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INVESTIGATION OF PRESERVICE SCIENCE TEACHERS' VIEWS ABOUT SCIENCE AND TECHNOLOGY

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ABSTRACT
Data access, data follow up and analysis and the ability to keep up with advances in science and technology and to transfer these into persons' daily lives are some of the characteristics needed by societies. These characteristics are listed among the specific characteristics including science and technology literacy, comprehension of science and technology purposes and science and technology integration. For this reason, many countries have updated the curriculums in order to follow and keep up with the innovations, and they include the nature of the advances in science, technology and the interactions of technology with the science-society-environment. Hence, in this case, investigation, a qualitative research design was used and it was aimed to put forward opinions of preservice science teachers (n= 49) about science and technology. Science and technology definitions and purposes, developed by the researchers, were used as a data collection tool and open-ended questions were used to reveal the opinions of preservice science teachers and the relations between the two concepts. Descriptive analysis and content analyses were used for data analysis and the researchers met sporadically and continued their analyses until they received the highest rate among the coders. Considering the answers of the preservice teachers about the relation between science and technology based on these analyses, it was ascertained that they had given similar answers and the concepts of science and technology were understood as two interwoven concepts, used in conjunction. Thus, it was observed that pre-service teachers generally associated the concept of science with research, curiosity, and imagination and that they associated the concept of technology with the concepts of providing convenience in life, and science/science products, and advances.
Keywords: Preservice science teachers, science, technology.

FEN BİLGİSİ ÖĞRETMEN ADAYLARININ BİLİM VE TEKNOLOJİYE YÖNELİK GÖRÜŞLERİNİN İNCELENMESİ

ÖZ
Bireylerin bilgiye ulaşabilme, bilgiyi takip ve analiz edebilme, bilim ve teknolojideki ilerlemeleri takip ederek günlük yaşamlarına transfer edebilmeleri, toplumların ihtiyaç duyduğu nitelikler arasında yer almaktadır. Bu nitelikler arasında bireylerin bilim ve teknoloji okuryazarlığı ile bilim ve teknolojinin amaçlarını kavrama ve bilim ve teknolojinin entegrasyonu gibi belirli özellikler yer almaktadır. Bu nedenle birçok ülke yenilikleri takip etmek ve onlara ayak uydurabilmek amacıyla öğretim programlarını güncelleyerek bilimdeki ilerlemelerin doğasına, teknolojiye, teknolojinin bilim-toplum-çevre ile olan etkileşimlerine yer vermektedirler. Nitel araştırma desenlerinden durum çalışmasının kullanıldığı bu araştırmanın amacı fen bilgisi öğretmen adaylarının (n=49) bilim ve teknolojiye yönelik görüşlerini açığa çıkarmaktır. Çalışmada veri toplama aracı olarak, araştırmacılar tarafından geliştirilen bilim ve teknolojinin tanımları, amaçları ile iki kavram arasındaki ilişkileri açığa çıkarmayı amaçlayan açık uçlu sorular kullanılmıştır. Veri analizinde betimsel ve içerik analizleri kullanılmış, araştırmacılar farklı zamanlarda bir araya gelerek kodlayıcılar arasında en yüksek oran elde edilene kadar analizlere devam edilmiştir. Yapılan analizler sonucunda öğretmen adaylarının bilim ve teknolojinin ilişkisine yönelik vermiş oldukları cevaplar incelendiğinde benzer cevaplar verdikleri, bilim ile teknoloji kavramlarının iç içe geçmiş, birlikte kullanılan iki kavram olarak anlaşıldığı tespit edilmiştir.

Anahtar Kelimeler: Fen bilgisi öğretmen adayları, bilim, teknoloji.

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INTRODUCTION

Data access, data follow up and analysis and the ability to keep up with advances in science and technology and to transfer these into persons' daily lives are some of the characteristics needed by societies. The unpredictably rapid and gradual development of information flow in our life makes these characteristics even more critical (Radder, 2009). This aspect is reflected in the education field, especially science education, in addition to science and technology (International Technology Education Association/ITEA, 2006). These curricula, developed accordingly, contain a series of reforms to keep up with the developments, changes, and transitions and to improve the quality of education, particularly science education. Reviewing the reforms made in the education field to improve science education's quality in Turkey shows that the changes made in the curriculum in 2014 had focused on information access, understanding, and interpretation. Furthermore, these reforms focused on the relation between science and technology and being a technologically literate and effective use of this ability. Furthermore, the accomplished reforms had focused on the fact that science was not only necessary for people but at the same time, it was involved in any moment of life. In addition, these reforms had focused on comprehending the concepts of science and technology knowledge through science and technology literacy, and focused on being aware of science-technology-environment interactions and distinguishing scientific and non-scientific information (The Board of Education & Discipline /BED, 2006).

Various definitions of the concept of science, known as a human activity conducted by scientists, have been made until today. For example, McComas (1996) has defined science as making valid and reliable generalizations and explanations so that they would be available to anyone's inquiry by using scientific research methods to answer questions on the natural world. Sönmez and Alacapınar (2017) have defined science as the process of correlation-making based on a part of reality and the complete knowledge acquired as an outcome of this process. Comprehending science also means an understanding of the contemporary age, keeping up with innovations and approaching the future. Science perceptions of individuals can be influenced by the school they attend, class setting and informal learning environments. Despite correctly structured science perceptions are important for societies, it comes forward as a fundamental element for the society's advancement and problem solution and for the establishment of sound science-society interaction and for raising future generations as both science and technology literates (Çelik & Onay, 2014; DiGironimo, 2011; McComas, 1996;).

Technology is one of the concepts used rather frequently today in addition to science (Brooks, 1994; Gardner, 1994; Güvenç, 2004; Roy, 1990;). Technology, going back as long as human history, has reached its present stage through numerous scientific advancements. Technology is defined as "a process that encompasses transformation and use of the data of fundamental and applied sciences into production and a process that encompasses resolution of their social impacts during creative processes" (MoNE, 2006). Reviewing the definition of technology, it is understood that it has particular characteristics as well. According to Aydın (2009), these characteristics designated by a technology education center are: technology is related with science, it contains a pattern, it has produced, it is multifaceted, it is about values, it is structured socially and it's structuring process is still continuing.

The relevant literature contains studies investigating opinions of individuals about science and technology, science's structure and its relations with society and technology. For example, DiGironimo (2011) has conducted a study on determine the understanding of secondary school students about what technology is and identify what they associate with is. The study group of 20 students in the study of the exploratory study of the answers given by the students are divided into 5 themes. The percentages of these themes and their response to these themes are: Technology as Artefacts (50%), Technology as a Creation Process (11.8%), Technology as a Human Practice (2.9%), History of Technology (8.8%), The Current Role of Technology in Society (26.5%). Erdoğan (2004) has investigated the opinions of science teachers (n= 116) about

the nature of science in his study. Erdoğan has found out that preservice teachers had many misconceptions about science's nature, had difficulty to establish interdisciplinary relations and had problems defining science and technology concepts particularly and that they were confused about the two concepts. Erdoğan has concluded that they defined science as a process and something that made the world as a better place to live and that they were not aware of the social aspects of science and viewed technology as an application of science as presented in books. Kahyaoğlu (2004) has scrutinized convictions of preservice science teachers (n=176) about science, technology, and society. A questionnaire and semi-structured interviews were used to determine the standpoints of preservice teachers during the data collection process. It was found out as a result of the analyses that preservice teachers confused the science and technology concepts with one another. It was concluded that they had defined science as an understanding of life and facts, developments and provable facts, and of the organization of knowledge. They had defined technology as the applications of science and reflection of nature's observations, and a life-facilitating element; and that technologic advances can be controlled by society yet they had different reasons to do scientific researches. In a similar fashion, Aydın and Taşar (2010) investigated cognitive structures and judgments of preservice science teachers (n= 41) about the nature of technology (n=41). They collected data by using survey and interview techniques and found out that preservice teachers' stances were at a poor level concerning the definition of technology and on technology and the interaction between technology and society. Furthermore, they concluded that preservice teachers were not able to distinguish science and technology and saw technology as a subfield or application of science and they defined technology as computers in general and as inventions or products generated by science. Aslan, Yalçın and Taşar (2009), on the other hand, investigated the arguments of science and technology teachers about the nature of science and came up with similar outcomes about the perspectives of teachers towards science. Namely, they indicated that teachers viewed science as a means to utilize knowledge in order to make the world a better place and as searching and discovering the unknown and that they saw science as undefinable and confused it with the complete knowledge. Doğan Bora, Arslan, and Çakıroğlu (2006) have studied the ideas of high school students about science and scientists. They have determined that the students defined science as activities performed for the purpose of discovering unknowns about the world and universe, conducting studies in physics, chemistry and biology subjects, and discovering or designing things. In a similar study, Narayan (2011) has scrutinized the science and scientist perceptions of eight-year-old children. They have emphasized that the students defined science as searching things that were substantially different from what they saw in movies, laboratory settings and chemical explosions and the things that they knew very little about and that were undiscovered.

Reviewing the related literature, various national and international studies were conducted to determine the opinions of preservice teachers about technology (Aydın & Taşar, 2010; Bilecik, Çağlayan & Güven, 2012; Fang, Teng & Chen, 2007; Işçioğlu & Kocakuşak, 2012; Van Rensburg, Ankiewicz & Myburgh, 1999). For example, Rensburg, Ankiewicz & Myburgh (1999) had studied the attitudes of South African individuals (n=1010) about technology and concluded that these individuals had positive attitudes towards technology and that they had the opinion that technology contributed to the improvement of society. Bilecik, Çağlayan & Güven (2012) studied the knowledge level of preservice science teachers (n=12) about technology and technological products with regard to the reformed curriculum. Open-ended questions developed by the researchers were used as the data collection tool in their quantitative research, conducted as a search. It was concluded as a result of descriptive analyses that the preservice teachers did not have any confusion about the definition of technology but, they perceived technological products only as electronic and mechanical products. Işçioğlu and Kocakuşak (2012) have examined the numerical literacy levels and technology perceptions of preservice primary school teachers (n= 100) in their study. They have reported that preservice teachers had the idea that technology was effective in many fields today and was a part of daily life and that their perceptions about the technology used in education were not great. Kara, Aydın, Bahar, and Yılmaz (2014) have

researched the standpoints of preservice science teachers (n= 313) about technology in their quantitative survey search. It was found out as a result of the analyses that preservice teachers thought that technology could change in time and therefore its definition could change over time. Furthermore, the preservice teachers had the following ideas: technology has advanced cumulatively. Technology was related with many factors including economy, culture, and language, it had risks that developed based on needs, it provided time and ease of use, educational technologies were different from normal technology, and science and technology have benefited from one another and were interrelated, and technology contributed to scientific development, technology had an effective role in societies, it has shaped societies socially, and development level of societies was directly related to their technological superiority. Korkmaz & Ünsal (2016) have examined perspectives of pre-school teachers (n=76) about the concept of "technology" by means of metaphors. The teachers were asked to complete the statement of ''Technology …….. is similar to/like; because …'' in order to find out the perceptions of the teachers about the concept of technology. 57 valid metaphors were determined as a result of the content analyses and it was concluded that 14.5% of the preschool teachers perceived the technology concept with its negative aspect, 23.7% saw it with its positive aspect, 10.5% perceived it as infinity, 11.8% regarded it as a live being, 31.6% saw it as a necessity, and 7.9% viewed it as life. Moreover, it was emphasized that metaphors could be used as an effective research tool to clarify the perceptions of teachers about the technology concept. In the other study of Fang, Teng and Chen (2007), the stances of Taiwanese people about technology were compared and the ITEA studies conducted between the years 2001 and 2004 were used for this purpose. It was put forward in the ITEA study that the majority of Americans thought of computers first when they were asked to consider technology and Taiwanese had a wider perspective based on their answers including computers, science, and the Internet. It was reported that the knowledge level of the majority of Taiwanese people in the technology field was high and that technological knowledge must be included in school curricula.

Purpose, significance, and reasons

This study is important because it consisted of concerns regarding that the technology aspect must be included in the curriculum of science and technology knowledge class (Turkish Ministry of National Education/ MoNE, 2005) in 2015 in Turkey. Subsequently, improvement of the level and importance of technology in science education, the scope of science literacy including the definition and targets of science, characteristic of science, technology, its definition and purposes, the relation between science and technology, and its integration must be included. Finally, science, technology, and science literacy aspects must be included in the updated 3^{rd} – 8^{th} graders' science class curriculum (MoNE, 2017, 2018). Some of the fundamental competencies required from people in the 21st Century are the scientific perception of the raised generations, the aim of science-use, knowing the place and definition of science and technology in our daily life, and its relation with science, structuring of science in their own mind and using science in real settings (Griffin, & Care, 2014).

The studies conducted on this subject in the relevant literature and based on science definitions of individuals were reviewed. It was seen that the conducted researches generally focused on finding/designing inventions and law and theory accumulation, and on the topics of discovering new and unknown things about the world and universe in the fields of physics, chemistry, and biology. In the studies conducted to determine the definitions of technology and opinions about the relation between science and technology, it was seen that individuals defined technology as a life- facilitating subfield of science and as a product of scientific phenomenon. In this study, it was aimed to determine the opinions of preservice teachers about science, technology and what type of interaction existed between the two and in addition, preservice teachers' views about their place in science education, and their relations with the society were aimed to be examined.

METHOD

Research Design

This research was conducted as a qualitative research paradigm. The qualitative research considers how detailed the searched topic was or how well it was in a wide aspect and it attempts to find out an answer to the question 'how was this' (Büyüköztürk, Çakmak, Akgün, Karadeniz, & Demirel, 2017; Barbour, 2013; Patton, 2005; Silverman, 2016). The case study, a qualitative research pattern, was used in this study. In a case study, a current situation in real life is put forward within its own boundaries holistically by using more than one data-source or proofs (Yin, 2003). A case study is an approach that puts forward the description of a situation, where detailed and in-depth information was collected. Or, it is a qualitative approach revealing the state themes about real life, the current, limited systems (situations) by means of multiple resources (observation, interview, visual-audial materials, documents, and reports) (Creswell, 2009). Questions covering science, technology, their relationship, and aims are asked to preservice science teachers during the research process and the opinions of preservice teachers about these phenomena are considered in detail.

The Participant Group

This study was conducted on junior preservice science teachers attending a state university located in Central Anatolia. 49 preservice teachers (36 women, 13men) participated in the study. Criterion sampling technique was used in the selection of the participants. The criterion for the prospective teachers to have experience in the learning experience, science and technology related courses and their applications is determined. The majority of the preservice teachers (f= 27) were general high school graduates and there were preservice teachers who graduated from Anatolian high schools (f=15), vocational schools (f=6) and Anatolian teaching high school (f=1). The preservice teachers stated the technological devices that they used in their daily life the most as a cellular phone (f=44), computer (n=44), a tablet computer (n=15), and they reported that they used television (n=12), electrical home appliances, elevators, trip computers, and bicycles. The participants told as they described themselves that they did scientific research when they had to (f=25), and the participants who conducted personal research reported that they accessed Internet-based resources generally during this process (f=16) [did no research (f=7)] for example YÖK Thesis Center, Google Scholar, TÜBİTAK ULAKBİM Data Bases, and platforms on the subject (social media groups) or that they examined educational software. In addition, 30 preservice teachers reported that they did not attend activities including scientific congresses, seminars, and fairs previously and 19 preservice teachers attended scientific activities including science fairs and student congresses previously. The preservice teachers who stated that they used science and technology in any place and the instant of their life indicated that they used science in education (f=12) and innovation/progress (f=18) and they used technology for communication (f=24) and transportation (f=19) purposes generally.

Data Collection Tool and Process

Open-ended questions developed by the researchers were used in this study. Though these questions were related with science and technology, it consisted of aspects including the definition, purposes and use areas of science, definition, purposes and use areas of technology and contribution of science and technology with each other. The relevant literature search was conducted during the process of question development and the researchers met sporadically and continued the question writing process. After the questions were prepared, opinions of two academicians specialized in the fields of science education were resorted to and integration between science education and technology was achieved. The questions were reviewed and then opinions of an academician specialized in Turkish education field were received in order to manage language validity. After these processes, the questions had gained their final format and the application process was initiated. These questions are represented below:

1. *When you hear or read a word, you relate this word with the words that remind it generally and form connection frequently. You think about the following concepts and write down the first three words that you come up with.*
2. *What is science? Explain by giving examples.*
3. *What is technology? Explain by giving examples.*
4. *Is technology possible without science? If your answer is yes or no, explain by giving examples.*
5. *Is science possible without technology? Whether your answer is yes or no, explain by giving examples.*
6. *Is there a relationship between science and technology? Whether your answer is yes or no, explain by giving examples.*
7. *Does science contribute to technology? Whether your answer is yes or no, explain by giving examples.*
8. *Does technology contribute to science? Whether your answer is yes or no, explain by giving examples.*
9. *What are the purposes of science? Explain by giving examples.*
10. *What are the purposes of technology? Explain by giving examples.*

Data collection process was accomplished with the supervision of the first author. The study purpose and the study's possible contributions to the literature were explained for the preservice teachers in the scope of the class, taught by the author. It was emphasized that participation in the research was on a voluntary basis. Following the explanations, the questions were handed out to the participants and the answering process was started.

Data Analysis

Descriptive analysis and content analysis, quantitative analysis methods, were used in the study. In the descriptive analysis, data collected by using the methods including interview, observation, written method, etc. are reduced and interpreted based on themes. The cause and result relations in the answers are scrutinized. The references are included to reflect the opinions of participants when the obtained results are presented (Silverman, 2016; Yıldırım & Şimşek, 2016). Content analysis is a technique conceptualizing the data, which are turned into a written form, and listing the generated concepts in a sound manner and determining them under a common theme (Creswell, 2003). Researchers code raw data, collected from the written data, and categories are formed by inductive analysis. Subsequently, data are classified under the specified categories and made meaningful for readers. One of the researchers repeated this categorization process at certain intervals. Thus, the problem and aim of the study were adhered to and unnecessary coding was eliminated and new coding was added in the necessary sections. The researchers acted together for naming the categories. In conclusion, data were presented to readers for each item by means of tables.

FINDINGS

Data collected in the research were gathered by using data collection tools and according to the subproblems.

Accordingly, content analysis results answer given to the item and relevant content analyses for the item "when you hear or read a word, you relate this word with the words that remind it generally and form connection frequently. You think about the following concepts and write down the first three words that you come up with," which can be assessed as the relation forming test of the participants in the first item, are shown in Table 1.

Table 1. Content analysis results for the item *When you hear or read a word, you relate this word with the words that remind it generally and form connection frequently. You think about the following concepts and write down the first three words that you come up with.*

Science	***f***	***Technology***	***f***
Research	17	Telephone	15
Curiosity	12	Simplicity in life	13
Experiment	8	Computer	12
Scientist	5	Advancement/Development	11
Imagination	5	Science	9
Discovery	5	Internet	5
Technology	5	Production/Product	5
Invention	4	Electronic device	3
Science	4	Development	3
Human	4	Tool	2
Knowledge	3	World	2
Study	3	Future	2
Physics	3	Imagination	2
Chemistry	3	Invention	2
Creativity	3	Communication	2
Biology	2	Transportation	2
Discovery	2	Space	2
Medicine	2	Innovation	2
Other	1	Other	1

Considering these words, preservice science teachers concluded that there was a relationship between science and technology. In addition, it was the word 'research' (f= 17) and following this word, the words 'curiosity (f= 12) and experiment (f= 8) were listed and the words 'telephone (f= 15), simplicity in life (f= 13) and computer (f =12) were ranked as related to technology. Moreover, we faced with the words 'full of theory, deep, difficult, advancement, infinite, repeat, observation, progress, article, culture, universe, learning, understanding, health, innovation, insomnia, no lies, laboratory, future, rising, philosophy, history, new information, being everywhere, book and Newton under the heading of Other (f= 1). Under the heading of 'Other' related with technology (f= 1), we faced with the words "socializing, application, science product, scientific research, advancement, progress, invention, imagination, dishwasher, washing machine, telescope, currency, astronomy, robot, superior skill, car, limitless, knowing the limits and need".

Table 2. Content analysis results for the item *What is science? Explain by giving examples.*

What is science?	f	Example	f
Doing research out of curiosity	11	Newton's studies	6
Studies to understand the world better	8	World-space studies	3
Method use	5	Disease treatment	3
Research-problem solving	4	Atom-Sub atom studies	1
Explanations based on observations and experiments	4	Darwin/Evolution studies	1
Simplicity in life	4	World's movements	1
Evidence-based proof	4	Covers the fields including physics, chemistry, biology, etc.	1
Finding the undiscovered	4	Galileo-Solar system studies	1
Discovery (by imagination)	4	Light refraction experiment	1
Understanding/Interpretation	3	Pharmaceutical production	1
Doing research "based on need"	3	Molding	1
Producing information	2	Buoyancy of water	1
Changing and developing a process	2	Gravity	1

Detailed search	2
Conducting world-renowned studies	2
Understanding the universe	2
Being enigmatic and extensive	1
Making observations	1
Cumulative advancement	1
Technology-based advancement	1
Inquiry	1
Coherency	1
No age	1

Definitions of science concept and examples given by preservice science teachers are shown in Table 2. According to the Table, it is seen that preservice teachers defined the science concept generally as doing research out of curiosity (f=11). Studies conducted to understand the world better (f=8) and method use (f=5), and the examples given by them included Newton's studies (f=6), world-space studies (f=3) and disease treatment (f=3). Furthermore, definitions including producing information, cumulative advancement, and technology-based advancement in science were provided and some examples in the fields of physics, chemistry, and biology including space studies, molding, and buoyancy of water were given.

Table 3. Content analysis results for the item *What is technology? Explain by giving examples*.

What is technology?	f	Example	f
Act making life easier as a result of science	35	Telephone	10
Science products	6	Transportation (Airplane)	4
Tools for information access and communication	2	Internet (3, 4,5 G)	3
Factor making science easier	2	Light bulb	2
Adaptation of information in daily life	1	Computer	2
Modernization studies and scientific studies	1	Space studies	2
Process revealed and changed by scientific studies	1	Informatics	1
Hierarchy occurring based on needs	1	Silver wear	1
Facilitating and addicting developments	1	Electric	1
Mechanized scientific studies	1	Clothing	1
Reaching the highest (best) boundaries	1	Disease treatment	1
		Calculator	1
		Lever	1
		Fungi, bacteria, lens studies	1
		Kitchen utensils	1
		Hydrostatic pressure-water mains	1
		Television	1

Definitions of technology concept and examples are given by preservice science teachers are shown in Table 2. According to the Table, the majority of the preservice teachers defined the technology concept generally as act making life easier owing to science (f=35). In addition, it is seen that they came up with definitions including science products (f= 6), information access and communication tools (f= 2), and a factor in making science easier (f= 2). Furthermore, the

students gave different examples when they defined technology including telephone (f=10), transportation (airplane) (f=4), and Internet (f=3).

Table 4. Content analysis results for the item *Is technology possible without science? If your answer is yes or no, explain by giving examples.*

	f		*f*
Yes	9	No	40
Why		Why	
The technology existed prior to science.	8	Technology advances with science.	21
Technology is a search for simplifying life.	2	Technology benefits from science.	13
Technology developed based on needs.	1	Technology and science are intertwined.	11
The boundary of technology is science.	1	No explanation.	1

Answers of the preservice science teachers to the item 'whether technology is possible without science' are shown in Table 4. According to the Table, the majority of the preservice teachers (f= 40) stated that technology was not possible without science. In addition, technology advanced with science (f= 21), technology benefited from science (f= 13), technology and science were intertwined (f= 11). The preservice students stated that technology existed prior to science (f= 8) and technology is a search for simplifying life (f= 2).

Table 5. Content analysis results for the item *Is science possible without technology? Whether your answer is yes or no, explain by giving examples.*

	f		*f*
Yes	23	No	26
Why		*Why*	
Science is possible without technology.	13	Technology and science are interconnected.	11
The technology existed prior to science.	7	Advancing technology aids in the progress of science.	10
Technology is a product of science.	1	Technology advances with science.	7
Technology produces products to make life easier.	1	Technology simplifies life.	1
No explanation.	1		

Answers of the preservice science teachers to the item 'whether science is possible without technology' are shown in Table 5. According to the Table, it is seen that the preservice teachers had two different opinions about this item. It was concluded that a group of preservice teachers had the opinion that science can progress without technology (f= 13) and a group of preservice teachers had the opinion that technology and science were interconnected (f= 26).

Table 6. Content analysis results for the item *Is there a relationship between science and technology? Whether your answer is yes or no, explain by giving examples.*

	f		*f*
Yes	48	No	1
Why		*Why*	
Science advances technology, technology advances science.	28	Technology is a science product.	1
Technology develops with the advance of technology.	14		
Technology produced science.	4		

Their common characteristics harm human life.	1		
No explanation.	1		
Example		*Example*	
Physics: Transportation/metro network Communication/cellular phones	3		
Health: Decreasing deaths/epidemics	2		
Scientific information: Steam engine	1		
Mathematics: Calculator	1		

Answers of the preservice science teachers about the relation between science and technology are shown in Table 6. According to the Table, it was concluded that almost the entire preservice teachers (f= 48) had the opinion that there was a relationship between science and technology. Science had advanced technology and technology advanced science (f= 28), a technology developed with the advance of science (f= 14). Only one preservice teacher stated that technology is a science product and gave the answer 'no'.

Table 7. Content analysis results for the item *Does science contribute to technology? Whether your answer is yes or no, explain by giving examples.*

	f		*f*
Yes	49	No	
Why		*Why*	
Technology advances as science advances.	33		
Technologic devices increase as science progresses.	5		
Science and technology advances together.	4		
Technology makes life easier.	1		
No explanation.	1		
Example		*Example*	
Physics:			
Transportation/metro network	2		
Communication/cellular phones	3		
Elevator	1		
Sensors	3		
Computer	1		
Print shop	1		
The transition from theory to application	3		
Buoyancy force/Maritime transportation	2		
Fuel system/Motor vehicles	1		
Lenses/Microscope	1		
Gravity/Space crafts	1		
Adaptation from nature/Airplane	1		
Biology			
DNA structure	1		
Disease treatment	1		
Mathematics			
Calculator	1		
Space travels	1		

Answers of the preservice science teachers to the item 'whether science contributes to technology' are shown in Table 7. According to the Table, it is seen that the entire preservice teachers (f= 49) had the opinion that science contributed to technology. In addition, they had the opinion that

technology advanced as science advanced (f= 33), and technological devices increased as science advanced (f= 5). It is seen that they gave examples for these advances and increases in the fields of physics, mathematics, and biology.

Table 8. Content analysis results for the item *Does technology contribute to science? Whether your answer is yes or no, explain by giving examples.*

	f		*f*
Yes	48	No	1
Why		*Why*	
Aids in advancing discovered science based on need.	14	Science is the basis of technology.	1
Science advances as technology advances.	7		
Technology contributes to science and science contributes to technology.	4		
Novel materials for science are found by using technological materials.	4		
Scientific data are proven by means of technology.	4		
Theories enable easy learning by means of technological devices.	2		
Time is saved by technology.	2		
It verifies laws and hypotheses introduced by science.	1		
Technology is used to review the previous scientific studies.			
Example		*Example*	
Physics:			
Transportation/metro network	2	Swimming and transportation are not possible without knowing about buoyancy force.	1
Communication/cellular phones	3		
Elevator	1		
Sensors	3		
Computer	1		
Print shop	1		
The transition from theory to application	3		
Buoyancy force/Maritime transportation	2		
Fuel system/Motor vehicles	1		
Lenses/Microscope	1		
Gravity/Space crafts	1		
Adaptation from nature/Airplane	1		
Biology			
DNA structure	1		
Disease treatment	1		
Mathematics			
Calculator	1		
Space travels	1		

Answers of the preservice science teachers to the item 'whether technology contributes to science' are shown in Table 8. According to the Table, it was concluded that the majority of the preservice teachers (f= 48) had the opinion that technology contributed to science. They had the opinion that it aided in advancing discovered science based on need (f= 14), science advanced as technology advanced (f= 7), technology contributed to science and science contributed to technology (f= 4) and only one preservice teacher had the opinion that science is the basis of technology.

Table 9. Content analysis results for the item *What are the purposes of science? Explain by giving examples.*

Purpose	*f*	Example	*f*
Studying the structure of the universe	20	Sun, space, time system	3
Simplifying life	10	The world's sustainability	2
Making explanations	9	Gravity	2
Finding out what is undiscovered	7	Health/Disease treatment	2
Setting the validity of what is discovered.	6	Studies on the world's creation	1
Curiosity	5	Electric/Lightbulb and its development	1
Problem-solving	5	Raising scientifically literate individuals	1
Establishing/explaining cause-result relations based on the discovered things	3	Genetics/Mendel's studies	1
Providing information (education)	2	Telephone	1
Making observations	2	Transportation	1
Imagination and creativity	2		
Progress (Change, innovation)	2		
Making predictions	2		
Raising individuals who are able to think deeply	1		
Creating needs	1		
Taking technology to a high level	1		

Answers of the preservice science teachers concerning the purposes of science are shown in Table 9. According to the Table, the preservice teachers listed studying the structure of the universe (f= 20), simplifying life (f= 10) and making explanations (f= 9) among the purposes of science. They gave examples for the purposes of science from different fields including solar, space and time system (f =3), the world's sustainability (f= 2) and gravity.

Table 10. Content analysis results for the item *What are the purposes of technology? Explain by giving examples.*

Purpose	*f*	Example	*f*
Making life easier	43	Telephone	6
Aiding scientific progress	4	Computer	4
Correspondence/Communication	4	Car	2
Transportation	3	Internet/Easy access	2
Universality	2	Time-saving	2
Fulfilling needs	2	Lightbulb	1
Advancement	2	Lighter	1
Time-saving	2	Kitchen utensils	1
Popularizing science	1	Television	1
Introducing and popularizing science	1	Telescope/space studies	1

Proving scientific evidences	1	Technological devices	1
Putting what is discovered into practice	1		
Problem-solving	1		
Contributing to the country economy	1		
Producing new scientific data	1		

Answers of the preservice science teachers concerning the purposes of technology are shown in Table 10. In this Table, the preservice teachers had listed simplifying life (f= 43), aiding in the advancement of science (f= 4) and communication/correspondence (f= 4) for the purposes of technology. They gave examples for the purposes of technology and gave examples for these purposes including telephone (f= 6), computer (f= 4), and car (f= 2).

DISCUSSION, CONCLUSION, AND RECOMMENDATIONS

In this research, the definitions of science and technology and their relationship with each other provided by preservice science teachers were revealed and their opinions about the purposes of science and technology were put forward. As a result of the performed analyses, it was concluded that the preservice teachers had related the science concept with research, curiosity, and imagination in general and they had related the technology concept with simplifying life, science/science products, and advanced concepts. Considering the opinions of the preservice teachers about the definitions of science and technology, they had defined science as research conducted out of curiosity to better understand the world by using methods, and they defined technology as a subfield of science, simplifying life and aiming to access information. It was seen that they gave telephone, computers, transportation vehicles and electronic devices used in daily life generally as examples of technology. Considering the studies conducted on the definitions of science and technology provided by individuals, their opinions and relation-forming, it was seen that similar conclusions had been drawn and the results were in line with the results of this study (Aslan, Yalçın, &, 2009; Aydın & Taşar, 2007; Bilecik, Çağlayan & Güven, 2012; Doğan Bora, Arslan and Çakıroğlu, 2006; DiGironimo, 2011; Fang, Teng & Chen, 2007; Gil-Pérez, Vilches, Fernández, Cachapuz, Praia, Valdés, & Salinas, 2005; İşçioğlu & Kocakuşak, 2012; Karaa, Aydın, Bahar, & Yılmaz, 2014; Kahyaoğlu, 2004; Korkmaz & Ünsal, 2016; Radder, 2009; Roberts, Reid, Schroeder, & Norris, 2013). For example, Karaa et al (2014) have reported that technology had emerged based on needs, and it has risks and it provides time and simplicity in use and it is an invention. In addition, science and technology benefits from each other, they are interrelated, and technology contributes to scientific development and it both influences society and is affected by society at the same time. In a similar fashion, Fang, Teng, and Chen (2007) have obtained answers such as computers, science, and the Internet for the visions of Taiwanese people about technology. Differing from this result, Aydın and Taşar (2010) have studied the opinions of preservice science teachers about the cognitive structures of technology. They have concluded that definitions of the technology of preservice teachers and their opinions about the interaction between technology and society were at a poor level and that they were unable to make a distinction between science and technology. In addition, they saw technology as a subfield or application of science and they defined technology like computers, inventions or products provided by science in general. It was seen that these results were in line with the relevant studies in terms of scientific definitions. For example, Aslan, Yalçın and Taşar (2009) have obtained similar results in terms of the perspectives of teachers toward science. They have reported that teachers stated the definitions of science as to find and use the information to make the world a better place to live, to search and discover the unknown and that science was undefinable, complete information. Doğan Bora, Arslan, and Çakıroğlu (2006) have reported that high school students defined science as acts conducted to discover the unknowns about the world and universe, and it was to study physics, chemistry and biology subjects and to invent or design things. Narayan (2011) saw that the students defined science as searching for the things that were substantially different from what they saw in movies, laboratory settings, chemicals and explosions and for the things that were unknown and undiscovered.

Preservice teachers were asked whether the technology was possible without science and whether science was possible without technology. The common result received from the two items was that science and technology were interrelated and that technology, in fact, existed prior to science at early ages, for example, wheel. In addition, science had caused the advancement of technology and technology had advanced science. Similarly, preservice teachers had emphasized that science and technology had contributed to the advancement of one another. Moreover, technology would advance as science advanced and in a similar fashion, novel materials that could be used in scientific research could be manufactured with the advancing technology. Higher levels could be reached in transportation, communication, informatics, and health fields, where the application areas of these materials could expand upon the explanations of theories. Considering the answers of the preservice teachers about the purposes of science and technology, they provided answers similar to the definitions. They defined science as understanding the structure of the universe and coming up with explanations to simplify life and establish relations between the cause and outcome, and they listed simplifying life, time-saving and presenting scientific evidence among the purposes of technology. Similar results were obtained upon comparison of the answers of the preservice science teachers and these items and the relevant literature (Aslan, Yalçın, &, 2009; Aydın & Taşar, 2007; Doğan Bora, Arslan and Çakıroğlu, 2006; DiGironimo, 2011; Fang, Teng & Chen, 2007; Gil-Pérez, Vilches, Fernández, Cachapuz, Praia, Valdés, & Salinas, 2005; İşçioğlu & Kocakuşak, 2012; Karaa, Aydın, Bahar, & Yılmaz, 2014; Kahyaoğlu, 2004; Radder, 2009; Roberts, Reid, Schroeder, & Norris, 2013).

In general, based on the answers of preservice science teachers about science, technology and their relation with each other, it was seen that they provided similar answers and that science and technology were two intertwined concepts that were used together. Reviewing the history of science, the reasons behind this circumstance can be stated such that technological advances have occurred in line with cumulative progress in science. Moreover, higher levels have been reached in their application fields because of the new theories obtained today (for example, preservice teachers gave similar answers to these questions and about space, medicine and engineering studies). It was considered that preservice teachers gave similar answers to the questions according to their education in science and technology and the classes they had attended on the characteristics and history of science during their educational life. Furthermore, they gave similar answers because of scientific and technological advances news provided in the media or press. In addition, they had no consensus about the definitions of science and technology because these maintained constant interaction by means of a few technological devices in their daily life, including, cellular phones, computers, electronic home appliances, devices used for transportation, etc. and that they had limited interaction with technology.

Based on the results acquired in the conducted study, the following suggestions are made:

- The relation between the attitudes of preservice teachers toward science and technology and their skills and competencies can be scrutinized by applied studies.
- Research or project papers can be assigned and preservice teachers can develop opinions about science and technology by attending them personally and activities can be organized during their undergraduate studies.
- ‘Direct/reflective science’ perspectives of preservice teachers can be benefited in the classes of the characteristics and history of science and the characteristics and integration of technology by keeping a distance from a classical/positivist perspective. In this context, it is contemplated that contributions can be made pedagogically during the preservice teachers’ education in class settings, where they started their teaching profession.

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Uzun Öz

Bireylerin bilgiye ulaşabilme, bilgiyi takip ve analiz edebilme, bilim ve teknolojideki ilerlemeleri takip ederek günlük yaşamlarına transfer edebilmeleri toplumların ihtiyaç duyduğu nitelikler arasında yer almaktadır (International Technology Education Association/ITEA, 2006). Yaşamımızdaki bilgi akışının ve teknolojinin her geçen gün öngörülemez bir şekilde hızla artması, bu nitelikleri daha da önemli hale getirmektedir. Bu durumun bilim ve teknolojiye olduğu kadar eğitim alanına, özellikle de fen eğitimine yansımaları olmaktadır. Bu doğrultuda gerçekleşen gelişim, değişim ve dönüşümlere ayak uydurabilmek ve eğitimin, özellikle de fen eğitiminin kalitesini arttırmak için öğretim programlarında bir takım yeniliklere yer verilmektedir. Doğru yapılandırılmış bir bilim algısı toplumlar için önemli olmakla birlikte toplumun ilerlemesi, problem çözme, sağlıklı bir bilim-toplum etkileşimi kurma ve gelecek nesillerin hem bilim hem de teknoloji okuryazarı olarak yetiştirilmesinde önemli bir bileşen olarak karşımıza çıkmaktadır (McComas, 1996; Çelik & Onay, 2014). İnsanlık tarihi kadar eskilere dayanan teknoloji, birçok bilimsel ilerlemeler ile bugünkü noktaya erişmiştir. Bireylerin bilim ve teknolojiye yönelik görüşleri, bilimin yapısını, toplum ve teknoloji ile olan ilişkilerini inceleyen çalışmalar, ilgili alanyazında yer almaktadır. Bu çalışma özellikle Türkiye'de 2005 yılında fen ve teknoloji bilgisi dersi öğretim programına (MEB, 2005) teknoloji boyutunun eklenmesi ile teknolojinin yer ve öneminin fen eğitiminde artması, ardından fen bilgisi öğretmen yetiştirme programlarında yer alan bilim, tanımı ve amaçları, bilimin doğası, teknoloji, tanımı ve amaçları, bilim ve teknoloji arasındaki ilişki, entegrasyonu gibi fen okuryazarlığının kapsamı, son olarak 3-8. sınıf güncellenen fen bilimleri dersi öğretim programında (MEB, 2017) fen, teknoloji ve bilim okuryazarlığı boyutlarının yer alması açısından önem taşımaktadır. Yetişen nesillerin bilim algısı, bilimin kullanılış amacı, öğretim ortamlarında, günlük yaşantımızdaki yerinin bilinmesi, bununla birlikte teknoloji ve tanımı, bilim ile olan ilişkisini bilmesi, kendi zihninde yapılandırması ve gerçek ortamlarda kullanması 21. yüzyıl bireylerinde bulunması gereken önemli yeterliliklerden bazılardır. Yapılan çalışma ile öğretmen adaylarının bilim, teknoloji, ikisi

arasında etkileşime yönelik görüşleri alınmakla birlikte her ikisinin fen eğitimindeki yerine dair görüşleri, aynı zamanda toplum ile olan ilişkilerine yönelik görüşlerini belirlemek amaçlanmaktadır. Yapılan çalışma nitel araştırma paradigması altında gerçekleştirilmiştir. Nitel araştırmalar araştırılan konunun ne kadar derin ya da ne kadar iyi olduğunu geniş bir açı ile ele alarak nasıl sorusuna cevap aramaya çalışırlar (Patton, 2005; Barbour, 2013; Silverman, 2016; Büyüköztürk ve diğerleri, 2017). Bu çalışmada nitel araştırma desenleri içerisinde yer alan durum çalışması kullanılmıştır. Durum çalışması ile gerçek yaşamdan güncel bir olgu kendi sınırları içerisinde bütüncül olarak, birden fazla veri kaynağı veya kanıt kullanılarak mevcut olan durum ortaya konulur (Yin, 2003). Araştırma sürecinde fen bilgisi öğretmen adaylarına bilim, teknoloji, birbirileri ile olan ilişkileri ve amaçlarını içeren sorular yöneltilerek öğretmen adaylarının bu olgulara yönelik görüşleri detaylı bir şekilde ele alınmaktadır. Yapılan araştırma Orta Anadolu'da bulunan devlet üniversitesinde öğrenim görmekte olan 3. sınıf fen bilgisi öğretmen adayları ile gerçekleştirilmiştir. Çalışmaya 49 öğretmen adayı (36k, 13e) katılmıştır. Öğretmen adaylarının büyük çoğunluğu düz lise (f=27) mezunu iken, Anadolu lisesi (f=15), meslek lisesi (f=6) ve Anadolu öğretmen lisesinden (f=1) mezun olan öğretmen adaylarının olduğu da görülmektedir. Öğretmen adayları günlük yaşantılarında en fazla kullandıkları teknolojik araçları cep telefonu (f=44), bilgisayar (n=44), tablet bilgisayar (n=15), televizyon (n=12) olarak tanımlarken, elektrikli ev gereçleri, asansör, yol bilgisayarı, bisiklet gibi araçları kullandıklarını belirtmişlerdir. Katılımcı grup kendilerini tanımlarken mecbur oldukça bilimsel araştırma yaptıklarını (f=25), bireysel olarak araştırma yapanlar ise bu süreçte (f=16) [araştırma yapmayanlar (f=7)] çoğunlukla internet temelli kaynaklara ulaştıklarını örneğin YÖK Tez Merkezi, Google schoolar, TÜBİTAK ULAKBİM Veri Tabanları, konu ile ilgili platform (sosyal medya grupları) ya da eğitsel yazılımları incelediklerini belirtmişlerdir. Bununla birlikte 30 öğretmen adayı daha önce bilimsel kongre, seminer, fuar gibi etkinliklere katılmadığını, 19 öğretmen adayının ise daha önce bilim şenliği, öğrenci kongreleri gibi bilimsel etkinliklere katıldıklarını vurgulamıştır. Bilim ve teknolojiyi yaşamlarının her yerinde, her anında kullandıklarını ifade eden öğretmen adayları bilimi genellikle eğitimde (f=12), yenilik/ilerlemede (f=18) kullanıldığını, teknolojinin ise iletişim (f=24), ulaşım (f=19) amaçlı kullandıklarını belirtmişlerdir. Yapılan çalışmada araştırmacılar tarafından geliştirilen açık uçlu sorular kullanılmıştır. Bu sorular Bilim ve Teknoloji ile ilgili olmakla birlikte bilimin tanımı, amaçları, kullanım alanları, teknolojinin tanımı, amaçları, kullanım alanları, bilim ve teknolojinin birbirilerine katkıları gibi içeriklerden oluşmaktadır. Sorular hazırlandıktan sonra fen eğitimi, fen eğitimi ve teknoloji entegrasyonu alanında uzman iki akademisyenin görüşleri alınarak sorular gözden geçirilmiş, ardından dil geçerliğini sağlamak amacıyla Türkçe eğitimi alanında uzman bir akademisyenin görüşlerine başvurulmuştur. Veri toplama süreci birinci yazar eşliğinde gerçekleştirilmiştir. Yazarın yürütmüş olduğu ders kapsamında öğretmen adaylarına çalışmanın amacı, alanyazına olası katkılarından bahsedilmiştir. Araştırmaya katılımın gönüllülük esası ile olduğunu vurgulanmıştır. Açıklamaların ardından sorular katılımcılara dağıtılmış, cevaplama süreci gerçekleştirilmiştir. Çalışmada verilerin analizinde nitel analiz yöntemlerinden betimsel analiz ve içerik analizi kullanılmıştır. Yazılı verilerden elde edilen ham veriler araştırmacılar tarafından kodlanarak ve tümevarımcı analiz ile kategoriler oluşturularak analiz edilmiştir. Ardından veriler, belirlenen kategoriler altında sınıflandırılarak okuyucu için anlamlı bir hale getirilmiştir. Kodlama ve kategorileştirme işlemi araştırmacılardan biri tarafından belirli aralıklar ile tekrarlanmıştır. Yapılan araştırmada fen bilgisi öğretmen adaylarının bilim ve teknolojiye yönelik tanımları, birbirileri ilişkileri, bilimin ve teknolojinin amaçlarına yönelik görüşlerini açığa çıkarılmıştır. Yapılan analizler sonucunda öğretmen adaylarının bilim kavramını genellikle araştırma, merak duyma ve hayal gücü ile ilişkilendirdikleri, teknoloji kavramını ise hayatta kolaylık sağlama, bilim/bilimin ürünleri, ilerleme kavramları ile ilişkilendirdikleri elde edilmiştir. Öğretmen adaylarının bilim ve teknolojinin tanımlarına yönelik görüşleri incelendiğinde ise bilimi dünyayı daha iyi anlamak için, yöntemler kullanılarak, merak ile yapılan araştırmalar, teknolojiyi ise hayatı kolaylaştıran, bilimin alt dalı ve bilgiye ulaşma amaçlı olarak tanımladıkları görülmektedir. Teknolojiye örnek olarak ise genellikle telefon, bilgisayar, ulaşım araçları, günlük yaşamda kullanılan elektronik aletleri örnek verdikleri görülmüştür. Öğretmen adaylarına bilim olmadan

teknoloji ve teknoloji olmadan bilim olup olamayacağı soruları sorulmuş ve her iki soru için karşımıza çıkan ortak bulgunun bilim ve teknolojinin karşılıklı olarak birbirine bağlı olduğu, erken dönemlerde teknolojinin aslında bilimden önce de var olduğu, örneğin tekerlek gibi, bilimin teknolojiyi teknolojinin de bilimi geliştirdiği sonuçları elde edilmiştir. Benzer şekilde öğretmen adayları bilim ve teknolojinin birbirilerinin gelişimlerine katkı sağladığı, bilimin ilerledikçe teknolojinin ilerleyeceği, aynı şekilde ilerleyen teknoloji ile birlikte bilimsel araştırmalarda kullanılabilecek yeni materyaller üretilebileceği, teorilerin açıklamaları ile uygulama alanlarının genişleyebileceği ulaşım, iletişim, bilişim, sağlık gibi alanlara daha üst seviyelere gidilebileceğini vurgulamışlardır. Bilim ve teknolojinin amaçlarına yönelik öğretmen adaylarının vermiş oldukları cevapları incelendiğinde ise bilimin amaçlarının evrenin yapısını anlamak ve açıklamalar üretmek, hayatı kolaylaştırmak, keşfedilenler arasında neden-sonuç ilişkileri kurmak; teknolojinin amaçları arasında ise yaşamı kolaylaştırma, zaman tasarrufu sağlama, bilimsel kanıtlamaları sunmak gibi cevaplar verdikleri elde edilmiştir. Genel olarak fen bilgisi öğretmen adaylarının bilim, teknoloji, birbirileri olan ilişkilerine yönelik vermiş oldukları cevaplar incelendiğinde benzer cevaplar verildiği, bilim ile teknolojinin iç içe geçmiş, birlikte kullanılan iki kavram olduğu görülmektedir. Bu durumun nedenleri arasında bilim tarihine bakıldığında bilimdeki kümülatif ilerlemelerle birlikte teknolojideki ilerlemeler meydana gelmiş, günümüzde de elde edilen yeni kuramlarla birlikte uygulama alanlarında daha üst seviyelere ulaşılmakta olduğu söylenebilir. Örneğin öğretmen adayları da buna benzer cevaplar vermekte (uzay, tıp, mühendislik alanlarındaki çalışmalar), öğrenim hayatlarında almış oldukları fen ve teknoloji, fen öğretimi, bilimin doğası ve tarihi ile ilgili dersler, medyada ya da yazılı basında çıkan haberlerde bilim ve teknolojideki ilerlemelere yer verilmesi, bilim ve teknolojinin tanımlarına yönelik net bir görüş birliğinin olmaması ve sürekli etkileşim içinde olması, günlük yaşamlarında sınırlı türdeki teknolojik aletler ile etkileşim içinde olmaları (örneğin cep telefonları, bilgisayarlar, elektronik ev eşyaları, ulaşımda kullanılan araçlar gibi öğretmen adaylarının sorulara benzer cevaplar vermelerine neden olmuş olabileceği düşünülmektedir. Yapılan çalışmadan elde edilen bulgular doğrultusunda şu öneriler getirilmektedir: i. Öğretmen adaylarının bilim ve teknolojiye ilişkin tutumları, becerileri, yeterlilikleri arasındaki ilişki uygulamalı araştırmalarla incelenebilir; ii. Öğretmen adaylarının lisans öğrenimi süreçleri boyunca bilim ve teknolojiye yönelik görüşlerini geliştirecek bireysel olarak katılabilecekleri araştırma veya proje ödevleri verilebilir, etkinlikler gerçekleştirilebilir; iii. Öğretmen adaylarının bilim ve bilimin doğası ve tarihi, teknolojinin doğası ve entegrasyonu ile ilgili derslerde klasik/pozitivist bakış açısından uzak durarak "Doğrudan/Yansıtıcı Bilim" bakış açısından faydalanılabilinir. Bu bağlamda öğretmen adaylarının öğretmenlik mesleğine başladıklarında sınıf ortamlarında gerçekleştirdikleri öğretimlerde de pedagojik olarak katkı sağlayabileceği düşünülmektedir.