ORIGINAL ARTICLE

Examination of the Views of Science Teachers Trained in a Project on Socioscientific Issues

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***Abstract**: Socioscientific issues (SSIs) have a scientific basis, have a dilemma in their nature and are often discussed under political and social influences. Teachers perceive SSIs as a difficult subject to teach. This project was carried out to guide teachers in overcoming this difficulty and to enable them to include practices that they can adapt more easily to their lessons. The purpose of the current study is to evaluate the views of science teachers on the teaching of SSIs and the project carried out within the scope of a funding project for teaching SSIs. The study was designed according to a single-group pre-test post-test experimental design. The study group the study comprises teachers from different branches of science (15 middle school science teachers, four biology teachers, three physics teachers and two chemistry teachers) from various provinces of Türkiye. As the data collection tools of the study, the Project Participation Form, the Scale of Views on Teaching Socioscientific Issues, the Know-Want-Learn Form and the Project Evaluation Form were used. Quantitative and qualitative data analysis methods were used together in the evaluation of the data. Because of the study, the implemented project activities contributed to the development of the participants' views on the teaching of SSIs and caused a positive development in their views on the project. Suggestions were made considering the results of the project so that guidance could be provided for teachers and teacher educators.*

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Introduction

"SOCIOSCIENTIFIC issues (SSIs) are up-to-date scientific issues that closely affect societies and their lives (Sadler, 2004). In other words, these issues include situations where there is a dilemma, no clear answer, and where decisions may depend on individual values (Zeidler et al., 2009). Nuclear power plants, nanotechnology, global climate change, cloning, stem cell applications, genetically modified organisms and vaccine studies can be given as examples of SSIs. The importance of SSIs in science education comes from there being an important component in the development of scientific literacy (Ke et al., 2021; Zeidler, 2014). Therefore, every science teacher who educates scientifically literate individuals should know the methods/techniques used in the teaching of SSIs in their lessons and have sufficient knowledge in the evaluation of students' SSI knowledge.

SSIs, which are in science curricula in many countries to ensure scientific literacy, were started to be included in the Middle School Science Curriculum (Ministry of National Education of Türkiye [MoNET], 2013a), Physics Curriculum (MoNET, 2013b) and Biology Curriculum (MoNET, 2013d), which were prepared in Türkiye in 2013. It has been seen that there has been an increasing interest in SSIs since then (Tekin et al., 2016). As in the Science Curriculum (MoNET, 2018a) developed in 2018, socioscientific objectives were also included in secondary curricula. The subjects covered by these objectives can be summarized as follows: thermal insulation, global climate change, solar cells (MoNET, 2018b), acid rain, convenience foods, fossil fuels (MoNET, 2018c), viruses, biodiversity, organ transplantation, biotechnology, cloning, agricultural applications (MoNET, 2018d), environmental issues, alternative energy sources, nanotechnology (MoNET, 2018b; MoNET, 2018c; MoNET, 2018d). As it can be seen, science teachers frequently encounter SSIs in their lessons starting from secondary education. According to Levinson (2013), one of the main dilemmas in teaching SSIs is whether SSIs addressed in curricula in schools have real-world counterparts. According to Zeidler et al. (2011), SSIs can be applied formally outside the school and formally learned at school. However, teachers who want to encourage their students to question SSIs, to argue, to reason and to make informed scientific decisions by using lesson plans are expected to act as a moderator, not as a provider of scientific knowledge. In this connection, teachers can make improvements in their pedagogical content knowledge (PCK) possible by using SSIs in their lesson plans. Minken et al. (2021) stated that because of five months of training, teachers developed PCK components related to SSIs by using lesson plans, but that they had difficulties balancing the social and scientific aspects of SSIs. Here, PCK has an important place in the teaching of SSIs in the curriculum. For this, Lee (2016) cre-

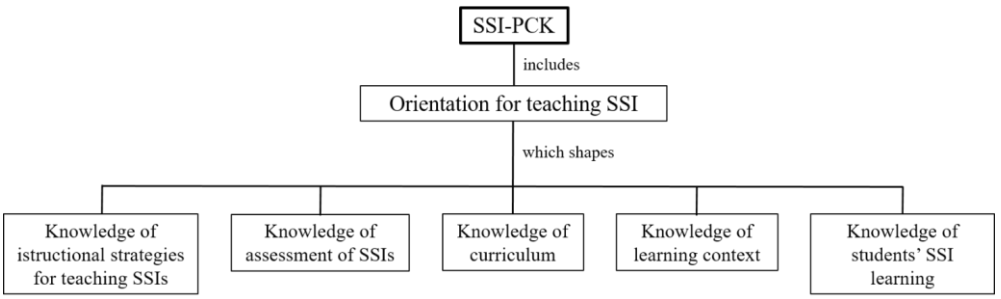

Figure 1. SSI-PCK Components and Relationships (Lee, 2016).

ated a map showing the SSI-PCK components and the relationships between them (**Figure 1**).

According to this map, SSI-PCK can be formed by shaping the information of students about teaching strategies, evaluation, curriculum, learning content and students' learning of SSIs for teaching SSIs. Activities suggested by Macalalag et al. (2020) made this content more understandable. Accordingly, discussing on SSIs, creating a lesson plan, planning prior knowledge expected from students, hands-on activities and evaluation of the lesson all support the efficient teaching of SSIs (Macalalag et al., 2020).

In order for teachers and pre-service teachers to be more closely interested in SSIs, to focus on these issues in their teaching and to develop their self-efficacy in this regard, these issues should be included in university education (Topçu et al., 2014). Not only pre-service teachers but also teachers need in-service training to improve their knowledge and skills on these issues (Topçu et al., 2014). However, in the study by Uluçınar Sağır and Dolunay (2021), pre-service teachers stated that they do not consider themselves be competent in the teaching of SSIs. They attributed their incompetence to the fact that the education they received was insufficient in teaching these issues and that they did not conduct individual research on these issues. Similarly, Evagorou and Puig Mauriz (2017) stated that both pre-service and in-service teachers have difficulties integrating the social aspects of science into teaching. Kokolaki and Stavrou (2022) stated that this situation is associated with teachers' limited content knowledge of SSIs (lack of knowledge about non-scientific aspects of the issues such as social, political and moral dimensions), lack of knowledge about scientific knowledge (inability to interpret scientific evidence and ambiguities) and limited knowledge of SSI teaching practices and evaluation strategies. When the renewed Council of Higher Education (CEH) Teacher Training Undergraduate Programs (CEH, 2018) is examined, it is seen that there is no required course related to SSIs in science, physics, chemistry and biology teaching undergraduate programs.

However, these issues are included in the content of two elective courses offered in the Science Education Undergraduate Program and in one elective course in the Physics Teaching Undergraduate Program. Therefore, both preservice teachers and teachers need in-service training to improve their knowledge and skills on these issues. Project studies based on teacher education can open an important door that includes activities that will guide them in this context. This necessity led the researcher of the current study to conduct a teacher education project with the content of SSIs.

When the projects involving teacher education are examined, it is seen that TÜBİTAK (The Scientific and Technological Research Council of Türkiye) funded science-society projects have been conducted on various subjects in recent years. Projects with the content of SSIs are seen to be focused on the areas that will contribute to the teaching of these issues (i.e. Identification and Comparison of Scientific Thinking Habits Using Socioscientific Issues), that will address local SSIs (i.e. Energy Resources in our Paradise Province of Muğla, Journey to Socioscientific Issues, Argumentation of Socioscientific Issues in the Eastern Black Sea Region, Konya Plains Project [KPP] Region Science Teachers are Learning Socioscientific Issues with Interactive Activities), where one of these issues comes to the fore (i.e. Recognizing the Energy Resources of the Future with the Architects of the Future, Teachers of the Future, Biotechnology as the Technology of the Future, Bridge from School to Society, Nanotechnology Clubs). Among these projects, the project titled "KPP Region Science Teachers Learn Socioscientific Issues with Interactive Activities" is the first project coordinated by the researcher in the current project. These projects have provided guidance to the research in the creation of the current project. However, in most of these projects, it is seen that only some objectives addressed in different fields of science are included. The current study is more comprehensive in terms of including the objectives of both secondary school science lessons and secondary school physics-chemistry-biology lessons, and the use of various teaching methods/techniques in teaching SSIs. The objectives addressed with the activities conducted within the project are given in detail in the methods section.

In teaching SSIs, many studies are focused on argumentation (Capkinoglu et al., 2020; Dawson & Carson, 2020; Namdar & Shen, 2016), dilemmas (Rydberg et al., 2017), reasoning (Cian, 2020; Karahan & Roehrig, 2017; Ozturk & Yilmaz -Tuzun, 2017), critical thinking (Gul & Akcay, 2020) and decision making strategies (Altmeyer & Dreesmann, 2021; Dauer et al., 2017; Sutter et al., 2019; Yapıcıoğlu & Aycan, 2018). From these studies, Capkinoglu et al. (2020) evaluated the 10-week argumentation process of students in their study of local environmental SSIs. Because of their study, they concluded that the quality of argumentation of each group varied depending on the data sources and SSI context. For example, while hydroelec-

tric power plants was a challenging issue for the groups participating in the study, the researchers found that high-quality arguments were made on issues such as artificial lakes and base stations. In another study, Chan (2020) informed teachers about different approaches to teaching SSIs depending on the issue and emphasized that students should be introduced to many SSIs. In another study, Gul and Akcay (2020), using a model based on SSIs, examined the change in pre-service teachers' critical thinking skills and tendencies in relation to the issue of climate change. Because of their studies, they concluded that the applied model increased the critical thinking tendencies of pre-service teachers. Yapıcıoğlu and Aycan (2018) examined the effects of teaching activities related to nuclear power plants on the decisions, positions and informal reasoning of pre-service teachers. In their study, they concluded that the pre-service teachers had decided that no nuclear power plant should be established. Another result related to the current study is that the pre-service teachers stated that the activities used led them to change their position. Therefore, the use of various teaching techniques in different SSIs is effective in the quality of argumentation, critical thinking tendency and changing decisions.

When the relevant literature is reviewed, it is seen that not including SSIs in the renewed teacher training undergraduate programs and their not having being introduced to SSIs before starting their professional career result in their having difficulty in creating the course content. The importance of teaching SSIs effectively by using various teaching methods/techniques in in-class activities, and therefore the need of teachers for these methods/techniques, created the current study. When the role of science-society projects in teacher education is considered, it is important to support science with out-of-school studies and teaching science in formal settings. In the studies conducted, it has been seen that the projects and research are mostly aimed at middle school students or teachers. It is seen as an important necessity to increase the number of studies on teaching SSIs in different branches of science starting from middle school by including physics, chemistry and biology teachers in the study. In this respect, it is valuable to ensure information sharing by referring to SSIs with the participation of teachers from almost every region of Türkiye, with both theoretical and practical training. Therefore, through this project, the following purpose was determined in accordance to create SSI awareness in teachers from different branches of science through interactive activities, their learning the nature and characteristics of SSIs, choosing activities to do so and including applications that they can use more easily in their lessons.

The purpose of the current study is to evaluate the views of science teachers about the teaching of SSIs and about the project carried out within the scope of a TUBITAK funding project that includes a teacher training

program for teaching SSIs. To this end, the following questions were determined as the research questions:

- *Did any changes occur in the views of science teachers about the teaching of SSIs after the project?*
- *Did any changes occur in the views of science teachers about the project after the completion of the project?*

Materials and Methods

Research Design

The current study was designed using a single-group pre-test post-test experimental design, which is one of the quantitative research methods. The single-group pre-test post-test experimental design is based on the measurement of the dependent variable through the administration of scales as a pre-test before the intervention and as a post-test after the completion of the intervention (Büyüköztürk et al., 2008). In this study, the Project Participation Form, the Scale of Views on Teaching Socioscientific Issues and the Know and Want stages of the Know-Want-Learn Form were administered as a pre-test, while the Scale of Views on Teaching Socioscientific Issues, the Want stage of the Know-Want-Learn Form and the Project Evaluation Form were applied as a post-test.

Participants

The study group of the current research comprises 24 teachers from different branches of science and from different provinces of Türkiye. Demographic information of the participating teachers is given in **Table 1**.

As shown in **Table 1**, the numbers of female teachers (n = 13) and male teachers (n = 11) participating in the project are similar to each other. More than half of the participating teachers are doing/have done their post-graduate degrees (n = 15). The teaching experiences of the participating teachers are as follows; 6–10 years (n = 8), 0–5 years (n = 5), 11–15 years (n = 4), 21 years and more (n = 4) and 16–20 years (n = 3). More than half of the teachers participating in the project are teachers from the branch of science (n = 15). Almost half of the teachers were from the Central Anatolian Region (n = 10). After the Central Anatolian Region, the Marmara Region (n = 6) had the highest number of participants. The lowest participation was from the Black Sea Region (n = 1) and there was no participation from the Eastern Anatolian Region. All the teachers participating in the project declared that they had not been involved in a project related to SSIs before.

Research Instruments

Table 1. Demographic Information of the Participating Teachers.

Characteristic		N	%
Gender	Female	13	54.2
	Male	11	45.8
Educational degree	Undergraduate	8	33.3
	Postgraduate	15	62.5
	Doctorate	1	4.2
Teaching experience	0–5 years	5	20.8
	6–10 years	8	33.3
	11–15 years	4	16.7
	16–20 years	3	12.5
	21 years and beyond	4	16.7
Branches	Science teachers	15	62.5
	Physics teachers	3	12.5
	Chemistry teachers	2	8.3
	Biology teachers	4	16.7
Region	Marmara	6	25.0
	Aegean	2	8.3
	Mediterranean	2	8.3
	Central Anatolia	10	41.7
	Black Sea	1	4.2
	South-eastern Anatolia	3	12.5
Participation in the previous project	Yes	0	0.0
	No	24	100.0

The Project Participation Form, the Scale of Views on Teaching Socioscientific Issues, the Know-Want-Learn Form and the Project Evaluation Form were used as data collection tools in the current research. Detailed information about the data collection tools used in the study is given below.

Project Participation Form

This form was used during the science teachers' process of application to the project. The form consists of demographic information and project participation application sections. The application section was created by the researcher to obtain information about the teachers' expectations from the project and methods-techniques they use in their lessons. In the study, the section of expectations from the project of this form was used as a pre-test in accordance with the research questions.

The Scale of Views on Teaching Socioscientific Issues

Table 2. Distribution of Activities, Aims and Learning Outcomes in Science Curricula.

Activity Title	Aim	Learning outcome*
Introduction to Socioscientific Issues	Introducing teachers to socioscientific issues and establishing their place in the context of science-society	Teachers were introduced to socioscientific issues in the science curriculum.
Which Socioscientific and Decision-making Criteria	To raise awareness among teachers about socioscientific issues, their history, their place in the curriculum and criteria for decision-making about these issues. To introduce different methods and techniques used in teaching these issues to teachers	F.6.4.3.4. Discusses the importance of thermal insulation in buildings in terms of family and country economy and effective use of resources. F.6.4.4.2. Discusses the effects of the use of different types of fuels for heating purposes on humans and the environment. F.8.7.3.4. They Generates ideas about the advantages and disadvantages of power plants. F.8.7.3.5. Discusses the importance of conscious and efficient use of electrical energy in terms of family and the national economy. 9.5.4.3. Designs for insulating the living space for energy saving. 12.6.2.5. Designs a system that facilitates daily life and uses solar cells.
Preparing a Lesson Plan according to the 5E Learning Model: Vaccines	To enable teachers to acquire the ability to prepare a lesson plan using the 5E Learning Model and to prepare a sample lesson plan suitable for the 5E Learning Model related to vaccines as a socioscientific issue	F.8.2.5.1. Relates genetic engineering and biotechnology. (Examples of breeding, vaccination, gene transfer, cloning, gene therapy are emphasized) F.8.2.5.2. We Discusses the dilemmas created within the scope of biotechnological applications and the beneficial and harmful aspects of these applications to humanity.
Turkey's Policy on GMO Foods	Implementing a sample SBK-based Jigsaw activity for teachers	F.8.2.5.3. Predicts what future genetic engineering and biotechnology applications might be. 12.1.2.4. We evaluated the effects of genetic engineering and biotechnology applications on human life.
Nanoscience Nanotechnology Education: I'm Designing a Nanobiosensor!	Teachers' discovery of the basic components for the use of nanoparticles, in biosensor technology, which is a nanotechnological application and increasingly involved in our daily lives	12.4.4.1. Evaluates developments in nanotechnology in terms of their effects on science, society, technology, environment and economy.
Our Space Trash	Discussing the pollution in the world based on critical thinking skills	F.7.1.1.2. We express the causes of space pollution and predict the possible consequences of this pollution.
Designing an Activity on Socioscientific Issues in the Ihlara Valley	Designing an activity involving socioscientific issues in the Ihlara Valley	F.5.6.1.2. discusses the factors that threaten biodiversity based on research data. 9.5.4.5. Develops a project for measures to be taken against global warming. 12.4.1.1. We offered solutions to reduce the harmful effects of fossil fuels on the environment.

**: Numbering such as "F.6, F.8" indicate middle school level learning outcomes, and numberings such as "9, 12" indicate high school-level learning outcomes.*

This scale was used to determine the views of the participating teachers about the teaching of SSIs. The 5-point Likert-type scale, adapted by Kara (2012) from the study by Lee et al. (2006), consists of 20 items and three sub-dimensions: Views on the necessity of SSIs in the content of the program (9 items, Cronbach alpha = 0.72); Views on the factors hindering the teaching of SSIs (7 items, Cronbach alpha = 0.78) and Belief in the personal efficacy of teaching SSIs (4 items, Cronbach alpha = 0.67). In this study, the Cronbach's alpha value of the scale was found to be 0.79 for the pre-test and 0.71 for the post-test. The scale was administered using paper and pencil in two stages as pre-test and post-test.

Know-Want-Learn (KWL) Form

It was used to determine what information the participating teachers had and what information they needed about the project subject before the project and what information they learned after the project. The form consists of three sections. Among these sections, the "Know" and "Want" sections were administered before the activities and the "Learn" section was administered after the activities.

Project Evaluation Forms

This was used to determine the participants' views about the project activities and the project at the end of the project. This form consists of two sections: "Evaluation of Activities," where the contents of the activities and the project team (project coordinator, experts, trainers and guides) are evaluated and "Additional Services," where the location of the activities, transportation service, accommodation services, and catering services are evaluated. In this study, the "Evaluation of Activities" section of this form was used as a post-test in accordance with the research questions. For reliability, this form was submitted to the review of three experts in the field of science education, who have studied on SSIs and their teaching, and it was finalized with 100% agreement (Miles & Huberman, 1994).

Pilot Study and Processes

In this study, the project in which the research data were collected was created as the continuation of the first project conducted on science teachers in the KPP region in 2020. Therefore, the project conducted in 2020 can be considered a pilot study for this study. According to the first project (Tekin, 2022) of the first author, a significant increase was observed in the examples given by the science teachers in the KPP region for SSIs after being involved in activities. Additionally, it was concluded that teachers generally had positive views about the project process and project services. Based on these re-

sults, the content of the project was enriched by adding new activities in this study. Furthermore, the most important feature of the current study that makes it different from the first project was the inclusion of physics, chemistry and biology teachers from all geographical regions of Türkiye in the study group, as well as middle school science teachers. Additionally, the project team (project coordinator, experts and guides) checked the time required for the activities, the usefulness of the materials to be used and the use of the places of activities.

The data collection process includes a pre-project activity period, during-project activity period and post-project activity period. In the pre-project activities period, the Project Participation Form was sent to receive the applications from teachers from different branches of science via Google Forms. After the determination of the teachers who would participate in the project, on the first day of the project, the Scale of Views on Teaching Socioscientific Issues and the Know and Want sections of the Know-Want-Learn Form were administered to the teachers as a pre-test. The project activity process was started with drama activities. After the interaction of the teachers was ensured, activities with the content of SSIs were carried out. **Table 2** shows some activities, their aims and the distribution of these activities across the objectives in the science curricula (MoNET, 2018a; MoNET, 2018b; MoNET, 2018c; MoNET, 2018d).

According to **Table 2**, some activities conducted during the project process can be summarized as follows: "Introduction to socioscientific issues" focused on the features of SSIs, "Preparing a lesson plan according to the 5E learning model: Vaccines," "Which socioscientific and decision-making criteria" aiming at the use of SSIs in the decision-making process, "Designing an activity related to SSIs in Ihlara Valley" related to the implementation of SSIs in out-of-school learning environments. Additionally, "Instructional SSI selection and teacher action research," which includes the methods/techniques used in teaching SSIs and will help teachers in their selection of SSIs, "How to evaluate an argument?" focused on the evaluation during the argumentation process, "Socioscientific reasoning and its evaluation" grounded in the reasoning process, "Blood transfusion timeline," which establishes the connection of SSIs with the nature of science and "Trade game," which establishes the connection between SSIs and sustainable development were also other activities included in the project. After these activities, the project team divided the teachers into groups and they asked them to create lesson plans with SSIs content and evaluated these lesson plans. After the activities and evaluations were completed, the Scale of Views on Teaching Socioscientific Issues, the Learn section of the Know-Want-Learn Form and the project evaluation form were administered as a post-test.

Data Analysis

Quantitative data obtained from the Scale of Views on Teaching Socioscientific Issues were analyzed with the SPSS 19.0 statistical program. Shapiro Wilk test was used to check the assumption of normality in the analysis of the data. The test results showed normal values for the pre-test and post-test ($p > 0.05$) p and that the skewness and kurtosis coefficients took the values between -1.50 and +1.50 recommended for social sciences (Tabachnik & Fidell, 2013). Therefore, data showed a normal distribution. Accordingly, paired samples t-test was used in the analysis of the Scale of Views on Teaching Socioscientific Issues since it was administered to the science teachers as a pre-test and post-test in the project. Qualitative data obtained from the Project Participation Form, Know-Want-Learn Form and Project Evaluation Form were analyzed according to descriptive analysis. While the descriptive analysis was performed, it was ensured that the project coordinator and project experts made comparisons by using independent coding. After the comparison, using the formula suggested by Miles and Huberman (1994), the percentage of agreement was calculated to be 90%. According to the rate suggested by Miles and Huberman (1994), it was concluded that the reliability was at an acceptable level.

Ethics

This research was approved be in compliance with ethical principles by the Human Research Ethics Committee of Aksaray University (Ethical Approval No: 2021/05-40). For confidentiality, information is not included here. Additionally, the personal information of the teachers participating in the study was kept confidential and the data collected from the project were used only for research purposes.

Findings

In this section, the findings related to the science teachers' views on the teaching of SSIs and the project carried out are presented to answer the research questions.

Findings related to the Science Teachers' Views on the Teaching of SSIs

The statistical information derived from the participants' views on the teaching of SSIs is given in **Table 3**.

As shown in **Table 3**, there is a difference of 5.25 points between the pre-test (Mean = 82.04) and post-test scores ((Mean = 87.29) of the participants' views on the teaching of SSIs because of the one-week project active-

Table 3. Comparison of Pre-Test and Post-Test Scores of Participant Teachers' Views on Teaching Socioscientific Issues with Paired Sample T-Test.

Variable		N	Mean	SD	df	t	p
VTSSI	Pre-test	24	82.04	8.02	23	-3.00	0.006
	Post-test	24	87.29	5.99			

Table 4. Distribution of the Answers Given by the Participant Teachers about Their Expectations from The Project.

Expectations of the Project	f	%
Learning in-class activities for SSIs	14	26.92
To gain a different perspective	7	13.46
Raising the awareness of students	7	13.46
Providing professional development	5	9.62
Providing academically development	4	7.69
Arouse students' curiosity	4	7.69
Guiding students	3	5.77
Share the learned information from this project with society	2	3.85
Learning new developments	2	3.85
Developing students' citizenship skills	2	3.85
Get project experience	1	1.92
Developing a project	1	1.92

Table 5. Answers to the Question "What Do You Know about the Project and Its Subjects?"

What Do I know? (K-Know)	f	%
Examples of socioscientific issues	12	37.50
Features of socioscientific issues	8	25.00
Methods/techniques for teaching socioscientific issues	4	12.50
Preparing a lesson plan with the content of socioscientific issues	4	12.50
Impact of socioscientific issues of society	3	9.38
Science-society interaction	3	9.38
Instructional difficulty of socioscientific issues	1	3.13

ties. This difference was found to be statistically significant because of the t-test ($t_{(23)} = -3.0$; $p < 0.05$). Considering these results, implemented project activities contributed to the development of the participants in terms of their views on the teaching of SSIs.

Findings related to the Science Teachers' Views on the Project

The data obtained from the Project Participation Form, the Know-Want-Learn Form and the Project Evaluation Form were evaluated together to obtain the findings regarding the views of the science teachers about the project. According to the answers given by the science teachers in the project participation form, the findings regarding their expectations from the project are shown in **Table 4**.

As shown in **Table 4**, what is expected by the science teachers from the project is to learn in-class activities for SSIs (f = 14), to gain a different perspective (f = 7) and to raise awareness in students (f = 7). Some excerpts related to the teachers' expectations from the project are given below:

> *"I think that I will improve myself in SSI teaching as there will be practice-based activities. In this context, I think that I will gain more competence and that I can transfer this to my classroom practices. Also, I like to improve myself academically." (T1)*

> *"I want to increase the students' scientific curiosity. I have been involved in many projects before. I find interacting with students through projects valuable for their development and that of mine." (T13)*

> *"The most important feature of science is that it must be based on provable and repeatable data. My expectations from this project are to be more productive in science for the children of my country by learning from the right people what the contribution of socioscientific issues to teaching is." (T15)*

> *"I believe that there will be experiences that I can learn from this project to raise awareness of socioscientific issues (vaccines, organ donation, nuclear energy, stem cells, space pollution, global climate change, GMOs, etc.) that we touch upon in our lessons from time to time, to arouse students' curiosity and to attract students' attention and to use methods and techniques that are unusual for them." (T18)*

> *"To provide a classroom environment where my students can express themselves more easily with different activities." (T24)*

Table 6. Answers to the Question "What Do You Want to Learn about the Project and Its Subjects?"

What do I want? (W-Want)	f	%
Activities for teaching socioscientific issues	12	21.82
Exercises of socioscientific issues in the course	7	12.73
Conveying socioscientific issues to students	6	10.91
Preparing material for socioscientific issues	3	5.45
Active processing of lessons on socioscientific issues	3	5.45
Integration of socioscientific issues with science	3	5.45
Ensuring environmental awareness in students	3	5.45
To raise social awareness in students	2	3.64
Promoting an interest in socioscientific issues	2	3.64
Arousing students' curiosity	2	3.64
Providing professional development	2	3.64
Obtaining content knowledge	2	3.64
Sharing project content with colleagues	1	1.82
Developing different perspectives for students	1	1.82
To learn about the current developments in socioscientific issues	1	1.82
Preparing lesson plans about socioscientific issues	1	1.82
To make the issues permanent	1	1.82
To learn about the features of socioscientific issues	1	1.82
To learn about the relationships of socioscientific issues with other fields	1	1.82
Evaluation of students' competencies in socioscientific issues	1	1.82

The answers provided by the science teachers about what they knew about the project content and activity topics before the project is classified in **Table 5**.

As shown in **Table 5**, the teachers participating in the project stated that they knew about the examples of SSIs (f = 12), features of SSIs (f = 8), preparing lesson plans with SSIs (f = 4), and methods and techniques used in teaching SSIs (f = 4). Sample excerpts about their knowledge before the project are given below:

> *"…Generally, the argumentation method is used in the teaching of these issues. It has gained increasing popularity recently. Issues such as nuclear energy and organ donation can be given as examples of socioscientific issues." (T24)*

> *"Regarding the project, I know that the formation of socioscientific issues is scientifically based and their results are social. I know that the activities will be based on interaction rather than classical teaching." (T19)*

"A project that deals with issues such as vaccines, global warming, sustainable development, and issues that affect all living things in the world." (T4)

"I know what socioscientific issues are dealt with in the project. However, I learned about some activities to be conducted or developed in relation to these issues of social media. I am not fully aware of their contents." (T17)

The answers through which the teachers stated what information they needed while participating in the project are classified in **Table 6**.

According to **Table 6**, the science teachers stated that they most wanted to learn about the activities that can be used in the teaching of these issues (f = 12), classroom implementation of SSIs (f = 7) and how to convey SSIs to students (f = 6). Below are given sample excerpts about what teachers want to learn about the project and its subjects:

"I want to increase my experience and knowledge about the transfer of socioscientific issues to students in an activity-based way that will arouse their curiosity students." (T6)

"I want to know what I can use in classroom activities. I want to know how I can increase the students' interest." (T19)

"I want to compensate for my incomplete knowledge and eliminate my misconceptions about socioscientific issues and convey the correct information to my students. I want to produce activities to make these issues more interesting (for students). I have participated in this project to achieve my goals." (T4)

"I want to implement these activities through the active participation of students in classroom environments where students can be instructed in such a way as to accomplish the objectives set in the science curriculum. I want to offer students the opportunity to learn by doing rather than conveying raw knowledge. I want to learn from the project content how to make lessons more enjoyable and not monotonous." (T17)

The answers through which the teachers stated what they learned after participating in the project are classified in **Table 7**.

As shown in **Table 7**, the science teachers stated that they most learned about the methods/techniques to be used in the teaching of these issues (f = 39), examples of these issues (f = 11) and the features of SSIs (f = 9) from the project and activity topics. Among the methods-techniques to be used in the teaching of SSIs, teaching SSIs with Web 2.0 tools (f = 10), using argumentation in the teaching of SSIs (f = 8) and using action research in

Table 7. Answers to the Question "What Did You Learn About the Project and Its Subjects?"

What I Learned? (L-Learn)	f	%
Methods/techniques for teaching socioscientific issues	39	39.00
Examples of socioscientific issues	11	11.00
Features of socioscientific issues	9	9.00
Activities on socioscientific issues	6	6.00
Preparing a lesson plan with the content of socioscientific issues	5	5.00
Differences between socioscientific issues and other topics	4	4.00
Dimensions of socioscientific issues	3	3.00
Edges of socioscientific issues	3	3.00
Socioscientific issues in out-of-school learning environments	3	3.00
Decision making on socioscientific issues	3	3.00
Recognizing incomplete information about socioscientific issues	2	2.00
The aim of socioscientific issues	2	2.00
Awareness of socioscientific issues	2	2.00
Integration of socioscientific issues into science lessons	2	2.00
Content knowledge	2	2.00
Importance of socioscientific issues	2	2.00
Socioscientific issues-nature of science connection	1	1.00
Human-environment interaction	1	1.00
Evaluation of students in courses on socioscientific issues	1	1.00
Clarification of existing conceptual confusions	1	1.00
Effective classroom management	1	1.00

Table 8. Answers from Participant Teachers about "Evaluation of Activities" in the Project Evaluation Form.

Characteristics	Contributed		Not Contributed	
	n	%	n	%
Learn socioscientific issues	24	100.00	-	-
To learn about the features of socioscientific issues	24	100.00	-	-
To teach socioscientific issues	24	100.00	-	-
To evaluate socioscientific issues	24	100.00	-	-

the teaching of SSIs (f = 6) come to the fore. Below are given sample excerpts about what the teachers learned about the project and issues:

> *"I learned which subjects are socioscientific by nature. I learned how to convey socioscientific issues to our students and what*

kind of activities to conduct. I learned how to teach subjects of nanotechnology within the scope of socioscientific issues. I learned about Web 2.0 tools, how to prepare puzzles and how to use them in lessons. I learned that when discussing socioscientific issues, a definite conclusion cannot be reached." (T13)

"I learned many methods and techniques to be used in the teaching of SSIs in the classroom. I was delighted to be informed about Web-based applications in particular. I learned about subjects such as argumentation, Web 2.0-based applications such as crossword lab, and how to create a discussion environment in the classroom." (T2)

"I learned what socioscientific issues are, how we can transfer socioscientific issues to our lessons, the usage areas of Web 2.0 tools and that socioscientific issues cannot be fully answered, and clear judgments cannot be reached." (T21)

"I learned the different aspects of SSIs specified in the project, what kind of activities I will do in the teaching of SSIs, how students will be evaluated before, during and after the teaching of SSIs." (T9)

According to the answers given by the teachers to the project evaluation form, the findings regarding the evaluation of the activities are shown in **Table 8**.

As shown in **Table 8**, all of the science teachers stated that the project contributed to the learning of SSIs (n = 24), the learning of the features of SSIs (n = 24), the teaching of SSIs (n = 24) and evaluation of SSIs (n = 24). Below are given sample excerpts from the answers of the teachers about the evaluation of activities:

"We covered the dimensions of SSIs in depth through the activities." (T7)

"The definition of socioscientific issue is rooted in my mind, I can now distinguish which issues are socioscientific and which are not." (T24)

"Because I learned and heard the term 'socioscientif issues' for the first time in this project." (T4)

"Teaching through the presentation of arguments and counter-arguments caused me to learn the features of socioscientific issues." (T10)

"It made me think that there is no single right answer, that it should be handled impartially and that we are maximally affected by the individual-society-environment interaction." (T17)

Results

The following results were obtained in the current study, which consisted of the results of a TÜBİTAK funding project based on teacher education, which was carried out using interactive activities, and which investigated the views of science teachers on the teaching of SSIs and the project.

This project activity contributed to the development of the participants in terms of their views on the teaching of SSIs. Additionally, it is seen that the expectations of the participating teachers from the project are to learn in-class activities for the teaching of SSIs, to gain a different perspective and to raise awareness among students. Additionally, the teachers stated that they knew the examples and features of SSIs before the project, and that they wanted to learn the activities and classroom practices to be used in the teaching of these issues and in their transfer to students. Accordingly, it is seen that the teachers knew the features and examples of SSIs before the project and they needed to learn the methods/techniques to be used in the teaching of SSIs. After the project, they stated that they learned the methods/techniques to be used in the teaching of SSIs, their examples and features. The fact that many examples of methods/techniques to be used in the teaching of SSIs were shown by the participating teachers after the project is an indication that the project led to a positive change in the views of the teachers. Additionally, all the teachers stated that the project contributed to the learning and teaching of SSIs, learning and evaluation of the features of SSIs. Therefore, the project activities carried out were effective in the development of the teachers' views on the project.

Discussion

In this section, discussion and conclusions for the research are given on the basis of the above-mentioned results. The implemented project activities contributed to the development of the science teachers' views on the teaching of SSIs. It is useful to remind again that the project conducted here was a one-week intensive activity process. In the literature, there are similar studies. Wu et al. (2022) conducted a study on pre-service science teachers and in this study they developed a short-term teaching module to develop the pre-service teachers' competence in teaching SSIs. In this module, the researchers adopted a two-week process that includes pre-service teachers discussing teaching topics with each other, reviewing the topics with a science education expert, and experiencing practices with in-service training. Because of their study, they concluded that both the pre-service teachers' self-efficacy

beliefs about teaching SSIs and their pedagogical content knowledge levels improved. This study supports the effectiveness of the project activities discussed in the current study in terms of achieving a positive development in a short time. In another study, Leung (2022) implemented a 12-week teacher training program for pre-service science teachers. Leung (2022) stated that there was a shift toward the view that these issues should be taught, as the pre-service teachers, who stated that SSIs are excluded in science education, experienced SSI teaching in this process. Similarly, Karahan (2022) researched the experiences and comments of pre-service science teachers in the design and implementation processes of SSI-based teaching. In the study, it was concluded that the views, ideas and practices of the pre-service teachers were transformed and changed during this process. The progress made in this process demonstrates the importance of practice/activity supported SSI teaching. From another viewpoint, to integrate these issues into science teaching in classrooms through practices, they should be presented to pre-service teachers and teacher education starting from the university. Borgerding and Dagistan (2018) stated that although pre-service teachers were willing to participate during methods to be used in teaching these issues, they confused SSIs with subjects that were rejected by society (for example, evolution). As in the project discussed here, collaborations on these issues in a practice-oriented environment in the community of teachers with similar scientific knowledge can help overcome such misconceptions. However, Sibic and Topcu (2020) in their study on pre-service science teachers stated that pre-service teachers' self-efficacy beliefs in dealing with these subjects in real classroom environments are not at a sufficient level. Similarly, Aydın and Karışan (2021) stated that science teachers do not have enough knowledge about SSIs and they can define these issues only superficially. The fact that both pre-service teachers and teachers do not have sufficient knowledge to teach these issues demonstrates the importance of determining their needs in this regard. Although the number of studies conducted with the participation of science teachers and pre-service science teachers is higher, it is possible to come across studies in the field of secondary education. However, they are few. Compared to the curricula of secondary education physics, chemistry and biology, SSI-related objectives are given more space in the science curriculum (Et & Gömleksiz, 2021). Therefore, the acquaintance of secondary school teachers on these issues may be lower. Including physics, chemistry and biology teachers and science teachers in the projects provided an opportunity to improve their views, perceptions, or teaching motivations on these issues. When the above-mentioned studies are compared with the results of the current project, the importance of practice-based education for all science fields is revealed once more. Owens et al. (2021) stated that in addition to the need for teachers to develop content knowledge in their classrooms and the methods/techniques that should be used while teaching these

subjects, there is also a need for classroom environments that contextualize learning and teaching and enable students to address the subject from multiple perspectives. Therefore, it is seen that there is a need for studies on how teachers implement these practices in their classrooms. Thus, it can be suggested to investigate the practices that teachers include in their classrooms longitudinally. Additionally, depending on the result obtained from the current study, it can be suggested that science teachers be included in larger-scale programs where they can evaluate themselves about teaching SSIs. As it is known, these projects are carried out with teachers who apply and participate voluntarily. Therefore, the initial motivation of the teachers participating in the project may have been high. In this connection, a holistic teaching package based on SSI that will appeal to all teachers can be created by examining the classroom practices of other teachers who both participate and do not participate in these projects.

TÜBİTAK funding projects are very supportive studies in presenting interactive activities for the professional development of teachers. From this perspective, the teachers' views on the project developed positively. The participating teachers stated at the beginning of the project that they had expectations and desires to learn the activities to be used in the teaching of SSIs. After the project, the teachers' expressing that they learned the methods/techniques to be used in the teaching of SSIs may be an indicator of positive development. Additionally, the fact that the teachers used the methods/techniques in their examples after the project proves that the project was effective. The statements of the participants about the project contributed to the learning and teaching of SSIs supported this result. Numerous TÜBİTAK funding projects involving teacher training have been carried out. In many studies, it has been seen that there are positive developments about the issue addressed and the project carried out (Aşkım Kurt et al., 2019; Fettahlıoğlu, 2019; Karakoç Topal, 2022; Sapsaglam & Kaya, 2022; Yoloğlu & Uçar, 2015). For example, Aşkım Kurt et al. (2019) in their study on Web 2.0 tools concluded that the teachers used Web 2.0 tools more after the project and they used these tools more easily in in-class activities. They also stated that the participants were satisfied with the training given. Similar results are also supported in the study of Karakoç Topal (2022). Karakoç Topal (2022) stated that the activities carried out were found enjoyable by the participants, that the activities aimed at creating products were liked more and that their awareness of the issue was increased. As mentioned above, there is no doubt that these projects are carried out with teachers who are aware of the subjects and willingly participate in the project. Participants are included in the study by focusing only on these activities, away from all work and daily life stresses. Moreover, it is normal for them to share their views with teachers from their fields and agree on a common point, and reason for the subjects covered. Therefore, it can be seen as an expected result that the participants

will gain the highest level of benefit in their field. The important point here may be to increase this knowledge sharing and to encourage all teachers. By using the results obtained from these projects, it can be ensured both to share information among colleagues and to increase the professional development of teachers in their own fields by developing projects as research teachers.

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