

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

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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.

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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

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 as 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. Kurtde 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 gain 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 Kurtdele 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.

Ethics Approval

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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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