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THE PERCEPTION OF SCIENCE TEACHERS ON SOCIO-SCIENTIFIC ISSUES AND TEACHING THEM*

Research Article

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Abstract

The present research aimed to analyse the perception of science teachers on socio-scientific issues and teaching them. The study group of the research consists of 22 science teachers (14 females, 8 males) working in 7 secondary schools in Sinop, who were determined according to the convenience sampling method. The case study as one of the qualitative research designs was adopted. The data source of the research consists of a questionnaire on teaching socio-scientific issues. The data of the research were obtained through focus group discussions and observation notes. The data obtained from the research were analysed according to the content analysis technique. As a result of the research, it was found out that most of the science teachers had not heard of the concept of SSI (socio-scientific issues) before. It was seen that teachers who did not have knowledge about SSI generally defined it as scientific issues that concern society and had difficulty in giving examples. It was determined that most of the teachers did not know to which learning area in the science curriculum SSI belonged. Teachers who stated that they mostly use the direct instruction, case study and discussion methods in the teaching of SSI in science course emphasised that the SSI teaching process makes positive contributions to the development of student skills like critical thinking, decision making and communication.

Key words: Socio-scientific issues, teaching socio-scientific issues, science teacher, science curriculum

1. Introduction

Looking from the past to the present, it is seen that science is influenced by the needs of society and the society by the scientific developments mutually. As a matter of fact, the rapid change experienced in the scientific field was felt strongly in social life and this situation established a ground for the emergence of a dilemma and discussion on some issues in the society (Topçu, 2017). For example, topics like cloning, stem cell studies, the genome project, global warming, alternative fuels, Genetically Modified Organisms (GMO), chicken meat, organ donation, hydroelectric power plants and nuclear power plants are on the society's agenda and they leave individuals in a dilemma in the decision-making process (Kilinc, Boyes, & Stanisstreet, 2013; Öztürk, Eş, & Turgut, 2017; Öztürk & Yenilmez Türkoğlu, 2018; Sadler, 2004a; Sadler & Zeidler, 2005; Topcu, Sadler, & Yilmaz-Tuzun, 2010; Topçu, Muğaloğlu, & Güven, 2014). Referred to as SSI, these issues are described as complex, open-ended and controversial issues, which push individuals into a dilemma and which do not have a single correct answer (Kolstø, 2001; Ratcliffe & Grace 2003; Sadler,

2004a). They are considered to be an important context in raising science-literate individuals / science literacy (Chang & Chiu, 2008; Driver, Newton, & Osborne, 2000; Ratcliffe & Grace 2003; Roberts 2007; Zeidler et al.,2002; Zeidler et al., 2005).

1.1 Science Literacy

The term "science literacy" was first used by Paul DeHart Hurt in 1958. In his 1958 book "Science Literacy: Its Meaning for American Schools", Paul DeHart Hurd explained this concept as separating theory from dogmas, data from legends and public discourses. Miller (1983) described science literacy as (i) understanding the norms and cognitive content of science, (ii) understanding scientific terms and concepts, and (iii) raising awareness of the impact of science and technology on the individual and society. In the 1990s, the concept of science literacy emerged as a more holistic and transdisciplinary structure by including natural and social sciences. This structure makes it necessary to use a more comprehensive and wide perspective and research for exploring a wide range of issues such as health, new energy sources, environmental problems, biotechnology in which science and social issues are addressed together (Hurd, 1998). Bybee (1997) described science literacy as the entirety of the skills of using scientific knowledge, identifying problems and drawing conclusions based on evidence, understanding the world, and making decisions about changes caused by people's activities. Laugksch (2000) defines science-literate individuals as those who can comprehend the relations between science and society, who know the ethical rules that a scientist who does his or her job should possess, who have an opinion about the nature of science, who can understand the difference between science and technology, who know the basic concepts of science and who can understand the mutual relationships between science and humanities. Goodrum et al. (2001) explained science literacy as an individual's interest in and understanding of the events around them, their participation in science talks, their sceptical approach to science situations spoken by others, their ability to identify problems, their researching and reaching evidence-based results, and their possessing knowledge about their health and environment. Sadler and Zeidler (2009) stated that science literacy, which is considered within the framework of scientific issues in society, should be a target not only for scientists, engineers or doctors but for all students, and that environments beyond the boundaries of schools should be created where students can use their personal experiences in the science contexts that they may encounter (Driver et al., 2000; Kolstø, 2001).

As for the historical development process of the science literacy concept, the dimensions of Science, Technology and Society (STS) have been integrated with the concept of science literacy since the 1950s (Chang, Yeung, & Cheng, 2009; Sadler, 2004b). These three dimensions, the science-technology-society (STS) movement, have remained important as a major component for more than 50 years (Chang et al., 2009). The STS movement is the most common and longest-lived movement to date that has emerged to emphasise the complexity and interrelationship of science, technology and society (Chang Rundgren & Rundgren, 2010; Sadler, 2004b). The relationship between society and science has also taken its place in science curricula with emphasis on science literacy as well as technological applications of science. At the end of the 1970s, many science education researchers set forth a theme that encompassed science, technology and society and reflected their combined effects (Zeidler et al., 2005). In this way, in the 1970s and early 1980s, science literacy was defined in a social context by expanding its scope more strongly with science (DeBoer, 2000).

It is stated that *Socio-Scientific Issues* are an appropriate and important context to support science literacy in today's globalised world, which started with the STS movement in the 2000s and appealed to STSE dimensions (Chang & Chiu, 2008; Chang Rundgren &

Rundgren, 2010; Driver et al., 2000; Hughes, 2000; MEB 2013; Zeidler et al., 2002; Zeidler & Keefer, 2003; Zeidler et al., 2005).

1.2 Socio-Scientific Issues

In the current century, developments taking place in science and technology have been closely related to society, and the science, technology, society and environmental components have been highly regarded in science education. Significant changes and arrangements have been made in science curricula in Turkey especially after 2005. According to the vision of both 2005 Science and Technology Curriculum and also the 2013 and 2018 Science Curriculum, *all students must be raised as science-literate individuals regardless of their individual differences* (MEB, 2006; 2013; 2018). "*Socio-Scientific Issues (SSI)*", which form an important context in the upbringing of students as science-literate individuals and which was brought up for the first time in the "Science-Technology-Society and Environment" learning area of the 2013 science curriculum, are also highlighted in the 2018 science curriculum. In the last decade, many studies emphasised the importance of SSI in science education to achieve the goal of becoming a science-literate individual, and SSI were discussed in detail in these studies (Zeidler & Sadler, 2011).

SSI are defined as controversial issues that involve ethical, moral or legal dilemmas comprising different perspectives with no definite consensus (Kolstø, 2001; Sadler, 2004a; Sadler et al., 2006; Walker & Zeidler, 2007). Regarding the nuclear power plant planned to be built in Sinop, for example, students, teachers, academicians, various institutions and organisations and the public are on the horns of a dilemma, and individuals who experience the decision-making process with their different perspectives about various aspects of the issue can approach the matter with the multidimensional structure of SSI and, upon making a cost and benefit analysis, they display either a positive or negative or undecided attitude about the issue. Again, it can be said that many controversial issues such as surrogate motherhood, glucose tolerance testing and abortion are discussed in the society and media, that different evaluations are made by different experts and that, as a result, a connection is established between science and society. These issues, which concern all humanity, have also become an important part of science education in recent years. Teachers play an important role in the effective transfer of SSI into the classroom as in every change in education (Lee, Abd-El-Khalick, & Choi, 2006). When a researcher, teacher or pre-service teacher decides whether the content of a subject includes a socio-scientific situation, they have to consider whether it is scientific, whether it causes a dilemma for the individual, whether it includes the science, society and technology dimensions, whether it is open-ended, whether it reflects multiple perspectives, and the importance of ethical, moral and emotional values (Evren & Kaptan, 2014). Teachers have great responsibilities in the teaching of SSI, and science teachers are expected to be equipped in this field. For an effective SSI teaching process, as a matter of fact, it is important that science teachers have knowledge and awareness of what SSI are and how they are related to the aims of science education (Sadler et al., 2006). Many research findings undoubtedly show that the teachers do not have the basic knowledge about SSI, the necessary information about the methods and techniques they can use in the process, and how these issues can be taught (Saunders & Rennie, 2013). In the literature about SSI, which is increasing in importance in Turkey, no study examining the perception of science teachers about these issues and the teaching of these issues has been found. Considering that the literature offers limited studies conducted with teachers (Han Tosunoğlu, 2018; Sezer, 2017; Sönmez, 2015), it gives hope to believe that positive outcomes will be achieved by identifying the SSI awareness of science teachers, who are the most important components of the teaching process and curriculum practitioners, and their perception of the process of teaching SSI, which is important for raising science-literate individuals. The present study

aimed to analyze the perception of science teachers on socio-scientific issues and teaching them. For this purpose, answers were sought for the following questions:

1. What is the perception of science teachers on SSI?
2. What is the perception of science teachers on the involvement of SSI in science teaching?

2. Method

In this study, in which science teachers' perception of SSI and its teaching was examined, the qualitative research paradigm was taken as the basis for the study group, data collection tool, data collection process and data analysis dimensions. The subheadings related to this section are presented below in sequence:

2.1. Study Group

The study group of the research study consists of all science teachers (a total of 22 science teachers working in 7 secondary schools) in the central district of Sinop province, Turkey, in the 2015-2016 academic years. The *convenience sampling* method, which is a purposeful sampling method, was used in order to determine the participants of the study. Convenience sampling is based on elements that are completely existent, easy-to-reach and fast (Patton, 2002). Table 1 shows data on the demographics of the science teachers participating in the study in terms of gender, year of seniority, the department they graduated from and the school year in which the course is taken.

Table 1. *Demographic Characteristics of the Science Teachers*

Science Teacher	Gender	Years of seniority	Graduation	Class level
ST1	Female	1-5 years	Science teaching	5-6
ST2	Female	15 years and older	Chemistry teaching	6-7-8
ST3	Male	15 years and older	Chemistry	5-6-7
ST4	Male	11-15 years	Science teaching	5-6
ST5	Male	6-10 years	Science teaching	5-6-7-8
ST6	Female	1-5 years	Science teaching	5-6-7
ST7	Female	15 years and older	Chemistry	5-6-7-8
ST8	Male	15 years and older	Chemistry	5-7-8
ST9	Male	15 years and older	Chemistry	5-7-8
ST10	Female	15 years and older	Biology teaching	6-7-8
ST11	Female	11-15 years	Science teaching	5-6-7
ST12	Female	6-10 years	Science teaching	6-7
ST13	Male	6-10 years	Science teaching	6-7-8
ST14	Female	1-5 years	Science teaching	5
ST15	Male	6-10 years	Science teaching	5-8
ST16	Female	15 years and older	Chemistry	6-7-8
ST17	Female	15 years and older	Physics teaching	5-6-7-8
ST18	Male	15 years and older	Chemistry	5-7-8
ST19	Female	6-10 years	Science teaching	5-6
ST20	Female	15 years and older	Biology	5-6-7-8
ST21	Female	15 years and older	Chemistry teaching	5-6-7-8
ST22	Female	6-10 years	Science teaching	5-6-7-8

**ST: Science Teacher*

Fourteen of the science teachers are female and eight are male. Regarding the seniority of the teachers, it is seen that three teachers have 1-5 years, six teachers have 6-10 years, two teachers have 11-15 years, and eleven teachers have 15 or more years of seniority. The faculty departments from which they graduated include science teaching (n=11), chemistry

department (n=6), chemistry teaching (n=2), biology teaching (n=2) and physics teaching (n=1) graduate teacher seen. Science teachers teach science classes at different school year levels.

2.2. Data Sources

The data sources of the research were developed by the researchers. The “Personal Information Form” for receiving personal information of the science teachers and the “Interview Form for Teaching Socio-scientific Issues” for receiving their opinions about socio-scientific issues and their teaching were used in the research. The Personal Information Form contains information on the science teachers' genders, years of seniority, the departments they graduated from and the year levels of the classes they teach. The questions in the "Interview Form on Teaching Socio-Scientific Issues" prepared by the researchers were presented to the opinion of two science education experts. As a result of expert opinions, some probing questions were removed and some added. In case, for instance, an interviewee could not answer the first question "What comes to your mind when socio-scientific issues are mentioned? Can you give an example?", it was deemed suitable to provide such clues as "nuclear power plants, organ donation", etc. The final form includes questions and probes about (i) the teachers' knowledge of socio-scientific issues, (ii) the methods and techniques they use in their classroom education, (iii) the resources they use, (iv) the benefits these issues provide to students, and (v) their suggestions about classroom teaching of SSI. The interview form was used in the focus group interviews made with science teachers during the research process. Moreover, during focus group interviews, one of the researchers recorded the observed situations with observation notes. To raise the reliability of the research, the participant made observations in all group interviews and took personal notes based on observation data. The notes taken during the process provided ease by reminding the process during data analysis and interpretation of the data.

2.3. Implementation Process

The data of the study were collected by focus group interviews made with science teachers working in secondary schools in the central district of Sinop province, and by observation notes. The data collection process of the research is shown in Figure 1:

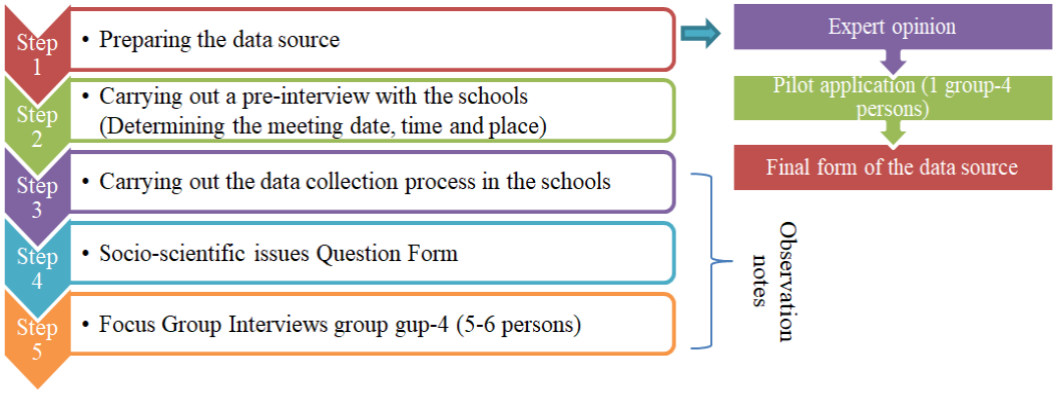

Figure 1. *Data Collection Process*

Managers and science teachers of the secondary schools in the central district of Sinop province were interviewed prior to the implementation, necessary permissions were obtained, and appropriate meeting time with teachers was determined. Each school included in the scope of the application was interviewed separately. Interviews with teachers from schools that are close to each other were held in common places and times. Teachers made self-

sacrifices for the interview process and participated in the interviews on a voluntary basis. Together with the teachers, focus group interviews were conducted with groups of 5-6 people within the context of teaching SSI. A focus group interview is an interview which is held on a specific topic with a small group of participants. Groups generally consist of persons with similar experience, and the process enables to obtain rich and high-quality data with various perspectives (Patton, 2002). In the present study, an interview was held with science teachers who apply the same science course curriculum. Many aspects such as the statements, views and mimics of the participants who answered the main and probing questions asked during focus group interviews were taken into consideration, and the process was recorded by one of the researchers. In order to raise the reliability of the study, one of the researchers made observations in all group discussions and took personal notes based on observation data. The notes were taken during the process provided convenience by reminding the process during data analysis and interpretation. The participant-observer occasionally interacted with the study group and reflected all the data they obtained in their personal notes.

Meeting places were the meeting rooms of the secondary schools, the teachers' room or the seminar rooms. Interviews were set out of school hours and preferably at the end of classes. Interviews lasted about 1.5 to 2 hours. The interview process was recorded with a voice recorder with the permission of the teachers.

2.4. Data Analysis

The qualitative data obtained from focus group interviews were subjected to deductive content analysis. In the present study, the transcript of the data obtained as a result of focus group interviews was first transferred to the computer environment. The data obtained through the interviews made with the teachers participating in the research were analyzed independently by the researchers, and then the support of a third expert was taken to determine the categories and codes. Each teacher was evaluated in his or her own account and compared with their written answers, and efforts were made to enable consistency in the presentation of the findings. In this way, it was tried to create a valid coding table. After examining the consistency of the codes with the answers given, frequency values were determined. The codes obtained were collected under certain categories and data analysis process was completed in this way (Maxwell, 2005; Strauss and Corbin, 1998). The categories, codes and example statements for a question that was subjected to content analysis are given in Table 2:

Table 2. *Example Categories, Codes and Teacher Views from the Interview Form on Teaching SSI*

Categories	**Code**	**Example Statement**
Social	Their being social	*"...SSI are issues that concern all society."*(ST6)
Personal	Their causing a dilemma	*"It will force us to decide in a dilemma."*(ST4)
	Their being arguable	*"Other science issues are proven issues, they don't need your comments, but these are issues open to discussion."*(ST8)

2.5. Validity and Reliability of the Research

In order to ensure *validity*, it was tried to keep the interview time long in the current study. While presenting the findings that were reached through the data obtained from the data sources, the supporting element among the data was taken into consideration and an effort was made to enrich the explanations. During the implementation process of the research, the science expert participated in the process along with the researcher and acted in cooperation from the beginning to the end. All documents were examined by the expert, the researcher was given feedback where necessary, and the course of the research was decided together. Direct quotations from the participants' opinions were included and the data were tried to be conveyed objectively without comments. Although reaching all the teachers who work in the central district of Sinop province might not be sufficient for a generalisation, it is considered important in terms of sustainability of the study.

In order to ensure *reliability*, the researcher's persistence in objectivity regarding the data obtained from the study was taken into consideration, the categorisations and coding derived from the data were carried out by the two researchers at different times, and they were continually compared to reach a consensus. When the inter-coder reliability between the two researchers was calculated using the reliability formula proposed by Miles and Huberman (1994), the percentage of agreement between the researchers was determined to be .92 and a third expert was consulted when deemed necessary. This rate that was determined is considered reliable according to Miles and Huberman (1994).

3. Findings

Research findings are sequentially presented under subheadings.

3.1. Findings relating to the science teachers' perception of SSI

The findings involving the science teachers' opinions about the nature of SSI are given in Table 3:

Table 3. *The Science Teachers' Views on the Nature of SSI*

Categories	Code	Science Teachers	f
SSIs nature	Social issues	ST3,ST4,ST5,ST8,ST9,ST12,ST13,ST16,ST17,ST19,ST20	11
	Issues involving a dilemma	ST22	1
	It is about science literacy	ST15	1
	I have no idea	ST1,ST2,ST6,ST7,ST10,ST11,ST14,ST18,ST21	9
Examples	Nuclear power plants	ST5, ST12, ST15, ST20	4
	Technological developments	ST3,ST6	2
	Recycling	ST7, ST19	2
	Global warming	ST8	1

Hydroelectric power plants	ST10	1
Genetic tests	ST22	1
No examples	ST1, ST2, ST4, ST9, ST11, ST13, ST14, ST16, ST17, ST18, ST21	11

As can be seen in Table 3, half of the science teachers (f=11) stated regarding the definition of SSI that they are social issues, that they are issues which put a teacher in a dilemma, and that they are issues relating to the science literacy of a teacher. Many other teachers (f=9) stated that they do not have an idea/knowledge about SSI. Examples from the science teachers' statements are given below:

> *"Unification of society and science comes to my mind. They can be scientific issues related to society." (ST8)*

> *"SSI is a concept I already know about. Those issues which push us into a dilemma are called SSI. In other words, they are issues which make it difficult for individuals to decide and which put them in a dilemma. (ST22)*

> *"Could it be about science literacy? That's because I think science literacy and SSI are similar concepts. I can say that all subjects that improve science literacy are socio-scientific. (ST15)*

As it is seen in the statements, teachers' explanations about SSI are more about their being issues which are social, which cause a dilemma and which relate to science literacy. On the other hand, teachers who did not have any idea about SSI stated that they had not heard the concept of SSI before.

Assessed in a general way, it was determined that there was a teacher who was familiar with the concept of SSI and had an idea about it. It was observed and determined by the researchers during interviews that the other teachers who made a definition about SSI rather took the concept of "socio-scientific" as the basis for their belief that these issues are social in nature. Observer notes also indicated that teachers thought for a long time, looked at each other, and had difficulty in defining SSI. In fact, when defining SSI, one of the teachers tried to reach a conclusion based on the concepts of socio- and science and eventually said, "*...maybe it is anthropology.*" It can actually be said that an almost similar situation was encountered in all of the interviews. As a matter of fact, the teachers thought for a long time about the meaning of the words related to SSI to develop an opinion.

According to Table 3, the science teachers' examples of SSI include nuclear power plants (f=4), technological developments (f=2), recycling (f=2), global warming (f=1), HEPP (f=1) and genetic tests (f=1). It was found that a majority of the teachers (f=11) could not give examples. Although the physical conditions of schools, ecosystem, energy conversions and epidemic diseases are not considered as SSI, they were given as examples by teachers. It was mentioned in observer notes that teachers were able to give examples relevant to their SSI definitions and that half of them failed to give examples of SSI. It was also observed that most of the teachers who could not give examples had difficulty in defining SSIor could not define it at all. In fact, a teacher's statement of "*It is certainly related to society but I can't remember it*" also supports this finding.

Table 4 presents the findings obtained from the explanations made by the science teachers after they were asked a probing question about the characteristics that distinguish SSI from other science issues:

Table 4. *The Science Teachers' Explanations about SSIs Difference from Other Science Issues*

Categories	Code	Science Teachers	f
Social	Their being social	ST1, ST6, ST9, ST10, ST12, ST13, ST14, ST15, ST16, ST18, ST20	11
	Their being preventable	ST2, ST5, ST7, ST11, ST20	5
Personal	Their causing a dilemma	ST3, ST4, ST8, ST17, ST22	
	Their being arguable	ST8, ST19	

As seen in Table 4, half of the teachers (f=11) considered SSI to be different from other science issues due to their sociality. Some of the teachers (f=5) stated that these issues are different from other science subjects as they are preventable. Teachers also stated that SSIare different from other science issues because they create a dilemma (f=5) and because they are arguable (f=2). Examples of teacher statements are as follows:

> *"… These issues put us in a dilemma." (ST4)*
>
> *"There are scientific issues which correspond to the needs of society, that is, which involve more common ground for society. (ST15)*
>
> *"SSI are issues that concern the entire society." (ST6)*
>
> *"Other science issues are proven issues, they don't need your comments, but these are issues open to discussion." (ST8)*

According to their statements, the science teachers explained that SSI are different from other science issues because of being social, creating a dilemma, being preventable and responding to a need. As a general assessment, it was determined that the teachers thought that the most important difference in SSI is about their being social issues. It was observed and determined by the researchers that the reason for this was the examples given during interviews. The statement of the teacher numbered 10 (ST10) "*I think that issues like organ donation and nuclear power plants are issues that concern society. Therefore, they are different from other science issues. They are open to comment…*" indicated that ST10 did not have any idea about the nature of SSI initially but made an inference based on the examples given.

In the study, the findings obtained from the explanations of the science teachers about the issues that put them in a dilemma when making decisions about SSI are given in Table 5.

Table 5. *The Science Teachers' Explanations about the Issues in Which They Remain in Dilemma*

Categories	Code	Science Teachers	f
Issues	Nuclear power plants	ST1, ST4, ST5, ST9, ST12, ST13, ST15, ST17, ST20	9
	GMO	ST6, ST8, ST10, ST18, ST19, ST16	6
	Sugar intake during pregnancy	ST3,ST7, ST14, ST17	4
	Use of medicine	ST1, ST2, ST11	3
	Genetic tests	ST22	1

As presented in Table 5, the examples given by the science teachers about controversial/dilemma issues included nuclear power plants (f=9), GMO (f=6), glucose tolerance test (f=4), use of medicine (f=3) and genetic tests (f=1). Some of the explanations made by the teachers are as follows:

> *"As a person from the Black Sea region who experienced a nuclear disaster, I'm in a dilemma. I'm against the establishment of nuclear power plants, but I'm also aware that clean energy isn't enough for so many people." (ST15)*

> *"While I was pregnant with my first child, I had a glucose tolerance test made on me but I didn't do it with the second child. As a result of my research, I decided to not have it in the second child." (ST7)*

When the statements of the science teachers are examined, it is seen that all of the examples given by teachers who had an idea about SSI were relevant to SSI. It was observed that most of the teachers expressed this during the interview. For instance, T18, who had no idea about SSI in the first question, referred backed to the first question in the next question and gave the example of GMO.

After the above question, it was asked to teachers as a probing question what source(s) they used for the issues about which they remain in dilemma and wonder about. Findings obtained from focus group interviews are presented in Table 6:

Table 6. *The Science Teachers' Explanations about the Sources They Use for Making Decisions*

Categories	Code	f
Media	Internet	10
	TV	7
	Newspapers	5
Authority	Expert opinion	7
Scientific publications	Articles	3

Table 6 shows that, when they make decisions on the issues about which they experience a dilemma, many of the teachers take the Internet (f=10), TV (f=7) and expert opinions (f=7) into consideration and benefit from newspapers (f=5) as media elements, whereas three teachers make their decisions based on the scientific articles they read. Some of the explanations made by the teachers are as follows:

> *"The result of the triple screening test I had during pregnancy was risky. I searched on the Internet for the advantages of having it and my doctor had already recommended it. I also searched online the drawbacks of having it…" (ST22)*

> *"I mostly examine scientific studies and articles because they are supported with data." (ST19)*

3.2. Findings Involving Science Teachers' Perceptions of SSIs Place in the Science Curriculum and Its Inclusion in the Curriculum

The findings obtained from the views of the science teachers regarding to which learning area socio-scientific issues belong are presented in Table 7:

Table 7. *The Science Teachers' Views about the Place of SSI in the Curriculum*

Categories	Code	Science Teachers	f
Area of learning	STSE	ST1, ST7, ST8, ST10, ST22	5
	Affect	ST11, ST14, ST21	3
	Knowledge	ST12, ST19	2
	I don't know	ST2, ST3, ST4, ST5, ST6, ST9, ST13, ST15, ST16, ST17, ST18, ST20	12

**STSE: Science-technology-society and environment*

Regarding in which learning area of science curriculum SSI is situated, answers of the science teachers included STSE (f=5), affect (f=3) and knowledge (f=2). Many of the teachers (f=12) stated that they do not know to which learning area SSI belongs. Some of the explanations made by the teachers are as follows:

> *"It's in the human and environmental unit. I don't know about learning areas but I can talk about units." (ST3)*

> *"We write the gains in notebooks. Global warming effects, earthquakes, effects of earthquakes, etc. but I don't know about learning areas. (ST13)*

> *"It belongs to the learning area of STSE." (ST7)*

According to the statements of the science teachers, most of them do not know the learning area to which SSI belongs. The fact that, during focus group interviews, ST17 stated that "*Actually, I haven't examined the science curriculum. I act according to the annual plans. That's why I don't know about the learning areas of the curriculum*" and ST15 stated that "*Since our aim is to educate according to the annual plans, we don't actually have knowledge about the general aims of the program and its learning areas*" indicates that they do not have knowledge about the learning areas of the curriculum. This situation appears to suggest that teachers focus on the course process and therefore lack knowledge about the general profile of the curriculum.

In order to determine the views of the science teachers about SSIs inclusion in a learning area of the Science Curriculum, they were asked why socio-scientific issues are included in science course and their perspectives about it, and the findings obtained from the interviews are presented in Table 8:

Table 8. *The Science Teachers' Explanations about SSIs Inclusion in the Curriculum*

Categories	Code	Science Teachers	f
Skill Development	Thinking critically	ST2, ST3, ST14, ST19	4
	Problem-solving	ST1, ST22	2
	Decision-making	ST10, ST22	2
	Discussion	ST6	1
	Thinking creatively	ST14	1
Social	Producing solutions to problems	ST5, ST7, ST11, ST12, ST16	5
	Issues concerning society	ST4, ST17, ST8, ST15, ST17	5
	State policy	ST13	1
Undecided		ST9, ST18, ST20, ST21	4

As seen in Table 8, a majority of teachers (f=18) stated that SSIs inclusion as a name in a learning area of the Science Curriculum is a positive situation. No teacher considered it as a negative situation but four teachers (f=4) were undecided about it. Regarding the reasons for teachers' considering it to be positive, answers included their being issues that concern society (f=5), that they require producing solutions (f=5), critical thinking (f=4), problem-solving (f=2), decision-making (1), discussion (f=1), their offering an opportunity for using creative thinking skills (f=1) and state policy (f=1). Some of the explanations made by the teachers are as follows:

> *"I certainly consider it positive. These are issues that concern society. Students are the core of society. If we can influence students, their families will also be influenced. I think the best guidance for society can be made from classes." (ST17)*

> *"I also certainly consider it to be positive. The effects have become more common with these issues… Questioning individuals need to be raised to find solutions to some problems." (ST5)*

In general, it was seen that a majority of the teachers consider that the inclusion of SSI in the curriculum is positive and they stated that the reason for this is solution generation and skill development. It was determined that the teachers who were undecided stated that its applicability in courses might be low and that this is why they are undecided.

The findings obtained from the explanations of the science teachers about teaching socio-scientific issues in their classes are given in Table 9.

Table 9. *The Science Teachers' Explanations about Including SSI in Courses*

Category	Code	f
Approach	Yes	14
	No	8

When Table 9 is examined, it is seen that a majority of the science teachers (f=14) stated that they include SSI in science classes. Some of the teachers (f=8) said that they do not teach SSI in their courses.

Table 10 presents the findings about the teachers' answers to the question of how they teach SSI in the classroom.

Table 10. *Findings Containing the Views of the Science Teachers about How They Teach SSI*

Categories	Code	Science Teachers	f
Method and Technique	Direct instruction	ST1, ST2, ST3, ST7, ST9, ST13, ST15, ST19, ST20, ST21	10
	Case study	ST5, ST6, ST7, ST10, ST12, ST13, ST15, ST19, ST21	9
	Debate	ST4, ST7, ST12, ST13, ST14, ST17, ST19, ST22	8
	Discussion	ST4, ST10, ST12, ST14, ST15	5
	Project	ST8, ST16, ST17	3
	Brainstorming	ST5, ST13, ST22	3
	Question-Answer	ST2, ST3	2
	Six hats	ST10, ST13	2
	Observation	ST18	1
	Presentation	ST17	1
	Questionnaire	ST4	1
Principle	Doing and experiencing	ST10, ST11, ST15	3
	Induction and deduction	ST1	1
Source	Media	ST2, ST5, ST8, ST9, ST11, ST13, ST14, ST15, ST16, ST17, ST18, ST19, ST21, ST22	1
	Textbooks-sourcebooks	ST1	1

Table 10 shows that most of the science teachers (f=10) used the direct instruction method to explain SSI in their classes, while other teachers used the methods of case study (f=9),

discussion (f=5) and project (f=3). It was ascertained that teachers used the techniques of debate (f=8), brainstorming (f=3), question & answer (f=2), six hats (f=2), observation (f=1) and presentation (f=1). Three teachers stated that they teach SSI in their classes according to the principle of doing-experiencing and another teacher according to induction-deduction. As for sources, 13 teachers mentioned the media, and one teacher mentioned textbooks and sourcebooks. Some of the explanations made by the teachers are as follows:

> *"It is already included in the gains. Of course, I also teach it in my classes. I teach it as it is specified in the gains. Sometimes I give more details if there is time. I prefer direct instruction." (ST1)*
>
> *"I normally do these classes according to the curriculum, but occasionally I also use the debate and case study methods to ensure that they can make conscious decisions." (ST19)*
>
> *"I want them to do a questionnaire in the form of "Who among your relatives will want to donate their organs and who will not?", for instance..." (ST4)*

ST13's statement "*Many methods may be used actually, but I suppose it's easier to implement whatever the curriculum stipulates*" and ST20's statement "*I agree that I was actually doing according to the curriculum because I don't have any knowledge about how to apply it but different things have come to my mind when talking about it…*" indicate that they teach SSI based on curriculum gains but that they also refer to different methods and techniques.

As can be seen in Table 10, a majority of the science teachers (f=14) stated that they utilize the media / that the media should be utilized when teaching SSI in the classroom setting. The media elements that the teachers stated that they use / should be used included newspapers (f=13), the Internet (f=1), visual materials (f=1), public service announcements (f=1), documentaries (f=1) and TV (f=1), respectively. Some of the explanations made by the teachers are as follows:

> *"They have already utilized it in their research assignments. The presentations they prepare and bring include newspaper reports." (ST19)*
>
> *"I prefer to benefit from the Internet; it is very attention-grabbing for students." (ST22)*

It was observed that science teachers stated that they and their students benefit from the media in SSI education, but a few teachers stated that it is difficult to use the media under the present conditions. ST20's statement "*You've seen our school; not every class is equipped with technology, which is a requirement for the media…*" and ST21's statement "*I understand that the media is important in these matters. I wish we had the opportunity of offering children examples from the media…*", which they made to the researcher and the consultant in an interview break, show that they made a positive emphasis on the use of the media in SSI education but indicated the limitation of its use due to lack of technical opportunities.

> *"...I present sections from daily newspapers". (ST18)*
>
> *"Socio-scientific issues are very popular in the media, especially on TV. Like flu vaccines, genetic tests, etc. I guide students to do research from the Internet. (ST22)*

"I tell them to watch the morning news. I tell them to buy newspapers. I gave oral exam points to those who watched and told the news. But time arrangement and examinations are a source of significant distress." (ST16)

Findings obtained from the science teachers' views about the benefits that SSI classroom education will offer to students are given in Table 11.

Table 11. *The Science Teachers' Views about the Benefits/Skills That SSI Education Provided to Students*

Categories	**Code**	**Science Teachers**	**f**
Life skills	Critical thinking	ST1, ST4, ST8, ST9, ST11, ST16, ST20	7
	Decision-making	ST2, ST8, ST17, ST19, ST21, ST22	6
	Communication	ST2, ST6, ST12, ST14	4
	Creative thinking	ST15, ST22	2
	Teamwork	ST5, ST19	2
Scientific process skills	Inferring	ST7	1
Engineering and design skills	Being able to produce solutions	ST3, ST10, ST13, ST18, ST22	5

According to Table 11, the science teachers listed the benefits/skills that SSI education contributes to students as follows: critical thinking (f=7), decision making (f=6), communication (f=4), creative thinking (f=2), teamwork (f=2), inference (f=1), ability to produce solutions (f=5). Some of the explanations made by the teachers are as follows:

"It is ensured that they learn the ideas of others. Communication is established among them. They also start looking for answers about things they wonder. This enables them to make their own decisions." (ST2)

"Students learn to question. They notice that not everything that is told to them is true. They gain the ability to criticise." (ST19)

The teachers pointed out that the process of teaching SSI has many contributions to students. Especially one of the teachers (ST1) who emphasised the decision-making skill said during an interview that "*Deciding is difficult for all of us. I'm sure the students will also have difficulty in these issues but it would still be good to experience this situation. Because they will also be learning to question*" and tried to support this opinion with examples from daily life (nuclear power plants, flu vaccines, etc.).

The findings obtained from the opinions of the science teachers about the difficulties they face in the teaching of SSI are given in Table 12.

Table 12. *The Science Teachers' Views about the Difficulties They Have in Teaching SSI*

Categories	**Code**	**Science Teachers**	**f**
Yes	Prejudices of students	ST4, ST5, ST6, ST11, ST16, ST17, ST18, ST19, ST20, ST22	10
	Readiness of students	ST2, ST7, ST10, ST11, ST17, ST21	6
	Teachers' lack of knowledge	ST13, ST15	2
	Insufficiency of class hours	ST15	1
No		ST1, ST3, ST8	3
Undecided		ST9, ST12, ST14	3

As it can be seen in Table 12, most of the science teachers (f=16) stated that they have difficulty in teaching SSI and some (f=3) stated that they do not. Three teachers stated that they are undecided. The teachers stated that the difficulties they experience are caused by the prejudices of students (f=10), the readiness level of students (f=6), students' lack of knowledge (f=2) and insufficiency of class hours (f=1). Some of the explanations made by the teachers are as follows:

> *"Of course, we occasionally suffer difficulty. Sometimes, the age of students is too small. They're not old enough to comprehend such things. Even students in the 5thand 6thyears can have difficulty in understanding such issues." (ST2)*

> *"There is a prejudice among students. They come with a complete conviction on some information and it is not possible to overcome it. Teaching critical thinking becomes very difficult." (ST4)*

When the statements of the teachers are examined, it is seen that they emphasise the elements of prejudice and age. It was determined that the teachers have difficulty in this situation and that any controversial issue they discuss with the students cause a negative attitude in them. One of the teachers (ST6) stated that *"…believe me that it's so hard to open the mind of some students to try to explain that different views also exist…*" and this supports the opinion of many teachers. However, in general, it was also observed that most of the teachers find it positive to include controversial issues in the teaching process and they agree that the outcomes will take time.

Then, within the scope of the research, the science teachers were asked to make suggestions about the teaching of SSI. The findings obtained from the interviews made with teachers are given in Table 13:

Table 13. *Suggestions of the Science Teachers about the Teaching of SSI*

Categories	Code	Science Teachers	f
Out of classroom	Interviews should be made.	ST2, ST3, ST5, ST7, ST8, ST9, ST11, ST16, ST17, ST18, ST21	11
	Experts should attend classes.	ST1, ST15, ST19, ST20, ST21	5
	Real-life practices should be made.	ST2, ST3, ST8, ST22	4
	Tours should be organised.	ST5, ST8	2
	Seminars should be organised.	ST20, ST21	2
	There should be a science applications course.	ST7, ST10	2
In classroom	Material support should be made.	ST13, ST14	2
	Noticeboards should be made.	ST6	1

As seen in Table 13, many of the science teachers (f=11) stated that, within the scope of teaching SSI, interviews should be made with those who carry out studies on the subject in various fields outside the classroom. Suggestions of other teachers included bringing experts to classes (f=5), carrying out daily life practices (f=4), organising tours (f=2), organising seminars (f=2), and discussing relevant subjects with selected students (f=2). Two teachers (f=2) stated that there will be sufficient time for teaching these issues only when there is a "science applications" course, two others (f=2) stated that the necessity for sufficient support in terms of materials, while one teacher (f=1) said that information on SSI has to be provided through noticeboards. Some of the explanations made by the teachers are as follows:

> *"Bringing experts will be helpful. I think it would be very interesting for students if relevant experts attended classes. We tried to do it before, but they didn't come because they didn't have to. It has to be compulsory for this to happen. It can only be possible by cooperation with the national education and other ministries." (ST1)*

> *"This can be taken out of school. Environments can be created in schools for this. They can learn better by organising trips and observations after obtaining necessary permits." (ST5)*

In the end of the interviews, teachers pointed out that they mostly wanted to reach the field experts and that these experts should be brought together with students. They stated that they think these will make positive contributions to themselves and students. For example, one of the teachers (ST15) said that "*There is no need to go far; everyone in Sinop is against*

nuclear energy, for example. I wish people and children were informed through seminars…" and similar opinions were expressed during many interviews.

Most of the research participants agreed that they need seminars, meetings and practical activities which will contribute to them and introduce and present the program framework to them. Stating that there are many questions they want to ask about these issues, the teachers pointed out that they need methods and techniques which they will use in the process of teaching these issues in the classroom and that they want to receive training about these. One of the teachers (ST10) said during an interview that "*The truth of the matter is different; yes, there is the curriculum but believe me that attending our classes is the only thing we can do due to the heavy load of our job. I wish they could give us training and we could practice it in our classes…*", and many teachers who agree with this idea emphasised that they want to have information on the issue and make applications towards the educational process.

4. Result and Discussion

In the present study, science teachers' perception of SSI was examined in 4 categories (SSIs nature, difference of SSI from other science subjects, the issues about which teachers remain in dilemma in decision-making, and the sources that teachers use in decision-making). Firstly, when the answers of the teachers were examined, it was determined that most of the science teachers did not know about SSI and did not hear of this concept before. Many participants in the group described SSI as *social issues* based on lexical meanings. It was observed that most of the teachers in the group did not express opinions. Similarly, Han Tosunoğlu and İrez (2017) stated in their study that biology teachers generally expressed SSI as 'scientific issues that produce solutions to social problems'. It was found within the scope of the research that only one teacher defined SSI as '*issues that put one in a dilemma*'. This indicates that only a small number of teachers are aware of the nature of SSI. Similar to the findings of the present study, Han Tosunoğlu (2018) conducted a study with biology teachers and found that the teachers did not know what SSI means. However, in a study conducted with prospective science teachers, Sıbıç (2017) found that many prospective teachers had previously encountered the concept of SSI. Similarly, in a study conducted with teacher candidates, Yolagiden (2017) ascertained that pre-service teachers' attitudes towards socio-scientific issues were above the intermediate level. This situation is thought to be due to the fact that SSI teaching, which has gained importance in recent years, has started to find a place in university education. A majority of science teachers stated that SSI differ from other science issues due to being social in nature. The teachers were subsequently asked to give examples of the situations which push them into a dilemma when making decisions in daily life. The examples given by them based on their own experiences varied considerably, but a majority of them were identified to be SSI. Many of the teachers who were in the decision-making process about SSI stated that they use the Internet as a source. This shows that teachers tend to use the Internet instead of scientific studies for easy accessibility. The results obtained from this study show that a significant number of science teachers do not have the level of knowledge which is a prerequisite for SSI. As a matter of fact, it is believed that science teachers do not have sufficient knowledge about SSI and about the methods and techniques with which they would teach it (Topçu, 2017).

In the present study, many of the science teachers stated that they do not know which learning domain SSI belongs to in the science curriculum. Some teachers stated that they did not examine the science curriculum and the learning areas of the curriculum. When the findings of the research were examined, it was found that science teachers took the concept of *society* in the learning area of STSE as basis for formulating opinions about the learning area to which SSI belongs. Similar to the findings of the present research, Han Tosunoğlu and

İrez (2017) reached the conclusion in their study that the SSI perception of a significant majority of the biology teachers in Turkey and their general perspective about SSI education are not compatible with the current literature. This result indirectly suggests that teachers do not follow and examine current curricula.

The science teachers stated that they found it favourable for SSI to be included in the science curriculum. When the reason for their positive opinion was asked, it was determined that the reason of this situation was that they thought it would increase the development of students' critical thinking, problem-solving, decision making and discussion skills, and that it was included in the curriculum for the purpose of producing solutions. In their study conducted with science teachers, Lee et al. (2006) show that teachers considered the inclusion of SSI in their curriculum to be favourable. In the study, it was seen that some of the teachers were undecided about this issue. When the reason for this was asked, the undecided teachers stated that the teaching process of these issues could be difficult for various reasons (such as class size).

In the present study, it was found that the majority of teachers included SSI teaching in their classes. No teacher who stated that they did not include SSI instruction in their class activities was identified. The researcher determined that those teachers who included the teaching of SSI in their classes stated that they teach SSI in their courses by using the direct instruction and case study methods. In accordance with the nature of SSI, some teachers were found to use the debate and brainstorming techniques. Some teachers explained that many methods and techniques are available but they have difficulties in classroom practice due to various factors. It was found out that, in SSI education, most of the teachers benefited from newspaper reports due to their easy accessibility and low cost. It was found out that most of the teachers benefited from newspaper reports because of their easy accessibility and low cost. In general, it was observed that the science teachers stated that they and their students benefited from the media in the teaching of SSI, but a few stated that it was difficult to use the media due to the lack of necessary means. Topçu (2017) emphasised that the most important deficiency for science teachers to use the methods and techniques they determine to teach SSIs better is that teachers do not have sufficient resources. Han Tosunoğlu and İrez (2017) reported that teachers generally use methods and techniques to engage students in the course and that inclusion in any subject matter does not occur. They discovered that teachers generally use techniques that are not directly related to the teaching of SSI, such as the use of smart boards, travel arrangements, and use of visuals.

The present study researched the opinions of science teachers about the contributions of discussing SSI in the classroom to students. When the results obtained from the findings are examined, it is seen that a majority of the teachers' answers such as critical thinking, finding solutions and communication are similar to the aims of the teaching of SSI. Similarly, Han Tosunoğlu and İrez (2017) reported that the participants thought that, as a result of SSI discussions, their students would acquire skills such as recognizing different opinions on a certain subject, approaching situations with different perspectives and questioning them.

The science teachers stated that they experienced difficulties when they included controversial topics such as SSI in their classes. It was found that the most important reason for this was the prejudices of the students. Many teachers stated that the age of the students was too small to understand such controversial issues and to have the skills to discuss them. Two teachers said that they do not have sufficient knowledge to teach these issues. It was seen that three teachers stated that they had no difficulty in teaching related subjects, while three others were hesitant to answer.

Teachers, who apply the curriculum, made suggestions about the teaching of these issues. When the findings were examined, it was found that most of the teachers stated that the teaching of SSI should also be performed out of the classroom. This can be indicating that the teachers think that the school environment is not sufficient for learning these issues. Teachers stated that students can only learn these issues together with experts. They argued that interviews can be made or experts can attend classes for this purpose. Some teachers reported that learning these issues is only possible by applying them in real life. Two of the teachers stated that they should be given seminars about these issues. This situation can be interpreted as teachers' feeling themselves insufficient and open to improvement.

According to the findings of the study, the science teachers stated that the elective course of science applications should be dedicated to SSI education because of insufficient course hours. The teachers stated that when adequate material support is provided to schools, an appropriate learning environment can be created for SSI teaching. This desire of teachers can be interpreted as being aware of their deficiencies and desiring to improve themselves. Topçu (2017) pointed out that science teachers do not have sufficient in-service education on SSI and that they do not have the necessary materials for SSI education. Some of the teachers stated that there should be guide books which they consider to be instructive. The teachers said that they think that the evaluation phase of the controversial issues such as SSI should be different from the evaluation phase of other subjects.

In conclusion, considering the importance of SSI in national and international literature and based on the findings of this study, it is believed that science teachers in Turkey feel themselves inadequate regarding SSI and SSI education. Our findings suggest that the teachers think that it is important for them to have knowledge about the methods and techniques they will use for SSI education and have opinions about the ways of dealing with the problems they will face in the process. It is believed that each of the suggestions of science teachers, who are the implementers of the curriculum, will strengthen the SSI education process and that the suggestions derived from the present study findings will guide educational researchers, teachers and pre-service teachers.

5. Suggestions

- Application examples of SSI can be added to the science curriculum.
- SSI related science education can be added to undergraduate programs as elective or compulsory courses. Within the scope of this course, opportunities can be offered for prospective teachers to be informed about these issues, be aware of the issues and gain experience about the methods and techniques to be used in teaching the subjects before starting the teaching profession.
- In accordance with the suggestions of science teachers in the present research, the vision of the renewed science course curriculum, learning areas, application examples related to various method techniques, applied in-service trainings and seminars about the adopted learning approaches can be given to the teachers.
- Quantitative studies can be conducted by developing measurement tools to determine the views of science teachers on their perception and teaching of SSI. In this way, a wider impact can be achieved by reaching more participants.
- In Turkey, a teaching model can be developed and its effectiveness can be evaluated.

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