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Relation of 21st-Century Skills with Science Education: Prospective Elementary Teachers' Evaluation

21. Yüzyıl Becerilerinin Fen Eğitimiyle İlişkisi: Sınıf Öğretmeni Adaylarının Değerlendirmesi

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ABSTRACT

The aim of this study was to determine which of the 21st-century skills of prospective elementary teachers associate with science education and the reasons behind these associations. The research was carried out according to the phenomenology design, one of the qualitative research methods. The study group of the research consisted of 48 prospective elementary teachers studying in the third-year Elementary Teaching Undergraduate Program of Education Faculty in Bayburt University. In order to collect data in the research, a form consisting of a single open-ended question was used in which prospective elementary teachers were asked to evaluate the relationship between 21st-century skills and science education. The content analysis method was used in the analysis of the data obtained using the data collection tool. According to the findings obtained from the analysis, it was determined that the prospective elementary teachers associated 21st-century skills such as critical thinking, creativity, information and media and technology literacy, problem-solving, cooperation and communication, innovation, entrepreneurship, and individual and social responsibility with science education. In addition, it has been determined that the reasons for associating these skills with science education of prospective elementary teachers vary. Particularly, it has been determined that the candidates associated these skills with science education because they support meaningful and permanent learning with their critical thinking, problem-solving, and cooperation and communication skills. On the other hand, it is noteworthy that many skills are associated with science education in terms of being in the nature of science, keeping up with the times and supporting high-order thinking.

Keywords: 21st-century skills, prospective elementary teachers, science education

ÖZ

Bu araştırmanın amacı, sınıf öğretmeni adaylarının 21. yüzyıl becerileri olarak hangi becerileri fen eğitimiyle ilişkilendirdiklerinin ve bu becerileri fen eğitimiyle ilişkilendirme gerekçelerine yönelik düşüncelerinin tespit edilmesidir. Araştırmada nitel araştırma yöntemlerinden olgu bilim deseni kullanılmıştır. Araştırmanın çalışma grubunu Bayburt Üniversitesi Eğitim Fakültesi Sınıf Öğretmenliği Lisans Programı'nın üçüncü sınıfında öğrenim gören 48 sınıf öğretmeni adayı oluşturmaktadır. Araştırmada veri toplamak amacıyla sınıf öğretmeni adaylarının 21. yüzyıl becerileri ile fen eğitimi arasındaki ilişkiyi değerlendirmelerinin istendiği, tek açık uçlu sorudan oluşan bir form kullanılmıştır. Veri toplama aracından elde edilen verilerin analizinde içerik analizi yönteminden yararlanılmıştır. Analizlerden elde edilen bulgulara göre, sınıf öğretmeni adaylarının 21. yüzyıl becerilerinden eleştirel düşünme, yaratıcılık, bilgi-medya ve teknoloji okuryazarlığı, problem çözme, işbirliği-iletişim, yenilikçilik, girişimcilik ve bireysel-sosyal sorumluluk gibi becerileri fen eğitimiyle ilişkilendirdikleri tespit edilmiştir. Ayrıca sınıf öğretmeni adaylarının bu becerileri fen eğitimiyle ilişkilendirme gerekçelerinin çeşitlendiği belirlenmiştir. Özellikle adayların eleştirel düşünme, problem çözme ve işbirliği-iletişim becerilerini anlamlı ve kalıcı öğrenmeyi desteklediğinden dolayı fen eğitimiyle ilişkilendirdikleri tespit edilmiştir. Diğer taraftan birçok becerinin fenin doğasında olması, bireylerin çağa ayak uydurmasını sağlaması ve üst düzey düşünmeyi desteklemesi yönünden fen eğitimiyle ilişkilendirilmesi dikkat çekmektedir.

Anahtar Kelimeler: 21. yüzyıl becerileri, sınıf öğretmeni adayları, fen eğitimi

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Introduction

The fact that individuals are in the process of learning throughout their lives is not only an individual need but also a social need. This learning need is very important for individuals to adapt to their environment and to meet various needs in their daily lives. In this context, all stakeholders in the field of education are working effectively to meet the needs of individuals, especially in the learning process. In order to meet these needs and in order for societies to adapt to the economic, global, technological, and scientific developments that have accelerated since the second half of the 21st century, countries have reviewed and restructured both their education policies and the understanding they follow in their education systems. As a result of these reconfigurations, on the one hand, new environments and applications have been created to support the learning process of individuals, and on the other hand, it is noteworthy that the skills that students should possess have been updated. Due to developing technology and changing world conditions, the skills expected from individuals in the 21st century have changed. Adapting to this change is extremely important both for individuals to adapt to the society they live in and for the social benefit. Undoubtedly, one of the most important and effective ways of ensuring this is to increase the quality of education given to individuals. Individuals are no longer asked to take and accept the information conveyed to them in the education and training process, but instead it is emphasized that they should be raised as individuals who can use the information they have learned and who have learned to learn in order to be ready for life (Öztürk et al., 2022). Moreover, Harari (2018) argues that knowledge is the last thing that should be given to individuals in today's education and training process and that it is important to be able to use knowledge, to make sense of it, to identify important and unimportant knowledge, and to relate the knowledge acquired to the world. Raising individuals with these skills who have learned to learn is realized by changing the duties, responsibilities, and roles that individuals will assume. This change defines individuals who can produce knowledge and use it functionally in their daily lives, can solve problems, can think critically, have empathy and communication skills, and are determined, entrepreneurial, and can contribute to culture and society (Güven & Bülbül, 2023; Ministry of National Education [MoNE], 2018a).

As the century in which science and technology change and renew very rapidly and daily life is constantly updated due to this change and renewal, the 21st century is expressed as a time period in which individuals feel the change and innovation very deeply (Posos Devrani, 2021). In this period of time, the skills that individuals need to have in order to keep up with the period they are in, to follow the changes and innovations taking place, and to respond to the expectations of the century are nowadays referred to as 21st-century skills. Twenty-first-century skills, which include both the concept of knowledge and skills, are explained as high-level skills and learning tendencies that need to be developed in order for individuals to be successful in the information age we live in (Akcan et al., 2023; Dede, 2009). Twenty-first-century skills, which are also referred to as personal, interpersonal, and mental skills and competencies that individuals should have in the 21st century, are handled and classified in various ways by different individuals, institutions, and organizations. For example, Anagün et al. (2016) state that 21st-century skills generally include critical thinking and problem-solving, creativity, innovation, leadership, communication, information and media literacy, and collaboration. Twenty-first-century skills are classified as *independent-autonomous behavior, interactive use of tools and interaction with heterogeneous groups* by the Organization for Economic Cooperation and Development in 2005 and *integrated learning, individual and social responsibility, intellectual and procedural skills* by the American Association of Colleges and Universities in 2007. Again in 2007, the International Society for Technology in Education described 21st-century skills as *communication and collaboration, creativity and innovation, digital citizenship, research and information flow, technology and concepts, critical thinking, problem-solving and decision making*. On the other hand, more recently, the World Economic Forum (WEF) has more comprehensively addressed and explained 21st-century skills. In this forum, it is noteworthy that 21st-century skills are grouped under three main headings and expressed in 16 different subskills (WEF, 2017). When the contents of the 21st-century skills mentioned here are analyzed, it is seen that the first main skill is "basic literacy skills." The basic literacy skill, which is a skill area related to how individuals adapt their skills and competencies to their daily lives, consists of six subskills: *scientific literacy*, *financial literacy*, *mathematical literacy*, *verbal literacy*, *information communication technologies (ICT) literacy*, and *cultural and urban literacy*. According to the WEF, the second of the main skills is emphasized as "competencies." The competencies focus on how learners deal with complex problems and consist of four subskills. These subskills are communication, creativity, critical thinking, and collaboration. Finally, the third main skill, "character traits," focuses on individuals' adaptation to ever-changing environmental conditions and includes six subskills: *entrepreneurship*, *leadership*, *curiosity*, *determination/resilience*, *social and cultural awareness*, and *adaptability*. Since this study aims to determine which of the 21st-century skills of prospective elementary teachers are associated with science education, *critical thinking*, *creativity*, *information and media and technology literacy*, *problem-solving*, *cooperation and communication*, *innovation*, *entrepreneurship*, and *individual and social responsibility skills* will be emphasized in line with the associations made by the candidates.

As it is known, all individuals encounter different problems in their daily routines throughout their lives and make efforts to find solutions to these problems and to eliminate the problems. *Problem-solving* as a 21st-century skill used in this process is a systematic and logical process explained as a set of cognitive operations applied against the obstacles encountered while trying to achieve a goal (Smith & Kosslyn, 2014) and the ability to find solutions to these obstacles (Özkaya & Öztürk, 2023; Öztürk, 2021). Since it is a multidimensional concept, there are many definitions of *critical thinking*. However, in the most general sense, *critical thinking* is the in-depth and logical evaluation of the good or bad aspects of a problem, situation, or event (Büte, 2019; Rudd, 2007). When the definitions are carefully examined, it is realized that there is a relationship between critical thinking and problem-solving skills. On the other hand, *creativity*, or in other words creative thinking, involves mental processes (Yılmaz, 2021) in which an individual creates products by thinking different, new, and original (Ayyıldız & Yılmaz, 2021; Yılmaz 2020). In this sense, every step taken to become an information society in the process of adapting to the developing world encourages individuals to be creative. Moreover, creativity skills are needed to produce solutions to different problem situations encountered in the continuity of the world's development. It can be inferred that creativity is intertwined with

both critical thinking and problem-solving skills. Before explaining the content of another skill, *information and media and technology literacy*, it would be appropriate to express the concept of literacy. The concept of literacy is explained as the effective use of communicative symbols that are given meaning by society (Ünlü, 2016). In this direction, information and media and technology literacy skill implies the ability to use both information-media and technology effectively and to recognize and select the contents within them. In a significant part of everyday life, all individuals communicate and cooperate with each other in many different ways. *Cooperation and communication* skill is a skill that includes cooperation with the team partnership (Turkish Language Association [TLA]) formed by those whose goals and interests are one and communication with the mutual communication of thoughts and feelings (Gülbahar & Sıvacı, 2018). *Innovation*, which is expressed as a high-level way of thinking, requires the use of many ways of thinking such as creative, critical, reflective, and analytical, and something new is developed or formed through the application of innovation (Yılmaz, 2020). *Entrepreneurship* is the ability of individuals to transform their ideas into action (MoNE, 2018a) and the process of responding to needs, obstacles, challenges, and tasks in innovative ways (Yurtseven, 2020) by following opportunities in a predictive way (Şentürk, 2022). Finally, *individual and social responsibility skills* are the state of being conscious of individuals toward social problems and may emerge depending on the demands and needs of the group and society in which the actions are carried out, and accordingly, their scope may change (Eraslan, 2011). When the scope of all these skills is evaluated, it is seen that each of them has very important content in itself. From this perspective, the value of teaching these skills to individuals and the underlying reasons why studies on 21st-century skills remain current are understood.

Many studies have focused on 21st-century skills and emphasized the importance of these skills (Belet-Boyacı & Güner-Özer, 2019; Erten, 2020; Gunadi et al., 2022; Kalemkuş, 2021; Kennedy & Sundberg, 2020; Kereluik et al., 2013; Martinez, 2022; Tuğluk & Özkan, 2019; Uyar & Çiçek, 2021; Yılmaz & Yanarateş, 2022). For example, Uyar and Çiçek (2021), in their study aiming to determine the level of 21st-century skills of teachers in different branches, found that teachers' skills were at a high level. Similarly, Erten (2020), in his study investigating the perception levels of prospective elementary teachers toward 21st-century skills, stated that the perceptions of the candidates were at an adequate level. Emphasizing that there is a consensus that 21st-century skills are necessary skills for all individuals, Kennedy and Sundberg (2020) stated that 21st-century skills include many skills such as collaboration, critical thinking, problem-solving, creativity, and innovation. Kalemkuş (2021), in his study evaluating the third- and fourth-grade outcomes of the science curriculum in terms of 21st-century skills, points out that creativity, innovation, communication, entrepreneurship, and self-management skills are emphasized in the content of the outcomes, with an emphasis on critical thinking and problem-solving. Again, Martinez (2022) emphasizes the importance of providing individuals with 21st-century skills and states that in order to develop these skills, it is necessary to focus on the curriculum and skill development within the curriculum.

The high number of studies and classifications and the diversity of the subject areas of the studies are among the indicators that reveal the importance of 21st-century skills and how necessary it is for individuals to acquire them. Similarly, it is seen that 21st-century skills are given special importance in our country. As a matter of fact, when the curricula created for different courses in our country are examined, it is noticeable that 21st-century skills are emphasized in the curricula (MoNE, 2018a, 2018b, 2018c, 2018d, 2019). In the relevant programs, skills such as critical, analytical, and creative thinking, decision-making, entrepreneurship, communication, cooperation/teamwork and problem-solving are emphasized as 21st-century skills. From this perspective, it is noteworthy that 21st-century skills are seen as a part of education and training practices in our country as in the whole world. In addition, it is seen that the studies in the literature on 21st-century skills are mostly focused on the classification of skills and determining the levels of students, prospective teachers, and teachers in some skill areas. However, the lack of a study in the literature in which the awareness of prospective teachers about 21st-century skills was determined and in which the skills they associated with science education were considered and the reasons for these associations were explained made it necessary to plan this study. Therefore, it is thought that it is important to determine which of these skills the prospective elementary teachers, who are the future implementers of some of these curricula and who will take first-hand responsibility for teaching 21st-century skills to students, associate with science education and the reasons behind their associations. Based on this idea, the aim of this study is to determine which skills the prospective elementary teachers associate with science education as 21st-century skills and their thoughts about the reasons for associating these skills with science education. In line with this purpose, the research questions were determined as follows:

1. What are the 21st-century skills that prospective elementary teachers associate with science education?
2. What are the reasons for acquiring the skills that prospective elementary teachers associate with science education?

Method

Research Design

In this research, the phenomenology design, one of the qualitative research approaches, was used. The phenomenology design focuses on phenomena that we are aware of but do not have in-depth knowledge about or do not think about much (Yıldırım & Şimşek, 2018). Phenomenology, in which the thoughts and perceptions of the participants about their experiences and how they create a state of consciousness for them (Patton, 2002) are considered, is a qualitative research design that examines the subjective experiences that people construct about the event and situation they have lived. In this study, the phenomenology pattern was used, as it was aimed to determine which of the 21st-century skills the prospective elementary teachers associate with science education and identifying the reasons underlying these associations.

Study Group

The study group of this research comprised of 48 prospective elementary teachers studying in the third year of the Bayburt University Faculty of Education's Elementary Teaching Undergraduate Program. The convenience sampling method, one of the nonrandom sampling methods, was used to determine the study group. In this method, existing, volunteering, or easily accessible individuals (Johnson & Christensen, 2014) are included in the research. In the convenience sampling method, the researcher works on a sample or situation that will provide maximum savings and gets the opportunity to work with the group of the size researchers need (Cohen & Manion, 1998; Ravid, 1994). Since this

research was conducted with prospective elementary teachers studying at the university where the researcher works, the convenience sampling method, which is considered to be suitable for the nature of the study, was preferred.

Data Collection Tools and Data Analyses

In order to collect data in the research, a form consisting of a single open-ended question was used in which prospective elementary teachers were asked to express which 21st-century skills they thought were related to science education and to indicate the reasons underlying these associations. The content analysis method was used in the analysis of the data obtained from the data collection tool. Content analysis is a method that starts with the collection of data, then creates categories and codes, and synthesizes and interprets data by researchers (McMillan & Schumacher, 2010). The content analysis method was adopted since there were no predetermined codes and categories in the research, and the interpretation of the data was made by the researcher.

In the content analysis process, firstly the codes and categories were created. For the reliability of the findings, the help of an experienced researcher outside the scope of the study was taken during the content analysis process. This process was repeated by both researchers at different times and codes were extracted. The consistency between researchers was calculated according to the formula of Miles and Huberman (1994); it was determined to be 94.1%. The consistency value calculated according to Miles and Huberman (1994) is over 70%, which indicates that the coding is consistent. The percentage value calculated indicates consistency between researchers in this study. Data analysis was carried out in a way that the names of the prospective elementary teachers were kept secret and candidates were coded as T_1, T_2, ..., T_{48}. In order to make the categories and codes understandable, the findings were tried to be interpreted by presenting them in tables.

Ethics in Research

Ethical rules were taken into consideration in the study. In this context, an explanation about ethical principles was given to the prospective elementary teachers who participated in the research together with the consent form. After the prospective elementary teachers were informed about the ethical principles, the candidates voluntarily participated in the study. In addition, the real names of the prospective elementary teachers participating in the research were not used due to ethical principles. Instead of this, candidates were coded as T_1, T_2, ..., T_{48}. On the other hand, ethics committee approval was obtained from Bayburt University with the date January 19, 2022, and number 52608 for the study.

Results

In this section, the findings obtained using the data collection tool are presented and explained in the form of tables. Twenty-first–century skills that prospective elementary teachers think are related to science education are presented in Table 1.

From Table 1, it is clear that the 21st-century skills that prospective elementary teachers associate with science education are structured as critical thinking, creativity, information and media and technology literacy, problem-solving, cooperation and communication, innovation, entrepreneurship and individual and social responsibility. Eighty three per cent of the candidates stated that critical thinking, 67% creativity, 67% information and media and technology literacy, 60% problem-solving, 56% cooperation and communication, 44% innovation, 31% entrepreneurship and 25% individual and social responsibility are related to science education.

The findings regarding the reasons for associating the critical thinking skill, one of the 21st-century skills, of the prospective elementary teachers with science education are given in Table 2.

From Table 2, it is clear that 33% of the prospective elementary teachers justify their association of the critical thinking skill, one of the 21st-century skills, with science education by stating that it supports permanent and meaningful learning, another 33% by stating that it provides the query, 28% by stating that it develops a different perspective, 25% by stating that it develops higher-order thinking skills, 20% by stating that it enables logical connection, 13% by stating that it supports reasoning, and 5% by stating that it enables conscious decisions.

The statement of the prospective elementary teacher with the code T_1, who justifies associating critical thinking skill with science education by supporting permanent and meaningful learning, providing query, and enabling logical connections, is as follows:

Table 1.
Twenty-First–Century Skills Associated with Science Education by the Prospective Elementary Teachers

Category	Prospective Elementary Teachers	Frequency	%
Critical thinking	T_1, T_2, T_3, T_4, T_5, T_6, T_8, T_9, T_{11}, T_{12}, T_{13}, T_{14}, T_{15}, T_{16}, T_{17}, T_{18}, T_{22}, T_{24}, T_{25}, T_{27}, T_{28}, T_{29}, T_{30}, T_{31}, T_{32}, T_{33}, T_{34}, T_{35}, T_{36}, T_{37}, T_{38}, T_{39}, T_{40}, T_{41}, T_{43}, T_{44}, T_{45}, T_{46}, T_{47}, T_{48}	40	83
Creativity	T_1, T_2, T_4, T_5, T_8, T_9, T_{10}, T_{12}, T_{13}, T_{14}, T_{15}, T_{16}, T_{19}, T_{20}, T_{21}, T_{22}, T_{23}, T_{25}, T_{26}, T_{27}, T_{28}, T_{30}, T_{32}, T_{36}, T_{37}, T_{38}, T_{39}, T_{41}, T_{44}, T_{45}, T_{46}, T_{47}	32	67
Information and media and technology literacy	T_1, T_2, T_3, T_5, T_6, T_8, T_9, T_{10}, T_{11}, T_{12}, T_{13}, T_{14}, T_{16}, T_{18}, T_{19}, T_{21}, T_{23}, T_{24}, T_{25}, T_{28}, T_{29}, T_{31}, T_{32}, T_{33}, T_{36}, T_{37}, T_{38}, T_{40}, T_{41}, T_{42}, T_{44}, T_{45}	32	67
Problem-solving	T_1, T_2, T_3, T_4, T_5, T_6, T_7, T_8, T_9, T_{11}, T_{12}, T_{13}, T_{14}, T_{15}, T_{16}, T_{17}, T_{18}, T_{20}, T_{21}, T_{27}, T_{29}, T_{30}, T_{32}, T_{35}, T_{36}, T_{38}, T_{44}, T_{45}, T_{46}	29	60
Cooperation and communication	T_1, T_2, T_3, T_4, T_5, T_6, T_8, T_{11}, T_{12}, T_{14}, T_{16}, T_{18}, T_{20}, T_{21}, T_{23}, T_{24}, T_{25}, T_{27}, T_{31}, T_{34}, T_{36}, T_{37}, T_{42}, T_{43}, T_{44}, T_{45}, T_{47}	27	56
Innovation	T_1, T_3, T_4, T_5, T_6, T_8, T_{10}, T_{12}, T_{13}, T_{14}, T_{16}, T_{18}, T_{19}, T_{20}, T_{23}, T_{26}, T_{27}, T_{30}, T_{34}, T_{40}, T_{45}	21	44
Entrepreneurship	T_1, T_2, T_8, T_{11}, T_{12}, T_{13}, T_{19}, T_{20}, T_{24}, T_{27}, T_{34}, T_{37}, T_{40}, T_{46}, T_{48}	15	31
Individual and social responsibility	T_1, T_2, T_5, T_8, T_{11}, T_{12}, T_{13}, T_{16}, T_{18}, T_{25}, T_{37}, T_{44}	12	25

Table 2.
Reasons for Associating the Critical Thinking Skills with Science Education by the Prospective Elementary Teachers

Category	Frequency	%	Code	Prospective Elementary Teachers	Frequency	%
Critical thinking	40	83	Supporting permanent and meaningful learning	T_1, T_2, T_6, T_9, T_{11}, T_{12}, T_{13}, T_{18}, T_{24}, T_{25}, T_{27}, T_{28}, T_{43}	13	33
			Providing the query	T_1, T_5, T_6, T_{12}, T_{16}, T_{29}, T_{34}, T_{35}, T_{39}, T_{44}, T_{45}, T_{46}, T_{47}	13	33
			Developing a different perspective	T_3, T_5, T_6, T_8, T_9, T_{25}, T_{30}, T_{37}, T_{38}, T_{45}, T_{48}	11	28
			Developing higher-order thinking skills	T_{11}, T_{17}, T_{25}, T_{28}, T_{30}, T_{31}, T_{32}, T_{33}, T_{40}, T_{41}	10	25
			Enabling logical connection	T_1, T_3, T_4, T_8, T_{11}, T_{16}, T_{32}, T_{36}	8	20
			Supporting reasoning	T_{14}, T_{27}, T_{29}, T_{38}, T_{45}	5	13
			Enabling conscious decisions	T_4, T_{12}	2	5

... When we enable students to use this skill by activating the critical thinking skill in science education, we will help them think more deeply about the subject and learn permanently. In this way, the student will be an open-minded person and the student does not directly accept every information and approaches skeptical and interrogative. In addition, thanks to critical thinking skills, we enable students to establish logical connections between different subjects. Therefore, students can better understand and relate to the subject.(T_1)

The explanation of the prospective elementary teacher with the code T_{37}, who explained the relationship between the critical thinking skill and science education on the basis of developing a different perspective, is as follows:

... The association between critical thinking and science education is quite great. Because with critical thinking, individuals develop themselves by always looking at science events from different angles. This allows them to look at life, events and people from the other side instead of always looking through a straight window. (T_{37})

The explanation of the prospective elementary teacher with the code T_{17}, who explained the relationship between the critical thinking skill and science education on the basis of developing higher-order thinking skills, is as follows:

... With critical thinking, students develop their higher-order thinking skills by being supported cognitively while learning. (T_{17})

The explanation of the prospective elementary teacher with the code T_{27}, who explained the relationship between the critical thinking skill and science education on the basis of supporting reasoning, is as follows:

... Students understand the nature of the subject by learning to interpret with this skill. In fact, they have reasoned and therefore they have learned the subject more permanently. (T_{27})

The explanation of the prospective elementary teacher with the code T_{12}, who explained the relationship between the critical thinking skill and science education on the basis of enabling conscious decisions, is as follows:

... Critical thinking enables the individual to question in proving the accuracy and reliability of an information or thought and it enables the individual to make a decision by researching, not just focusing on a criterion in decision making. By using this skill, students are not blindly attached to the information that they encounter. Students try to reach the right information and make conscious decisions. (T_{12})

The findings regarding the reasons for associating the creativity skill, one of the 21st-century skills, of the prospective elementary teachers with science education are given in Table 3.

From Table 3, it is clear that 47% of the prospective elementary teachers justify their association of the creativity skill, one of the 21st-century skills, with science education by stating that it enables the emergence of original ideas, 31% by stating that it develops the imagination, 25% by stating that it enables an effective approach to problems, 22% by stating that it enables higher-order thinking, and 13% by stating that it enables discovery.

The explanation of the prospective elementary teacher with the code T_{10}, who explained the relationship between the creativity skill and science education on the basis of enabling the emergence of original ideas and developing the imagination, is as follows:

... Creativity skills enable students to produce new and original ideas and carry out these ideas to life. An individual who has gained the ability to be creative will be open to discovery and these individuals are sensitive to science and production. The production means to use your imagination. Therefore, the creativity skill also supports the imagination of the students. (T_{10})

Table 3.
Reasons for Associating the Creativity Skills with Science Education by the Prospective Elementary Teachers

Category	Frequency	%	Code	Prospective Elementary Teachers	Frequency	%
Creativity	32	67	Enabling the emergence of original ideas	T_1, T_4, T_8, T_{10}, T_{12}, T_{13}, T_{16}, T_{19}, T_{20}, T_{22}, T_{23}, T_{37}, T_{41}, T_{44}, T_{47}	15	47
			Developing the imagination	T_9, T_{10}, T_{14}, T_{15}, T_{19}, T_{21}, T_{25}, T_{27}, T_{39}, T_{46}	10	31
			Enabling an effective approach to problems	T_5, T_8, T_{13}, T_{20}, T_{26}, T_{37}, T_{38}, T_{44}	8	25
			Enabling higher-order thinking	T_{13}, T_{19}, T_{23}, T_{26}, T_{30}, T_{45}, T_{47}	7	22
			Enabling discovery	T_{12}, T_{13}, T_{23}, T_{36}	4	13

The explanation of the prospective elementary teacher with the code T_{13}, who explained the relationship between the creativity skill and science education on the basis of enabling an effective approach to problems, higher-order thinking, and discovery, is as follows:

> *... Science education has important contributions to develop 21st century skills. For example, new ideas emerge with creativity skills, students find inventions. Creativity enables individuals to become aware of their own thoughts and abilities and to approach problems effectively. From this perspective, creativity is also inherent in science education. Because with experiments in the laboratory, students learn to explore using their creativity, they think more effectively and rationally.* (T_{13})

The findings regarding the reasons for associating the information and media and technology literacy skill, one of the 21st-century skills, of the prospective elementary teachers with science education are given in Table 4.

From Table 4, it is clear that 53% of the prospective elementary teachers justify their association of information and media and technology literacy skill, one of the 21st-century skills, with science education by stating that it enables accurate and reliable selection of resources, 38% by stating that it supports science literacy, 31% by stating that it supports keeping up with the times, 28% by stating that it supports permanent and meaningful learning, 19% by stating that it enables to follow scientific development, 17% by stating that it supports research discovery, and 6% by stating that it enables raising qualified individuals.

The explanation of the prospective elementary teacher with the code T_3, who explained the relationship between the information and media and technology literacy skill and science education on the basis of enabling accurate and reliable selection of resources, supporting science literacy, and keeping up with the times, is as follows:

> *... The aim of science education is to raise scientific literacy individuals. In fact, we can say information and technology literacy as one of the first steps in the formation of science literacy. Individuals should analyze the information they encounter well, prove its accuracy, and look at causation with other information. While doing this, the individual should pay attention to reach the right resources. Accessing the right resources can only be achieved when the individual is information and media literacy. Individuals who do all these and develop themselves in this skill area also keep up with the times.* (T_3)

The explanation of the prospective elementary teacher with the code T_{10}, who explained the relationship between the information and media and technology literacy skill and science education on the basis of supporting permanent and meaningful learning, enabling to follow scientific development, and supporting research discovery, is as follows:

> *... In science education, teachers can support their lessons by using media and technology. In this way, students' learning becomes easier and meaningful. In addition, as they see its use in the course, they can learn to use these resources and follow scientific developments as they wish. They can do research and discover different information. In addition, they learn where, how and for what purpose they will use these resources, that is, reliable use.* (T_{10})

The explanation of the prospective elementary teacher with the code T_{29}, who explained the relationship between the information and media and technology literacy skill and science education on the basis of enabling raising qualified individuals, is as follows:

> *... Information-media and technology literacy is frequently used in science education. Because science lessons include abstract subjects. To eliminate this abstraction, teachers often make use of technology. Students also begin to get used to using technology, internet and media over time. It is considered important to use them nowadays. Because today, we reach a lot of information with them. Therefore, these ensure that equipped and qualified individuals are raised.* (T_{29})

The findings regarding the reasons for associating the problem-solving skill, one of the 21st-century skills, of the prospective elementary teachers with science education are given in Table 5.

From Table 5, it is clear that 62% of the prospective elementary teachers justify their association of the problem-solving skill, one of the 21st-century skills, with science education by stating that it develops higher-order thinking skills, 41% by stating that it supports permanent and meaningful learning, 31% by stating that it enables logical connection, 24% by stating that it establishes causation, 17% by stating that it supports reasoning, 17% by stating that it is in the nature of science, and 14% by stating that it supports the use of science process skills.

The explanation of the prospective elementary teacher with the code T_6, who explained the relationship between the problem-solving skill and science education on the basis of developing higher-order thinking skills, supporting permanent and

Table 4.
Reasons for Associating the Information and Media and Technology Literacy Skill with Science Education by the Prospective Elementary Teachers

Category	Frequency	%	Code	Prospective Elementary Teachers	Frequency	%
Information, media, and technology literacy	32	67	Enabling accurate and reliable selection of resources	T_3, T_5, T_6, T_8, T_{10}, T_{11}, T_{12}, T_{14}, T_{16}, T_{21}, T_{25}, T_{29}, T_{32}, T_{38}, T_{40}, T_{41}, T_{42}	17	53
			Supporting science literacy	T_3, T_9, T_{11}, T_{12}, T_{14}, T_{16}, T_{28}, T_{31}, T_{33}, T_{36}, T_{44}, T_{45}	12	38
			Supporting keeping up with the times	T_1, T_3, T_5, T_6, T_{12}, T_{14}, T_{19}, T_{23}, T_{24}, T_{45}	10	31
			Supporting permanent and meaningful learning	T_1, T_2, T_{10}, T_{12}, T_{13}, T_{37}, T_{38}, T_{42}, T_{44}	9	28
			Enabling to follow scientific development	T_8, T_{10}, T_{11}, T_{19}, T_{21}, T_{38}	6	19
			Supporting research discovery	T_9, T_{10}, T_{18}, T_{31}, T_{36}	5	17
			Enabling raising qualified individuals	T_{29}, T_{36}	2	6

Table 5.
Reasons for Associating the Problem-Solving Skill with Science Education by the Prospective Elementary Teachers

Category	Frequency	%	Code	Prospective Elementary Teachers	Frequency	%
Problem-solving	29	60	Developing higher-order thinking skills	T_2, T_6, T_7, T_9, T_{11}, T_{12}, T_{14}, T_{15}, T_{17}, T_{20}, T_{27}, T_{29}, T_{30}, T_{32}, T_{35}, T_{44}, T_{45}, T_{46}	18	62
			Supporting permanent and meaningful learning	T_1, T_3, T_4, T_6, T_{11}, T_{13}, T_{16}, T_{17}, T_{18}, T_{21}, T_{27}, T_{38}	12	41
			Enabling logical connection	T_1, T_3, T_4, T_6, T_9, T_{11}, T_{16}, T_{20}, T_{29}	9	31
			Establishing causation	T_3, T_5, T_8, T_9, T_{12}, T_{20}, T_{36}	7	24
			Supporting reasoning	T_8, T_{14}, T_{27}, T_{29}, T_{38}	5	17
			Being in the nature of science	T_6, T_9, T_{32}, T_{38}, T_{44}	5	17
			Supporting the use of science process skills	T_2, T_6, T_{21}, T_{44}	4	14

meaningful learning, enabling logical connection, and being in the nature of science, is as follows:

> *... Science education aims to enable students to become individuals who research the source of information, question and discuss scientific issues. Individuals with a science education are individuals who exchange ideas with others, analysis, synthesis and evaluate ideas. The student can achieve all of these by finding problem-solving skills in the nature of science. With problem-solving, students establish logical relationships and learn permanently the subject that they solve the problem.* (T_6)

The explanation of the prospective elementary teacher with the code T_8, who explained the relationship between the problem-solving skill and science education on the basis of establishing causation and supporting reasoning, is as follows:

> *... We need to use experiments frequently in science lessons. In experiments, we ask questions for students to solve different problems. In solving these questions, students begin to establish causation while doing the experiment. They make inferences by doing cause-effect analysis. In other words, when they are asked to solve a problem on the basis of the situation given to them during the experiment or in a different way, they try to reach a solution by reasoning with their friends.* (T_8)

The explanation of the prospective elementary teacher with the code T_{44}, who explained the relationship between the problem-solving skill and science education on the basis of supporting the use of science process skills, is as follows:

> *... Students encounter many problems in science lessons. For example, if a child who makes a simple electrical circuit in science class sees that the light bulb does not light when the child starts the circuit, child should think critically and find solutions to it. This is not a problem-solving. To solve these and similar problems, the student uses science process skills such as observation, experimentation, data collection, changing and controlling variables. Since science lessons are based on experiments, they develop these skills by using scientific process skills in the problems they encounter in these experiments.* (T_{44})

The findings regarding the reasons for associating the cooperation and communication skill, one of the 21st-century skills, of the prospective elementary teachers with science education are given in Table 6.

From Table 6, it is clear that 59% of the prospective elementary teachers justify their association of the cooperation and communication skill, one of the 21st-century skills, with science education by stating that it enables better outcome, 41% by stating that it supports social skills, 37% by stating that it enables the exchange of information, 22% by stating that it enables effective work, 19% by stating that it supports permanent and meaningful learning, 15% by stating that it prepares students for real life, 11% by stating that it enables an effective approach to problems, and 7% by stating that it supports responsibility.

The explanation of the prospective elementary teacher with the code T_2, who explained the relationship between the cooperation and communication skill and science education on the basis of enabling better outcome and supporting social skills, is as follows:

Table 6.
Reasons for Associating the Cooperation and Communication Skills with Science Education by the Prospective Elementary Teachers

Category	Frequency	%	Code	Prospective Elementary Teachers	Frequency	%
Cooperation and communication	27	56	Enabling better outcome	T_1, T_2, T_3, T_{11}, T_{12}, T_{14}, T_{18}, T_{21}, T_{23}, T_{24}, T_{25}, T_{27}, T_{31}, T_{37}, T_{42}, T_{44}	16	59
			Supporting social skills	T_2, T_5, T_6, T_8, T_{11}, T_{12}, T_{20}, T_{27}, T_{43}, T_{45}, T_{47}	11	41
			Enabling the exchange of information	T_1, T_3, T_5, T_6, T_8, T_{16}, T_{24}, T_{34}, T_{36}, T_{44}	10	37
			Enabling effective work	T_6, T_{11}, T_{14}, T_{34}, T_{44}, T_{47}	6	22
			Supporting permanent and meaningful learning	T_3, T_{11}, T_{27}, T_{34}, T_{42}	5	19
			Preparing for real life	T_1, T_8, T_{12}, T_{23}	4	15
			Enabling an effective approach to problems	T_{12}, T_{18}, T_{23}	3	11
			Supporting responsibility	T_4, T_6	2	7

... When students work collaboratively in science classes, there is strength in unity. With this work, they become more productive in their work. Collaboration and communication skill with togetherness also improves students' social skills. (T_2)

The explanation of the prospective elementary teacher with the code T_{34}, who explained the relationship between the cooperation and communication skill and science education on the basis of enabling the exchange of information and effective work and supporting permanent and meaningful learning, is as follows:

... For example, communication and cooperation skills are important for science education. Because we use these skills a lot in science education, especially when students make experiments in the laboratory. Experiments are done collaboratively, students who working together exchange ideas and share what they know with their friends. Collaboration is also important for task sharing on how the experiment is conducted. Communication skills should be good about what they will learn as a result of the experiment and for a more permanent and efficient learning. In addition, communication skills should be good to avoid confusion during the experiment. This provides students with the opportunity to work effectively. (T_{34})

The explanation of the prospective elementary teacher with the code T_{12}, who explained the relationship between the cooperation and communication skill and science education on the basis of preparing for real life and enabling an effective approach to problems, is as follows:

... One of the important skills that we use in science lessons is communication and cooperation skills. These skills are the most basic skills that people need to acquire in order to meet their needs in daily life and adapt to the environment. This skill which is also very important in science education, enables people to better cope with the problems they face. Communication skills help to express information more easily, be more understandable, and learn better. Collaboration enables students to learn together. Since both are skills that are frequently used in daily life, they prepare a people for life. (T_{12})

The explanation of the prospective elementary teacher with the code T_4, who explained the relationship between the cooperation and communication skill and science education on the basis of supporting responsibility, is as follows:

... Through communication and collaboration, the student works with different friends in experiments in science. In these studies, students take responsibility by collaborating. In this way, after a while, the responsibilities of the students develop. (T_4)

The findings regarding the reasons for associating the innovation skill, one of the 21st-century skills, of the prospective elementary teachers with science education are given in Table 7.

From Table 7, it is clear that 38% of the prospective elementary teachers justify their association of the innovation skill, one of the 21st-century skills, with science education by stating that it supports adapting to different ideas, 33% by stating that it supports keeping up with the times, 29% by stating that it provides new ideas, 19% by stating that it supports creativity, 14% by stating that it develops higher-order thinking skills, and 10% by stating that it enables the emergence of original products.

The explanation of the prospective elementary teacher with the code T_{14}, who explained the relationship between the innovation skill and science education on the basis of supporting adapting to different ideas and creativity, is as follows:

... Innovation is a 21st century skill. With innovation, students are expected to be creative. In addition, in the activities which we have done in science lessons, students can be open to different ideas and perspectives of their friends if they have an innovative perspective. (T_{14})

The explanation of the prospective elementary teacher with the code T_{19}, who explained the relationship between the innovation skill and science education on the basis of supporting keeping up with the times and providing new ideas, is as follows:

... Let's think like this, for example, the innovation skill helps to get new ideas in science education. Identifying and solving problems with their own thoughts and abilities helps to come up with new ideas. Innovation can be considered as a skill that improves the quality of life of children. Namely, with this skill, the child keeps up with the times and adapts to the period in which he/she lives with innovative ideas. (T_{19})

The explanation of the prospective elementary teacher with the code T_{45}, who explained the relationship between the innovation skill and science education on the basis of developing higher-order thinking skills, is as follows:

... With the developing and changing world, new things are emerging every day. Since science is a part of our life, it is important to be innovative so that we can keep up with the innovating world. Innovation encourages individuals to think and it supports higher-order thinking. (T_{45})

The explanation of the prospective elementary teacher with the code T_{16}, who explained the relationship between the innovation

Table 7.
Reasons for Associating the Innovation Skill with Science Education by the Prospective Elementary Teachers

Category	Frequency	%	Code	Prospective Elementary Teachers	Frequency	%
Innovation	21	44	Supporting adapting to different ideas	T_4, T_6, T_8, T_{10}, T_{14}, T_{20}, T_{30}, T_{40}	8	38
			Supporting keeping up with the times	T_1, T_3, T_5, T_{12}, T_{18}, T_{19}, T_{45}	7	33
			Providing new ideas	T_{13}, T_{16}, T_{19}, T_{20}, T_{30}, T_{34}	6	29
			Supporting creativity	T_{14}, T_{19}, T_{23}, T_{27}	4	19
			Developing higher-order thinking skills	T_{13}, T_{26}, T_{45}	3	14
			Enabling the emergence of original products	T_{16}, T_{23}	2	10

Table 8.
Reasons for Associating the Entrepreneurship Skill with Science Education by the Prospective Elementary Teachers

Category	Frequency	%	Code	Prospective Elementary Teachers	Frequency	%
Entrepreneurship	15	31	Enabling that opportunities are evaluated	T_1, T_8, T_{11}, T_{12}, T_{24}, T_{34}, T_{37}	7	47
			Enabling effective decision making	T_2, T_8, T_{19}, T_{24}, T_{27}, T_{48}	6	40
			Supporting keeping up with the times	T_1, T_{11}, T_{20}, T_{24}, T_{37}, T_{46}	6	40
			Developing self-confidence	T_2, T_{13}, T_{20}, T_{34}, T_{48}	5	33
			Being the need of the age	T_1, T_2, T_8, T_{19}, T_{46}	5	33

skill and science education on the basis of enabling the emergence of original products, is as follows:

> *... The relationship between science education and innovation skill is quite high. Science is a field that is suitable for putting forward new ideas with innovative thinking. Also, science is a field that is suitable for different and original studies.* (T_{16})

The findings regarding the reasons for associating the entrepreneurship skill, one of the 21st-century skills, of the prospective elementary teachers with science education are given in Table 8.

From Table 8, it is clear that 47% of the prospective elementary teachers justify their association of the entrepreneurship skill, one of the 21st-century skills, with science education by stating that it enables that opportunities are evaluated, 40% by stating that it enables effective decision-making, 40% by stating that it supports keeping up with the times, 33% by stating that it develops self-confidence, and 33% by stating that it is the need of the age.

The explanation of the prospective elementary teacher with the code T_{24}, who explained the relationship between the entrepreneurship skill and science education on the basis of enabling that opportunities are evaluated and effective decision-making and supporting keeping up with the times, is as follows:

> *... An enterprising individual can seize many opportunities in the 21st century and can take advantage of them. For example, with a good science education, individuals can direct their lives by using their logic and analysis. Individuals can take effective decisions that enable them to adapt to the age with entrepreneurship. Therefore, the effect of science education on entrepreneurship is undeniable.* (T_{24})

The explanation of the prospective elementary teacher with the code T_{48}, who explained the relationship between the entrepreneurship skill and science education on the basis of developing self-confidence, is as follows:

> *... In science education, the student is constantly engaged with experiments, discussions, etc. Since students have acquired many skills, they do not have difficulty in gaining entrepreneurship skills. The individuals who gain the entrepreneurship participate in the discussions more. Because their self-confidence has increased.* (T_{48})

The explanation of the prospective elementary teacher with the code T_{19}, who explained the relationship between the entrepreneurship skill and science education on the basis of being the need of the age, is as follows:

> *... Entrepreneurship is one of the skills we gain through experiments and laboratory studies in science education. Entrepreneurship is about responding to needs. This skill which we bring to students with science, contributes to the development of society and humanity. It should not be forgotten that humanity has always developed under the leadership of people who are in need of the age and who can think entrepreneurship.* (T_{19})

The findings regarding the reasons for associating the individual and social responsibility skill, one of the 21st-century skills, of the prospective elementary teachers with science education are given in Table 9.

From Table 9, it is clear that 58% of the prospective elementary teachers justify their association of the individual and social responsibility skill, one of the 21st-century skills, with science education by stating that it enables raising sensitive individuals, 40% by stating that it enables raising conscious individuals, and 25% by stating that is supports the doing of good work.

The explanation of the prospective elementary teacher with the code T_{18}, who explained the relationship between the individual and social responsibility skill and science education on the basis of enabling raising sensitive individuals, is as follows:

> *... This skill can be gained more easily in science lessons than in other lessons. Because science includes the subjects that the student will see about life. For example, by developing this skill on the environment, students know their responsibility as individuals on how to keep the environment clean and protect it. Students begin to act sensitively by knowing what to do.* (T_{18})

The explanation of the prospective elementary teacher with the code T_1, who explained the relationship between the individual

Table 9.
Reasons for Associating the Individual and Social Responsibility Skill with Science Education by the Prospective Elementary Teachers

Category	Frequency	%	Code	Prospective Elementary Teachers	Frequency	%
Individual and social responsibility	12	25	Enabling raising sensitive individuals	T_2, T_5, T_{13}, T_{16}, T_{18}, T_{25}, T_{44}	7	58
			Enabling raising conscious individuals	T_1, T_8, T_{11}, T_{12}, T_{37}	5	42
			Supporting the doing of good work	T_{12}, T_{13}, T_{25}	3	25

and social responsibility skill and science education on the basis of enabling raising conscious individuals, is as follows:

> *... We provide support for this skill in science education. With the inclusion of this skill in science education, the student directs how to behave in real life. For example, about living things and life. The student who has acquired this skill will be aware of how to treat living things and what to pay attention to.* (T_1)

The explanation of the prospective elementary teacher with the code T_{25}, who explained the relationship between the individual and social responsibility skill and science education on the basis of supporting the doing of good work, is as follows:

> *... We give students responsibility with science education. In this respect, an important skill gained through science education is individual and social responsibility. The students who we have acquired this skill will do useful things for themselves and their surroundings in the future with a sense of responsibility.* (T_{25})

Discussion and Conclusions and Recommendations

As a result of the findings obtained from the research, it was determined that prospective elementary teachers associated 21st-century skills such as *critical thinking*, *creativity*, *information and media and technology literacy*, *problem-solving*, *cooperation and communication*, *innovation*, *entrepreneurship*, and *individual and social responsibility* with science education (Table 1). From this association made by the prospective elementary teachers, it is seen that they express the behaviors expected from individuals as stated in the science curriculum (MoNE, 2018a) because in the relevant curriculum, it is emphasized that individuals should be raised as individuals who can produce knowledge and use it functionally in life, think critically, solve problems, be entrepreneurial, determined, and empathetic, have communication skills, and contribute to society and culture. Similarly, it is noteworthy that other curricula (MoNE, 2018b, 2018c, 2018d, 2019), which are of interest to prospective elementary teachers, emphasize 21st-century skills such as analytical thinking, entrepreneurship, decision-making, creative thinking, critical thinking, problem-solving, and cooperation-teamwork and communication skills. From this, it can be inferred that prospective elementary teachers are aware of the characteristics of individuals that are emphasized both in the science curriculum and in other curricula, including 21st-century skills. This awareness of the candidates about the individual characteristics and 21st-century skills in the curriculum is pleasing, but it is also valuable in terms of following today's world and curricula. On the other hand, it is seen that prospective elementary teachers tried to express information and communication technologies literacy, which is one of the "basic literacy" skills, which is the first main skill reported in WEF (2017), by associating it with science education. Again, the candidates associated communication, creativity, critical thinking and cooperation from the "basic literacy" skills, which are stated as the second basic skill in this report. Finally, the candidates associated the entrepreneurial skill which of "character traits", which is expressed as the third main skill. Similarly, the candidates mentioned critical thinking and problem-solving, creativity, innovation, collaboration and communication, and information and media literacy among the 21st-century skills mentioned by Anagün et al. (2016). Again, the fact that the candidates mentioned individual and social responsibility as described by the American Association of Colleges and Universities and communication and collaboration, creativity and innovation, critical thinking, and problem-solving emphasized by the International Society for Technology in Education as 21st-century skills related to science education draws attention to the compatibility of the findings with the literature and the awareness of the candidates on this issue.

The majority of the 48 prospective elementary teachers included in the study group (40 prospective elementary teachers) primarily expressed critical thinking skills in relation to science education. It was determined that prospective elementary teachers associated critical thinking skills with science education on the grounds that it supports permanent and meaningful learning, enables questioning and developing different perspectives, develops high-level thinking skills, and establishes logical connections, reasoning, and making informed decisions (Table 2). According to Rudd (2007), critical thinking, which is a logical, reflective, and in-depth thinking process, allows individuals to go through processes such as analyzing, organizing, evaluating, and synthesizing (Gürkaynak et al., 2008; Johnson, 2000) because it requires high-level thinking skills (Moore, 2001). Critical thinking skill supports individuals to make informed decisions, as it provides them with the opportunity to evaluate the ideas they have and to become aware of the reasons underlying their ideas (Hayırsever & Oğuz, 2017). Considering the definitions of critical thinking and the scope of critical thinking, it can be inferred that critical thinking requires scrutiny and multidimensional thinking in the process of acquiring knowledge. In this direction, it can be said that critical thinking has a structure that supports individuals' permanent and meaningful learning by organizing information. On the other hand, one of the reasons why prospective elementary teachers associate critical thinking with science education is that science is an important branch of science. Since science begins with curiosity and questioning, critical thinking is also seen as a requirement of scientific thinking (Çolak et al., 2019). Science has a dynamic in which scientific thinking is actively used and questioning is constantly on the agenda. In this respect, critical thinking, which is considered as a lifelong process (Ferrent, 2015), can be considered as a skill area that is quite suitable for the nature of science. In addition, critical thinkers are curious and inquisitive individuals who have the skills of understanding the problems they face and determining the processes for solving them, using reliable and valid information, interpreting the data they obtain, explaining the data within logic, making inferences from the results, and reconstructing the information they experience and using it in different situations (Fisher et al., 2007). Therefore, the relationship between science and critical thinking cannot be denied in terms of ensuring the formation of this infrastructure in individuals. In this direction, it can be said that the associations of prospective elementary teachers with critical thinking and science education and the justifications they based these associations on are compatible with the literature.

It was determined that creativity was the second 21st-century skill that prospective elementary teachers associated with science education, with a high level of participation after critical thinking. It was determined that the candidates expressed these associations on the basis that creativity enables the emergence of original ideas, effective approach to problems, and high-level thinking and discovery and develops imagination (Table 3). Creativity as a skill that supports high-level thinking enables individuals to come up with new, original, and unique ideas about a

subject (Amabile & Pratt, 2016; Ayyıldız & Yılmaz, 2021; Gökalp, 2018; Walia, 2019). According to Walia (2019), creativity is a skill that helps solve problems. Craft (2003) defines creativity as a lifelong skill based on using imagination. From this perspective, the reasons of prospective elementary teachers for associating creativity with science education overlap with the scope of creativity. Moreover, in education in general and in science education in particular, it is seen that creativity is given special importance. As a matter of fact, it is seen that the steps of Bloom's taxonomy, which has an important place in determining the basic objectives of education, have been revised and the creation (producing) step has been added to the steps. The creation step in this new revised taxonomy refers to creativity. According to Anderson and Krathwohl (2001), in this step where individuals bring together different components to form a coherent and functional whole, individuals create an original product by associating their new learning with previous ones. In terms of science education, creativity has a complementary structure with science. In other words, science as a branch of science feeds creativity when its structure is considered. Science enables individuals to use what they learn functionally in their daily lives and requires them to use creativity. This shows the value of science education in helping individuals acquire creativity, which is important for individuals to keep up with the age. In addition, the fact that the prospective elementary teachers in the research group made their justifications for making associations by considering the nature of science and expressed in which aspects science supports creativity in line with the literature is considered important in terms of reflecting their awareness on this issue.

It was determined that 32 prospective elementary teachers who evaluated information and media and technology literacy in relation to science education based their associations on the fact that this skill enables accurate and reliable selection of resources, meaningful and permanent learning, following scientific developments, and raising qualified individuals and supports science literacy, keeping up with the age and research and discovery (Table 4). This is the age of information, the age of technology. It is known that there is a rapid development and change in information and technology in this age. These developments and changes are reflected in all areas of education and cause differentiation in educational structures and understandings. As a matter of fact, this differentiation also manifests itself in the understanding of science education. While raising science-literate individuals is emphasized among the aims of science education, the characteristics of this individual are stated as being a researcher-inquirer, open to cooperation, able to make effective decisions and communicate, and a lifelong learner (MoNE, 2013). It is noteworthy that science literacy is also emphasized in the current science program. So how will it be possible for students to acquire these skills? One of the most important ways to ensure this is to integrate technology and media into science as a necessity of the age and to support knowledge with these components. In this way, an effective science education is provided. Therefore, the justifications of the prospective elementary teachers show that they emphasize the successful realization of science education. In addition, when all justifications and the components of information and media and technology literacy are considered, it can be inferred that the statements of the candidates overlap with the structure of today's educational understanding.

Problem-solving has an important place in science teaching and learning. The fact that prospective elementary teachers consider problem-solving as a 21st-century skill related to science education reveals that they know the importance of problem-solving in science education. Candidates indicated these associations by stating that problem-solving develops high-level thinking skills in science education, supports permanent and meaningful learning, uses scientific process skills and reasoning, and establishes logical connections and cause–effect relationships and that it is in the nature of science (Table 5). When the related literature is examined, it can be inferred that the justifications of the prospective elementary teachers for making these associations are appropriate. As a matter of fact, since the problem-solving process involves organizing thoughts and systematic thinking, high-level thinking skills are used in this process. Therefore, problem-solving develops mental skills (Liljedahl et al., 2016). In addition, since individuals actively use their minds by establishing logical connections and cause–effect relationships in the problem-solving process (Özkaya & Öztürk, 2023), it can be said that problem-solving supports meaningful and permanent learning. On the other hand, individuals face many problems in their daily lives. Science as a branch of science manifests itself in the functioning of daily life and in some problem situations in this functioning. So problem-solving is inherent in science. In solving these problems, scientific process skills such as observation, classification, data collection, data recording, experimentation, hypothesizing, and modeling (Akdeniz, 2016) are often used. In this sense, it can be said that problem-solving has a structure that supports the use of scientific process skills.

Another important and relevant skill for science education is collaboration and communication. Because the most basic feature that distinguishes science from other sciences is that it is primarily based on experimentation, observation, and discovery (Odubunni & Balagun, 1991), and therefore cooperation and communication are considered important in science. As the prospective elementary teachers in the research group stated, when individuals work in cooperation and communication in accordance with the nature of science, they develop their social skills (Leighton, 2003), exchange ideas and information, realize meaningful and permanent learning by obtaining better outcomes (Borich, 2017; Gradel & Edson, 2011; Peterson & Miller, 2004), and learn to work effectively and be a responsible individual (Demirel, 2015; Eshietedoho, 2010). Although the individual seems to be becoming more isolated in the age we live in, cooperation and communication skills have become much more important today, especially in terms of business life. From this point of view, it can be said that prospective elementary teachers' expressions of cooperation and communication skills in relation to science education and their justifications (Table 6) are appropriate. In addition, the fact that the candidates made their justifications by considering the nature of science can be considered as an indicator that they developed an understanding of science.

The Next Generation Science Standards (NGSS, 2013) state that innovation is one of the basic skills that individuals should possess. With a quality science education, it is aimed for individuals to question, internalize what they have learned, and reflect it in their daily lives. In this way, individuals gain innovation skills (Barak & Yuan, 2021) among many other skills. Innovativeness is expressed as a high-level way of thinking (Yılmaz, 2020). In addition, innovation is one of the criteria used to determine the level of development of countries and for individuals to keep up with the age (Kennedy & Odell, 2014). Considering that individuals with innovation skills are open-minded individuals, it is clear

that they will be successful in producing original products. For this reason, innovation skill directly or indirectly affects different education programs around the world (Gelen, 2017). Therefore, it is possible to say that this effect is reflected in science education programs. It is possible to see this reflection in the explanation of the characteristics expected from individuals among the aims of science education. Individuals are no longer expected to take and use information verbatim but to have the ability to apply what they have learned in different situations. One way to achieve this is to provide individuals with innovation skills. The related literature and the findings of the study show that the prospective elementary teachers' associations of innovation skills with science education and their justifications for this issue overlap with the educational understanding of today's world.

It was determined that prospective elementary teachers explained entrepreneurship by justifying it as making use of opportunities, making effective decisions, keeping up with the age, developing self-confidence, and being a necessity of the age (Table 8). It can be said that the reasons for associations of prospective elementary teachers about entrepreneurship are compatible with the literature. Entrepreneurship is defined as discovering opportunities and taking action to take advantage of these opportunities in order to keep up with the times and achieve success (Huerta de Soto, 2010). Moreover, it is emphasized that entrepreneurial individuals see opportunities, can act independently and make effective decisions, can easily adapt to differences/change, have high self-confidence, and are innovative and determined (Hisrich et al., 2005). Based on this emphasis, the reason why entrepreneurship skill has taken its place among the 21st-century skills is understood and the relationship between science education and entrepreneurship skill is realized.

The last skill that prospective elementary teachers associate with science education is individual and social responsibility. It was determined that prospective elementary teachers made their associations by justifying them in accordance with the requirements of individual and social responsibility (Table 9). Because individual and social responsibility is a state of being aware of what is happening in social life. In addition, this skill includes an affective process (Eraslan, 2011). Being socially responsible depends on being individually responsible and sensitive. In science education, there are contents that prepare the ground for the formation of a sense of responsibility in individuals, for example, the protection of the environment. Therefore, a good science education can help individuals grow up to be responsible. Individual responsibility can then form the basis for the development of socially responsible individuals. From this point of view, it can be stated that individual and social responsibility is a skill appropriate to the nature of science education and that the development of this skill can be ensured through effective science education.

As a result, when the scope of *critical thinking*, *creativity*, *information and media and technology literacy*, *problem-solving*, *cooperation and communication*, *innovation*, *entrepreneurship*, and *individual and social responsibility* skills that prospective elementary teachers stated to be related to science education is evaluated, it can be said that it is not possible to distinguish these skills from each other with precise lines. This is because many skills support each other and are closely interrelated. In addition, the fact that the expressions used by prospective elementary teachers while presenting their justifications for making associations are compatible with the nature of skills is valuable in terms of showing their awareness of this issue. The results of this study are considered to be important in terms of providing an evaluation of the association of 21st-century skills with science education from the perspective of prospective elementary teachers. The study is also important in terms of providing a general framework of which skills are referred to as 21st-century skills. In this respect, the study also contributes to the review of the content and reiteration of the importance of 21st-century skills, the importance of which is always emphasized.

When all content is evaluated, it is recommended to determine the awareness of teachers and teacher candidates in different branches, who play an important role in the acquisition of 21st-century skills, about these skills. Moreover, by focusing on the awareness of science teachers and prospective science teachers on this issue, it can be determined which reasons teachers use to associate these skills with science education.

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Genişletilmiş Özet

Amaç

Gelişen teknoloji ve değişen dünya koşullarının sonucunda 21. yüzyılda bireylerin sergilemeleri beklenen beceriler değişmiştir. Bu değişime uyum sağlamak hem bireylerin içinde bulundukları topluma uyum göstermeleri hem de toplumsal yarar açısından son derece önemlidir. Hiç şüphesiz bunu sağlamanın en önemli ve etkili yollarından biri bireylere verilen eğitimin niteliğinin arttırılmasıdır. Artık eğitim-öğretim sürecinde bireylerden onlara aktarılan bilgileri aynen alıp kabul etmeleri istenmemekte, hayata hazır olmaları için öğrendiği bilgileri kullanabilen, öğrenmeyi öğrenmiş bireyler olarak yetiştirilmeleri gerektiği vurgulanmaktadır. Bilimin ve teknolojinin çok hızlı bir şekilde değişerek yenilendiği ve bu değişim ve yenilenmeye bağlı olarak günlük yaşamın sürekli güncellendiği bir yüzyıl olarak 21. yüzyıl, bireylerin sözü edilen değişim ve yeniliği çok derinden hissettikleri bir zaman dilimi olarak ifade edilmektedir (Posos Devrani, 2021). Bu zaman diliminde bireylerin içinde bulundukları döneme ayak uydurabilmeleri, gerçekleşen değişim ve yenilikleri takip edebilmeleri ve yüzyılın beklentilerine cevap verebilmeleri için sahip olmaları gereken beceriler günümüzde 21. yüzyıl becerileri olarak ifade edilmektedir. 21. yüzyılda bireylerin taşıması gereken kişisel, kişilerarası ve zihinsel beceri ve yeterlilikler olarak da ifade edilen 21. yüzyıl becerilerinin farklı kişi, kurum ve kuruluşlar tarafından ele alınıp çeşitli şekillerde sınıflandırıldığı görülmektedir (Anagün ve ark., 2016; WEF, 2017). Dahası birçok çalışmada 21. yüzyıl becerileri konu alınmış ve bu becerilerin önemine dikkat çekilmiştir (Belet-Boyacı & Güner-Özer, 2019; Erten, 2020; Gunadi ve ark., 2022; Kalemkuş, 2021; Kennedy & Sundberg, 2020; Kereluik ve ark., 2013; Martinez, 2022; Tuğluk & Özkan, 2019; Uyar & Çiçek, 2021; Yılmaz & Yanarateş, 2022). Üzerine yapılan araştırma ve sınıflandırma sayısının fazla olması, araştırmaların konu alanlarının çeşitliliği esasında 21. yüzyıl becerilerinin önemi ve bireylere kazandırılmasının ne denli gerekli olduğunu ortaya koymaktadır. Benzer şekilde ülkemizdeki farklı öğretim programlarına dikkat edildiğinde de 21. yüzyıl becerilerine verilen önem fark edilmektedir. Bu çerçeveden bakıldığında tüm dünyada olduğu gibi ülkemizde de 21. yüzyıl becerilerinin eğitim-öğretim uygulamalarının bir parçası olarak görüldüğü dikkat çekmektedir. Ayrıca 21. yüzyıl becerilerine ilişkin literatürdeki çalışmaların daha çok becerilerin sınıflandırılması, bazı beceri alanlarında öğrencilerin, öğretmen adayların ve öğretmenlerin düzeylerinin belirlenmesi odağında yürütüldüğü görülmektedir. Ancak 21. yüzyıl becerilerine yönelik sınıf öğretmeni adaylarının farkındalıklarının belirlendiği, fen eğitimiyle hangi becerileri ilişkilendirdiklerinin tespit edildiği ve bu ilişkilendirmelerinin gerekçelerinin açıklandığı bir çalışmanın literatürde olmaması bu araştırmanın planlanmasını gerekli kılmıştır. Dolayısıyla söz konusu öğretim programlarının bir bölümünün gelecekteki uygulayıcısı konumunda olan ve öğrencilere 21. yüzyıl becerilerinin kazandırılmasında ilk elden sorumluluk alacak olan sınıf öğretmeni adaylarının bu becerilerden hangilerini fen eğitimiyle ilişkilendirdikleri ve ilişkilendirmeleri altındaki gerekçelerin belirlenmesinin önemli olduğu düşünülmektedir. Bu düşünceden hareketle bu araştırmanın amacı, sınıf öğretmeni adaylarının 21. yüzyıl becerileri olarak hangi becerileri fen eğitimiyle ilişkilendirdiklerinin ve bu becerileri fen eğitimiyle ilişkilendirme gerekçelerine yönelik düşüncelerinin tespit edilmesidir.

Yöntem

Araştırmada nitel araştırma yöntemlerinden olgu bilim deseni kullanılmıştır. Araştırmanın çalışma grubunu Bayburt Üniversitesi Eğitim Fakültesi Sınıf Öğretmenliği Lisans Programı'nın üçüncü sınıfında öğrenim gören 48 sınıf öğretmeni adayı oluşturmaktadır. Çalışma grubunun belirlenmesinde kolaylıkla erişilebilen, mevcut ve gönüllü kişilerin (Johnson & Christensen, 2014) araştırmaya alındığı seçkisiz olmayan örnekleme yöntemlerinden uygun örnekleme yöntemi kullanılmıştır. Bu araştırma, araştırmacının görev yaptığı üniversitede öğrenim gören öğretmen adayları ile yürütüldüğünden çalışmanın doğasına uygun olduğu düşünülen uygun örnekleme yöntemi tercih edilmiştir. Araştırmada veri toplamak amacıyla sınıf öğretmeni adaylarının 21. yüzyıl becerilerinin hangilerinin fen eğitimiyle ilişkili olduğunu düşündüklerini ifade etmelerinin ve bu ilişkilendirmeleri altında yatan nedenleri belirtmelerinin istendiği, tek açık uçlu sorudan oluşan form kullanılmıştır. Veri toplama aracından elde edilen verilerin analizinde içerik analizi yönteminden yararlanılmıştır. İçerik analizi sürecinde ilk olarak kodlar ve kategoriler oluşturulmuş. Güvenilir ve doğru bulgular elde etmek için kod oluşturma süreci araştırmacıdan bağımsız, içerik analizi süreci konusunda deneyim sahibi farklı bir araştırmacı ile birlikte yürütülmüştür. Veri analizi sınıf öğretmeni adaylarının isimleri gizli tutulacak şekilde gerçekleştirilmiş ve adaylar $Ö_1$, $Ö_2$,....$Ö_{48}$ şeklinde kodlanmıştır. Sonuçta oluşturulan kategori ve kodların anlaşılır olmasını sağlamak amacıyla bulgular tablolar halinde sunularak yorumlanmaya çalışılmıştır.

Sonuç, Tartışma ve Öneriler

Sınıf öğretmeni adaylarının 21. yüzyıl becerilerinden eleştirel düşünme, yaratıcılık, bilgi-medya ve teknoloji okuryazarlığı, problem çözme, işbirliği-iletişim, yenilikçilik, girişimcilik ve bireysel-sosyal sorumluluk gibi becerileri fen eğitimiyle ilişkilendirdikleri tespit edilmiştir. Sınıf öğretmeni adaylarının yaptıkları bu ilişkilendirmeden, adayların Fen Bilimleri Dersi Öğretim Programı'nda ifade edildiği gibi bireylerden sergilemeleri beklenen davranışları ifade ettikleri görülmektedir (MEB, 2018a). Benzer şekilde sınıf öğretmeni adaylarının ilgi alanlarına giren diğer öğretim programlarında da (MEB, 2018b, 2018c, 2018ç, 2019) 21. yüzyıl becerilerinden özellikle analitik düşünme, girişimcilik, karar verme, yaratıcı düşünme, eleştirel düşünme, problem çözme, işbirliği-takım çalışması ve iletişim becerilerinin ön plana çıktığı dikkat çekmektedir. Buradan sınıf öğretmeni adaylarının hem Fen Bilimleri Dersi Öğretim Programı'nda hem de diğer öğretim programlarında vurgulanan ve 21. yüzyıl becerilerini de kapsayan birey özelliklerinden haberdar oldukları çıkarımı yapılabilir. Adayların programda yer alan birey özellikleri ve 21. yüzyıl becerileri konusundaki bu farkındalıkları sevindirici olmakla birlikte, günümüz dünyasını ve öğretim programlarını takip etmeleri açısından da değerlidir. Diğer taraftan sınıf öğretmeni adaylarının WEF (2017) de rapor edilen becerilerinden *bilgi iletişim teknolojileri okuryazarlığını*, *iletişim, yaratıcılık, eleştirel düşünme ve işbirliğini* ve *girişimcilik* becerisini fen eğitimiyle ilişkilendirerek ifade etmeye çalıştıkları görülmektedir. Yine adayların Amerikan Üniversite ve Yüksekokullar Birliği'nin açıkladığı *bireysel ve sosyal sorumluluğu*, Uluslararası Eğitimde Teknoloji Topluluğu tarafından vurgulanan *iletişim ve işbirliği, yaratıcılık ve yeniliği, eleştirel düşünme ve problem çözmeyi* fen eğitimiyle ilişkili 21. yüzyıl becerileri olarak dile getirmeleri bulguların literatürle uyumuna ve adayların bu konudaki farkındalığına dikkat çekmektedir.

Ayrıca sınıf öğretmeni adaylarının bu becerileri fen eğitimiyle ilişkilendirme gerekçelerinin çeşitlendiği belirlenmiştir. Özellikle adayların eleştirel düşünme, problem çözme ve işbirliği-iletişim becerilerini anlamlı ve kalıcı öğrenmeyi desteklediğinden dolayı fen eğitimiyle ilişkilendirdikleri tespit edilmiştir. Diğer taraftan birçok becerinin fenin doğasında olması, bireylerin çağa ayak uydurmasını sağlaması ve üst düzey düşünmeyi desteklemesi yönünden fen eğitimiyle ilişkilendirilmesi dikkat çekmektedir. İlgili bulgular ve literatür incelendiğinde sınıf öğretmeni adaylarının ilişkilendirme gerekçelerini sunarken kullandıkları ifadelerin, becerilerin doğasıyla uyumlu olması bu konudaki farkındalıklarını göstermesi bakımından değerlidir. 21. yüzyıl becerilerinin fen eğitimiyle ilişkilendirilmesine yönelik sınıf öğretmeni adaylarının gözünden bir değerlendirme sunması açısından, bu çalışmanın sonuçlarının önemli olduğu düşünülmektedir. Çalışma aynı zamanda 21. yüzyıl becerileri olarak hangi becerilerin anıldığına ilişkin genel bir çerçeve sunması açısında da önemlidir. Bu yönüyle çalışma, önemi her zaman vurgulanan 21. yüzyıl becerilerinin içeriğinin gözden geçirilmesine ve öneminin yinelenmesine de katkı sağlamaktadır.

Bütün içerikler değerlendirildiğinde, 21. yüzyıl becerilerinin bireylere kazandırılmasında önemli roller üstlenen farklı branşlardaki öğretmenlerin ve öğretmen adaylarının bu becerilere ilişkin farkındalıklarının belirlenmesi önerilmektedir. Dahası fen bilgisi öğretmenlerinin ve fen bilgisi öğretmeni adaylarının bu konudaki farkındalıkları üzerine yoğunlaşılarak, öğretmenlerin bu becerileri fen eğitimiyle ilişkilendirmede hangi gerekçeleri kullandıkları belirlenebilir.

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