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A Day at the Science Center: Examining the Experience of the Pre-Service Elementary Teachers on the Practices at the Science Center

Bilim Merkezinde Bir Gün: Sınıf Öğretmeni Adaylarının Bilim Merkezindeki Uygulamalara İlişkin Deneyimlerinin İncelenmesi

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ABSTRACT: This research was carried out to reveal the experiences of pre-service elementary teachers during their visit to the science center and their observations and opinions about this experience. For this purpose, a case study, which is one of the qualitative research designs, was adopted. 32 pre-service elementary teachers participated in the research. Interviews, observations, and diaries were used to obtain the data, and the data were subjected to content analysis. As a result of the analysis, four themes were reached: image, interest, contribution, and improvement. The results show that pre-service teachers associate the science center image they create with technology, laboratory, and scientists. It was determined that pre-service teachers showed more interest in some disciplines of science, scientists, and technology-related fields in the science center. In addition, it was concluded that the science center would contribute to the innovative and productive vision, economy, and science literacy of the society in the city where it is located, science teaching, and the professional development of teachers. Finally, the pre-service teachers made suggestions to increase the contribution of science centers to the region and society. The results of this study are expected to be a valuable guide, providing science teaching experience and a qualified science teaching vision for pre-service elementary teachers in informal environments.

Keywords: Pre-service elementary teacher training, science education for pre-service elementary teacher, Out-of-school learning environments, science center.

ÖZ: Bu araştırma, sınıf öğretmeni adaylarının bilim merkezi ziyaretinde edindikleri deneyimleri ve bu deneyime ilişkin gözlem ve görüşlerini ortaya çıkarmak amacıyla gerçekleştirilmiştir. Bu amaç doğrultusunda nitel araştırma desenlerinden biri olan durum çalışması benimsenmiştir. Araştırmaya 32 sınıf öğretmeni adayı katılmıştır. Verilere ulaşmak için görüşme, gözlem formu ve günlükler kullanılmıştır. Elde edilen veriler içerik analizi yöntemi ile analiz edilmiştir. Analiz sonucunda; imaj, ilgi, katkı ve iyileştirme şeklinde dört temaya ulaşılmıştır. Sonuçlar öğretmen adaylarının oluşturdukları bilim merkezi imajını teknoloji, laboratuvar/deney odaklı mekân ve bilim insanlarıyla ilişkilendirdiklerini göstermektedir. Öğretmen adaylarının bilim merkezinde bazı bilim dallarına, bilim insanlarına ve teknoloji içerikli alanlara daha fazla ilgi gösterdikleri saptanmıştır. Ayrıca bilim merkezlerinin bulunduğu şehrin yenilikçi ve üretken vizyonuna, ekonomisine, toplumun bilim okuryazarlığına, bilim öğretimine ve öğretmenlerin mesleki gelişimlerine katkı sunacağına ilişkin sonuçlara ulaşılmıştır. Son olarak öğretmen adayları, bilim merkezlerinin bölgeye ve topluma katkılarının artırılması için önerilerde bulunmuşlardır. Sonuçların informal ortamlarda sınıf öğretmeni adaylarına bilim öğretimi deneyimi ve nitelikli fen öğretimi vizyonu kazandırılması bakımından yol gösterici olacağı düşünülmektedir.

Anahtar kelimeler: Sınıf öğretmeni yetiştirme, sınıf öğretmeni adayları için fen eğitimi, okul dışı öğrenme ortamları bilim merkezi.

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Learning is a formal and informal process that continues throughout the life outside of school (Laçin-Şimşek & Öztürk, 2021). Contrary to the formal education provided in the school system with traditional methods, learning in informal and out-of-school learning environments is more effective and motivating (Salmi, 1993; Selanik-Ay & Erbasan, 2016). Out-of-school learning is implemented during the school term and according to the curriculum, but takes place in environments and institutions outside the school building. This shows that out-of-school learning, which seems to be a part of informal education, is also related to formal education (Salmi, 1993). The steps taken to support learning in out-of-school learning environments in parallel with the curriculum can also contribute to science education because out-of-school teaching and learning help students understand science in a more contextual and holistic way compared to classroom learning (Rodéhn, 2019). Out-of-school learning environments such as museums, zoos, libraries, open-air museums, and aquariums support formal education environments. One of the most important of these out-of-school learning environments is science centers (Bell et al., 2009; Şentürk & Özdemir, 2014). Science centers, which started to serve in the 1960s, aim to popularize science among the general public (Yıldız Kuyrukçu, 2018) and present scientific information to their visitors in an entertaining and interesting way (Laçin-Şimşek & Öztürk, 2021; Weitze, 2003). Shein et al. (2019) stated that visits to science centers contribute to the knowledge, understanding, participation, and interest in science and technology in the general public. In other words, the aim of science centers that appeal to large masses is to contribute to the development of scientific literacy and the discovery of the mysteries of science throughout science education (Medved & Oatley, 2000). In science centers, emotional and interactive sensory experiences are accompanied by specific informational and cognitive goals (NRC, 2009).

To make children's science learning effective, teachers should enrich the teaching process with out-of-school learning environments such as science centers (Tasdemir et al., 2014). Science centers, with a large target audience of school-age children (Kisiel, 2006), enrich students' science learning processes and offer an inquiry and research-based learning opportunity (Phillips et al., 2007). These centers increase interest and curiosity in science and technology and make science and technology an important topic in society (Bozdoğan, 2008). Interactive and interesting activities within science centers are complementary environments for science education (Koyuncu & Kırgız, 2016; Rennie, 2007). Considering the studies conducted with students in science centers, it is found that science center experiences improve knowledge, skills, and attitudes towards science, provide a relationship between real life and what is learned at school, and provide a scientific perspective on daily events (Laçin Şimşek, 2011; Kırgız, 2018). However, although out-of-school learning experiences offer beneficial results for students, they may not suffice on their own. In such out-of-school environments, teachers can take on different roles to make learning more effective. While some teachers take on more passive roles, others may act like a maestro to organize students' experiences (Şentürk, 2015). In these trips, the teacher's interaction with the students, process planning, and their knowledge of the field and learning styles affect the learning process (Tran, 2011). Krange et al. (2020) reported that students had difficulty in trying to make sense of scientific concepts during the trip, and groups supported by teachers and guides made sense of these concepts more easily. Elementary

teachers' perceptions, which largely mediate the effectiveness of science teaching in enriched out-of-school learning environments, will affect their interest and participation in enriching curriculum resources (Luehmann & Markowitz, 2007). Although the target audience during the trip is students, these learning experiences are shaped by teachers (Kisiel, 2006). For this reason, teachers' experiences, attitudes, and perspectives towards science centers will also help them plan and conduct science center trips in parallel with the curriculum. In addition, teachers must have sufficient pedagogical content knowledge in order for out-of-school science activities carried out outside the school context to be successful (Geveke et al., 2017). Dewitt and Hohenstein (2010) argue that the effectiveness of such school trips depends on teacher-student interactions both during, before, and after the trip. In addition to the students' experiences during the science center trip, the teacher's plan, practices, and activities to reinforce the learning after the visit also encourage effective learning (Köseoğlu et al., 2020). On the contrary, in the study conducted by Morentin and Guisasola (2015), most of the teachers who visited the science center with their students reported that they made almost no preparation for the visit.

Therefore, teachers need to be equipped with the knowledge and skills they feel sufficient to activate all learning environments inside and outside the school. In this respect, the importance of furnishing prospective teachers with sufficient equipment and knowledge becomes evident. It is suggested that teacher candidates feel anxiety and insecurity about science education, and therefore, studies on different applications in science education can provide valuable guidance for educators and researchers (Steele et al., 2013). It has been reported that elementary teacher candidates have low self-efficacy (Kazempour & Sadler, 2015; Mintzes et al., 2013). Palmer (2006) emphasizes that this low self-efficacy may negatively affect prospective science teachers' future science teaching. For this reason, it is considered important for pre-service teachers to have experiences in which they can be successful in science education and to feel competent in this regard (Carrier, 2009). This outcome reveals the importance of studies with elementary teacher candidates in the context of science education. Studies show that different experiences in science education shape pre-service teachers' beliefs and approaches to science and science education (Bleicher, 2007; Carrier et al., 2017; Mintzes et al., 2013). In addition, Tasdemir et al. (2014) reported that pre-service elementary 'teachers' visits to science centers were effective in developing positive attitudes towards science centers and science courses. Eren-Sisman et al. (2020) stated that science teacher candidates' visits to science centers positively changed their views on the nature of science.

Within the framework of this research, it is important to reveal the experiences of the prospective elementary teachers about the science center and their thoughts on these experiences. For this purpose, a science center trip was organized in which first-year students were included in the study. The aim of this study was to examine the experiences of pre-service elementary teachers during the trip and gather their observations and opinions about this experience after the trip. In this context, it is anticipated that the research will make a valuable contribution to the literature by providing pre-service elementary teachers with science teaching experience in informal environments.

Method

Research Model

Qualitative research method was used in the research. Qualitative research method allows more in-depth information to discover subjects about which the information is scarce (Creswell, 2020). This research was conducted as a case study, one of the qualitative research designs and a research approach that emphasizes understanding, defining, predicting, or controlling an individual, group, or cultural situation (Akar, 2016). In case studies, which allow one or more phenomenon to be investigated in depth, factors related to the phenomenon (environment, individuals, events, processes, etc.) are investigated with a holistic approach by focusing on how they affect the relevant situation and also how they are affected by the relevant situation (Yıldırım & Şimşek, 2021). In case studies planned based on experience, each researcher has a unique approach to determining their own process (Akar, 2016). In this context, the research was carried out with a case study pattern to describe the first-year pre-service elementary 'teachers' visits to the science center and their experiences related to these visits.

Study Group

The study group of the research consists of first-year students studying in the Elementary Education Department at a university in Türkiye. The study group of this qualitative research was determined using the purposive sampling method. The logic and power of purposive sampling, which allows for an in-depth study, lies in the selection of information-rich situations (Patton, 2018). In this study, an easily accessible case sampling method, which is one of the purposeful sampling methods, was used in terms of practicality and convenience. This sampling method is generally used when the researcher does not have the opportunity to use other sampling methods (Yıldırım & Şimşek, 2021). The sample group of this study consists of 32 pre-service teachers, 22 females, and 10 males, who were studying at the faculty of education, where the researchers were teaching and participating voluntarily due to easy accessibility. 20 of the pre-service teachers stated that they had never been to a science center before. However, six pre-service teachers stated that they visited the science center during their secondary school or high school periods, and six of them when they came to the university for enrollment.

Data Collection Tools

In case studies, it is generally recommended to reach a richer data diversity using more than one data source to provide an in-depth perspective on the subject (Creswell, 2019; Yıldırım & Şimşek, 2021). Therefore, this research aimed to obtain rich data using interviews, observations, and diaries. The semi-structured interview form, an observation form, and a diary form, which were prepared by taking the opinions of the researchers, were used to collect data in the research.

Observation Form

An observation form was developed by two researchers to observe the experiences of the students in the science center. A field expert in science examined this observation form. Thus, the observation form, which was adapted in line with the

opinions of the field expert, aims to present the students' experiences during their visit to the science center from the researchers' point of view. The observation form consists of individual and group observations: "How were the students' reactions? Which exhibits were they most interested in? Which gallery received the most attention? How were the workshops? Observations about the planetarium; observations about free time; the status of active-passive participants; interaction of students with each other; interactions of students with their mentors and other teachers; the 'guides' content knowledge proficiency levels; physical capacity of exhibits in the science center and technical problems."

My Science Center Trip Diary

A form titled "My Science Center Trip Diary" was prepared by the researchers to allow pre-service teachers to express their ideas about the science center visit from their perspective. The observation form and "My Science Center Trip Diary" focus on pre-service teachers' experiences during their visit to the science center. In the travel diary, certain reference points were added so that the prospective teachers do not deviate from the context. A few of these references are: "My thoughts on the location, physical appearance, and transportation of the Science Center; what I saw/ learned in the gallery I visited; what did I see/learned in the workshop?" In addition, an open-ended section was added to the trip diary about other issues that pre-service teachers wanted to add.

Interview form

After the science center visits, a semi-structured interview form was used to evaluate the pre-service teachers' perceptions towards science centers. There are 13 questions in the semi-structured interview form, such as "What kind of contributions can the galleries, experiment sets, and activities in the science center have on science teaching? As a pre-service teacher, how can the galleries, experiment sets, and activities in the science center affect the future lives of primary school students? What kind of contributions do you think science centers will make to your professional development?" In addition, drilling questions such as the following were included in order to obtain more detailed information: "How do the galleries, exhibits, and activities in the science center relate to the field-specific skills (scientific process skills, life skills, engineering design skills) in elementary level teaching of science? Can you evaluate it?". To analyze the data related to the semi-structured interview form in more depth, face-to-face interviews were conducted with five students who filled out the form. The interviews were recorded with the consent of the participants, and then the recordings were transcribed.

Data Analysis

The data were analyzed by an inductive analysis method. The main purpose of the inductive analysis is to reach concepts and relationships that can explain the collected data. For this purpose, the obtained data are first conceptualized by subjecting them to a deep process, then the themes and patterns that explain the data are obtained by organizing them logically according to the emerging concepts (Yıldırım & Şimşek, 2021). The data obtained in this research were transcribed in detail and transferred to electronic media. The entries were read by two researchers separately, and more than once, and notes were taken next to the answers given by the pre-service teachers.

Possible codes in this process were determined separately by both researchers. At this stage, all the answers given by the pre-service teachers to a question in the interview form, the diary covering a situation and all the observation statements were taken into consideration. In creating codes, both researchers created coding schemes for the interview, observation, and diary. The codes identified were compared, and a consensus was reached in 27 of the 30 codes presented under each category within the findings (90%). For example, it was observed that the researchers had different codes, such as "science in a fan" and "science tube" for the question "How were the reactions of the pre-service teachers?" in the observation form. Afterwards, a common opinion was reached using the code "scientific fan" for this situation. A new evaluation was made on situations differing in terms of reasons and perspectives. As a result of this evaluation, new codes were created for situations reflecting a different opinion. From this point of view, appropriate codes, categories, and themes were reached. A detailed content analysis was carried out by determining the percentages of codes and categories obtained. A different field expert monitored the whole code and category creation process, and their opinion was taken in case of dilemmas. Thus, the final data classification was completed. Correlation value for the inter-research agreement was examined. The themes, categories, and codes generated from the coding schemes were presented in a summary table by adopting the principle of presentation of findings at a glance (Saldana, 2019).

Credibility and Ethical Procedures

The quality and credibility of qualitative research refer to the transparency of the entire research process, the processes related to the verification of findings and results, and the credibility of the truth of the findings (Agar et al., 2004; Lincoln & Guba, 1985). Some steps were taken to increase credibility in the research process. To give valid and reliable results from the data collection tools used in the research, experimental and theoretical publications made with pre-service science teachers, in-service teachers, and primary/secondary school students were reviewed, and the results of national and international education indicators on informal learning environments were examined (World Economic Forum [WEF], 2020; Organization for Economic Co-operation and Development [OECD], 2019). In addition, the opinions of field experts were taken. Thus, the research questions were created by comparing the relevant literature, expert opinions, and the objectives of the Ministry of National Education Science Curriculum (MEB, 2018). A pilot study of the data collection tool was made, and the data collection tools were finalized.

It is recommended to use multiple validity methods to evaluate the accuracy of interpretations in studies (Creswell, 2019). Glesne (2020) suggested some methods to ensure credibility in qualitative research. Another important step taken in ensuring the credibility of this research is the use of multiple data collection tools (triangulation). In order to diversify the data collection methods, interview, observation, and document analysis methods were used together. When observation, interview, and document analysis methods are used together in qualitative research, it significantly increases the validity of the research by serving the purpose of "data triangulation" (Yıldırım & Şimşek, 2021). In addition, methods such as receiving the opinions of field experts

(colleague evaluation) and confirming the participants' opinions (participant approval) were applied in the research.

Cross-checks are very important when analyzing qualitative research data (Denzin & Lincoln, 2011). For this, the results of the analysis were compared and discussed by the researchers. In addition, the results obtained are explained with examples to increase credibility (Arastaman et al., 2018). Thus, code-category and themes are supported by direct quotations. Another dimension related to ensuring the reliability of the research is the compatibility of the coders with each other. In terms of the reliability of the research, more than one researcher should review each lists together after coding the data separately (Miles & Huberman, 2019). To this end, two researchers came together frequently to achieve consensus between the codes, categories, and themes they created and completed the coding, theming, and conceptualization processes. For this study, the percentage of agreement among the coders was calculated (90%). The data with disagreement were re-examined and re-coded, and a consensus was achieved. The voluntary participation statement form was sent to all teacher candidates participating in the research in an electronic environment, and their approvals were obtained. Data from participants who had a voluntary participation declaration were used only. In accordance with the ethical principles of the research, these people were given codes as "PSET1" (indicating the first participant who is a pre-service elementary teacher). In addition, official permission was obtained for this research by the Scientific Ethics Evaluation Committee of the Faculty of Education of Selcuk University (#E-16343714-605.02-316109, Date: 02/07/2022).

Results

In this section, the findings obtained as a result of the analysis of the data obtained from different data sources such as interviews, observations, and diaries to reveal the experiences, observations, and opinions of the pre-service elementary teachers about the practices in the science center are included. In the presentation of the findings, it was aimed at protecting the integrity of the study. For this reason, the pattern consisting of themes, categories, and codes is presented in line with the principle of "representation of findings at a glance" (Saldana, 2019) to give the reader a clear perspective. Because important points may be overlooked when embedded in explanations, the codes or categories reached can be highlighted by using simple tables and figures, rich text features, headings, and subheadings so that the reader can see them at a single glance (Saldana, 2019, p.285). A summary of the study findings obtained from the research data is presented in Table 1.

As shown in Table 1, 4 themes, 10 categories, and 30 codes were obtained in the analysis of the data obtained from the interviews, observations, and diaries involving 32 pre-service teachers. To preserve the integrity of the study, the findings are presented with sample expressions in the text, without separating the data sources, instead of showing the codes and percentages in the table (Çavuş-Güngören & Hamzaoğlu, 2020).

Table 1

Summary of Study Findings on the Experiences of Pre-Service Elementary Teachers in the Process of Their Science Center Visits

Theme	Category	Code
Image	Spatial Image	Technology
		Scientific showcase
		Simulation
		Scientific Experiments
		Laboratory
		Astronomy
	Scientist Image	Invention and Discovery
		Scientists in the age they lived
		Scientific Development
Interest	Sciences	
		Geology
		Climatology
		Astronomy
		Biology
	Scientists	Turkish-Islamic Scientists
		Inventions
	Technology	Technology from the Past to the Present
Contribution	Contribution of the Science Center to the City Where It Is Located	Contribution to the Innovative and Manufacturing Vision of the City
		Contribution to the Economy of the City
		Contribution to Development of Scientific Literacy of People in the City
	Contribution to Science Teaching	Supporting Science Teaching for Primary School Students
		Enriching a Vision of Science Teaching in Teacher Training
		Opportunity for Children and Parents to Learn Science Together
	Contribution to Professional Development	Providing Experience for Out-of-School Learning Environments
		Supporting Domain Knowledge
Improvement	Improvement Ideas	Location of Science Center
		Number of Science Centers
		Community Access of Science Centers
	Renovation Works	Necessity of Repairing Non-Working Experiment Sets
		The Need for Presenting New Inventions and Developments

Image

In the study, in which the experiences, observations, and opinions of the pre-service teachers regarding the practices in the science center were examined, it was observed that the pre-service teachers developed an image for the science center. Under the image theme, there are two categories: "Spatial Image" and "Scientist Image".

In the Spatial Image category, the pre-service teachers developed an image that focuses on the physical features of the science center. They matched the spatial image of the science center with Technology (47%), Laboratory (45%), Scientific Experiments (44%), Astronomy (38%), Scientific showcase (11%), and Simulation (10%). Based on the science center observations and experiences of the pre-service teachers, it was observed that they created a spatial image for the science center that is focused on technology, laboratory, and experiment. Some of the opinions obtained from the interviews and diaries of the prospective teachers regarding the Spatial Image category are as follows:

> An area where many technologies and technological inventions take place (PSET1).
>
> Sections with interesting materials that bring science and technology together. Experiment rooms with elements that are unlikely to be encountered. Innovative sections that go in parallel with new inventions. Simulation rooms which allow us to experience (PSET7).
>
> The science center is like a scientific showcase with laboratory environments and experimental materials (PSET28).
>
> When I first entered, it was very impressive and large. The first thing that caught my attention was the robot I saw on the giant screen. A huge technologically advanced space consisting of many galleries… (PSET30, Diary).

In the Scientist Image category, it was determined that the pre-service teachers identified their image of the science center with the scientist. Under this category, two different codes are seen: Inventions and Discoveries of Scientists (78%) and Scientists in the Age They Lived (65%). Pre-service teachers identified the science center with the inventions that emerged as a result of the efforts of scientists specific to the period in which they lived. Some of the opinions obtained from the interviews and diaries regarding this category are as follows:

> It is a huge room where the inventions that emerged in the fields of physics, chemistry, and biology from the past to the present and the scientists who made these discoveries (PSET18).
>
> A field full of scientists and inventions (PSET22).
>
> When I first entered, I was very impressed by the reflection of Hezarfen Ahmet Çelebi on the screen, and it made me feel like I was in a science center (PSET32, Diary).

Interest

Pre-service elementary teachers showed interest in different galleries or sections in the science center. In the construction of the theme of interest, pre-service teachers' "feeling closeness to, liking, or prioritizing a certain event, activity, or person" was taken into consideration. There are three categories under the theme of interest: Scientific Disciplines, Scientists, and Technology. It was observed that the pre-service elementary teachers, who saw many different galleries, activities, or workshops in the science center, concentrated more on some particular areas. These activities or applications are explained in detail in the codes under categories.

In the category of "Scientific Disciplines", pre-service teachers preferred galleries, activities, or workshops regarding Geology (56%), Climatology (54%),

Astronomy (49%), and Biology (47%). To this end, it was determined that pre-service teachers showed more interest in the sections of Earthquake Simulations, Natural Disasters, Climate Studies, Climate Capsules, Solar System, Galaxies, Space, Stars, Human Body/Systems, and Harms of Smoking. However, very few teacher candidates visited the mechanics gallery in their free time. Some of the samples from the interviews, diary entries, and participant observations related to this category are given below:

> …AFAD was a place that provided experience. We were able to experience natural events such as storms and earthquakes. I simulated natural events such as tsunamis, tornadoes, floods, and avalanches. The climate rooms were also very nice. Maybe I felt the air temperatures that I could never feel. I was very interested in examining the structures in our bodies in more detail (PSET8).
>
> …one of the applications that I liked the most was the part where we examined our fingers and the structure of our t-shirt with a microscope (PSET10).
>
> I was excited to see the systems in our body and their functioning in detail... Also, the three-dimensional movie we watched, traveling in Space, was amazing… It helped me realize once again how magnificent and orderly the space is (PSET13, Diary).
>
> …In general, they had a more enjoyable time in "our body" gallery. The female students showed interest in the experimental sets related to respiration and cell subjects and listened to the guide more carefully… (Participant Observer 2)

Another area of interest for pre-service elementary teachers during their science center trips was ""Scientists". There are two different codes in the "Scientists" category, namely, Turkish-Islamic Scientists (77%) and Inventions of Scientists (68%). Pre-service teachers showed a great interest in scientists and their contributions to society at the science center. Participant observer notes and findings from the interviews point out that pre-service teachers were interested and excited about Turkish-Islamic Scientists because they did not have enough knowledge about this field before. Some opinions from interviews, diary entries, and participant observation notes regarding this category are given below:

> I studied Turkish-Islamic scholars and their inventions in the free section. I didn't know before that our own ancestors had such important work (PSET8).
>
> The area where the works of Muslim scientists were exhibited was the one that was most interesting to me. It was enjoyable to examine the models that showed the working mechanism of the inventions there (PSET9)
>
> The discoveries of scientists were very interesting. The structures were complex and different in mindset. For example, I found Al Jazari's lock system very interesting and successful (PSET27, Diary)
>
> It was observed that the teacher candidates showed great interest in the Sultans of Science Gallery. During this period, the pre-service teachers told each other and the advisor faculty member that they had never heard of this information about scientists before and did not know. In addition, it was observed that they were surprised next to the sets in which some scientists-inventions took place (Participant Observer 1).

Another category under the theme of interest is "Technology". Two different codes are listed under this category: Technology from Past to Present (69%) and Robots (56%). Pre-service teachers showed a great interest in the technological departments or galleries in the science center both in guided field trips and in their free time. Findings from interviews, diaries, and observation notes indicate that male pre-service teachers showed more interest in technology-related fields. Some opinions regarding this category are given below:

> It was the robot upstairs that caught my attention the most. It was mimicking your moves. Future uses for robots were inspiring (PSET15)
>
> It was very interesting to observe the scientific progress from the inventions made in the past centuries to the developments in the current century (PSET26, Diary)
>
> …It was observed that male pre-service teachers wanted to spend more time in the galleries visited, especially in technological tools, engineering, and design mechanisms (Participant Observer 2)

Contribution

In the study, it was observed that the pre-service teachers also focused on the contributions of the science center. There are three different categories under the theme of contribution: "Contribution to the City where the Science Center is Located," "Contribution to Science Teaching," and "Contribution to Professional Development."

Pre-service teachers evaluated "Contribution of the Science Center to the City Where It Is Located" based on their experiences of visiting the science center. Under this category, there are three different codes: Supporting the City's Innovative and Manufacturer Vision (68%), Supporting the City's Economy (62%), and Developing the City's Science Literacy (56%). Based on the experience they gained, the pre-service elementary teachers gained an awareness that the science center can contribute to the city where it is located. They interpreted this contribution in terms of the students living in the city, the people of the city, and the city's economy and innovative vision. Some opinions from interviews, diaries, and participant observation notes regarding this category are given below:

> I think that if the people in the region can take full advantage of it, it will significantly improve the science literacy of the people there and promote science (PSET10).
>
> I think it attracts students or individuals interested in science not only in the city where it is located but also in the whole region, and thus increases the interest in science. I also believe that this will contribute to the economic development of the city (PSET30).
>
> Such a place undoubtedly gives the region the feature of being an area frequented by visitors. It supports the city's work in science and technology. It makes the city more productive and innovative (PSET6, Diary).

Another category discussed under the contribution theme is the science center's contribution to Science Teaching. In this category, there are three different codes: "Supporting Science Teaching for Elementary Students (69%)", "Providing Science Teaching Vision in Teacher Training (67%)", and "Children's and Parents' Opportunity to Learn Science Together (55%)". Pre-service elementary teachers interpret the contribution of the science center to science teaching in terms of students, teachers, and parents. Pre-service elementary teachers are of the opinion that science centers will contribute to increasing the interest and passion of especially primary school children in science, supporting permanent learning, and increasing science achievement. In addition, they see the science center as an important element in training elementary teachers and supporting teacher candidates' science teaching competencies. In addition, pre-service teachers think that the science center is important for the child to learn and experience science with their parents. Some of the opinions obtained from the interviews and diaries regarding this category are given below:

> In theory, everyone knows about science more or less. However, learning by observing and understanding by discovering makes learning science more permanent and enjoyable. I think that the science center will bring this perspective to teachers in science teaching (PSET1)

> Undoubtedly, children are more willing and creative than us in imagination and discovery. It will contribute much more to their creativity and learning if they see these features by trying and living in the science center instead of just learning them as theory. I think it will also support children to develop permanent skills in their future lives (PSET12)
>
> Today I saw children visiting the science center with their parents. It's nice that the science center offers the opportunity to learn science together for both parents and children. I think it will have positive effects if the school encourages families to visit the science center (PSET20, Diary).

Another category discussed in the context of the contribution theme is "Contribution to Professional Development". Pre-service elementary teachers emphasized the contribution of the science center to the professional development of in-service and pre-service teachers in line with their experiences in the science center. This emphasis is mostly on Gaining Experience (78%) and Supporting Field Knowledge (68%) for out-of-school learning environments. Pre-service elementary teachers see science centers as an effective out-of-school learning environment for science teaching. In addition, they see it as an opportunity, especially for schools that do not have laboratories or teaching materials. Another point that the pre-service elementary teachers find important in contributing to professional development is that the science center is an important component supporting the subject knowledge. Pre-service teachers believe that the experiments, activities, and practices in the science center will support the current and basic subject knowledge required for science teaching. Some opinions regarding this category are given below:

> When I become a teacher, I would like to take my students to the science center often because it is easier for them to understand something they see with their eyes and try. It also gives me an important experience outside the classroom as a teacher (PSET17).
>
> Since my students will be more inclined to be influenced by what they see and have more fun because of their young age, the science center will keep their minds active and offer them the opportunity to have a pleasant time. For this reason, I would like to take my students to places such as science centers whenever possible (PSET18).
>
> I think that science centers will provide an important awareness for science teachers. The teacher can realize their productive, curious, questioning, and observant characteristics, learn new information, complete missing information, and come up with new project ideas (PSET22).

Improvement

Another prominent theme within the scope of the study is "Improvement". Within the scope of this theme, the pre-service elementary teachers mentioned "Improvement Ideas" and improvements to be done in order for the science center to operate more effectively, based on their experiences.

In the category of "Improvement", there are three different codes: Location of the Science Center (72%), Number of Science Centers (58%), and Accessibility of Science Centers by the Community (51%). Pre-service teachers stated that science centers should be located closer to the city to increase the science literacy of society, reach more students, and be beneficial for all segments of society. They also stated that the number of science centers should be increased or research centers or workshops affiliated with the science center should be established in different parts of the city. Finally, they mentioned that the science center should be supported with activities that

provide access to the community. Some of the opinions obtained from the interviews, diaries, and participant observer notes are given below:

> It would be better if the location of the science center was accessible to everyone. It is very difficult to reach here from many parts of the city (PSET3, Diary).
>
> …exhibitions, galleries, and seminars on different subjects can be opened every month. People can benefit from these activities by announcing all segments of society through advertisements (PSET12).
>
> Children and teachers should be encouraged to visit this place frequently and benefit from different activities. For example, for me, it was a day worth getting up at 6 in the morning and walking for half an hour and traveling by tram for half an hour (PSET9).
>
> …the conversations with the pre-service teachers in front of the science center in the early morning hours were related to the fact that the science center was so distant. Some students had come by transferring three different vehicles. Some were even late. However, although the science center was distant, it impressed and excited them with its external appearance. At the end of the science center tour, the conversations between them were like "everyone should benefit from it", "When I become a teacher, I would definitely bring my students"... (Participant Observer 1)

Another category in the improvement theme is "Renovation Works". In this category, the codes "the Need for Repairing Non-Working Exhibits (73%)" and "To Include New Inventions/Innovations and Developments (56%)" were included. Based on their experiences, the pre-service teachers mentioned that the exhibitions that did not work in the science center should be repaired, and some closed galleries should be opened. In addition, they made suggestions for the addition of new galleries, inventions and innovations in light of the current scientific developments in order for the science center to operate more effectively. Some of the opinions obtained from the interviews, diaries, and participant observer notes regarding this category are given below:

> New galleries may be opened over the years, or new research and events may be added to existing galleries. New scientists and their studies can be added. Events for that day can be organized on certain special days (PSET16).
>
> I think non-working instruments and test sets should be repaired. My second visit here, and the same test exhibits were not working (PSET24, Diary).
>
> …the pre-service teachers asked questions of the lecturers and guides that some of the exhibits did not work. In addition, it was observed that some teacher candidates directed their criticisms to the guides about the fact that they could not see the work of some Turkish scientists, such as Canan Dağdeviren and Mete Atatüre (Participant Observer 2).

Discussion and Conclusion

The study aimed to examine the experiences of pre-service elementary teachers during the Konya Science Center trip and their observations and opinions about this experience after the trip, and the results are discussed in the context of "image"," "interest"," "contribution," and "improvement" themes.

In the study, it was determined that the pre-service elementary teachers developed an image for the science center. This image focused on the spatial characteristics of the science center and scientists. Science center images of teacher candidates focusing on space are mostly related to technology, laboratories, and scientific experiments. Sayar and Arat (2017) define Konya Science Center as a building that has the feature of being a symbol building for Türkiye and Konya City with its design considering many criteria in detail and because it is a Leeds-certified sustainable building. Colors and lighting used in the design of the spaces in Konya

Science Center impress the visitors, especially children (Burkut, 2018). In this study, pre-service teachers found the interior and exterior design of the science center quite technological and were affected by this design. Furthermore, the identification of the science center with the spatial image dimension with laboratories, scientific experiments, astronomy, scientific showcase, and simulations is an original result. In addition, another image developed for the science center is the scientists' dimension. Based on the observations they obtained during the science center trip, the pre-service teachers identified the science center with the inventions that emerged as a result of the studies of scientists specific to the period in which they lived. Considering the limited number of studies in the related literature on how pre-service teachers perceive science centers or how they create an image related to science centers, the results of this study are new in the field in terms of the images developed for the science center.

It was determined that the pre-service teachers showed interest in different galleries or sections during the science center trip. This interest stands out with scientific disciplines, scientists, and technology. In terms of scientific disciplines, it was observed that pre-service teachers preferred the following galleries, activities, or applications that represent Geology, Climatology, Astronomy and Biology: Earthquake Simulation, Natural Disasters, Climate Studies, Solar System, Galaxies, Space, Stars, and Human Body/Systems. However, it was determined that very few teacher candidates visited the mechanics gallery in their free time. Studies have shown that students have problems at the conceptual level in the mechanics-related subjects of physics, that these subjects are difficult and boring for the students, and that they have difficulties in practice in daily life (Eryılmaz & Tatlı, 2000; Gülçiçek & Yağbasan, 2004; Lye et al., 2002; Yeltekin-Atar et al., 2021). There may be different reasons why prospective elementary teachers, who see many different galleries, activities, or workshops in the science center, show more interest in some areas. As a matter of fact, the pre-service elementary teachers participating in the research were in the second term of their undergraduate education. They take Basic Science and Environmental Education in Elementary School courses. The subject areas they learned within the scope of these courses and the galleries, activities, and practices they were interested in at the science center were similar. This situation may have caused the pre-service teachers to turn to and be interested in practices that provide evidence about the subjects they know theoretically. Similarly, in their research with teachers, Yolcu and Karamustafaoğlu (2021) determined that elementary teachers, unlike science teachers, talked about topics that can be matched with the topics in life studies and social studies courses in addition to the science course in the virtual science center trip. The reason for this situation is explained by the fact that elementary teachers receive training for different courses. Another area of interest for pre-service teachers during their visit to the science center was "Turkish-Islamic Scientists" and "Inventions of Scientists". The reason why the pre-service teachers were interested and excited about Turkish-Islamic Scientists may be due to the fact that they did not have enough knowledge about scientists, research processes, and inventions of scientists. Studies have shown that the perceptions and knowledge of pre-service elementary teachers about scientists include stereotypes and are not based on a realistic basis (Çermik, 2013; Oğuz-Ünver, 2010). The research results indicate that adequate educational support should be provided not only in terms of the perception of scientists but also in terms of having knowledge about

scientists. Finally, another area that teacher candidates are interested in in the science center is the technology dimension. In the study, it was observed that especially male pre-service teachers showed more interest in technology galleries, which also include robots, in the science center. When review studies in the field are examined, studies show that male pre-service teachers' attitudes and competencies towards technology were higher than those of female pre-service teachers (Aksoğan & Bulut Özek, 2020; Arslan et al., 2011; Çetin et al., 2012; Kubiatko et al., 2010; Özdemir & Taç, 2017; Sainz & López-Sáez, 2010). This result indicates that measures should be taken to positively support female pre-service elementary teachers' interests and attitudes towards technology.

It was concluded that the pre-service elementary teachers made inferences about the contributions of the science center based on their experiences in the science center. The results obtained in the context of contribution can be considered in three different dimensions: its contribution to the city where the science center is located, its contribution to science teaching, and its contribution to professional development. In line with their experiences, pre-service teachers interpreted its contribution to the city where it is located in terms of supporting the city's innovative and manufacturing vision and economy and improving the city's science literacy. Shein et al. (2019) stated that visits to science centers contribute to the public's knowledge, understanding, participation, and interest in science and technology. Görkemli and Solmaz (2012), who discussed what the Science Center could add to Konya in their study, stated that science centers would attract more visitors and investors to the city, will be an important center of attraction in the city, and these effects will contribute to the city's economy and development. According to Tlili et al. (2006), these centers establish a link between science, education, and industry. The elementary teachers' ideas about the science center's contribution to the city where it is located are considered as an important result of the study. This evaluation sheds light on how they perceive science centers as centers of attraction for science teaching in their professional lives. According to another result in the context of contribution, pre-service teachers believe the science center contributes to science teaching. It was concluded that they interpreted this contribution as supporting science teaching for primary school students, providing a vision of science teaching in teacher training, and providing the child with the opportunity to learn science with their parents. Studies with students have shown that science center trips increase children's desire to be a scientist and do scientific research, improve success in science courses, create a desire to choose professions in the field of science and technology and provide a better understanding of scientific concepts (Dohn, 2013; Erçetin & Görgülü, 2018; Guisasola et al., 2005; Ok & Aslan, 2020; Ross et al., 2010). The research showed that the science center supports science teaching, which is similar to the results of studies conducted with in-service and pre-service science teachers in the literature (Bozdoğan, 2008; Çiçek & Saraç, 2017; Selanik-Ay & Erbasan, 2016). The result of this study is based on the science center observations and experiences of the pre-service elementary teachers. At this point, it is considered important that elementary teachers, who will also assume the role of science teaching, understand the importance of science centers in terms of supporting science teaching. Moreover, it can also be considered as an original result that pre-service teachers consider the science center to provide a vision of science teaching in teacher training. Another result obtained from

pre-service teachers' experiences is that the science center will support the learning of children and parents in terms of its contribution to science teaching. Öztürk and Laçin-Şimşek (2019) examined the behavior of families in the science center and determined that parents and children mostly preferred to perform the visit together. Compared with the results of this study, the contribution of the science center was determined by the pre-service teachers in terms of providing the child with the opportunity to learn science with their parents. It is anticipated that this outcome will guide prospective elementary teachers in terms of guiding the parents in their professional lives.

Another result that can be considered as part of the contribution dimension is how the pre-service teachers interpret the contribution of the science center to professional development. The pre-service teachers see science centers as an effective out-of-school learning environment for science teaching. Moreover, they see it as an opportunity, especially for schools that do not have laboratories or teaching materials. Another point that the pre-service teachers find important in terms of contribution to professional development is that the science center is an important component that supports the content knowledge. Various studies have also revealed that teachers should effectively guide their students and have sufficient content knowledge in science centers, which are an out-of-school learning environment (Dewitt & Hohenstein, 2010; Geveke et al., 2017; Krange et al., 2020; Luehmann & Markowitz, 2007; Tran, 2011; Turkmen, 2015). Thus, the present research has made elementary teachers aware that science centers are an opportunity for professional development.

Another result of the research is that the pre-service elementary teachers drew attention to the measures to be taken for the science center to provide more effective benefits and the improvements to be done within the scope of renovation works. Science center experiences of pre-service teachers indicate that science centers should be located closer to the city to increase the science literacy of society, reach more students, and be beneficial for all segments of society. In addition, suggestions were made that research centers or workshops should be established in different parts of the city and that the science center should carry out activities that provide access to society. Based on the experiences of the pre-service teachers in Konya Science Center, the exhibits that do not work in the science center should be repaired, and some closed galleries should be opened. Bozdoğan (2008), in their study at the Feza Gürsey Science Center, revealed that non-working exhibits constitute a problem faced by pre-service teachers. It can be suggested that the exhibits should be repaired, the closed galleries should be opened, and new galleries should be added in light of current scientific developments in order for the center to operate more effectively.

The results of this research, which is based on the experiences of pre-service elementary teachers visiting a science center, which is an informal learning environment, contain original findings regarding providing pre-service elementary teachers with a qualified science teaching vision and experience. Based on these findings, the effective use of science centers can be added to undergraduate programs as a separate applied course to attain well-equipped training for elementary teachers. However, considering the contribution of science centers to the city and region where they are located, it is necessary to take measures to ensure that these centers are utilized in the most effective way.

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Statement of Responsibility

The authors contributed equally to the study.

Conflicts of Interest

The authors declare that there is no conflict of interest.

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