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Pre-Service Elementary Teachers' Experiences in Researching and Evaluating Scientists and Sharing Their Findings

Sema AYDIN CERAN[1], Mücahit KÖSE[2]

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This research aimed to reveal the experiences of the pre-service elementary teachers' researching and evaluating scientists and sharing their findings through original posters. The research was designed in a phenomenological pattern, one of the qualitative research methods. The research included 28 pre-service elementary teachers who were in the second term of their undergraduate education. A three-month implementation process was carried out to provide pre-service elementary teachers with experience in researching and evaluating scientists, and sharing their findings, and to interpret their experiences. In the research, a semi-structured interview form, an observation form, video recordings and photographs, and posters prepared by pre-service teachers were used as data collection tools. The obtained data were analyzed by the content analysis method. The research showed that before the research and evaluation process, pre-service elementary teachers generally had superficial knowledge about scientists. The qualities of scientists that attract the participants' attention were as follows: scientists' dedication, creativity, hard work despite all the difficulties, and approaching life from a different perspective. Emphasizing the contributions of the experience to the pre-service teachers in terms of individual and social gain and benefits for the future students is another result. It was determined that pre-service teachers frequently referred to non-scientific sources such as web pages and blogs as much as scientific sources. The experience they gained made the teacher candidates feel pride and happiness and increased their professional self-confidence. The results are discussed based on the pre-service elementary teachers' awareness of science and scientists and their gaining experience in this activity.

Keywords: Teacher education, pre-service elementary teacher, phenomenological research, nature of science.

INTRODUCTION

A scientist is a person who examines the events and phenomena in the universe, investigates the source of the mechanisms underlying them, tries to understand the reasons for these mechanisms, and lets the others know what they understand in a way that they can be understood by the general public (Ortaş, 2004). One of the first conditions of understanding science and the nature of scientific knowledge is the correct understanding of the people who create this knowledge (Kaya et al., 2008). Teachers play an effective role in improving the perspective of individuals towards scientists, building trust in scientific knowledge, and raising awareness in the acquisition of scientific knowledge. The process of creating a positive attitude and interest in science in schools attained via the science course (Ministry of National Education [MEB], 2018) taught independently in the 3rd and 4th grades in elementary school. Science enables individuals to develop scientific understanding, learn the ways of using knowledge, find logical solutions to the problems they may encounter in daily life, and use scientific processing skills more effectively (Hançer et al., 2003). Every event experienced in daily life is effective in helping children understand and recognize the world they live in, adapt to the outside world, and gain scientific thoughts. For this reason, the earlier the science education is started, the more systematically the child is able to perceive and interpret what is going on around them (Ünişen & Kaya, 2015). The importance of teaching science courses in primary school is also seriously emphasized in international education indicators, and children's science literacy is the subject of many international studies (Trends in International Mathematics and Science Study [TIMSS], 2020; the World Economic Forum [WEF], 2020; The Organization for Economic Co-operation and Development [OECD], 2019). The United Nations Educational Scientific and Cultural Organization (UNESCO, 2015) points to qualified science education as a measure of welfare of societies. For this reason, it can be said that elementary teachers play an active role in creating an effective science teaching climate in elementary school, gaining an understanding of the nature of science, developing scientific process skills, and raising qualified science literate individuals. This research is the starting point for pre-service elementary school teachers to develop their competencies in taking on this active role.

Michael R. Matthews (1994) stated that the work and life stories of scientists make knowledge concrete and understandable in teaching scientific subjects. In addition, the working processes of scientists can be used in education and training to improve students' understanding of the nature of science and to increase their level of knowledge in the history of science. From this point of view, the following study process was adopted in

[1]Selcuk University, sema.aydinceran@selcuk.edu.tr, orcid.org/0000-0001-6847-2766
[2]Alanya Alaaddin Keykubat University, mucahit.kose@alanya.edu.tr, orcid.org/0000-0002-1938-6092

the research: first of all, pre-services teachers should develop positive attitudes towards science and scientists; internalize the scientific process steps followed by scientists; have a knowledge of scientific innovation, invention, and ideas; and presenting this information with their own unique designs. This point of view adopted within the scope of the research reveals a very original process in the literature. Studies conducted with pre-service teachers have shown that there is a trend in studies to identify the image of the scientist (Görecek Baybars, 2018; Çermik, 2013; Korkmaz & Gürçay, 2016; Şenel & Arslan, 2014). Studies on evaluating the scientist image and perceptions of elementary school students have also gained popularity (Balkı et al., 2003; Emvalotis & Koutsianou, 2018; Korkmaz & Kavak, 2010; Küçük & Bağ, 2016; Nuhoğlu & Afacan, 2011; Ruiz-Mallén. & Escalas, 2012). In these studies, it is seen that students have stereotypical perceptions of scientists. The sources of this perception are mostly audiovisual media tools and textbooks (Manzoli et al., 2006; Reis & Galvão, 2007; Steinke et al., 2007) and partially teachers (Bayram, 2018; Özgelen, 2012; Turkmen, 2008). Kenneth Jones & Hite (2020) conducted a study in students at different levels and reported interesting results that students' definitions of scientists had no effect on their role models. It was emphasized that if the role model has no direct interaction with students, there is no role model effect (Flouri & Buchanan, 2002). This outcome shows that the results of a research experience that pre-service teachers obtain via the images and perceptions of scientists are also important for their prospective students.

Scientists' life stories are one of the tools aiming to improve individuals' attitudes towards science and scientists at different educational levels. To use this tool more effectively, a study in which the experiences of pre-service teachers in such a process are examined in depth will contribute to the literature. Lederman (1992) stated that, to develop students' conceptions about the nature of science, it is necessary to focus primarily on in-service and pre-service teachers. In this context, Çermik (2013) conducted research aiming to determine the "scientist" perceptions of the pre-service teachers and reported that "scientists" in the minds of the pre-service teachers are generally not realistic. Laçin Şimşek (2011) conducted an action research design investigating the effect of research studies about the contributions of civilizations and scientists to science on the level of knowledge of students about the history of science, and reached the conclusion that this process increased the pre-service science teachers' knowledge levels of history of science. Kurtdede Fidan and Konak (2016) determined the followings as the basic qualities of scientists in their research conducted in the phenomenology design, in which they aimed to determine the views of graduate students on science and scientists: patience, industriousness, determination, sense of curiosity, openness to innovation, and having the power to think critically.

This research is expected to make significant contributions to the field and the professional development of pre-service teachers on the basis of increasing their awareness of science, scientists, and scientific research methods, as well as improving their ability to present their original designs before the public and to disseminate knowledge. Therefore, it was aimed to reveal the experiences of pre-service elementary teachers in the process of researching and evaluating scientists and sharing the information they obtained in the process with the general public. For this purpose, in the research, an answer for the following question was sought "How are the experiences of pre-service elementary teachers in the process of researching and evaluating scientists and sharing the information they obtained in this process with the public?"

METHOD

Research Design

This study was designed as phenomenological research, one of the qualitative research methods. A phenomenon refers to anything that we can know through observations or inferences. Phenomenological research aims to reveal experiences related to a phenomenon. Phenomenological studies are important in revealing the facts that we are not fully aware of in detail (Creswell, 2013; Yıldırım & Şimşek, 2016). In this study, the process of pre-service teachers' researching/evaluating scientists and sharing their findings through original posters was considered as a phenomenon. The phenomenological design was used to reveal the experiences of pre-service teachers.

Participants

The participants of the research are pre-service teachers who were selected by the "criterion sampling method", which is one of the "purposive sampling methods". All participants volunteered to participate in the research.

Being in the first year of the elementary education program and not having received a higher education course on the nature of science and the history of science were the inclusion criteria. In addition, the participants were registered to Basic Science and Environmental Education courses in the Elementary Education program. Participants were 28 pre-service teachers, 10 males and 18 females.

Implementation Process

An implementation process was planned to provide the pre-service elementary teachers with experience in researching and evaluating scientists and presenting their findings, and to interpret their experiences. The implementation process took about three months (February to May). First, a pool of scientists was created by two faculty members specialized in science education. While creating the pool of scientists, care was taken to select scientists that changed the world, made a vast contribution, and had an immense influence. In addition, an objective, independent, and inclusive approach was adopted in the creation of the scientist pool. Pre-service teachers selected from a pool of 42 scientists by drawing lots. The supervising faculty provided a two-hour training to the pre-service teachers. Various basic topics were included in the training such as: "Who is a scientist? What are the characteristics of the scientist? Bias-free and inclusive attitude in researching the scientist? What is a poster? How to prepare a poster? What are the points to be considered while preparing a poster? What web tools can be used to prepare posters?" The research, evaluation, and poster preparation processes of the pre-service teachers were periodically examined in the classroom environment. In these regular reviews, the posters were displayed on the board and presented for discussion, and ideas were exchanged in the classroom. In addition, pre-service teachers were given the opportunity to share their own evaluation and research processes. Thus, the process of supporting and developing the research, review, and poster design processes has been established. The poster design process was completed 15 days before the event day. In the next process, the posters were printed. One week before the event, pre-service teachers and advising faculty members organized the event area and announced the event.

Data Collection Tools

The data collection process in phenomenological research is carried out through observations, various documents, and in-depth interviews (Cresswell, 2013; Moustakas, 1994). In this study, care was taken to diversify the data using multiple data collection tools during the data collection process. In this context, a semi-structured interview form and an observation form developed by the researchers were used in the study. In addition, video recordings and photographs to support participant observation and posters prepared by pre-service teachers were also used as data collection tools.

Interview Form

A semi-structured interview form prepared by the researchers was used in the study. In order for the semi-structured interview form to yield valid and reliable results, scientific publications were scanned using keywords such as: "perception of science and scientist, scientific research, scientific process skills, pre-service elementary teachers and science teaching, nature of science, pre-service elementary school teachers, and nature of science." In addition, national and international reports on teacher education and elementary teachers were examined. The draft form of the interview form was submitted to researchers specialized in Science Education, Elementary Education, and Turkish Education. As a result of the examinations of the experts, two items were revised to increase clarity and provide scientific expression. A pilot study was conducted by applying the revised version of the semi-structured interview form to four pre-service elementary teachers. As a result of the pilot study, revisions were made in three items to increase the clarity of the form and a drilling question was added. There are 11 items in the interview form. Sample items are given below:

> *"Did you have any previous knowledge about the scientist you worked on as part of the project? If yes, please elaborate?"*
>
> *"How did your work and researching on scientists affected your perspective on science and scientists? How did it differ from your previous point of view?"*
>
> *"As a pre-service teacher, what kind of benefits do you think your experience with scientists, science, and scientific benefit will be for your students?"*

To reveal the experiences of teacher candidates regarding the research, evaluation and presentation processes in more detail, this drilling question was added: "*Would you like to add any other point about your experience in the process?*"

Observation Process

Participatory observation is a method in which the researcher takes part in the overt and implicit aspects of a group of people's interactions and events (Musante & DeWalt, 2010). In this study, the researchers acted as participant observers at every stage of the research. In participant observation, the researcher is part of the examined phenomenon (Baltacı, 2019). The observation form has two stages. The first stage covers the 3-month period from the day of random assignment of the scientists to the event day. The second stage covers the event day. The second stage observation form consists of three parts: pre-event preparation, the event process, and post-event. The data obtained as a result of participant observations were used to interpret the findings.

Video Recordings and Photos

Video recordings obtained in the research were used by the researcher for objective self-evaluation and also to evaluate the implementation process objectively. For this purpose, all processes from the beginning to the end of the event titled "Scientists Shaping the Societies/Scientists Changing the World" were video recorded. The video recordings were effective in terms of repeated evaluations of all the dialogues during the process, the processes experienced by the pre-service teachers during the presentation, the reactions of the participants and the pre-service teachers, and similar issues.

Poster

The posters designed by the pre-service teachers for the event were another data collection tool used in this research. During the three-month implementation period, the draft posters developed by the pre-service teachers and the final versions were examined in two stages. Five basic criteria were used in the evaluation of the posters, namely, accuracy of information, interpretation of information, use of visual elements, integrity of information and visual elements, and originality in design. Thus, the design processes of the pre-service teachers were also supported in this process. The data obtained from the posters examined by the researchers in line with the basic criteria were used to interpret and justify the findings.

Data Analysis

In this study, the content analysis method used by Giorgi (1997) in descriptive phenomenology, which is recommended by Şimşek, and Yıldırım (2016) was used in four steps, namely, 1. Data Coding, 2. Developing the Themes, 3. Organizing the Codes and the Themes, and 4. Defining the Findings. First, the raw data were examined in detail by the researchers, preliminary coding was made, and draft notes were taken (Saldana, 2019). As a result of these examinations, coding was completed. Then, the researchers discussed and compared their codes in several meetings. In this comparison process, common and different codes were identified. While the common codes were accepted by both researchers, re-evaluations were made on discrepancies. At the end of this process, 34 codes, 11 categories, and three themes emerged. Direct statements of pre-service teachers were used to show the basis of the theme and code formation processes. Abbreviations "PT1" and "PO1" were used for each participant (PT1 represents the first pre-service teacher in the random order, PO1 represents the participant observer in the first place in the random order). The video recordings obtained during the poster presentations were examined by both researchers. During the evaluations, the reactions of the pre-service teachers during the presentation, their approach to the participants, the changes in their presentation skills from the beginning to the end of the project, the reactions of the audience to the pre-service teachers were determined and evaluations were made on these. The presence of both researchers as participant observers during the implementation process enabled the observations of the whole process to be evaluated from two different perspectives. The results of these observations enabled the mutual discussion of ideas in the data analysis process regarding the research, evaluation, and sharing processes of the pre-service teachers and made it possible to identify the reciprocal supportive aspects of different data collection tools.

Credibility and Ethics

Before the research, the ethics committee approval was obtained. Permissions were obtained from to the unit where the pre-service teachers were registered. In a phenomenological study, data on personal opinions and

experiences are collected from individuals; therefore, apart from these institutional permissions, pre-service teachers were informed about the research before data collection. In addition, written consent of the participants was obtained, and it was explained that they had the right to withdraw from the research at any time. Only the data of the participants who had a voluntary participation declaration were used in analyses.

In phenomenological research, it is important to protect participant confidentiality and to keep the data secure (Ersoy, 2016). For this reason, codes were used instead of the names of the participants, and both in archiving the data and presenting the findings. In the research, certain approaches and measures were considered for credibility. One of the points to be considered in phenomenological research is that the researcher should avoid directing the phenomenon by abstaining the use of the previous knowledge and experiences with the purpose of making an objective evaluation. In terms of the reliability of the research, more than one researcher should code the data independently and they should review each code together (Miles & Huberman, 2019). Therefore, two researchers convened regularly to achieve consensus on the codes, categories, and themes they created, and then they completed the coding, theming, and conceptualization processes. For this study, the percentage of agreement among the coders was calculated as 91%. The data with disagreement were re-examined and re-coded, and a consensus was achieved. After the interviews conducted by the researchers for the correct understanding and interpretation of the data, the consent of the participants was obtained. Although interviews were used as the main data source in this research, it was aimed to ensure internal validity by providing data diversity using observation, video recordings, and posters. By comparing the data obtained from different data collection tools, the consistency between the data was ensured. The transferability of the research was aimed by explaining the research process, the setting carried out, the participants, and the data collection and analysis processes in detail.

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, videos, photographs, and posters are included. In the presentation of the findings, it was aimed to present codes, categories and themes in a holistic and understandable way. For this reason, the percentages of the codes are included in the presentation of the findings in order to present the general framework more clearly. Based on the principle of "representation of findings at a glance," Saldana (2019) states that summarizing the findings and links in a simple text table covering as few pages as possible will enable readers to perceive the main findings of the research at a single glance (p.283). In this context, a summary of the study findings obtained from the research data is presented in Table 1.

Table 1. Summary of study findings on the experiences of pre-service elementary teachers in the process of researching and examining scientist and sharing their findings.

Theme	Category	Code
Perception	Preliminary information	I have no idea
		I have superficial knowledge
		I have detailed information
	Scientist Overview	Devotion
		Creativity
		Working despite all the difficulties
		Patience
		Different perspective on life
		Trust in science
Benefit	Benefit to the Society	Innovative Society
		Productive Society
		Science Literate Society
		Economically Prosperous Society
	Individual Benefits	Gaining Vision
		Professional development in teaching
		Confidence
		Research skill
		Presentation skill
		Interest in science and scientific events
	Benefit to Elementary School Students	Development of domain-specific skills
		Curiosity and interest in science in elementary school
		Education tailored to students' individual differences
	Understanding the Real Life-Science Link	
Research Process	The Path Followed in the Research	Scientific publications
		Non-scientific sources
	Design process	Interpreting information
		Integrating visual elements with information
	Affective Domain	Excitement
		Anxiety
		Pride
		Happiness
	Challenges	Conflicting information
		Challenges experienced in design
		Inexperience
		Difficulty in using web tools

When Table 1 is examined, three themes, 11 categories, and 34 codes were obtained in the analysis of the data obtained from the interviews, observations, video-photographs, and poster reviews of 28 pre-service teachers.

Perception

It was found that pre-service teachers had a perception of the scientist assigned to them before and after the research. One of the categories under the theme of perception is pre-research "preliminary knowledge." The pre-service teachers were assigned the scientists they will research by drawing lots. Based on the interview form and observation notes, the pre-service teachers stated that they had no information (62%), they had superficial information (27%), or they had detailed information (11%) about the scientist assigned to them. From this point of view, pre-service teachers' knowledge about scientists, their inventions, or their contributions at the beginning of the poster preparation process was quite insufficient. It can be said that this finding provides motivation for the development of pre-service elementary teachers' perceptions about

science and the nature of science. Some of the opinions and observations of pre-service teachers regarding the pre-research "preliminary knowledge" category are as follows:

> *"…Unfortunately, I had no information about the scientist I was researching. It was a huge loss for me…"* PT18.

> *"The scientist I worked on was Edwin Hubble. I knew about the theory he created (big bang theory) but I didn't know it was his theory, so it can be said that I didn't really know much."* PT25.

> *"I had learned about Bohr atomic theory in high school chemistry classes. We focused on the shortcomings and principles of the atomic theory. He could explain monatomic elements. But he could not explain polyatomic spectra. Bohr is also one of the pioneers of modern atomic theory."* PT23.

> *"Pre-service teachers made their selections from the pool of scientists by drawing lots. Some of the pre-service teachers were assigned scientists they were more familiar with. What they knew about these scientists they shared with me and their friends. However, most of them stated that they did not have information about the scientist they were assigned, or they only heard their name…"* PO1.

Another category under the theme of perception is "pre-service teachers' view of the scientist." In this category, it was observed that pre-service teachers made some inferences about scientists during the process of researching scientists and preparing posters; therefore, they developed a point of view. Six different codes were defined under the theme of "pre-service teachers' view of the scientist." These are dedication (38%), creativity (29%), hard work (27%), patience (23%), different perspective on life (13%), and trust in science (10%). Pre-service teachers became aware of the characteristics of scientists and focused on the features that distinguish them from other people. When the posters were examined, it was observed that they used interesting titles that highlight the features specific to scientists. The pre-service teachers stated that scientists dedicate themselves and their inventions to people/humanity and therefore they are free from egos, they make very original inventions considering the then-current conditions, and they do not give up working despite all kinds of difficulties they encounter. However, they stated that other important features that distinguish scientists from other people are their patience and their approach to ordinary events from a different perspective. Finally, it is seen that the pre-service teachers' confidence in science has also improved based on the experience they have gained in the process. Some opinions and observations belonging to the category of "pre-service teachers' view of scientists" are below:

> *"At that time, when it was very difficult for women to get education, and despite financial difficulties, she did not give up and continued to work, as a result of which she won the Nobel Prize twice, but the burns on her hands due to radiation and her death impressed me a lot."* PT11.

> *"It is surprising that he looks at everyday events so differently and reflects on them. Also, we try something and just give up if it doesn't work. However, Einstein worked for the Relativity Theory for years and continued until he got results."* PT24.

> *"Benjamin Franklin wanted to reveal the unknown facts in the nature of lightning and electricity. He almost died in the experiment he designed to reveal these facts. Even two of his assistants died. It's great that he's willing to take such risks for science and humanity."* PT26.

The pre-service teachers presented original topics (the story of the perseverance in success leading to the Nobel Prize, the person almost died for science, the physicist who modernized the 21st century, the woman who died for science) in presenting the characteristics specific to scientists. Some examples of poster titles are given in Figure 1.

Figure 1. Samples of posters and headlines prepared by pre-service elementary teachers.

Benefit

In the study, it was determined that the pre-service teachers who made research about scientists and their studies primarily developed a perception towards science and scientists. In this process, pre-service teachers reinforced this perception they developed for science and scientists with comments regarding the scientists' benefit to the society as well as their own individual development. Furthermore, in the context of the theme of benefit, they emphasized the benefit of the experience they gained regarding science and scientists in relation with their research processes to elementary students and to understanding the real life-science connection. In this context, four categories are listed in the context of the benefit theme, namely, "Social Benefit, Individual Benefit, Benefit to Elementary Students, and Understanding the Real Life-Science Link".

In the "*Social Benefit*" category, pre-service teachers mentioned the benefits of individuals who have knowledge and awareness towards science and scientists. In this context, they mentioned that individuals who have knowledge and awareness of science and scientists and those who place importance on science will create innovative and productive societies. Furthermore, it was emphasized that societies that place importance on science will raise science literate individuals leading to economic welfare. From this point of view, the social benefit category consists of four codes: "innovative society (44%), productive society (35%), scientifically literate society (32%), and society with economic welfare (30%)". Some examples containing the opinions of pre-service teachers regarding the category are given below:

> *"For example, a student with a passion for science will pass on their knowledge to their family when he they go home and to their playmates when they go out. Maybe this seemingly a small chain can turn it into a productive and innovative society in the long run"* PT4.

> *"A positive approach to science and scientists will enable individuals to take the first step to become science literate. This step is important for the development of societies"* PT14.

> *"Individuals who produce and develop themselves without being dependent on foreign countries will assume the most prominent role in the development of the country"* PT25.

Another category under the benefit theme is "individual benefit." There are six different codes under this category. These are "gaining vision (44%), professional development in teaching (41%), presentation skills (39%), self-confidence (33%), research skills (31%), and interest in science and scientific events (28%)". Pre-service teachers mentioned that the experience they gained provided them with a vision. In this context, pre-service teachers emphasized that they gained a vision of working regardless of barriers, focusing on the target, being patient and determined, and being successful in more than one field. Furthermore, pre-service teachers stated that the experience they gained in the process contributed to their professional development, especially in raising students who are interested in and curious about science. Pre-service teachers also emphasized that the interactive work in the process improved their research skills. They stated that the poster presentations

improved their presentation and expression skills and provided them with self-confidence in making a presentation before the public and completing a task successfully. As part of the participant observation notes, it was observed that the anxiety of the pre-service teachers decreased, they had the self-confidence of knowing, and their presentation and self-expression skills improved from their first presentation to the event day. Some examples containing opinions and observations regarding this category are below:

> *"A lot of scientists had a lot of problems compared to the lives of normal people. They ignored these problems and achieved where they were. Like them, we need to ignore the problems and move forward towards our goal without fail"* PT3.

> *"In the first place, it helped me gain self-confidence in terms of presenting before the people. I also think that it contributes to the development of my knowledge and culture about science. It made me feel that I should be better equipped for my students professionally. If I may talk about the preparation phase; I realized that I was acting like a teacher while presenting my poster about the scientist. I was working with, and I had a lot of fun doing it. I am proud of the beauty of my profession" PT6.*

> *"Before, I didn't do much research on scientists or wonder who the inventor of anything was. But after our activity, my sense of curiosity developed, and I started to ask myself questions such as what questions were asked, or which experimental methods were used before an invention was made"* PT15.

> *"The students were very anxious during the event preparation process as they were 1st Year and had no previous experience of presenting before different audiences. It was observed that they were more anxious when making presentations to university professors and students from other departments of the faculty who came to listen to them. About 30 minutes after the event started, it was seen that many students made their second or third performances to different audiences, so their anxiety decreased, and they were more confident."* PO1.

In the category of "Benefit to Elementary Students," pre-service teachers emphasized the benefit that science education placing importance on science and scientists will be beneficial for the students in the future. There are three different codes under this category. These are "development of field-specific skills (56%), curiosity and interest in science in elementary education (30%), and teaching tailored to students' individual differences (28%)". The pre-service teachers stated that the experience they gained would contribute to the development of their students' scientific process skills, STEM skills, and life skills in the future. In addition, based on their experience, they referred to the importance of raising children who are curious about science. Pre-service teachers emphasized that their students might have different interests and skills due to the different characteristics of the scientists they studied, and they mentioned the necessity of teaching tailored to student differences. Some examples of the statements are below:

> *"When we look around us today, almost everything we see has a scientific basis. Seeing the people who create these foundations, their ideas and how they defend these ideas will give my students the ability to explain and defend a subject, and will develop their self-confidence, courage, and problem-solving skills."* PT8.

> *"When I share the experiences, I have gained in this study with the students, I think that it will contribute to raising curiosity and interest in science and scientists and enabling them to conduct research on this subject. Also, every student has a different mindset. I realized that unlike the way Einstein was treated, all of them should be given special attention."* PT17.

> *"…I believe it will develop students' engineering and design skills, creativity, analytical intelligence, etc. Thus, I think they will be useful individuals for our country."* PT28.

In the category of *"Comprehending the Real Life-Science Connection,"* pre-service teachers stated that they started to notice science in daily life, they saw the real-life benefits of scientific knowledge, and that they make better sense of scientific concepts in daily life. Moreover, in the examinations of the video recordings, it was seen that some pre-service teachers included real-life examples while describing the inventions of scientists. For example, PT3 compared the mechanisms of the COVID-19 vaccines with the method used by Pasteur in his rabies vaccine study. However, PT6 explained how Aziz SANCAR's discovery on DNA repair will treat cancer and how factors affect the cellular structure in daily life.

Research Process

Another element that pre-service teachers focused on throughout the study is the process. The findings obtained from the data sources regarding the process of pre-service teachers in evaluating, researching, and presenting via posters can be examined in four categories. These are "the path followed in the research, the design process, the affective process, and the difficulties experienced."

In the category of "the path followed in the research", pre-service teachers referred to the data collection sources that scientists used during the research process. There are two codes in this category. These are "scientific publications (43%) and non-scientific sources (57%)". It was observed that the pre-service teachers used reliable sources such as scientific articles, periodicals, books, documentaries, autobiographies, and interviews. In addition, some pre-service teachers stated that they also benefited from the science center in the city they lived in. However, a significant majority of the pre-service teachers also used sources on the Internet (unofficial web pages, YouTube, Spotify, etc.), with low reliability. Pre-service teachers who used unreliable sources had difficulties in terms of contradictory information they encountered, as indicated in the category of "difficulties experienced". Some of the opinions of the pre-service teachers regarding this category are as follows:

> *"While researching Uluğ Bey, I first made research on various sites on the Internet about his life and his contributions to the world of science and took various notes. Later, I asked my friends who I thought might have information about Uluğ Bey. And I listened to various podcasts on YouTube and took notes."* PT14

> *"I have benefited from various websites, articles, and magazines. I had the opportunity to go to the science center and personally examine Al-Jazari and the elephant water clock he developed at the Sultans of Science Gallery."* PT18

> *"First of all, I made a detailed review about Canan Dağdeviren. While doing the review, I used only reliable sources. Since she is a scientist alive, I studied her interviews. I read her autobiography. I even found the articles she wrote."* PT22.

Another category included in the Research Process theme is the "design process." Under this category, two codes are listed: "interpreting information (54%) and integrating visual elements with information (49%)". Pre-service teachers used similar methods in the design process of the posters in which they reflect the research and examination processes of scientists. In this framework, pre-service teachers operated mechanisms such as comparing the information they obtained, deciding which information to include, and making the information short and concise while forming the design process. Thus, they interpreted the information they obtained in a unique way and formed the basis of the poster draft. Another aspect in design is the process of integrating the information with visual elements to make the poster interesting and original. In this process, it was observed that pre-service teachers made different designs. The designs of the pre-service teachers were evaluated by presenting on the blackboard in the classroom environment 2 weeks before the event. The participant observer note in this evaluation is as follows:

> *"…it was seen that most of the pre-service teachers made more than one design. Opinions were received from the advisor and other teacher candidates about the posters with more than one design. However, some problems such as spelling errors, incorrect information, and color, text, and image inconsistencies were detected in the posters of some pre-service teachers. It was observed that such problems were corrected with the supervising teacher."* PO1.

Some of the opinions of the pre-service teachers regarding their experiences about the design process are as follows:

> *"…Then I wrote it on my poster page by collating the information I've gained. I made it clear and understandable by simplifying it day by day"* PT4.

> *"…I reviewed the information and tried to make it short enough to be included in the poster. I decided what information I should include. I converted the information in my poster into sentences with brief and concise explanations. After extracting and editing the information, I've decided how to design the poster. I tried to make my poster remarkable by matching the information with the pictures I chose"* PT28.

Another category included in the Research Process theme was "affective process." In this category, there are four codes: "excitement (63%), pride (52%), happiness (48%), and anxiety (37%)". Based on their experiences

in the process, pre-service teachers focused on the excitement of presenting before an audience. They attributed the reason for this outcome to their experience of making presentations for the first time. Pre-service teachers were in their first year of undergraduate education and it was their first experience in public presentation. Another emotion they emphasized with "excitement" is "anxiety." The cause of anxiety is the factor of presenting before the public, which also causes excitement. The findings obtained as a result of the examination of participant observer notes and video recordings during the activity are that excitement and anxiety decreased over time during the activity. Although it was observed that the pre-service teachers were very anxious and excited in their first presentation, they were more relaxed in the poster presentations after the first presentation. Other emotions that pre-service teachers experienced were happiness and pride. Pre-service teachers stated that they experienced the happiness of sharing information, getting to know new people, and due to the good comments from the faculty and fellow students. In addition, they stated that they were proud of informing faculty member and students and completing a job successfully and felt like a teacher for the first time. The opinions of the pre-service teachers expressing their affective processes and the participant observer notes are given below. The photographs taken from the examined videos are presented in Figure 2.

> *"I had the pleasure of participating in such a beautiful event. As a pre-service teacher, I felt just like a teacher. Everyone was asking questions with curious eyes. The sparkle in their eyes when they learned their answers made it feel like they were worth everything."* PT27.

> *"I was super excited at first. But then my excitement gradually faded. I made presentations about my poster to many people. It was an honor to be on the field and successfully complete my job."* PT18.

> *"The students were very anxious during the preparation process of the event as they were first year and had no previous experience of presenting in front of different audiences. They were more anxious, especially when they were making presentations to university professors and students from other departments who came to listen to them. As many students made their second or third presentations to different audiences about 20 minutes after the event started, their excitement and anxiety decreased, and they seemed more confident. The high turnout surprised some students and worried others. However, especially the students who were in the booths next to each other supported and relieved each other in this regard. Towards the end of the activity, the students were tired but very happy."* PO2.

Figure 2. Examples from the poster presentation day.

The last category in the Research Process theme was "difficulties experienced". In the difficulties experienced in the process, four codes are listed, namely, "contradictory information (23%), difficulties in designing (42%), inexperience (34%), difficulty in using web tools (14%)". Pre-service teachers who did not use reliable sources during the research process had difficulties in deciding which of the contradictory information they encountered about scientists to trust. However, pre-service teachers emphasized the difficulties arising from their lack of experience. They attributed this difficulty to the fact that they were in the first year of undergraduate education and that they did not have basic skills in terms of scientific research. Based on the experiences in the process, it can be stated that pre-service teachers had difficulties in using the web tools used

in preparing posters. According to the participant observer notes, it can be said that they often received support from their advisor and other experienced people to overcome this difficulty. Finally, the pre-service teachers experienced difficulties in preparing a good content in poster design, not being able to decide on the design elements and what information to include in the poster design due to the anxiety of preparing a poster for the first time. Some of the views on experiences in this category are as follows:

> *"There were many outstanding activities and great achievements regarding the scientist. Putting all of this on the poster was confusing. That's why I had the hardest difficulty in design. I also wanted to put an interview of Aziz Sancar as a QR code on my poster. However, I could not do it because my technical knowledge was insufficient.* PT7.

> *"This activity was a task that I did for the first time in my life. For this reason, the most challenging thing for me was to grasp the features of the software I used and to make a very short summary from all that information. After preparing my poster three times, I was able to grasp the process"* PT21.

CONCLUSION and DISCUSSION

According to the results of the present research, the experiences of the pre-service teachers in the research, evaluation, and sharing process are discussed under the themes of perception, benefit, and research process.

In the study, it was determined that pre-service teachers did not have any knowledge about scientists before the study or they had a superficial knowledge. Bozdoğan et al. (2013) found that year 4 pre-service science teachers had sufficient knowledge about scientists and Sahin et al. (2019) stated that pre-service science teachers did not have the desired level of knowledge about scientists. In this study, it was concluded that the knowledge that pre-service teachers had about scientists was generally related to the scientist's most important contribution to science or their most important invention, such as Newton-gravity and Graham Bell-telephone. Görecek Baybars (2018) also stated that the examples of pre-service science teachers about the contributions of scientists to science are stereotypical brief information. This may be due to the fact that the pre-service teachers did not make any research on scientists in detail and that they had the knowledge about scientists with the scientist-invention pairings mentioned in the books. Presenting scientists in detail with a specific context enables students to have more detailed and permanent knowledge about scientists. As a matter of fact, the statements of the pre-service teachers at the end of the process in this study also support this result. Another point that can be expressed here is that the findings on the level of knowledge about scientists in the literature are limited to that of pre-service science teachers. For this reason, this finding of our research is important in terms of both revealing the knowledge levels of pre-service elementary teachers towards scientists and also providing knowledge and awareness towards science and scientists in the first years of undergraduate education.

During the implementation process, pre-service teachers had the opportunity to research and examine scientists in detail. In addition, they were impressed by the dedication and creativity of scientists, their work despite all the difficulties, and their ability to approach life from a different perspective. In addition, another striking factor in the process is that pre-service teachers were affected in terms of trust in science. Studies in the literature assessing the scientist perceptions of pre-service teachers have shown that pre-service teachers describe scientists are people conducting research, questioning, striving, and delivering useful information (Şenel & Aslan, 2014). Pre-service science teachers in the present study described scientists as individuals who make experiments and inventions and find instant solutions to problems. Pre-service social sciences teachers describe scientists as individuals with multi-dimensional and universal thinking (Ürey et al., 2017). Korkmaz and Kavak (2010) reported that scientists' dedication, creativity, and the ability of overcoming difficulties were the qualities that were highlighted in their study. Song and Kim (1999) stated that Korean students respect the achievements of scientists and their services to humanity because of their characteristics such as ambition, effort, humanity, dedication, responsibility, following the truth, intelligence, curiosity, thinking power, observation and research ability, and creativity. Kurtdede Fidan and Konak (2016) stated that patience, hard work, and perseverance qualities were cited by the master's students regarding the basic characteristics of scientists, which are similar to the "qualities of dedication and work despite all the difficulties" in this study. In the study conducted by Doğan-Bora (2005), it was observed that the students emphasized the value of patience while describing the characteristics of scientists. In addition, in the study conducted by Çermik (2013), pre-service teachers emphasized that scientists should be curious, inquisitive, patient, critical, and determined people. Mbajiorgu and Iloputaife (2001) argued that the training given in their practical research to improve

teachers' perception of scientist enabled pre-service teachers to acquire a more scientifically accurate perception of scientist. The perception of science that individuals gains through their lives and the image of scientist, which is one of the important elements in the perception of science, has become an important topic of research (Bilir et al., 2020). The results of this study differ from the research results in the literature in terms of methodological process. While the studies in the field aimed to determine the current status that does not involve a long process, the qualifications of the scientists that emerged in this research are the product of an experience process. For this reason, both different and similar features with the literature were observed. However, one of the important results obtained is that the pre-service teachers developed a sense of trust in science in the context of their perception of scientists. Plohl and Musil (2021) conducted a study related to the Corona Virus pandemic and found that individuals with high intellectual curiosity trust science more. With the COVID-19 pandemic in recent years, the tendency in the general public to believe in non-scientific news and the denial of scientists and scientific knowledge (Nguyen & Catalan-Matamoros, 2020; Valladares, 2021) have gained popularity. Moreover, UNESCO (2020) draws attention to the need for an in-depth examination of curricula in the fight against the denial of scientific knowledge, especially in this current global crisis. In this context, in this study, pre-service teachers gained a sense of trust in science, which can be considered an original result. For this reason, it is considered that the practice-based education that will be given to the elementary teachers, who lays the foundations of science education at the elementary level, is important in terms of developing a correct perception of science.

Pre-service teachers focused on the benefits of this experience, i.e., researching-examining-sharing process. First of all, pre-service teachers think that gaining knowledge and experience about science and scientists has social and individual benefits. It is noteworthy that educational processes that provide experience with science and scientists in the context of social benefit will yield the formation of innovative, productive, scientifically literate, and economically prosperous societies. Cofre et al. (2019) stated in their critical review that an adequate understanding of the nature of science is a critical component of scientific literacy and a fundamental goal in science education. Scientific literacy moves a society from a smaller state to a state of knowledge and well-being, especially for economic development and national security (Liu, 2009, 2013). In this context, it is a remarkable result that pre-service elementary teachers associated their experiences with science and scientists with social science literacy. In Kurtdede Fidan and Konak's (2016) research, it is seen that while postgraduate students explain the importance of science, they emphasize the dimensions of access to information, the development of humanity, and the development of the country. In this study, it is an original finding that gaining knowledge and experience about science and scientists gives pre-service teachers an understanding of their benefits at the social level. Findings obtained within the scope of individual benefits show that pre-service teachers gain a vision to look at the future with increasing hope, develop an interest in science, gain research and presentation skills, and increase their professional self-confidence. It is a desired and important result in the present study that the experience of pre-service teachers towards science and scientists contributes primarily at the individual level. In addition, pre-service teachers also mentioned the benefit of their experience to elementary students, which is considered to have a widespread effect. Pre-service teachers emphasized that with experiential approaches towards science and scientists, the development of field-specific skills of elementary students can be achieved, curiosity and interest in science can be increased, and an education tailored to individual differences can be applied. Dabney (2022) states that teachers affect students' attitudes towards science; therefore, it is important to consider the perceptions and beliefs of elementary teachers towards scientists as a factor in science education. The fact that the prospective teachers in the present study developed an understanding of supporting their prospective students' science education is again a unique finding. Another point that can be made as a final benefit is the establishment of the relationship between daily life and science. Pre-service teachers stated that they started to notice "science" in daily life, saw the benefits of scientific knowledge in real life, and made a better sense of scientific concepts in daily life with the experience they gained. This result also reveals the necessity of experiences gained regarding science and scientists in terms of providing pre-service elementary teachers the opportunity to see science in real life.

In the research, it is seen that the methods followed by the pre-service teachers during the project contained certain deficiencies in terms of scientific research methods. Individuals need to be able to participate in discussions on issues with a scientific basis and to know and use scientific research methods and principles on these issues (Lederman et al., 2020). However, it was observed that pre-service teachers benefited from

scientific sources as well as non-scientific sources in their research during the project. They associated the difficulties they experienced with their being novice. The contradictory information they encountered was another issue that challenged them. One of the reasons why pre-service teachers encountered conflicting information is that they benefit from primary scientific sources such as theses and articles, as well as non-reliable sources such as web pages and blogs in their research. It is thought that the possibility of sources to contain non-scientific information in non-primary sources will increase (Punch, 2005; Karasar, 2008); therefore, the importance of accessing and benefiting from primary sources in scientific research is highlighted (Balcı, 2009; Moorthy & Karisiddappa, 1997; Geray, 2006). The fact that pre-service teachers had not yet taken scientific research methods courses that would enable them to evaluate the scientificity and reliability of their sources shows that there is a need for such courses.

It was observed that pre-service teachers had difficulties in using technological elements while preparing their designs and presentations. This may be due to the fact that they had not yet taken education courses based on the use of technology for instructional purposes. As a matter of fact, Aydoğmuş and Karadağ (2020) stated in their research that year 4 pre-service teachers' proficiency in using information and communication technologies is at a better level than first year students. Research results showing that information and communication technologies increase student achievement, improve students' high-level thinking skills, and increase quality and equality of opportunity in education (Aypay, 2010; Hernandez Ramos, 2005; Herzig, 2004; Sanchez et al., 2011) show that this competence should be gained by pre-service teachers from the first year through trainings based on practices. For this reason, it is thought that pre-service teachers will gain technological competence in their courses such as computer-assisted teaching, instructional technologies, and material design that they will take in the coming years. A similar study can be carried out with senior-level pre-service teachers and their experiences of research-review-sharing process can be examined.

Pre-service teachers stated that their anxiety decreased, and their self-confidence increased, and they were happy and proud during the research and sharing process. Pre-service elementary teachers considered this activity as the first experience of being a "teacher". The similarity of these feelings with the feelings that the pre-service elementary teachers feel on the first day of teaching experience also supports this outcome (Çapraz & Sabancı, 2014). It is an indication that these experiences and responsibilities also provide them with important experiences for the teaching profession. Similar experiences that teacher candidates undertake beginning with the first year of undergraduate education will contribute to their professional development. For this reason, it is recommended to include research, analysis and sharing experiences and practices in different subject areas in the curriculum.

Declarations

Conflict of Interest

No potential conflicts of interest were disclosed by the authors with respect to the research, authorship, or publication of this article.

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Research and Publication Ethics Statement

The study was approved by the research team's university ethics committee of the Selcuk University (Approval Number/ID: 02.07.2022-E.316411). Hereby, we as the authors consciously assure that for the manuscript "Pre-Service Elementary Teachers' Experiences in Researching and Evaluating Scientists and Sharing Their Findings" the following is fulfilled:

- This material is the authors' own original work, which has not been previously published elsewhere.
- The paper reflects the authors' own research and analysis in a truthful and complete manner.
- The results are appropriately placed in the context of prior and existing research.
- All sources used are properly disclosed.

Contribution Rates of Authors to the Article

The authors provide equal contribution to this work.

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