparing a lab setting	Zeynep
	Doing level-appropriate experiments	Rüya

Participants' experiences with DESLA were categorized under three themes: *"Academic," "Social,"* and *"Professional"* (Table 2). Most participants expressed their experiences with DESLA under the codes of "Using simple materials to do experiments," "Doing various experiments," and "Drawing up reports" under the theme of "Academic." The second most prominent theme was that of "Professional." Under this theme, "Gaining experiment," "Getting students to use simple materials to do experiments," and "Having a sound grasp of primary school science subjects" were the three codes on which most participants elaborated. Lastly, participants focused on the code of "Fun" under the theme of "Social." The following are some quotes from participants:

Ömer: The report assignments helped us figure out the dependent and independent variables quickly. We comprehended the units of the primary school science course. I believe we made good progress, although it was online.

(Academic, professional)

Cem: I did some research online and found different kinds of experiments. I had some problems doing the experiments that I found online, and fixing those problems helped me learn from my mistakes. Drawing up reports helped me develop scientific and multidimensional thinking skills.

(Academic)

Zeynep: It is the best experience I've ever had. I didn't have some materials at hand, but I checked around and used different materials to do the experiments, so if one day I end up working at a school in a remote village without a lab and equipment, then I know that I can always find a way to set up a lab-like environment for my students. I've had very nice experiences when it comes to that. I'm sure I'd have had more experience if it'd been face to face. There is so much that students have to learn from their teachers.

(Academic, professional)

Çiğdem: I dreaded the idea of doing experiments, but not anymore. The first homework assignment was the hardest, but I got the hang of it thanks to the sample report and the weekly experiments you assigned. For example, the first week, it took me about four hours to do the assignment, but it took me less and less in the following weeks. It was sometimes hard, like, I couldn't get a hold of materials, but I knew I had to do it one way or another, so I completed the process. You know how? I found experiments that I could do with the materials at home.

(Academic, social, professional)

Table 3 shows the codes and themes concerning the third research question.

Table 3. Challenges of DESLA

Theme	Code	Participants
Finding materials	Having difficulty accessing materials	Canan, Mert, Ela, Filiz, Murat, Çiğdem, Veli
	Having to go out to find materials	Betül, Ela
	Finding a different experiment	Cem, Ela, Mehmet, Sibel, Cemal
	Pandemic measures	Faruk, Seda, Zeynep, Merve
Application process	Lack of a lab setting	Ömer
	Doing research online	Canan, Gaye
	Not understanding the topics	Canan, Gaye
	Drawing up reports	Esra, Seren, Öykü, Ezgi
	Lack of knowledge of the concepts of the experimental process	Derya, İpek, Ece, Ömer
	Shooting videos	Burcu, Ebru
	Finding experiments appropriate for the topics at hand	Ece, Seren
	Lack of instant feedback	Özge
	Family issues	Çiğdem
None	Materials at home	Ayşe, Selim
	Teacher feedback	Gamze, Rüya
	Not specified	İnci, Melek

Participants' views of the challenges of DESLA were grouped under three themes: *"Finding materials," "Application process,"* and *"None"* (Table 3). Most participants made statements that were classified under the codes of "Lack of knowledge of the concepts of experimental process" and "Drawing up reports" under the theme of "Application process." Under the theme

of "Finding materials," participants stated that they had difficulty accessing materials. Under the theme of "None," they emphasized the codes of "Materials at home," "Teacher feedback," and "Not specified" equally. The following are some quotes from participants:

Ela: We had to do a lot of experiments, and sometimes I had a hard time finding materials. I couldn't go out much because of the pandemic restrictions. I went to the supermarkets, stationeries, or shopping malls close by, but I wouldn't go to the ones far away when I couldn't find the materials I was looking for there, so what I did was, I found different experiments I could do with the materials at hand. So, the only problem for me was getting at materials for the experiments.

(Finding materials)

Seren: At first, I had a hard time finding experiments and drawing up reports, but after a couple of weeks, I did more research, and I made use of the sample reports to draw up mine, which made the process much easier, and so I got around it.

(Application process)

Canan: I sometimes had difficulty figuring out what the experiment was all about, so I did some research, and I watched some videos online, but sometimes, no matter how easy it might have been, I just couldn't get a hand on the materials that I needed.

(Finding materials, application process)

Ayşe: I had no problems whatsoever, I had all the materials I needed at home, and DESLA was a good course, I mean practice-wise.

(None)

Table 4 shows the codes and themes concerning the fourth research question.

Table 4. Positive Aspects of DESLA

Theme	Code	Participants
Advantages	Using simple materials to do experiments	Ayşe, Ömer, Öykü, Zeynep, Ezgi, Gamze
	Professional experience	Betül, Cem, Ela, Melek, Rüya
	Learning how to do simple experiments on different topics	Betül, Derya, Ela, Seren
	Engaging in fun activities	Betül, Esra, Burcu, İnci, Merve, Çiğdem, Ezgi, Ebru, Rüya
	Learning retention	Canan, Mehmet, Gamze
	Learning by doing and living	Canan, Mehmet, Sibel, Çiğdem, Rüya, Gaye
	Effective learning	Cem
	Promoting inquiry	Cem, Sibel, Veli, Gaye
	Scientific thinking	Cem
	Multidimensional thinking	Cem
	Doing experiments at home	Esra, Ela, Faruk, İpek, Seda, Ömer, Merve, Ezgi, Selim, Gamze
	No space restrictions	Mert,
	No exams	Ece
	Doing experiments easily	Murat, İnci, Özge, İpek
	No time restrictions	Özge, Ömer, Veli, Cemal
	Drawing up reports	Ela, Mehmet, Öykü
Not specified	No opinion expressed	Filiz

Participants' views of the positive aspects of DESLA were grouped under the themes of *"Advantages"* and *"Not specified"* (Table 4). Almost all participants talked about the advantages of DESLA. To them, the greatest advantage of DESLA was doing experiments at home". They also stated that DESLA allowed them to engage in fun activities, do experiments with simple materials, and learn by doing and living. One participant did not express any opinion, hence the theme of "Not specified" with no codes. The following are some quotes from participants:

Ela: We all did experiments at home. We couldn't have done it if it'd been face to face. I did primary school experiments and typed up reports about them. I had a tough time doing the experiments and writing down reports in the first week, but now I can get primary school students to do experiments and deliver lectures based on them.

(Professional experience, learning how to do simple experiments on different topics, doing experiments at home, drawing up reports)

Faruk: The biggest difference between the lab and home was the comfort of the latter. I did the experiments over and over again at home until I nailed them.

(Doing experiments at home)

Çiğdem: At least, it [DESLA] was not only theoretical. The teacher covered the topics, and we got to learn by doing and living, which was quite effective. Well, I hope one day I'll get assigned, and when I have my own students, I'll get them to do the experiments that I did. Another advantage was that I've had so much experience.

(Learning by doing and living, engaging in fun activities)

Veli: It [DESLA] was advantageous only time-wise. I mean, we had the whole week to do the homework assignment, so we had enough time to do research and think about the experiment and do it.

(No time restrictions)

Table 5 shows the codes and themes concerning the fifth research question.

Table 5. Negative Aspects of DESLA

Theme	Code	Participants
Negative aspects	No presentations	Ayşe, Veli
	Difficulty finding materials	Betül, Cem, Ela, Mehmet, Murat, Faruk, Seda, Sibel, Merve, Çiğdem, Veli
	Not face to face	Canan, Özge, Seda, Seren, Rüya, Cemal
	Drawing up reports	Derya
	Being away from the lab	Esra, İpek, Ömer, Merve
	Lack of instant feedback	Mert, Filiz, Özge, Gaye
	Doing an experiment every week	Ece
	Inability to conduct high-level experiments	Ela
	A limited number of experiments	İnci, Selim
	Not being supervised by the teacher	Özge, Seda, Ömer, Gamze
	Lack of prior knowledge	Sibel
	Inability to understand the topics	Ömer, Öykü, Zeynep
	Lack of computers and Internet	Zeynep
None	Efficient	Burcu, Ezgi
	Not specified	Melek, Ebru

Participants' views of the negative aspects of DESLA were grouped under the themes of *"Disadvantages"* and *"None"* (Table 5). Under the theme of "Disadvantages," most participants noted that they had difficulty finding materials and had a hard time because DESLA was not delivered face-to-face. Under the theme of "None," two participants stated that they found DESLA efficient, but they did not elaborate on it, hence the code of "Not specified." The following are some quotes from participants:

Ela: We had to use simple materials to do the experiments. Besides, there were times when we didn't have the materials we needed to do the experiments. Maybe, we could have done experiments with chemicals if it'd been face to face.

(Difficulty finding materials, inability to conduct high-level experiments)

Özge: The downside of DESLA was that it was not face-to-face and that it was student-focused. It didn't have any restrictions, though. The downside of distance education was that we couldn't get any feedback.

(Face to face, not being supervised by the teacher, lack of instant feedback)

Ömer: It was not like we were in the lab doing experiments with the teacher, which was a downside. I couldn't have a full grasp of the topics. In that setting, we didn't do experiments to draw up reports.

(Being away from the lab, inability to understand the topics, not being supervised by the teacher, drawing up reports)

Ezgi: I have no idea how DESLA would have been like if it was face to face, but I believe that the distance education process was efficient, so I think the advantages of DESLA outweigh its disadvantages, I mean distance education-wise.

(None, efficient)

Table 6 shows the codes and themes concerning the sixth research question.

Table 6. The Contribution of DESLA to activity-designing

Theme	Code	Participants
Positive	Brainstorming	Betül
	Doing various experiments	Ela, Canan, Derya, Cem, Mehmet, Filiz, Özge, Seda, Zeynep, Merve, Selim, Ebru, Gamze, Cemal
	Promoting inquiry	Ela, Cem, Filiz, Ömer
	Seeking alternative ways	Selim, Cem, Gaye
	Using simple materials to design activities	Seren, Sibel, Çiğdem, Ezgi, Selim
	Problem-solving	Cem
	Creativity	Özge, Seda, Seren, Sibel, Rüya, Gaye
	Observation skill	Özge
	Putting theory into practice	Esra, Mehmet
	Hands-on experience	Ece, İnci, İpek, Melek
	Student-level appropriateness	Burcu, Çiğdem, Rüya
	Practical thinking	Mert
	Drawing up reports	Seren, Ömer
	Making quick decisions	Mert
Negative	Internet experiments	Ayşe
Not specified	No opinion expressed	Faruk, Murat, Öykü, Veli

Participants' views of the contribution of DESLA to their ability to design activities were grouped under three themes: *"Positive," "Negative,"* and *"Not specified."* Participants expressed mostly positive opinions and especially noted that DESLA allowed them to conduct various experiments. They also stated that they were able to use simple materials to design activities and get creative. One participant expressed negative opinions and considered DESLA experiments to be "Internet experiments." Some participants did not express any opinion regarding the contribution of DESLA to their activity-designing skills, hence the theme of "Not specified." The following are some quotes from participants:

Ela: We did an experiment a week. I checked some other experiments as well. I think that I'm good at searching for experiments and finding the best experiment for each topic. I found at least five to ten experiments for each topic. I have a more extensive repertoire now.

(Positive, doing various experiments, promoting inquiry)

Mehmet: Putting theory into practice always leads to learning retention. I'd heard a lot about the effects of a force acting on an object or charged objects. With DESLA, I've learned how to put that knowledge to use in everyday life, and I've realized that I can do different sorts of activities with that knowledge.

(Positive, putting theory into practice, doing various experiments)

Seda: I think it contributed a lot to our ability to design activities because we had to find all the materials and do all the experiments by ourselves, which made us more creative about it. For example, I figured out the experiment "A liquid takes the shape of its container" by myself, and I thought about how I can put it into practice; I think that the experiment helped me improve myself.

(Positive, doing various experiments, creativity)

Ayşe: The experiments were mostly the same or similar, and everybody did the first experiment they laid their hands on. It's because DESLA was not done in the classroom.

(Negative, internet experiments)

Table 7below shows the codes and themes concerning the seventh research question.

Table 7. Participants' Preference: DESLA or FESLA?

Theme	Category	Code	Participants
DESLA	Easy to do at home		Betül
	Doing it alone		Melek
	Not specified		Burcu
FESLA	Distance education	Limitations	Filiz
		Problems at home	Seda
		Purchasing material	Seren, İnci
		Miss classmates	Seren, İnci
	Putting theory into practice		Sibel
	Self-expression		Ayşe
	Efficient		Murat, Cem, Canan, Mert, Mehmet, Ela, Çiğdem
	Being supervised by the teacher		Canan, Mert, Cem, Mehmet, Seda, Ömer, Gamze, Rüya
	Interaction		Canan, Cem, Özge, Seda, Zeynep, Merve, Selim, Rüya, Ece, Gaye
	Dispelling misconceptions		Mert
	Learning retention		Ela, Zeynep, Gaye
	Effective learning		İpek, Ela, Veli
	Receiving feedback		Özge, Ömer, Öykü, Cemal, Gaye
	Fun		İpek, Merve, Selim
	Doing experiments in the lab		Esra, Faruk, Zeynep, Merve, Selim, Veli
	Difficulty finding materials		Mehmet
	Not specified		Derya, İnci, Ezgi
Either	Not specified		Ebru

Participants' preferences were grouped under three themes: *"FESLA," "DESLA,"* and *"Either"* (Table 7). Most participants favored FESLA over DESLA because they considered it a more efficient way of teaching, allowing them to interact with the teacher and classmates and be supervised by the teacher. Some participants preferred DESLA to FESLA. Their views were grouped under the codes of "Easy to do at home," "Doing it alone," and "Not specified." One participant did not prefer one over the other but did not express any opinion, hence the theme of "Either" with "Not specified" code. The following are some quotes from participants:

Faruk: Come to think of it, I think it is better to do it in the lab than at home.

(FESLA, Lab experience)

Çiğdem: I'd rather have FESLA because face-to-face education is definitely more efficient than DESLA.

(FESLA, efficient)

Ömer: I would definitely prefer FESLA because the teacher would supervise us at all times, and help us with the experiments and answer all our questions and give us feedback.

(FESLA, being supervised by the teacher, receiving feedback)

Betül: I'd rather have DESLA because our teacher was able to manage the whole process very well and help us with the experiments with the best methods.

(DESLA, easy to do at home)

Table 8 shows the codes and themes concerning the eighth research question.

Table 8. Effect of DESLA on Participants' Attitudes towards Science Lab Activities

Theme	Code	Participants
Positive	Loving	İnci, Ebru, Veli
	Fun	Betül, Faruk, Rüya, Veli, Gaye
	Enjoyable	Faruk, Cem
	Facilitating a change in perspective	Cem, Merve, Çiğdem, Gamze
	Surprising	Selim
	Instructive	Selim, Derya, Seren, Öykü
	Raising awareness	Mert, Mehmet, Çiğdem, Murat, Özge, Sibel, Ömer,
	Arousing curiosity	Ece
	Conquering fear	Ela, Gamze
	Growing a liking	Ela
	Building up passion	Cem, Ela
	Making one feel good	Canan, Burcu
	Appreciating	Seda, Çiğdem, Öykü, Çiğdem, Veli
	Boosting self-confidence	Merve, Ela, Murat, İpek, Ezgi, Veli
Negative	Feeling upset	Zeynep
	Discouragement	Zeynep
None	Finding it useful	Ayşe
Not specified	No opinion expressed	Esra, Filiz, Cemal, Melek

Participants' views of the effect of DESLA on their attitudes towards science lab activities were grouped under four themes: *"Positive," "Negative," "None,"* and *"Not specified."* Most participants stated that DESLA affected their attitudes towards science lab activities positively. They noted that DESLA was a fun course that boosted their confidence and made them appreciate science lab activities. One participant stated that DESLA made her feel upset and discouraged. Another participant stated that DESLA had no effect on her already-positive attitudes towards science lab activities, and therefore, she found it useful. Some participants did not express any opinion, hence the theme of "Not specified." The following are some quotes from participants:

Cem: I used to be prejudiced against DESLA before I took it, but it turned out to be my favorite course. It broke down all my prejudices against lab activities. I'm looking forward to doing the same activities with my students.

(Positive, facilitating a change in perspective, enjoyable, building up passion)

Ela: It helped me conquer my fear. I mean, at first, I was concerned, I was like, "how am I supposed to finish all those experiments in a week?" and "how am I supposed to write down all those reports?" but after a couple of weeks, I was excited about experiments, and I was looking forward to doing them. DESLA helped me conquer my fear of the course and the field in general. I like it better, and I'm enthusiastic about it.

(Positive, conquering fear, surprising)

Mert: I was a Math-Turkish student when I was in high school, so I didn't know much about science experiments, but as I did more and more experiments, I learned about interactions between chemicals and nature.

(Positive, raising awareness)

Zeynep: I had a hard time doing the experiments, like force and motion, pulley, electricity, and whatnot. I would love to teach my students the subject of electricity by using a full-fledged circuit and making an analogy between blood circulation and electrical circuit, but I couldn't do it because it was online, which made me upset.

(Negative, discouragement, feeling upset)

Ayşe: I've always considered experimentation and observation to be important, so I find DESLA very useful.

(None, finding them useful)

5. Conclusion and Discussion

This paper investigated preservice classroom teachers' views of distance education science lab activities (DESLA).

The first research question investigated what preservice classroom teachers thought about DESLA. Participants had more negative opinions than the positive ones about DESLA. Some participants considered it a useful and efficient course that encouraged them to do research, conduct experiments by themselves, and promoted multidimensional thinking and effective learning. This is because participants did research on experimental topics and carried out all activities on their own. They also played an active role in the process, resulting in more effective and efficient learning. Research shows that teachers who are not tech-savvy enough to conduct experiments during distance education are likely to do more research to fill in the gaps in their knowledge and that students are likely to learn more permanently during distance education as they actively participate in the process. Sarıoğlan et al. (2020) argue that distance education is less effective and efficient than face-to-face education when it comes to conducting experiments. Some participants stated that DESLA reduced education quality and efficiency because they could not interact with teachers and had difficulty understanding the topics. Participants had to perform the experiments at home but had difficulty accessing most of the materials that would be available to them in a lab. What is more, the lack of teacher-student interaction at home made the education less effective, making it more challenging for participants to understand the topics. Distance education in Turkey cannot substitute traditional face-to-face education, especially in applied courses, because it lacks interaction and reduces education quality. This may be due to the nature of distance education and the outcomes of some distance education programs applied in Turkey (Kaya, Çitil Akyol, Özbek & Pepeler, 2017). In distance education, teachers cannot monitor students' learning, preventing student-student and teacher-student interaction (Kaya, Erden, Çakır & Bağırsakçı, 2004). Some studies show that distance education is less effective than face-to-face education because students cannot get feedback from teachers, think that they cannot express themselves, and forget what they learn (Keskin & Kaya, 2020). However, Lipson and Kurman (2013) report that distance education is efficient in many respects.

The second research question focused on preservice classroom teachers' experiences with DESLA. Participants gained academic, social, and professional experiences with DESLA. It allowed them to conduct different experiments with simple materials and turn their homes into

labs. Designing experiments individually stimulated their creativity, encouraged them to do research, and helped them learn new things. The new knowledge enabled them to better understand the concepts and subjects related to the experiments. Participants generally performed FESLA in groups but had to perform DESLA on their own. Designing and doing experiments by themselves encouraged them to be creative and do research and learn new things, allowing them to better understand the experimental concepts and topics, participate more actively in the process, and achieve learning retention. Research also shows that DESLA is better at improving academic performance and providing learning retention than traditional FESLA (Chang, 2000; Duman & Avcı, 2016; Huppert, Lomask & Lazarowitz, 2002). However, some studies have shown that students perform more poorly in distance education than in conventional classroom-centered education because distance education fails to bring depth and structure (Ak, Oral & Topuz, 2018; İbicioğlu & Antalyalı, 2005). Participants made use of the materials at hand and conducted primary-school-level experiments at home. In this way, they got a sound grasp of primary school science subjects and learned how to choose experiments according to student level and conduct them with simple materials and create a lab environment. Participants did uncomplicated experiments and had a better understanding of science topics. This changed their attitudes towards science lab activities and eliminated their prejudices. Besides, studying and doing experiments by themselves made them more responsible and confident. Through DESLA, participants had a sound grasp of primary school science topics. They also learned how to design level-appropriate science experiments with simple materials and create a lab setting. DESLA also dispelled their prejudices against science lab activities and made them more responsible and confident. They also enjoyed conducting DESLA experiments. Baki and Çevikoğlu (2020) argue that distance education encourages teachers to use educational technologies and improve themselves and makes them feel confident enough to teach even in harsh conditions. In distance education, students are responsible for their own learning due to the lack of or limited interaction. Therefore, they should learn how to learn in order to have high academic performance. They should also show up on time for class, listen to their teachers attentively, participate in classes actively, take notes, go over what they have learned, and recognize their own weaknesses and see them as an opportunity for their own growth (Başaran, Doğan, Karaoğlu & Şahin, 2020).

The third research question addressed the challenges of DESLA. Most participants had difficulty finding materials and conducting the experiments by themselves, whereas some participants stated that they did not face any challenges. Participants did not have some of the materials they needed to conduct the experiments and had to go outside during lockdowns. However, they could not find the materials they looked for, and therefore, search for different experiments and designed them from scratch. Kahraman (2020) also found that the lack of access to course materials was one of the greatest challenges of applied courses in distance education because students had to stay indoors due to the nationwide lockdowns. Participants also noted that they had a hard time writing down reports and comprehending the concepts of the experimental process. This may be because participants could not receive information or feedback from teachers during distance education. They also had difficulty researching and finding experiments appropriate for the topics because they had no Internet connection. However, those who did not face any challenges asserted that they had enough feedback from teachers and enough materials to conduct the experiments at home. Distance education falls short of expectations when it comes to applied courses. The challenges of online lab activities are that students lack digital devices (computers, tablets, smartphones) and have difficulty accessing the Internet, interacting with teachers and classmates, communicating face-to-face, receiving instant feedback from teachers, engaging in class, and learning by doing and living (Özgöl, Sarikaya & Öztürk,2017; Sarıoğlan et al., 2016). Besides, it is hard to ensure learning

retention in online education because students lack prior knowledge and cannot carry out group activities, and cannot exchange ideas (Akman & Güler, 2008).

The fourth research question looked into the positive aspects of DESLA. Participants figured out the whole process by themselves and conducted the experiments with simple materials. This allowed them to enjoy learning by living and doing. Unlike face-to-face education, distance education broke the limits of time and space, allowing participants to conduct the experiments whenever and wherever they wanted and redo them until they got them right. DESLA allowed them to conduct the experiments anywhere, anytime, and redo them until they got them right, which resulted in more efficient and permanent learning. Distance education is a time-effective and flexible alternative to traditional face-to-face education (Kaba, 2012) because it allows students to participate in virtual classes and activities anywhere, anytime (Akman & Güler, 2008). Redoing the experiments and seeking ways to fix their issues helped them develop scientific processes and multidimensional thinking skills and encouraged them to turn to different sources to find solutions to problems. Participants turned to different sources to learn more about the experiments. Therefore, we can state that distance education encouraged them to do research. Online lab activities allow students to do and redo experiments outside the lab, helping them learn science concepts better (Duman & Avcı, 2016). Distance education provides students with a flexible study environment where they can achieve individual or group learning by communicating and interacting with their teachers and classmates. It also helps them take responsibility for their own learning and encourages them to inquire, explore, experiment, and participate in group discussions (Kaya, 2002).

The fifth research question investigated the disadvantages of DESLA. Participants had to conduct simple and limited experiments because they had no access to materials and the lab. Moreover, they had a hard time understanding the topics of which they did not have prior knowledge and finding answers to their questions because they could not receive any feedback from their teacher. They also stated that they faced numerous problems due to technical issues and lack of Internet/digital devices. Some participants found DESLA efficient. According to Keskin and Kaya (2020), the disadvantages of distance education are that students tend to forget things too quickly and have difficulty getting feedback and expressing themselves. Özgöl et al. argue that students who receive distance education have a hard time accessing the Internet, interacting, practicing, getting feedback, and asking questions. Paydar and Doğan (2019) think of distance education as a limited process because not all students have access to the Internet and digital devices, and therefore, some students cannot get any feedback and cannot ask any questions, resulting in reduced motivation. The authors also maintain that it is hard to incorporate different teaching methods and applied courses into distance education. According to Görgülü-Arı and Hayır Kanat (2020), distance education cannot replace face-to-face education because it makes students more passive and asocial, falls short of expectations in applied courses, brings out technical issues, and prevents information sharing.

The sixth research question focused on how DESLA contributed to preservice teachers' ability to design activities. All participants stated that DESLA helped them design better activities. Participants were actively engaged in DESLA and made use of simple materials to design and conduct experiments, which were actually less challenging than what their levels could handle. They also had the opportunity to solve their problems and do more research and observation, which helped them develop design, problem-solving, inquiry, and observation skills. Distance education students can study and learn at their own pace because online lab activities have no time restrictions. Besides, they can put together experimental setups easily, test different scenarios, and redo experiments when they need to. In this process, they acquire

the ability to design experiments and analyze and interpret results (Bell, 1999; Finkelstein et al., 2005). Some participants noted that DESLA allowed them to use simple materials to design activities, and therefore, improved their problem-solving, research, and observation skills. DESLA helped some participants get creative when designing experiments, put forward hypotheses, and brainstorm possible experimental results. DESLA encouraged them to seek alternative ways, think practically, and make quick decisions when they had difficulty finding materials. They were also able to put theory into practice and conduct various experiments. Teachers who are not tech-savvy enough to conduct online experiments are likely to do more research to fill in the gaps in their knowledge (Sarıoğlan et al., 2020). Synchronized distance education allows students to engage in real-time brainstorming and discussion sessions (Midkiff & DaSilva. 2000).

The seventh research question addressed which one preservice classroom teachers preferred: DESLA or FESLA. Most participants preferred FESLA to DESLA, while only a few preferred the other way around. Most participants preferred FESLA because it allowed them to get instant feedback from teachers, who could also dispel their misconceptions, resulting in effective and permanent learning. They would like to have FESLA also because they could express themselves and access materials, and enjoy face-to-face learning that promoted student-teacher and student-student interaction. They found FESLA more fun because it allowed them to express themselves better, access materials, and interact with their teachers and classmates. In traditional face-to-face education, teachers can engage students in class and detect and focus on topics they have a hard time understanding. Face-to-face education also allows students to ask questions about things they do not understand (Karataş, Özgüler, Özgüler & Özgüler, 2017). Face-to-face education ensures learning retention because students can actively participate in their own learning (Sarıoğlan et al., 2020). Erfidan (2019) also notes that students prefer face-to-face education because it guarantees interaction and learning retention. They preferred FESLA to DESLA also due to the disadvantages of the latter. Some participants preferred DESLA because they found the chance to figure out the tasks and do the experiments by themselves easily at home. Therefore, the advantages of distance education are that it allows students to participate in learning whenever and wherever they want and learn at their own pace (Altıparmak, Kurt & Kapıdere, 2011). One participant preferred either of them but expressed no opinion. Although distance education is effective in Bloom's taxonomy domains of “remembering” and “understanding,” it is below expectations in the domains of “applying,” “analyzing,” “synthesizing,” and “evaluating” (Forehand, 2010). Distance education prevents socialization and learning retention and causes practical problems in applied courses (Horzum, 2003). Face-to-face education helps students develop practical skills more than it helps them acquire theoretical knowledge. Therefore, we can state that applied courses should be held face-to-face. One-to-one application after listening to the course content can contribute more to the development of professional application skills (Keskin & Kaya, 2020).

The eighth research question looked into the impact of DESLA on preservice teachers’ attitudes towards science lab activities. Most participants stated that DESLA improved their attitudes towards science lab activities, whereas few believed it negatively affected their attitudes. After DESLA, some participants appreciated science lab activities more because they had a chance to conduct "natural" science experiments. Some participants had some prejudices against DESLA before participating in it because they thought it required high-level knowledge and skills. Therefore, they were concerned that it would be a challenging experience in which they would have to study much harder than they already did. However, participating in DESLA changed their minds and dispelled their fears and prejudices because it allowed them to study

alone, conduct experiments with simple materials, do research on things they were curious about, and build self-confidence. However, according to Sarıoğlan et al. (2020), doing experiments alone during distance education makes students more confident and encourages them to take more responsibility for and manage their own learning. Students engaged in online lab activities are likely to develop more positive attitudes towards lab activities and learn better than they do in traditional education (Aşıksoy & İşlek, 2017; Daşdemir & Doymuş, 2016; Olympiou & Zacharia; 2012; Yavuz & Akçay, 2017). They grew a liking to science lab activities and found them fun. Some participants were surprised by the results of the experiments. They noted that the whole process aroused their curiosity and got them to learn more. Distance education lab activities make students more interested in and curious about online classes (Heard & Aravind, 2010; Karagöz-Mırçık & Saka, 2016). Research also shows that distance education lab activities help preservice teachers develop more positive attitudes towards online experiments and become more interested in applied online courses (Akgül, Geçikli, Konan & Konan, 2018; Duman & Avcı, 2016). One participant found DESLA quite challenging. She stated that it made her disheartened and upset because she had difficulty conducting the experiments by herself. Another participant expressed that she found DESLA useful because she already liked science activities before attending the course, which, therefore, did not make any difference in her attitudes. Students of online science courses have difficulty finding materials to design and conduct experiments, adversely affecting their interest, motivation, attitudes, and class engagement (Sarıoğlan et al., 2020).

6. Suggestions

The following are suggestions based on the results:

The COVID-19 pandemic has thrown education in a loop. Future crises may further disrupt education all over the world. DESLA is an integral part of the science course. Future studies should propose models instructing preservice teachers on how to perform DESLA. Experimental research is warranted to better understand the effect of online lab activities on learning retention, academic performance, and attitudes. Universities should develop content and curricula for online applied courses based on expert feedback and provide students with preservice training on online science activities and experiments. Universities should take steps to overcome the problems of DESLA. High-level experiments are hard to do at home. Therefore, experiments should be designed in such a way that students can conduct them with simple materials available. Universities should have centers where students can easily access technological devices and the Internet. Faculties of education should provide students with training on distance education to equip them enough to develop positive attitudes towards distance education in general and online science activities in particular.

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