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Examination of Gifted Students' Views on Science, Technology, and Society**

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Abstract

This research aimed to examine the views of gifted students at Science and Art Centers in the Eastern Black Sea Region on the sub-dimensions of the Science-Technology-Society (STS) approach. The research was carried out with 251 gifted students (5, 6, 7, 8th) enrolled in Samsun, Ordu, Giresun, Trabzon, and Rize Science and Art Centers (S&ACs) in the Eastern Black Sea Region of Turkey in the first semester of 2018-2019 academic year. A survey method was used within the scope of the quantitative research approach, and data were collected by Views on Science-Technology-Society (VOSTS) survey. Descriptive statistics were used to determine the percentage of the answers given as a result of the VOSTS survey. The results revealed that in the views of the gifted students about STS, only three of the responses to the VOSTS (TR) questionnaire showed the expected level of answers, and in the other items, the views they had completely coincided with the non-gifted students. It is recommended that the STS views of the gifted students should be continuously monitored and STS views should be included in the student identification for science and art centers.

Introduction

Recently, organizations such as the American Association for the Advancement of Science [AAAS] stated that one of the most important goals of science education is to teach all students to be scientifically literate. The purpose of science education is to develop a scientifically literate individual who understands the relationship between science, technology, and society and can use that knowledge in daily life (Ayvaci & Ozbek, 2015; Kucuk & Yildirim, 2020). Scientifically literate individuals think creatively and critically, solve the problems they

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encounter with the information they have learned, decide against a problem, express their opinions in a scientific discussion, and interpret a scientific study by reading it. However, increasing the number of scientifically literate individuals who can understand the relationship between science-technology-society and have the modern values necessary for the society they live in is very important for societies to be the leaders of the world both socially and economically (Cepni et al., 2004).

Hughes (1997) explained the five most basic characteristics that a scientifically literate individual should possess as follows: (i) comprehending the nature of scientific knowledge and the scientific method, (ii) having skill areas that can be identified with scientific research method, (iii) basic science to be familiar with the concepts and theories, (iv) to understand the relationships between science and technology and societies, and (vi) to have the ability to apply the previous four basic behaviors in personal, urban and business life.

One of the sub-dimensions of science literacy as the Science-Technology-Society relationship has gained importance in science education in raising science-literate individuals who research, discuss, use scientific process skills, and exhibit positive attitudes towards science. Since the 1980s, the ineffectiveness of traditional courses has been discussed in the world, and it has been determined that the most appropriate reform will be the Science-Technology-Society (STS) movement aiming to make the content interesting and entertaining to increase the efficiency of science lessons, as well as to be relevant to the daily lives of students (Cepni, Gokdere & Kucuk, 2002). The most effective movement in helping individuals and students comprehend science literacy, STS has attracted worldwide attention. The most important goal that STS bring for students is high-level thinking, high mental skills, creativity, moral values and the explanation of these values, universal view, decision-making, and problem-solving capacity. At the same time, all individuals should understand the relationships between science-technology-society and have the ability to evaluate technological and scientific activities in a socio-theological context (Cepni, Ayvaci & Bacanak, 2004).

A full understanding of the STS connection in society enables the decisions about science and technology to be critically evaluated and analyzed impartially (Kahyaoglu, 2004). This, in turn, has activated the activities produced to identify local, regional, national and international problems, create individual or group studies and solve the problems, and they have more decision-making responsibility in daily life (Akcay et al., 2010).

The STS reveals the impact of science on technology, the impact of science on society, the impact of technology on science, the impact of technology on society, and the impact of society on science and technology. They explain why everyone should be science literate, including the gifted. It is known that 2% and 3% of society consist of special talents and they are called gifted individuals (Gokdere & Kucuk, 2003). Although giftedness is defined as the combination of above-average ability, creative thinking, and task responsibility, gifted students are individuals who can develop these characteristics (Cepni et al., 2002). They are different from normal students in the cognitive and affective areas (Asut & Koksal, 2015). They are fast learners, remember correctly, have in-depth knowledge, make rapid progress in literacy, understand and use numbers at an advanced level, are open to new ideas, intensely curious about research. In addition, they have a high level of motivation, interest, and developed imagination (Kadioglu-Ates & Mazi, 2017).

Science education is one of the important parts of gifted education. The studies in science cause gifted students to wonder, question, and research. In particular, computer, laboratory, and project-supported science education attracts gifted students' desire and perseverance towards science lessons (Kemaneci, 2012). The use of various techniques and methods in the teaching process in Science and Art Centers (S&ACs) will make the science course more enjoyable, make the course easier to understand, and will reveal positive outcomes in the attitudes of gifted students towards science. From this point of view, the views of gifted students about STS are

expected to be largely positive. Now, the question is of what do we expect from gifted students within the framework of STS views. The gifted students in the field of science have the high verbal ability, good memory, superior numerical ability, great interest in the question of how it works, curiosity, freedom, mastery in thought, breadth of interest, and talent in similar thoughts (Hoover, 1989). Now, since teachers think that gifted students will always be successful may harm them. The ability of gifted students to create new products by using their potential due to their interest in science reveals the ability of science teachers to prepare learning models and activities for them (Cepni et al., 2004; Gokdere & Cepni, 2005). However, it is seen that S&ACs teachers who are far from the field of education of gifted students and who do not have experience in this field take some courses and are appointed to these centers (Sak et al., 2015). It would not be wrong to say that there is no suitable structure in the teacher selection process for S&ACs and objective criteria are rarely applied.

S&ACs have made it their mission to provide enriched education during out-of-school hours without segregation. That gifted students studying at S&ACs will play an important role in scientific and technological developments in Turkey and extreme caution should be exercised at the point of science education. Project-based teaching has been put into practice in S&ACs taking into account both the gifted students and the characteristics of science. Therefore, the activities developed and proposed should be compatible with science in terms of applicability (Cepni et al., 2002; Keser & Kalender, 2016). The most important stage of S&ACs education is project work, and this stage aims to develop students' independent working skills and creative productivity. In addition, gifted students generally work on social and scientific projects and produce solutions to real-life problems (Sak et al., 2015). In this context, it is expected that gifted students will put forward important projects that will contribute to the development of countries in terms of the STS.

Gifted students are individuals who are thought to have the greatest potential to do science and become a scientist, especially because they have special interests and feelings of curiosity in science and mathematics. For this reason, recently, countries around the world, including Turkey, attach importance to the education of gifted students and their activities in scientific fields, and they use their resources for these students to reveal their potential (Camci-Erdogan, 2013). It is thought that those with this potential will have a career and make career choices in terms of STS, and they are also expected to have a comprehensive understanding of how science and technology affect society. Moreover, these students are thought to know STS equally as boys and girls and are expected to use them in real life at the same rates. It is also expected that the views of gifted students about STS will increase from the 5th grade to the 8th grade. However, many studies have revealed that gifted students are most interested in science and mathematics (Benbow et al., 2000; Dunnell & Bakken, 1991; Heller & Ziegler, 1996; Keser & Kalender, 2016; Silverman, 1993; Spelke & Grace, 2007; Turgut, Ozturk & Es, 2016).

The main purpose of science education is for students to feel like scientists and do science by following the path they follow (Camci-Erdogan, 2013). Therefore, the most important condition for gifted students to understand science and the nature of scientific knowledge, namely STS, is a correct understanding of the scientists who create this knowledge (Kaya, Dogan & Ocal, 2008). From this point of view, it emerges as a situation where gifted students need to know many things in detail, such as the scientist, their characteristics, studies, the effects of the scientist on the society, the effects of the society on the scientist, and whether they are ethical or not in the society.

Special talent is not only an inherited trait but also a trait that can be developed with appropriate learning environments. Therefore, what is expected from these children is not only to grow up using their ready knowledge but also to bring knowledge and art producers to the society that will contribute to the solution of modern civilization problems (Celikten, 2017). They should be properly educated and guided in cooperation with families and educational

institutions. They, who are the greatest wealth of society, are the ones who will shape society in every field. Now, the STS views of gifted students are very important for society.

This situation makes gifted students different from normal talented students due to their characteristics and it is expected that their desire to learn science, technology and society outside of school is higher. Thus, it is essential to examine the views of gifted students about STS, which is accepted as one of the most fundamental values for Turkey to become an advanced country in science and technology in the 21st century.

Problem Statement

It is stated that there are common aspects that should be focused on the attitudes and perceptions of gifted students towards science and scientists, their perceptions of technology, and their views on the nature of science (Camci-Erdogan, 2013; Demirbas, 2009; Holland, 2004; Kemaneci, 2012; Keser & Kalender, 2016; Lee & Choi, 2003; Liu & Lederman, 2002; Turgut et al., 2016; Urek, 2012). From this point of view, it is an important need to investigate the views of gifted students, who are considered as the most valuable group of society, about science-technology-society.

In Turkey, all students as scientifically literate individuals have been the primary goal of science teaching programs (Kucuk & Yildirim, 2020). Therefore, the opinions of gifted students with high mental levels and unique innate characteristics about STS, which is a sub-dimension of science literacy, will differ from normal students at this point. For this reason, to increase the scientific research and technological development capacity, socio-economic development, and competitiveness of the country, gifted students should understand the relationship between STS and the effects on each other.

Today, when science and technology are of such importance, gifted students are individuals with the potential that we strive to direct them to scientific fields and to specialize in scientific fields (Camci-Erdogan, 2013). Now, the opinions of gifted students about STS are important especially in terms of their impact on their future career choices and contributions to society. However, many studies revealed that the interest in mathematics and science is not high enough for gifted students (Camci-Erdogan, 2013; Cuberal, 2004; Kemaneci, 2012; Keser & Kalender, 2016; Orbay et al., 2010; Turgut et al., 2016). Based on these studies, especially in terms of career choice, the tendency of them to choose a career in mathematics and science is very low. This is because the perception of scientists is influenced by the "male" dominant culture and science fiction films, textbooks in the media, etc. and it may be that the "female" scientist is rarely reflected in media (Camci-Erdogan, 2013).

The purpose of this research is to examine the opinions of gifted students in S&ACs in the Eastern Black Sea Region about the sub-dimensions of the STS.

Theoretical Background

One of the measurement tools used to investigate the opinions of students about STS is the VOSTS (Views on Science- Technology-Society) questionnaire, which was developed by Aikenhead, Ryan, and Fleming and took its final form in 1989 as a result of a six-year study. The VOSTS questionnaire contains 114 items and consists of nine sub-dimensions (Aikenhead & Ryan, 1992). The 26 items of the VOSTS questionnaire were adapted into Turkish by Kahyaoglu (2004). These 26 items were classified according to the "Realistic", "Acceptable" and "Unsatisfactory" perspectives in many studies using Rubba, Harkness, and Bradford's (1996) categories (Aydin, 2009; Besli, 2008; Kilinc, 2010; Tairab, 2001).

The realistic perspective is the most appropriate contemporary perspective on STS. The reasonable point of view is also suitable for STS but it does not show a realistic point of view. Inadequate point of view refers to an inadequate, weak point of view that is not suitable for STS. Now, considering the different innate characteristics of gifted students it is expected that

students with a mostly or wholly realistic view of STS. In this context, the answers expected from special, normal, and weakly talented students in terms of the sub-dimensions in the STS questionnaire were classified in a study done by the second researcher and under the supervision of the first researcher.

Table 1
Gifted students expected answers about the STS survey

Item No	Dimension	Sub-items of the Dimension of Science-Technology-Society	Expected Reaction from Gifted Students
1	Science and Technology	Definition of science	In general, science is an effort to understand what is going on in the world and the universe.
2		Definition of technology	The way of solving the everyday problem is the ideas and techniques necessary to design and manufacture things and to organize and develop the people of society.
3		The relationship between science and technology	Scientific studies lead to technological developments and technological developments accelerate scientific studies.
4	Society's Impact on Science/Technology	Government and science	Governments must subsidize scientific work so that scientists can make our world a better place to live.
5		Ethics	Religious, moral, and cultural views directly affect the work of scientists.
6		Educational institutions	The better students learn about science and technology, the better they will use science and technology by creating new ideas, and the better they will inform society and receive the necessary support from society.
7		Impact of society on scientists	Generally, intelligence, talent, and interest in science are innate, but the fact that family, school, and society encourage children to be scientists and provide opportunities for them to become scientists makes the upbringing style important.
8	The Impact of Science/Technology on Society Social	Social responsibility of scientists	Scientists cannot predict and control the long-term effects of their work and whether they are used for dangerous purposes.
9	Responsibility of Scientists	Contribution of societal decisions	The views of scientists, engineers, and society should all be taken equally in making decisions that affect society.
10		Solutions to social and practical problems	Scientists' rational problem-solving thinking and specialized knowledge are better than other people at solving practical problems.
11		Contributions to economic prosperity	Science and technology bring productivity, production, and development to our country, and it provides wealth by selling new ideas and technology to other countries.
12		Contribution to military power	Military power has a strong military, partly dependent on science and technology and partly on the strength of the government.
13	Typical Characteristics of Scientists	Values that affect the work and life of the scientist	Scientists have the characteristics of being open-minded, logical, unbiased, impartial, highly imaginative, intelligent, and honest, and the more they have these characteristics, the better they will do science.
14		The effect of gender on the scientific process and product	Regardless of the inventions made by male and female scientists, there is no difference between them, everyone is equal, and if there is a difference, it is due to individual differences.
16	Social Structure of Scientific Knowledge	Social interaction	Since scientists interact with their environment, the content of their studies is also affected by this social interaction.

17		National influence on scientific knowledge and technique	A country's educational and cultural system often influences the results scientists reach in their work. On the other hand, personal opinions can also affect these results.
19	Social Structure of Technology	Technological decisions	The utility of a new technology depends on its cost, usefulness, utility for society, adequacy, and impact on building power use.
21	The Nature of Scientific Knowledge	The nature of the observations	The fact that scientists have different perspectives and use different methods will also differentiate their observations.
22		The changeability of scientific knowledge	Scientific knowledge can change over time as old knowledge is reinterpreted in the light of new knowledge.
24		The scientific approach of research	Considering what scientists do, there is no such thing as the scientific method.
25		Giving rational justification	To present a logical justification for a research, it is necessary to do more research and to reveal the reasons that indirectly affect that research.
26		Paradigms, interdisciplinary harmony of concepts	The paradigms of scientists working in different fields will also differentiate the interpretation of scientific ideas.

*This table was adapted from the second researcher's master thesis (Goz, 2019, p.37)

Method

In this study, a survey method was used within the scope of the quantitative research approach based on the paradigms of positivism and realism.

The sample

The universe of this study consists of 800 gifted middle school students (5, 6, 7, 8.) enrolled in S&ACs in the provinces of Rize, Trabzon, Giresun, Ordu, and Samsun in the Eastern Black Sea Region of Turkey in the 2018-2019 academic year. To represent a population of 800 people, the sample size to be selected should not be less than 240 ($n= N\ t^2\ p\ q/\ d^2(N-1)+ t^2\ p\ q$) (Dikmentepe, 2012). The sample of this study consisted of 251 gifted students in total. Table 2 shows the distribution of the number of samples based on gender and grade level.

Table 2
Gender and grade level frequency distributions of gifted students

Gender	Grade Level				
	5th Grade	6th Grade	7th Grade	8th Grade	Total
Female	34	39	30	22	125
Male	37	26	30	33	126
Total	71	65	60	55	251

Data collection

In this research, the sample's opinions about STS were obtained with the VOSTS (TR) (Views on Science- Technology-Society) questionnaire developed by Aikenhead, Ryan, and Fleming (1992). The VOSTS questionnaire contains 114 multiple-choice items and consists of nine sub-dimensions. The selected 26 items were adapted into Turkish by Kahyaoglu (2004). The pilot study of this questionnaire was also applied by the same researcher to 15 students studying in the second year of the science teaching department at Middle East Technical University in Turkey. The results obtained from the pilot study were found to be appropriate in terms of the adequacy of the 26 selected items of VOSTS (TR) for teacher candidates and the validity and reliability of the questionnaire was established. 23 of these 26 items have been

classified using Rubba, Harkness, and Bradford's (1996) categories according to the "Realistic", "Acceptable" and "Unsatisfactory" perspectives in many studies shared before.

In the current study, data were collected from gifted students by using 22 items instead of 26 items in the VOSTS (TR) questionnaire. The adapted 26-item were most suitable to high school, higher education, and other adult groups, however, expert opinion was sought for this study. In this context, an expert who previously produced many works on gifted students and also one of the researchers of this work criticized each item of the questionnaire. In this context, items 15, 16, 20, and 23, which may be difficult for students to understand, do not reflect the expected achievements from the students, and are above the mental level of the students, were removed from the questionnaire.

Each of the items in the survey consists of a different number of alternative roots. The last three alternative answers are the same for each item. These are, "I do not understand", "I do not have enough information to make a choice", "None of the options reflect my personal views.". The charts were developed to see the percentage of the alternatives that gifted students chose for each item. Each item reveals the views of gifted students on the different dimensions of STS.

Data collection

The 22 items of the VOSTS (TR) questionnaire, were applied to the gifted middle school (5th, 6th, 7th, and 8th) students enrolled in S&ACs in the Eastern Black Sea Region of Turkey in the first semester of the 2018-2019 academic year. The data were collected during the lesson hours where the questionnaire would be administered and with the permission of the responsible teacher. Before the survey application, detailed information about the scope of the research was provided to the gifted students by the second researcher. The structure and instructions of the VOSTS (TR) questionnaire were also verbally introduced to the gifted students. Participation in the survey was carried out voluntarily by the gifted students and they were asked to complete it within 45 minutes.

Data analysis

In this study, data were analyzed using descriptive statistics. This type of statistics includes methods that enable the information belonging to the population or sample to be organized or to represent the whole data. It includes methods and techniques such as ordering, preparing a frequency table, calculating standard deviation, variance, and percentile distribution values, and drawing graphs. Tables were created for each item. The categorization method used in the data analysis was similarly applied in many other studies (Erdogan, 2014; Tairab, 2001). In this way, the survey data were classified according to the "Realistic", "Acceptable" and "Unsatisfactory" perspectives using Rubba, Harkness, and Bradford's (1996) categories, and the alternative answers to the survey items were grouped as follows.

The realistic perspective is the most suitable contemporary perspective on STS. The acceptable point of view, although does not show the realistic point of view, is also appropriate for STS. Insufficient perspective shows the inadequate, weak perspective that is not suitable for STS. The last three alternative answers of the 22 items were also evaluated as insufficient perspective. These values are included in the percentage values reflecting the "inadequate" point of view under the tables. The answers in the VOSTS (TR) questionnaire is marked as "Realistic" perspective (***), "Acceptable" perspective (**), and “Insufficient" perspective (*). The total percentage values of realistic, acceptable, and insufficient perspectives of the data were presented below in table 4. In addition, explanations for each item were made under the tables according to realistic, acceptable, and inadequate perspectives, respectively.

The "Science and Technology" sub-dimension of STS was examined under the titles of the definition of science, the definition of technology, and relations between science and

technology. For item 1 (Definition of Science) analyzes made analyses are presented below as an example.

Item 1: Science is difficult to define because science is complex and deals with many issues. But science is essential…

Table 3
A sample analysis for Item 1 in the VOSTS (TR) questionnaire

%	Option
29.5	C
26.7	B
11.2	F
8.0	H
6.8	E
5.6	D
3.6	A
1.2	G

The first item of the VOSTS (TR) questionnaire is about how participants define science. In this item, 29.5% of the participants marked option C, which reflects a realistic perspective as "exploring the unknown about our world and universe, discovering new things and how they work". Similarly, 48.3% of them preferred options A, B, D, F, and G, which reflect the acceptable perspective. However, 14.8% of the participants marked the E and H options which reflects the insufficient perspective.

Results

The analysis of the data obtained from the VOSTS (TR) questionnaire about STS were provided under seven sub-titles as “science and technology”, “the effect of society on science/technology”, “the effect of science/technology on society”, “the characteristic features of scientists”, “the social structure of scientific knowledge”, “the social structure of technology” and “the nature of scientific knowledge”. The realistic, acceptable, and insufficient views by gifted students to the items of the questionnaire are in Table 4.

Table 4
Percentage of students' answers to the items of the VOSTS (TR) questionnaire

Item No	Content of the Subscale		%
1.	Definition of science	Realistic ***	%29,5
		Acceptable****	%48,3
		Insufficient *	%22
2.	Definition of technology	Realistic ***	%25,1
		Acceptable****	%51
		Insufficient *	%23,9
3.	The relationship between science and technology	Realistic ***	%43
		Acceptable****	%6,8
		Insufficient *	%49,5
4.	Government and science	Realistic ***	%25,2
		Acceptable****	%15,2
		Insufficient *	%58,2
5.	Ethics	Realistic ***	%35,4
		Acceptable****	%29,1
		Insufficient *	%35,5
6.	Educational institutions	Realistic ***	%34,2
		Acceptable****	%52,6
		Insufficient *	%12,8
7.	Impact of society on scientists	Realistic ***	%18,7

		Acceptable****	%61
		Insufficient *	%19,5
8.	Social responsibility of scientists	Realistic ***	%9,2
		Acceptable****	%51
		Insufficient *	%29,1
9.	Contribution of societal decisions	Realistic ***	%18,7
		Acceptable****	%41
		Insufficient *	%40,3
10.	Solutions to social and practical problems	Realistic ***	%45
		Acceptable****	%37,8
		Insufficient *	%16
11.	Contributions to economic prosperity	Realistic ***	%51
		Acceptable****	%41,5
		Insufficient *	%7,2
12.	Contribution to military power	Realistic ***	%20
		Acceptable****	%68,5
		Insufficient *	%11,2
13.	Values that affect the work and life of the scientist	Realistic ***	%56,6
		Acceptable****	%8,4
		Insufficient *	%34,7
14.	The effect of gender on the scientific process and product	Realistic ***	%15,5
		Acceptable****	%23,5
		Insufficient *	%60
17.	Social interaction	Realistic ***	%37,5
		Acceptable****	%38,9
		Insufficient *	%23,2
18.	National influence on scientific knowledge and technique	Realistic ***	%47
		Acceptable****	%36,6
		Insufficient *	%16
19.	Technological decisions	Realistic ***	%36,3
		Acceptable****	%40,7
		Insufficient *	%22,8
21.	The nature of the observations	Realistic ***	%68,5
		Acceptable****	%14,8
		Insufficient *	%16
22.	The changeability of scientific knowledge	Realistic ***	%67,3
		Acceptable****	%21,6
		Insufficient *	%10,4
24.	The scientific approach of research	Realistic ***	%3,6
		Acceptable****	%13,2
		Insufficient *	%83
25.	Giving rational justification	Realistic ***	%42,2
		Acceptable****	0
		Insufficient *	%57,1
26.	Paradigms, interdisciplinary harmony of concepts	Realistic ***	%27,5
		Acceptable****	%30,7
		Insufficient *	%41,6

Definition of science (item 1)

Normal students see physics, chemistry, and biology as study fields, and scientists who have ideas and techniques to invent knowledge and experiment to solve problems in the environments to make the world more livable. It is also expected that gifted students know that it is about searching the unknown about the world and the universe. It turns out that only 29.5% of the participants responded as expected on this issue. Inventing practical and useful things, using technology in the research were found out with not special but normal talented students (Balki et al., 2003; Celikdemir, 2006; Demir & Akarsu, 2013; Erenoglu, 2010; Ince, 2017; Kilinc, 2010). In this context, it could not sufficiently reveal the difference of the gifted students in the study group for a definition of science. It means that students have misconceptions about

concepts such as theory, law, principle, experimentation, invention, physics, chemistry, biology, and knowledge, and they see these concepts as directly equal to science. Similar results were found by Turgut et al. (2016) with gifted students. They focused on the product rather than a scientific process and emphasized that it was experimental. Liu and Lederman (2002) and Lee and Choi (2003) were also found out that gifted students have many misconceptions and contradictory statements on the nature of science. Solomon et al. (1996) revealed that normal students were influenced by their teachers' views of science. For this reason, the views of science teachers working in S&ACs about science are particularly important. In this context, the scientific understanding of S&ACs teachers has the potential to penetrate similarly to gifted students (Gokdere & Cepni, 2004; Hirca, 2013). There is almost no work in the literature about S&ACs science teachers' conceptual schemes for science.

Definition of technology (item 2)

Normal students see technology as new methods, tools, machines, computers, practical tools, robots, electronic tools, communication systems, and automation for daily use instead of thinking techniques of doing things and solving everyday problems. It is expected that gifted students should know the ideas and techniques necessary to invent and design and they are expected to test something different from this, to organize workers, businessmen, women, consumers, and to develop society. In this context, only 25.1% of the sample appeared to respond as expected. Similar results were also observed with normal students. In the study conducted by Eristi and Kurt (2011), they defined technology as computers and electrical devices and explained that the reason for this was that the most frequently used technological devices in daily life were perceived as technology. In the study of Solomonidou and Tassios (2006), normal students defined technology with modern tools and equipment, especially computers, TVs, mobile phones, satellites, and other micro and macro technologies, and expressed technology as technical tools. Herdem et al. (2014) revealed that normal students see technology like computers, televisions, and mobile phones, and this shows that students' perceptions about technology are insufficient. Karacam and Aydin (2014), on the other hand, found out that students define technology mostly as "something useful" and least as "something that spreads rapidly". In Eristi's (2011) study, however, it was determined that the students related to the concept of technology formed different surreal and imaginative themes. This situation could not reveal the difference in the sample for the definition of technology. However, technology is a broad concept that includes process information and cost dimensions apart from the product. Both in the literature and the current research, it is revealed that the sample focused only on the product dimension of technology and do not perceive technology as a holistic activity. S&ACs teachers and curricula can be criticized as the reason for this. In this context, Gokdere et al. (2004) investigated how often do the S&ACs science teachers use educational technologies and found out that they have used a very small number of technology and technological materials. In this sense, it is an inevitable result that sample students have deficiencies in the recognition of technology. In Holland's (2004) technology attitude and perception study conducted with gifted students, it was revealed that fifth-grade students explained technology with concepts such as "exploring something new, getting more information, inventing something new and knowing mathematics". It is understood that there is not enough talk about the function of technology in S&ACs especially for the development of a society.

The relationship between science and technology (item 3)

Normal students know that science and technology are closely related and interconnected, while gifted students, on the other hand, know that scientific research guides the developments in technology and that technological developments accelerate scientific research. In this

context, only 43% of the sample responded appropriately as expected. There are similar results conducted with normal students. In three related studies, respectively, the students expressed their views on the question "what would happen if there was no science?" that technology will not exist (Balki et al., 2003), stated that the primary purpose of science is to develop technology (Celikdemir, 2006), and finally, they defined science and technology as the same concept (Herdem et al., 2014). This situation could not reveal the difference between the students in the sample for science and technology. In Turgut's (2016) study with gifted students, it was observed that students took on tasks such as producing solutions to daily life problems for science and technology and developing tools that make life easier, and this situation revealed that students had misconceptions and stated that they could not establish a relationship between science and technology. Now, it is concluded that the students' inability to establish the relationship between science and technology is due to their lack of knowledge about the definition of science and technology, as also seen in the first two items.

Government and science (item 4)

Normal students should consider that providing financial support to scientific research whether or not done by scientists is beneficial or not an investment risk that should be taken and that the financial support should be used directly in scientific research related to health, environment, or agriculture. Gifted students are expected to know that scientists need to make the world a better place to live in. In this context, it turns out that only 25.5% of the sample responded as expected. Similar results were also found in a study conducted with normally talented students by Ince (2017). In the current study, the sample supported the view that scientific research should be supported, but this is not enough. In this context, it is clear that the views of the sample on the relationship between science and government are not sufficient, and they do not know enough from which sources and whose support scientific projects are funded. Now, it is an important necessity to increase the awareness of gifted students about the main power behind the realization of these projects by increasing the projects in which they participate or are the directors themselves.

Ethics (item 5)

Normal students are expected to know that religious, moral, and cultural views affect the work of scientists in line with their own will, while gifted students are expected to know that religious, moral, and cultural views directly affect the work of scientists. In this context, only 35.4% of the sample responded appropriately as expected. Similar results were found by Celikdemir (2006), which was conducted with normally talented students, and it was concluded by the students that religion adopts science as something that they could do directly, but not as an influence. In Kemaneci's (2013) study with gifted students, it was revealed that although not directly related to this item, gifted students expressed a positive opinion by saying "scientists should be respectful to each other's work" in terms of ethics. Based on the current data, the sample cannot adequately associate religion and moral views with science. In this sense, it is up to the teachers of gifted students to say that science is influenced by religious and moral views, by looking at the project processes and results of exemplary scientists under the name of the history of science, and to transfer them to students. Now, it is argued that for S&ACs teachers to be a qualified guide for gifted students, they need well-planned courses to eliminate the lack of knowledge, method, and technical deficiencies (Altun & Vural, 2012; Gokdere & Cepni, 2004).

Educational institutions (item 6)

Normal students know that the better they learn science and technology, the more scientists, engineers, technicians will be trained and the more the country will develop while

gifted students are expected to know that they will use technology and technology better and that they will receive the necessary support from society by informing the society well. In this context, only 34.2% of the sample responded appropriately as expected. Nowadays, gifted students can easily access information and attend science camps outside of their regular schools (Hirca, 2012; Metin & Leblebicioglu, 2011). In this respect, they should be aware that society is trying to contribute to science and technology with educational institutions and that they support them.

The effect of society on scientists (item 7)

Normal students know that some societies and families encourage their children to ask questions and to teach all the values that they will carry throughout their lives, and the upbringing style and the person's upbringing are equally effective in this process. However, gifted students are expected to know that intelligence, talent, and interest in science will be effective in determining who will be a scientist and that family, school and society will teach children scientific skills and both provide opportunities and encourage them to become scientists. In this context, only 18.7% of the sample responded appropriately as expected. There are similar results in some of the studies by Ince (2017) and Kemaneci (2013). In those studies, normal and gifted students agreed that a scientist's level of success can be affected by the family members' education levels. Similarly, they stated that scientists have an impact on the success of their children and that the school and the science teachers at school can also affect this process. However, there was no difference between the sample and normal students' views about the effect of society on scientists.

Social responsibility of scientists (item 8)

Normal students know that the purpose of science is to make the world a more livable place, whether the effect of inventions is beneficial or harmful and will not prevent scientists from making inventions for their future, fame, and pleasure, and that gifted students should be able to make the world a more livable place. They are expected to know that they cannot predict the effects of their inventions for a long time and cannot control whether these inventions will be used for dangerous purposes. In this context, only 9.2% of the sample responded appropriately as expected. There are similar results conducted by Ince (2017) and Kilinc (2010) with normal students. According to the common result of those studies, it is seen that the students argued that scientists were generally interested in the beneficial aspects of inventions such as mobile phones, cancer drugs, computers, or they were not interested at all. This could not reveal the difference of the students in the sample group regarding the social responsibility of scientists. It is believed that this is because gifted students do not know scientists closely or they are not adequately introduced. In a study of Camci-Erdogan (2013) with gifted students, it was determined that the students expressed their favorite scientists as Einstein, Edison, Tesla, Maria, Curie, and Pasteur, and emphasized how the inventions made by these scientists were beneficial to humanity and society. In another study by Kemaneci (2012), it is stated that gifted students accept that scientists make life easier with their projects, do useful works for the benefit of all humanity and that they are exemplary models for the people around them with their studies and success. Now, it is seen that the results of these studies do not coincide with the current results with the new sample.

Contribution of social decisions (item 9)

Normal students know scientists, and engineers that due to their good education and knowledge, the decisions to be taken for the society should be made by them, however, the gifted students should know that the opinions of the society should be taken equally. In this context, only 18.7% of the sample responded appropriately as expected. Similar results were

observed in a study by Celikdemir (2006), which was conducted with not special but normal talented students. According to the research, it is envisaged that developing countries such as Turkey will raise individuals who have good decision-makers in the fight against other issues related to the environment and science, and it is seen that the best decisions for the society are the educated decision-makers. This result could not reveal the difference of the sample gifted students regarding the contribution of social decisions. From this point of view, it is thought that gifted students ignore the social part of the science courses, they cannot touch on science related to daily problems and social problems, and society is ignored in their solution.

Solutions of social and practical problems (item 10)

Normal students know that the education of scientists is not aimed at solving daily problems and that since scientists are like everyone else, they can solve everyday problems with experience and common sense. However, gifted students are expected to know scientists that their ability to solve logical problems with their specialized knowledge is better than others. In this context, only 40% of the sample gave appropriate answers as expected. Similar results were also found in the study of Kilinc (2010), which was conducted with normal, not special, talented students. This result did not reveal the difference between the students in the sample for the solution of social and practical problems compared to the normal students. Looking at the main purpose of the education given in S&ACs is to enable gifted students to produce projects to solve a problem in daily life, the result showed that this goal has not been adequately achieved.

Contributions to economic welfare (item 11)

Normal students should know that the development of science and technology will reduce the dependence on other countries, but that there should be different ways to increase wealth, while gifted students, on the contrary, should know that a country's new ideas and profit-oriented ideas. It is expected that selling technology to other countries will increase the wealth of the countries and contribute more to economic welfare. Now, only 51% of the sample responded as expected.

Values affecting the work and life of the scientist (item 13)

Normal students do not need to have the characteristics of scientists such as honesty, attention, openness, originality, education, social responsibility, legality, opportunity, mutual respect, efficiency. It is expected that even the best scientists will know that they cannot always be logical and sometimes closed to new ideas and views, and that gifted students, on the contrary, are expected to know that the more scientists have these characteristics, the better they will do science. In this context, only 56.6% of the sample responded appropriately as expected. A similar result was also observed in studies conducted with gifted students by Kemaneci (2013). They think that scientists are people who are involved in scientific activities, researching, inquiring, explaining, understanding and interpreting, and thinking, free from prejudice, objective and critical, with a wide imagination and interpretation power, intelligent, knowledgeable, and self-confident. In Demirbas's (2009) study, it is seen that gifted students generally regard scientists as positive in terms of features such as careful, intelligent, hardworking, and creative, but they describe them with low scores in terms of being an artist. In the study by Ince (2017), on the other hand, normal students consider scientists as hardworking, not sleeping late, non-smoker, curious, patient, courageous, determined, intelligent, etc. Balki et al. (2003) stated in their study that normal students think that they are people who research the characteristics of scientists and people who are useful to society, they also need to work hard and not everyone can be a scientist. While Celikdemir (2006) thought that normal 8th-grade students would be different in their studies and affect their success due to the personal differences of scientists, it was revealed that 6th-grade students did not agree

with this view. Hasturk et al. (2014) emphasize that normal students have incomplete and wrong information about the characteristics of scientists, and this reveals that students cannot explain how successful scientists will be due to the characteristics they have. This result reveals the difference between the students in the sample group for the values that affect the work and life of the scientist since the knowledge of the normally talented students is incomplete and insufficient according to item 13. However, for all the sample to have a realistic view on this item, activities and projects can be organized for them to bring together different scientists at S&ACs, or it can be ensured that scientists follow their studies closely (Metin & Leblebicioglu, 2011; Hirca, 2012).

The effect of gender on the scientific process and product (item 14)

Normal students know that there is no difference between male and female scientists, but women come up with different discoveries by nature, and everyone is equal, and if there is a difference, it is due to individual differences. In this context, only 15.5% of the sample responded appropriately as expected. Similar results were also observed in studies conducted with normal students. In the study conducted by Urek (2012), it is seen that normal and gifted students used different expressions such as science and scientist. From this point of view, it was concluded that the students could not form a complete view of the scientists on gender yet. In a study by Ince (2017), it was determined that gifted students shared that the number of men dealing with science is more than women. Eyceyurt-Turk and Tuzun (2017) found out that the scientist is male has emerged in the minds of normal students. This result could not sufficiently reveal the difference between the students in the sample regarding the effect of gender on the scientific process and product compared to the normal students. The reason for this is that in the new century, a great effort is spent to make sense of the term scientist instead of the term science man in public.

Social interaction (item 17)

Normal students should know that scientists will work towards the needs of society by observing social behavior, however, gifted students are also aware of the fact that social interaction will affect scientists' work in terms of interaction with people and benefiting from their ideas, experiences, and enthusiasm. In this context, only 37.5% of the sample responded appropriately as expected. There are similar results in the study of Kilinc (2010), which was conducted with normal talented students. In the study of Celikdemir (2006), it was revealed that the majority of normal students were not aware of human activity from the social aspects of science. However, it is intensely emphasized in studies conducted with the nature of science that science will be affected socially and culturally (Celikdemir, 2006; Demir & Akarsu, 2013; Erenoglu, 2010; Hasturk et al., 2014; Ince, 2017; Irwin, 2000; Khishfe & Abd- El-Khalick, 2002; Khishfe & Lederman 2006; Kucuk, 2008; Kucuk & Cepni, 2015; Liu & Lederman, 2002). This result could not sufficiently reveal the difference between the students in the sample for social interaction compared to the normal students. In the study by Camci-Erdogan (2013), it was argued that the main reason for the perception of gifted students that scientists work indoors may be because science-related activities are usually carried out indoors. However, the media's perception of scientists on students is emphasized that the scientist is seen as a person who isolates himself and works alone away from everything. The current research revealed that the sample thinks that scientists are not social and isolate themselves from external life as reflected in the media.

National impact on scientific knowledge and technique (item 18)

Normal students are expected to know that the work of scientists will be affected by the education of the country in which they grew up and the financial support that country can

provide, and the gifted students are expected to know that the personal opinions of scientists can also affect their work. In this context, only 47% of the sample responded appropriately as expected. Similar results were found in the study by Ince (2017), which was conducted with normal students. Normal students usually believe that science can be affected by the education and culture system and social relations of the countries where people were educated. This result could not also sufficiently reveal the difference of the students in the sample on the national impact of scientific knowledge and technique.

Technological decisions (item 19)

Normal students know that the use of a new technology depends on how well it works, whether it will make a profit for the company, and whether it is put into practice and then developed, and gifted students differ from this view on the cost of the technology, whether it is useful for society, or not. It is expected that it depends on its usefulness, adequacy, and its effect on the use of society. In this context, only 36% of the sample responded appropriately as expected. Similar results were also observed in studies conducted with normal students. In the study conducted by Ince (2017), students' views on technological decisions came out in line with the answers reflecting the acceptable point of view, and they are similar to the current research. This result could not sufficiently reveal the difference between the students in the sample for technological decisions compared to the normal students. In a study done by Karacam and Aydin (2014) on technological concepts with normal students, it was seen that the awareness of the participants that technology is affected by society was low. In another study with gifted students, while evaluating the scientificness of the claim, they connected whether it works or not to the difference between science and technology, and as a result of the science, they evaluated the benefit-harm of technology, whether it is useful or not, and concluded that the quality of life is an invention-oriented action (Turgut et al., 2016). In this context, environments and experiences should be created in which gifted ones can be more active and take responsibility while making technological choices in their scientific research, and in this way, they can evaluate the cost of technology, whether it is useful or not, and its benefits for society.

The nature of observations (item 21)

Normal students know that scientists have similar observations even though they have different points of view and science is progressing in this way, however, gifted students should have different perspectives and use different methods. In this context, only 68% of the sample responded appropriately as expected. Similar results were observed in studies conducted with normal talented high school students. In the study of Kilinc (2010), the opinions of normal students about the nature of observations were found to be highly positive, and in the study of Kemaneci (2013), the gifted students completely agreed that the observations and research of the scientist are based on scientific foundations and that their effective observations guide their studies. This result may be because teachers talk more about the dimension of observation and inference, as well as the fact that observations are experimental, in studies conducted for gifted students in the STS approach in S&ACs. In this context, the difference between the views of the gifted students on the nature of the observations compared to the normal students has emerged in the current research.

The changeability of scientific knowledge (item 22)

Normal students know that new information is added to the current information and it seems to change while remaining the same, and gifted students know that old information can change over time by reinterpreting it in the light of new information. In this context, only 67.3% of the sample responded appropriately as expected. There are similar results observed in studies

conducted with normal students by Ince (2017), Irwin (2000), Khishfe and Abd-El-Khalick (2002), Khishfe and Lederman (2006), and Kucuk (2006). In some other studies, Celikdemir (2006), Kang (2004), Kaya et al. (2013), and Kilinc (2010) revealed that most of the normal students believe that scientific knowledge is changeable, but they emphasize that this should be developed by researchers. This result is similar to the students in the sample regarding the changeability of scientific knowledge. Both in the literature and current research, it is revealed that the students mostly have the view that scientific knowledge is changeable. It is thought that the effect of teachers and textbooks is based on this, and this aspect of science is generally emphasized. On the other hand, in Kemaneci's (2013) study with gifted students, it was revealed that students argued that scientific knowledge can change over time. It sufficiently reveals the different views of the gifted students in the sample compared to the normal students.

The scientific approach of the research (item 24)

Normal students know that there is a well-known scientific method guiding the work of scientists as asking questions, hypothesizing, collecting and analyzing data, and reaching conclusions. However, gifted students are expected to know that there is no single way to do science and that there is no universal scientific method. In this context, only 13.2% of the sample responded appropriately as expected. Similar results were also observed in studies conducted with normal students. In the study by Celikdemir (2006), students believe that there are certain steps that scientists need to follow to question the scientific method, hypothesize, collect data and reach a conclusion. In the study by Demir and Akarsu (2013), it was revealed that the students had traditional views about the scientific method. In the study by Ince (2017), all of the students believe that there is a plan followed by scientists. This result could not sufficiently reveal the difference between the students in the sample for the scientific approach of the research compared to the normal students. In a study by Liu and Lederman (2002) with the gifted student, they concluded that the intensive use of cookbook-like laboratory work led students to believe that there was only one scientific method, and students' views on experimentation, their experiences in the laboratory, and their activities at the door of science became a universal concept.

Conclusion

Within the scope of this study, which examines the views of gifted students about STS, the VOSTS (TR) questionnaire was applied to 251 gifted middle school students (5, 6, 7, and 8th) registered in S&ACs. The data were analyzed by making a triple classification – realistic, acceptable, insufficient – for each item. The gifted individuals who make up 2-3% of a society have a high potential to carry the society to the highest levels. For this to be achieved they are expected to have realistic views, behaviors, and characteristics about the impact of technology and science on society and the social structure of technology and scientific knowledge, the characteristics of scientists, and the natural structure of scientific knowledge (Kahyaoglu, 2004). This pragmatic expectation made it necessary to examine how the views of gifted students enrolled in S&ACs about STS are shaped.

There is almost no work directly addresses the views of gifted students about STS in Turkey or abroad, and there is only a limited number of work that deal indirectly with them. In three of these, the attitudes and images of gifted students towards science and scientists were investigated (Kemaneci, 2013; Turgut et al., 2016). In two studies abroad on the subject, the views of gifted students in the science camp about the nature of science were examined (Lee & Choi, 2003; Liu & Lederman, 2002). In another study abroad, the technology attitudes and views of gifted students were determined (Holland, 2004). The common result reached in these studies; there are similarities as well as incomplete information and misconceptions in the science, scientist, and technology views of gifted students. However, it was concluded that there

is still not enough data set on the subject (Lee & Choi, 2003; Liu & Lederman, 2002; Holland, 2004). For this reason, in the current research, a new research design was developed to examine the views of gifted students about STS together. Based on the data, it turns out that the sample's views on the sub-dimensions of the STS are not sufficiently different from those of normal students. In this context, although gifted students must have high-level characteristics; For the sample examined, the expected performance towards the nature of science and the science-technology-society covering it did not emerge. For only three of the answers given by the sample to the VOSTS (TR) questionnaire - the values that affect the work and life of the scientist (item 13), the nature of the observations (item 21), and the changeability of scientific knowledge (item 22) - were as expected. It has been revealed that the views they have are almost entirely consistent with those of normal students. This result makes the status of students enrolled in S&ACs for discussion after the special talent diagnosis is made. The similarity of the sample's views on STS and the indirect views of science teachers on science and technology, including those in S&ACs, are similar, both in formal education institutions where students normally attend and in related centers, through the lessons taught and interactions established. This may lead to the inability to transfer the views to students. The purpose of establishing S&ACs is to provide gifted students with a differentiated education without separating them from their schools, peers, and classmates. They are expected to be able to think logically, establish relationships between events and concepts, be inquisitive, apply scientific theories, understand the concepts of validity and reliability, use different strategies, think about alternative suggestions, analyze data and show interest in scientific fields. They are also expected to be able to use their imaginations and put forward objective arguments. To reach these outputs, the STS views of the gifted students who are diagnosed and registered with special abilities should also be adequate-realistic. However, as a result of the current study, it was determined that the views of the sample towards STS were not at the expected level, and accordingly, there was no difference compared to the normal talented students. From this point of view, it is recommended to include STS opinions in student identification for S&ACs. Lastly, studies are showing that views on the nature of science can be transferred from a teacher to a student (Kucuk, 2008). In this context, it is thought that teachers may be one of the sources of the problems that arise in the views of gifted students about science-technology-society in the current study. From this point of view, there is a need to investigate the views of science teachers who teach in S&ACs about STS.

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