Pre-service Science Teachers' Views towards Socio-scientific Issues and Socio-scientific Issue-based Instruction

Okan Sibic[1], Mustafa Sami Topcu[2]
[1]İstanbul University-Cerrahpasa
[2] Yıldız Technical University

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Article Info	Abstract
	Today, many countries have revised their science curricula to ensure an effective science-learning environment and Turkey is one of such countries. Thanks to the revisions within this scope, socio-scientific issues were integrated into the curriculum. Their presence has brought about the requirement of knowing what socio-scientific issues are and how to integrate them into lessons. The aim of this study is to explore pre-service science teachers' views towards socio-scientific issues and socio-scientific issue-based instruction in Turkey. To this end, it utilized qualitative research method. The qualitative data were collected from thirty pre-service science teachers through semi-structured interviews and they were analyzed through content analysis technique. The study revealed that while some participants were aware of socio-scientific issues, some were not. In addition, some did not know those issues existing in science education curricula, and how to deal with them during lessons. Besides, participants did not have sufficient self-efficacy beliefs towards dealing with socio-scientific issues in real classroom settings. These results suggest that socio-scientific issues should be integrated into science education programs of universities and more teaching opportunities should be provided for pre-service teachers to practice SSI-based instruction.

Introduction

Socio-scientific issues (SSIs) are ill-structured issues with open-ended, complicated, and argumentative features which have scientific and social dimensions at the same time (Ratcliffe & Grace, 2003; Sadler, 2004; Sadler & Zeidler, 2005; Sadler, Barab & Scott, 2007; Topçu, Sadler & Yılmaz-Tüzün, 2010; Gardner & Jones, 2011; Klosterman, Sadler & Brown, 2012). As Eastwood et al. (2012) point out, there are some main criteria to introduce a topic as an SSI, which are: First, the issue must be related to science and second, it should have significant effect on the society. Nuclear energy, global warming, genetically modified foods (GMOs), take home foods, and embryonic stem cell can be given as examples of SSIs (Lee, Abd-el-Khalick & Choi, 2006; Levinson, 2006; Morris, 2014; Topçu, 2017). It is possible to notice that different parts of the society can handle and interpret SSIs differently by considering them from different perspectives. Ratcliffe and Grace (2003) summarize the nature and the features of SSIs as follows: SSIs have multidimensional structure with moral and ethical dimensions and risk and benefit analysis, additionally, those issues are up-to-date issues and found in the media frequently.

After SSIs were developed as a follow-up of science-technology-society (STS) approach (Topçu, 2017), a variety of studies were conducted by science educators to examine their effect and find out how to integrate them into science education. One of the most important findings was that SSI can come in useful in bringing up scientifically literate people (Kolstø 2001; Sadler & Zeidler, 2005; Zeidler & Nichols, 2009). In addition, SSIs can increase students' science content knowledge (Dawson & Venville, 2013), motivation and interest towards science and science learning (Parchmann, Gräsel, Baer, Nentwig, Demuth & Ralle, 2006; Albe, 2008). Moreover, the literature suggests that incorporating SSIs into science lessons might affect students' argumentation abilities (Dawson & Venville, 2013; Zohar & Nemet, 2002), communication abilities (Chung, Yoo, Kim, Lee, and Zeidler, 2016), and nature of science comprehension and decision making skills (Eastwood et al., 2012; Walker & Zeidler, 2007) positively.

By virtue of such significant contributions of SSIs, their inclusion into science education curriculum in Turkey occurred in 2013 under the scope of the subject called science-technology-society. With the recent revisions on national science education curriculum undertaken in 2018, SSIs retain their place in the curriculum. Therefore, for science teachers or pre-service science teachers (PSTs), i.e. teachers of the future, being knowledgeable in

SSIs and integrating them into science lessons have become crucial. Thus, the present study reports the views of PSTs towards SSIs and SSI-based instruction in depth.

Literature Review

After detailed literature review, we found out that pre-service teachers', teachers' and students' views towards SSIs are examined in some studies. In the following, we reported the studies in which pre-service teachers' views towards SSIs are evaluated.

Lee et al. (2006) conducted a study with secondary school science teachers in order to get their views towards SSIs, how to integrate them into lessons and their place in the curricula. They reported that teachers regard SSIs as dangerous and destructive topics and a natural consequence of nature of science (NOS). Despite positive feelings towards SSIs in lessons, teachers emphasized the need for more time and class materials for SSI integration. One of the most important findings of the study was that teachers have low self-efficacy beliefs towards bringing SSIs into lessons. Kara (2012) also found that pre-service biology teachers (PBTs) perceived SSIs as negative issues resulted from humankind. In a similar vein with Lee et al.'s (2006) results, Kara also found that PBTs have positive opinions about the integration of SSIs into lessons despite the presence and need for more time, classroom management skills, materials and in-depth knowledge about the presented issues. The participants of Alaçam-Akşit's (2011) study pointed out that more pedagogical knowledge is required for successful inclusion of SSIs into lessons as emphasized in the studies of Lee et al. (2006) and Kara (2012). Yapıcıoğlu (2016) examined PSTs' views towards SSIs. She found that participants consider organ donation, GMOs, environmental topics, founding base stations, and cloning as SSIs. In addition, the participants discussed how to teach SSIs effectively and emphasized that it is possible through using argumentation, problem-based learning methods.

Özden (2015) conducted a study with pre-service elementary school teachers and found that the participants perceive SSIs as open-ended, current and mediatic topics which have risk and probability analysis, moral and ethical dimension and affect individuals. The participants of the study emphasized that bringing SSIs into lessons can increase students' higher-order thinking skills and they emphasized that teachers should act as a guide while integrating SSIs into lessons. One of the important findings of this study was that when the students are mature enough, their interest in SSIs increases. Alaçam-Akşit (2011) also found that their participants (pre-service elementary school teachers) emphasized that SSIs are mediatic issues that are sources of social and science lessons. They also were willing to learn more about SSIs.

Espeja and Lagaron (2015) are other researchers who collaborated with pre-service teachers and found that after the participants are taught through SSIs and SSI teaching, their understanding and ability in SSIs and SSI teaching increase. Muğaloğlu, Küçük, and Güven (2016) also found that if teacher candidates are trained about the integration of SSIs into classrooms, their understandings of SSIs and SSI-teaching and their self-efficacy beliefs towards bringing such issues into lessons increase.

The Framework of the Study

In accordance with the purpose of the present study, we specified the study by Presley et al. (2013) as the frame by considering the definition and explanation of Ratcliffe and Grace (2003) about SSIs. As stated earlier, Ratcliffe and Grace (2003) defined SSIs as issues which have some important features such as having multidimensional structure, having risk and cost analysis; being up-to-date, and easy to encounter in daily lives. Accordingly, Presley et al. (2013) developed an instructional strategy to incorporate SSIs into classroom settings. They emphasized that in order to deal with SSIs in the classroom successfully, three core aspects – '*design elements*, *learner experience* and *teacher attributes*', which are surrounded by '*classroom environment* and *several peripheral influences such as curricula*' must be considered by teachers:

(1) *Design elements:* The lesson must be built around a tough topic and a compelling question. The topic should not be complicated, and the questions should not be very difficult for students to brainstorm and discuss on the issues presented. Besides, the lesson should permit students to engage in higher order thinking skills and require using technology and media.
(2) *Learner experience:* Students should engage in higher order thinking skills and participate in discussions. They should consider all the claims and arguments produced by other students about the issues and create their own claims. Students should consider different stakeholders' position towards the issues while

producing arguments and claims and conceive of different dimensions such as morality, politics and economy.

(3) *Teacher Attributes:* Teachers should know the different dimensions of the issues and associate the issue with those dimensions. They should be open to all ideas produced by students and behave as a learner. Additionally, teachers should not act as the only authority in the classroom, rather should be a guide during lessons.

(4) *Classroom Environment* and *Peripheral Influences:* There should be an interactive classroom environment in which students easily express their ideas and respect others', work collaboratively during lesson, and use several interactive materials such as the internet. In addition to the impact of classroom environment, different peripheral influences have significant effects on SSI-based instruction. For instance, science curriculum should be flexible to include SSIs and different stakeholders should participate during lessons. Lastly, school administrations should provide the required permissions for SSI teaching.

Study Rationale

As we stated earlier, there are some studies in which the views of teacher candidates, students, and teachers from different majors such as biology, science, and elementary school teaching etc. towards SSIs were examined from various perspectives. Alaçam-Akşit (2011), Kara (2012), Lee et al. (2006), Özden (2015), Yapıcoğlu (2016), and Sadler et al. (2006) can be given as examples of such studies. Due to the crucial importance of SSIs for teaching and learning, their integration in classrooms has become one of the most attractive topics in science education. We discovered that general opinions of the participants towards SSIs were examined in the literature, but their views towards how to use and integrate SSIs in science classrooms were not directly examined. In other words, there were no studies in which PSTs' views towards SSI-based instruction were examined. Additionally, we did not find any study in which PSTs' awareness towards the place of SSIs in national science education curricula and their self-efficacy beliefs for SSI-based instruction were examined. This study examines the views of PSTs, as teachers of the future, towards SSIs, SSI-based instruction and their self-efficacy beliefs for integrating SSIs in science lessons. Therefore, the present study will contribute to the literature in these aspects. After acquiring knowledge about those aspects in consequence of the study, it might be decided whether a revision is needed in science education programs of universities towards integrating new courses in which SSIs and SSI-based instruction are lectured in detail, and also the need of in-service trainings about SSIs can be discussed.

Research Questions

Based on the rationale and the aim of the study, this study is shaped by the following two research questions:
   (1) What are the views of pre-service service science teachers towards socio-scientific issues?
   (2) What are the views of pre-service science teachers towards socio-scientific issue-based instruction?

Method

Research Design

In the present study, we aim to reveal the views of PSTs towards SSIs and SSI-based instruction in depth. We desire to reveal the views from different perspectives by considering all the aspects of SSIs and SSI-based instruction. By using qualitative research method, one can deeply examines the questions of their research (Merriam, 1998) and accordingly, to deeply examine the views of PSTs towards SSIs and SSI-based instruction, we used qualitative research method in the study. Additionally, we decided that the qualitative research method is consistent with the nature and the philosophical stance of the presented research.

Participants

The data were collected during Spring Semester in 2018. Thirty PSTs studying at science education department participated in the study. The participants were selected from two state universities (fifteen PSTs from each) located in Istanbul, Turkey. In the study, we collaborated only with those who volunteered to participate in the study. While eight of the participants were male, twenty-two of them were female. On the other hand, while sixteen participants of the study were 3rd grade students, the others (fourteen participants) were 4th graders. The

PSTs' age ranged between 21 and 23; except for one who was 27 when the study was conducted. The participants' GPA were between 2.5-3.7 and therefore we could state that the participants were from between middle and high achiever groups. While the 4th grader in the study finished 'School Experience' course and took 'Practice in Teaching Science' course in which they had experienced real classroom settings; the 3rd grade participants did not experience real classroom settings but were aware of different science teaching strategies. During 'School Experience' course, it is highly possible that PSTs might encounter with one of the SSIs in real classroom settings and might observe how teachers deal with those issues. Therefore, in the 'Results' section we also emphasize participants' teaching experience.

Data Collection

In the present study, we used interview method to get the views of PSTs towards SSIs and SSI-based instruction. A semi-structured interview was conducted with the all participants and each lasted on average 30 minutes (ranging from 25 and 45 minutes). The use of an interview helped the participants of the study to easily express their views and ideas in their own words, provided them opportunities to garner new ways to see and understand the topic at hand, and helped researchers to ensure the collection of valid, reliable and comparable qualitative data (Cohen & Crabtree, 2016). All the interviews were conducted either in the first or the second researcher's office in which participants expressed positive attitudes stating that they were feeling comfortable. All the participants were also informed about the confidentiality of the interviews. After all semi-structured interviews were conducted, the researchers transcribed the audio-recordings verbatim in order to analyze the data in detail.

Instrument

As the data collection instrument, we used an interview tool consisting of semi-structured questions. To create the instrument, first, we made detailed literature review and created seventeen semi-structured questions. Next, we conducted interviews with 3rd grade PSTs, who were not included in the main sample of the study, to check whether the questions were consisted with our aims. Additionally, three experts, two of them were experts in science education and qualitative research and one of them was an expert in science education with different quantitative studies, examined the interview questions independently from the perspectives of validity and applicability. Considering the reviewers' feedback and conducted interviews, we made some major revisions on the instrument. First, we divided the instrument into two parts. In the first part, we aimed to reveal PSTs' views towards SSIs and, in the second part; we aimed to reveal PSTs' views towards SSI-based instruction. Second, we reduced the number of the questions. The final version of the instrument consists eleven questions: In the first part, there are six questions which reveal PSTs' views and understanding towards SSIs, the place of SSIs in national science education curricula, and their examples of SSIs and in the second part, there are five questions which reveal PSTs' views and understanding towards SSI-based instruction and their self-efficacy beliefs towards bringing SSIs into lessons. Sample questions of the instrument and related research questions of those questions can be seen in Table 1. As a result of the revisions, we built consensus between researchers and experts for the final version of the instrument.

Table 1. Sample interview questions

Research Question	Sample Interview Question
What are the views of pre-service service science teachers towards socio-scientific issues?	How can you define SSIs in science education context? Could you give any examples to SSIs?
What are the views of pre-service service science teachers towards socio-scientific issues?	What kind of teaching strategies would you prefer if you were dealing with SSI-based instruction?

Data Analysis

All the interviews were transcribed verbatim by the researchers to analyze the data by following content analysis technique. In the present study, we followed Harris's content analysis technique (Harris, 2001). In this technique, researchers pursue the following steps: (1) Determining the research questions of the study, (2) Determining the text(s) which is examined, (3) Deciding 'unit of analysis', (4) Detecting 'the categories', (5) Making coding, and, (6) Evaluating reliability and validity. In accordance with these, we, first, transcribed all

the data verbatim. Second, we determined 'sentences' as our 'unit of analysis'. Then, we examined the data and created categories (e.g. 'biotechnology' and 'teacher-centered'). Afterwards, we started 'coding' (e.g. 'argumentation' and 'GMO') and presented the findings in terms of their frequencies. We also presented some excerpts from the interviews to emphasize important points. We followed the same above-mentioned steps for each research question. The calculated inter-coder reliability was 80%, which means the data were valid and reliable.

Results

PSTs' Views towards SSI

In the present study, we, first, examined the views of PSTs towards SSIs. In accordance with this aim, we revealed their awareness towards SSIs and the place of SSIs in the national science education curricula of Turkey, their understanding towards the nature of SSIs, and the topics/issues which they considered as SSIs. First, we found that more than half of the participants (n=19) were aware of SSIs before the present study. Whereas a few participants had encountered SSIs through their own effort by researching (n=4), other participants emphasized that they had encountered SSIs during such courses as 'Special Issues in Biology', 'Special Issues in Chemistry' and an elective course which was designed for teaching SSIs. For instance, while STD8 pointed out that he enrolled in a course which was related to SSIs, STD13 mentioned that he came across SSIs in 'Special issues in Biology' course.

> Interviewer: Have you ever encountered SSIs before?
> STD8: Yes, I have. I have encountered during a lesson.
> Interviewer: What was the lesson about, could you please explain?
> STD8: It was done as an adaption of an SSI to science program in its (the lesson) content, I mean we had a lesson whose aim was to show how to adapt SSI that we encounter in our daily lives to science education…
> Interviewer: Have you ever encountered SSIs before?
> STD13: Socio-scientific issues… we had a lesson, 'Special Issues in Biology', I encountered there, not in the previous week but two weeks ago […]

Next, we examined the awareness of the participants who had encountered SSIs (n=19) towards the place of such issues in the national science education curricula (published in 2005 and 2013). We discovered that all participants were aware of the both curricula since they had examined the curricula in their regular lessons and the participants pointed out the presence of SSIs in the 2013 curriculum and the absence of them in the 2005 one.

Table 2. Features and characteristics of SSIs

Category	Code (f)
Multidimensional structure	Social and scientific (16)
	Scientific (13)
	Social (8)
	Multidimensional (4)
	Ethical and moral (3)
General Features	Interesting and riveting (11)
	Argumentative (7)
	Real life (5)
	Reliable (4)
Specific Features	Ill-structured (with not solution) (7)
	Up to date (5)
	Risk and benefit analysis (2)
Other	Science branches related with structure of society (1)

In the following excerpts, STD1 emphasized the presence of SSIs in the 2013 curriculum by providing some details and additionally, STD17 emphasized the absence of SSIs in the 2005 curriculum.

> Interviewer: Have you examined the Science Education curriculum published in 2013 by the Ministry of National Education?
> STD1: Yes. We've examined it in the lesson.
> Interviewer: Have socio-scientific issues been included into this curriculum?

STD1: Yes, socio-scientific issues have been examined under a separate heading there (2013 curriculum). Objectives have been regulated based on that. Additionally, the abilities used for constructing arguments have been gained with the opportunities presented with socio-scientific issues. I remember this way.

Interviewer: Have you examined the Science and Technology curriculum published in 2005 by the Ministry of National Education?

STD17: A little. Socio-scientific issues have not been given under a separate heading. There are perception and motivation kinds of things but it did not separate socio-scientific issues. The word "socio-scientific issues" was not used.

After revealing the awareness of participants towards SSI, we examined their understanding of SSIs and the issues they consider as SSIs. In Table 2, we present general perspectives about understanding of SSI. As presented in Table 2, the participants mostly emphasized the social and scientific dimension of SSIs whereas other dimensions were emphasized less frequently. For instance, only few participants emphasized ethical and moral dimension of SSIs. In the following excerpts, STD2 and STD10 pointed ethical and moral dimension of SSIs.

STD2: Socio-scientific issues are issues which have both scientific content and social content. They are argumentative, do not have exact solutions, then, our teacher emphasized the need for the presence of ethical and moral elements. So, that's it.

STD10: Socio-scientific issues, as the name suggests, are social, scientific, quotidian, interesting, argumentative, and argumentative in ethical and moral dimensions.

In the study, participants specified wide range of examples of SSIs. According to their responses, we constituted six different categories and represented each category in Table 3 with examples and frequencies.

Table 3. Examples of SSIs

Category	Code (f)
Environment	Global Warming (7)
	Environmental Pollution (7)
	Acid Rain (3)
	Zoo (3)
	Greenhouse Effect (1)
	Migration (1)
Biotechnology	Genetically Modified Organisms (11)
	Cloning (2)
	Experimental Animals (2)
	Organ Donation (1)
	Stem Cells (1)
	Genetics (1)
Technology	Base Station (3)
	Electricity (3)
	Technology (1)
	Technological Weapons (1)
	Cyber Attacks (1)
Energy	Nuclear Power Plant (5)
	Nuclear Energy (2)
	Energy (2)
	Nuclear Weapons (1)
	Energy Plants (1)
Health	Health (3)
	Nutrition (3)
	Antibiotic usage (3)
	Vaccination (2)
	Puberty (1)
	Cancer (1)
	Consanguineous marriage (1)
	Smoking (1)
Other	Anatomy (1)
	Light (1)
	Viruses (1)

The examples were generally related to up-date-date issues such as global warming, nuclear issues and GMOs. Our findings showed that participants mostly stated GMOs and global warming as SSIs. Some of the participants pointed out general areas such as technology and health as SSIs instead of giving specific examples.

> STD18: For example, GMO is a socio-scientific issue […] or for example, nuclear power plants, energy types, I mean those kinds of topics can be included. […]
> STD8: […] we can talk about zoo from this point such as taking animals from their natural environments and placing them into artificial environments. Besides, it might be the benefits of GMOs or normal foods that we use in our daily lives.
> Interviewer: Could you tell me why those examples are SSIs?
> STD8: Those examples are not actually the topics which need to be explained in lessons, but we encounter them in our daily lives, and we might encounter some of them in our lessons. So, since we might encounter them in the lessons.

Some of the participants also pointed anatomy, health, light and viruses which we did not categorize them as SSIs.

PSTs' Views towards SSI-based Instruction

In the present study, we examined the views of PSTs about how to deal with SSIs when confronted with them in science classes and how they design the lessons to integrate SSIs successfully. Additionally, we examined PSTs' views towards the role of different stakeholders such as teachers, students, school administration and more for SSI-based instruction. Lastly, we aimed to examine the self-efficacy beliefs of PSTs for the integration of SSIs into their lessons and the reasons behind their beliefs. In the following, we present our findings in detail. First of all, we asked our participants about how to design a lesson which is related to SSIs. The findings are presented in Table 4.

Table 4. Proposed instructional approaches for SSI-based instruction

Instructional approaches for SSI-based instruction	f
Catching attention about the SSI provided – arousing curiosity by presenting video, news etc. – discussing the SSI – doing related activities	9
Informing students about the SSI provided – discussing on the SSI – showing and sharing different sources	6
Grouping students – distributing essays related to the SSI assigned to groups – discussions on essays between groups – discussion in class about the SSI	1
Real setting observation – discussions	1

Table 4 illustrates that, except two participants, all the participants pointed similar approach for SSI-based instruction and most of them concentrated on two different approaches. In the first approach, the participants expressed that they firstly caught students' attention by presenting different materials related to the issue. Then, they continued the lesson by making discussions and activities related to the lesson and the SSI presented. For instance, STD12 pointed this approach.

> STD12: I think, it is started with socio-scientific issues, I mean because of the fact that they are already issues from everyday life, by starting with them students' attention should be caught and this should be explained this way […]
> Interviewer: How do you continue the lesson?
> STD12: Some videos could be watched related to the lessons. Besides, news examples could be shown, they are already usually exposed to them.

In the second approach, participants expressed that they present all the information about an SSI and continued the lesson by discussing it. STD2 emphasized the importance of presentation of the materials related to the issue and the need of diversifying the materials.

> STD2: First of all, no matter which topic is discussed, the concepts related to it should be provided to students […] then, because of the fact that I teach students I have to have a lot of sources […]

We also examined which teaching method the participants preferred to use in their lessons while dealing with SSIs. We found that our participants mostly preferred student-centered teaching methods. 5E, argumentation

and investigation methods were mostly emphasized methods by the participants (Table 5). In the excerpts presented below, STD13 pointed out the importance of discussion and usage of cartoon map and cartoon web; and STD7 laid emphasis on the usage of 5E and 4E as instructional methods for SSI teaching in science lessons.

> STD13: There are discussion environment, brainstorming, concept map and concept webs kind of things, I mean I put a bait in the middle and try to make students active. […]
>
> STD7: […] I would prefer 5E, but apart from that the methods that we saw, 4E method or any method, method of Gagne… […]

Table 5. Teaching methods for SSI-based instruction

Category	Teaching Methods
Student-centered	4E-5E-7E Methods (7)
	Argumentation (6)
	Investigation (5)
	Brainstorming (3)
	Gagne's teaching method (2)
	Researching-questioning (1)
	Gaming (1)
	Concept maps-Concept web (1)
Teacher-centered	Presentation (5)
	Question-Answer (2)
	Precedent (2)
	Demonstration (1)
	Experts' Presentations (1)

Although most of the participants were willing to use student-centered teaching methods for SSI-based instructions, some participants still pointed out their preferences towards using teacher-centered teaching methods such as presentation and question-answer methods (Table 5).

> STD1: I wanted to say investigation method, but I do not know how to use investigation method, I mean what I want students to discover about socio-scientific issues, thus I would use presentation method more and more I mean by showing something to them.

At that point, we examined the views of PSTs towards possible factors which facilitate or impede the integration of SSIs into lessons. In Table 6, we present our results.

Table 6. Facilitating and impeding factors for SSI-based instruction

Category	Factors
Impeding Factors	Planning/Preparing (13)
	Finding appropriate materials (12)
	Classroom Management (10)
	Classroom participation (5)
	Time-consuming (5)
	Cost (4)
Facilitating Factors	Expressing idea (8)
	Learning and comprehension of topics (7)
	Connecting issues with everyday life (7)
	Focusing (2)
	Developing argumentation skills (2)
	Being economic (1)
	Planning (1)
	Developing curiosity (1)
	Developing research skill (1)

Frequently, the participants pointed out that the process of planning, finding appropriate materials and preparation for instruction with classroom management are among the top impeding factors for SSI-based instruction.

STD4: Once, we said that there is no exact answer of SSIs, in-class discussions should be used, and this makes classroom management difficulties definitely. […] and also, I think while preparing materials, we can confront with difficulties. […] Additionally, for example, making students active could be difficult […]

STD28: So, for instance, the impeding factors might be that it could create chaos environment in the class. […] that discussion might turn into to quarrels. […]

STD10: First, application process might take too much time.

The participants emphasized that with the integration of SSIs into science lessons, students can easily express their ideas and the learning might be easier. Moreover, they stated that by bringing SSIs into lessons, real life topics such as GMOs could be integrated in lessons more.

STD6: In the end, you could make whatever comment you want, you are free after all.

STD19: Facilitating factors… because of the fact that the topic that we explain is intriguing, I think it would be easier to explain and understand that.

In the wake of examining the views of participants towards how to deal with SSIs during their lessons in terms of instructional approach and teaching methods and also examining their views towards the possible impeding and facilitating factors for SSI-based instruction, we examined participants' views towards the role different stakeholders such as teachers, students, school administrations and more. In Table 7, we present all the findings in detail.

First, participants emphasized different roles of teachers. Among them, the most emphasized roles of teachers were 'being a guide during lessons' and 'entering the lessons after good preparation and planning'.

STD11: I think teachers should not directly explain the topics. They should direct students to discover. I want teachers to have guidance role more and more. I think this way. So, as a guide, that's it.

Additionally, they also emphasized that teachers should 'have good classroom management skills, be knowledgeable about issues and impartial during classroom debates' (Table 7).

Table 7. Different stakeholders' roles for SSI-based instruction

Category	Roles
Teachers	Guidance (11)
	Good planning/preparation (9)
	Being knowledgeable about issues (8)
	Having good classroom management skills (6)
	Being knowledgeable (6)
	Being impartial (4)
Students	Active participation (12)
	Expressing his/her ideas (8)
	Researching/preparing (8)
	Being willing towards lessons (5)
	Respectful towards each other (4)
Program Developers	Making revisions on the available curricula for integration of SSIs (8)
	Producing materials (4)
Researchers	Giving information about SSIs and SSI topics (8)
	Making continuous research about SSIs (2)
Parents & Society	Researching with open mindedness (4)
	Providing easiness (1)
School Administration	Providing resources and opportunities (3)
Others	Dealing with exam anxiety problems (1)

About students' roles, participants emphasized 'active participation, expression of idea frequently, making research about the topic which will be handled or already discussed, being willing towards lessons and participation and also being respectful towards each other in the class during lessons' (Table 7).

STD10: Students should be willing active, and think about that topic.

STD4: […] I expect students to volunteer for researching too. Active participation and making research. Of course, I create a discussion platform and I want them to generate ideas. My main aim is

that. During generating ideas, they should continue by listening and understanding each other's idea with mutual respect. […]

In the present study, the participants also noticed that some other stakeholders such as school administration and program developers have some crucial roles for SSI-based instruction. We found that our participants generally had consensus on two important roles (see Table 7). One was producing a more flexible curriculum to which SSIs could be integrated more easily and the other was informing every part of the society about SSIs (about what they are and what kind of examples they have). Below, we shared two excerpts from the interviews about these points.

> STD15: […] I think while in the process of regulating curricula, they might leave open doors for them (SSIs). […]
> STD3: […] in their (teachers) holiday they go in-service training. During in-service trainings, they could be given information about them (SSIs). […]

In the final phase, we desired to confirm participants' self-efficacy beliefs towards SSI-based instruction. In other words, we desired to learn whether they perceived themselves enough to deal with SSIs in their future science classes and the underlying reasons for their beliefs. In Table 8, we present our findings. Among nineteen participants, only four of them stated that 'Yes, I am competent enough to deal with SSIs in my future class' while 6 of them noticed 'partially yes' and 9 of them noticed 'no'. When the responses were analyzed, it is possible to specify that there were several reasons for different self-efficacy beliefs towards SSI teaching and SSI-based instruction. The most frequent ones were 'lack of teaching experience' and 'lack of content knowledge'. Besides, teacher candidates emphasized the fact that SSIs are relatively new topics and more research need to be conducted on them affect their self-efficacy beliefs negatively.

> STD21: I am. I like to form different views; I like searching scientific magazines. […] and I could use that method.
> STD20: No, of course I am not, at the moment I can not even make normal presentation and so at that moment it is more difficult. […] You could see lack of self-confidence maybe, but when I enter the class I just know A+B=C, I just learned that. I have not educated myself about those, my training is not enough […]
> STD8: I could not say directly that I apply, I could apply SSI-based instruction in my lessons because I think that I am not still ready for that […]
> STD3: So, I think it is not possible to see completely enough; of course, we took lessons of that but this is something open-ended so I could not say I am competent enough.

Table 8. Reasons of lack of self-efficacy towards SSI-based instruction

Category	Code
Personal Characteristics	Lack of experience (5)
	Lack of content knowledge (4)
Characteristics of SSI-based	Requirement of research (6)
Instruction	Requirement of being up to date (2)

Discussion

The inclusion of SSIs into national science education curriculum was made in 2013 and with recent revisions (made in 2018), SSIs preserve their place on the curriculum (MONE, 2013; MONE, 2018). As we stated in the very beginning of the article, SSIs can contribute to students from various aspects such as increasing higher-order-thinking abilities, scientific literacy level, science content knowledge and more. When bearing these factors in mind, being aware of SSIs and understanding how to deal with them in science classes arise its importance for teachers. Thus, in the present study, we examined the views of PSTs, teachers of the future, towards SSIs and SSI-based instruction.

In this study, we found that while some of the participants had encountered SSIs through the compulsory or elective courses which they attended during their university education and some encountered them through their own efforts, there were still some other participants who did not encounter SSIs. Due to the fact that some participants were aware of SSIs through the courses that they had attended during university education, we examined the structure of corresponding courses in detail and realized that in compulsory courses e.g. 'Special Issues in Biology', instructors only indicated some issues as SSIs, but did not explain what SSIs are and how

those issues are classified as SSIs in detail. In the elective course, participants noticed that the focus of the lesson was on teaching what SSIs are and how SSI-based instruction can be carried out. They also emphasized that they are composed of different activities related to the SSIs within that course. Nonetheless, whether they encountered SSIs through courses, compulsory or elective, or through their own efforts, we found that the participants did not define SSIs and specify their features effectively. The most emphasized feature of SSIs was having both social and scientific dimension. Kara (2012) and Lee et al. (2006), in their studies, obtained the same results. Although in those studies, the participants strongly emphasized the multidimensionality of SSIs, especially the moral and ethical dimension; in our study, only a few participants emphasized the multidimensional structure of the SSIs. In her study, Özden (2015) found that the participants emphasized SSIs as ill-structured and open-ended issues. The present study's participants also stated those points as the features of SSIs.

In the present study, PSTs noticed environmental issues, for instance global warming, greenhouse effect etc., as SSIs. On the other hand, the most frequent proffered example was GMOs. Yapıcıoğlu (2015), in her study, also found the same results. In her study, environmental issues, GMOs, organ and blood donation etc. were given as examples to SSIs. In the present study, on the other hand, no participants specified organ and blood donation as examples of SSIs. In a study, Kolstø (2001) stated that SSIs are the issues which we encounter through our daily life activities. In line with that, we noticed, the participants mostly provided examples of SSIs among which they encountered through media (such as TV and social media) and through their lessons.

In the present study, next, we examined participants' ideas towards SSI-based instruction; how to design the instruction, what kind of teaching approaches can be used during such instructions and what different stakeholders' roles can be within SSI-based instruction. First, we found that PSTs were generally willing to use student-centered teaching methods such as 5E teaching method, argumentation and etc. for SSI-based instruction rather than to use teacher-centered teaching methods. Alaçam-Akşit (2011) found that prospective elementary teachers stated that SSI-based instruction could be more effective if student-centered teaching methods were used in the classrooms. Yapıcıoğlu (2016) also explored that participants of her study were willing to use student-centered teaching methods. On the other hand, in this study, some participants were willing to use teacher-centered teaching methods such as presentation and question and answers methods.

Friedrichsen et al. (2016), in their study, developed an instructional model for SSI-based instruction. Their model was based on 5E teaching method combined with argumentation. We realized that some of the participants stated a similar instructional model for SSI-based instruction with that instructional model. In the present study, we also examined the views of PSTs towards the easiness and difficulties of applying SSI-based instruction. Lee et al. (2006) and Kara (2012) stated time problems for planning and preparation, presence of less educational materials, and requirement of advance classroom management skills as some difficulties for SSI-based instruction. Similarly, the present study's participants pointed out planning and preparation, requirement of good classroom management skills and requirement of great amount of time for planning and preparation for lessons as the most significant difficulties of SSI-based instruction. On the other hand, as an advantage of SSI-based instruction, participants mostly emphasized that in class interaction could be more easily developed and the handled issues could be easily associated with real life.

Heretofore, we discussed the idea of PSTs towards successful integration of SSI in science lessons and possible impeding and facilitating factors of SSI-based instruction. At that point, we discuss what PSTs think about the roles of different stakeholders such as teachers, students, school administrations and etc. to conduct SSI-based instruction. As the role of teachers, our participants strongly emphasized that teachers should act as a guide during lessons and be knowledgeable about SSIs from both content and pedagogical perspectives. Özden (2015), in his study, obtained the same results and in the study of Presley et al. (2013), the importance of acting as a guide during lessons was shown as one of the most significant roles of teachers. Additionally, having adequate pedagogical knowledge and science content knowledge to teach SSIs were also emphasized as important teachers' roles which they should have for satisfactory SSI-based instruction (Alaçam-Akşit, 2011; Presley et al., 2013; Özden, 2015). As students' roles, PSTs emphasized that students should be active during lessons and be willing to participate actively in discussions, activities etc. Similarly, Kara (2012) found that students should be willing to learn the presented issues and participate actively in lessons. The present study also examined the views of PSTs towards different stakeholders' roles for SSI-based instruction. As we stated earlier in this article, Presley et al. (2013) emphasized that for SSI-based instruction, in addition to teachers and students, some other stakeholders such as school administration and program developers have some roles such as developing appropriate curriculum to integrate SSIs, providing materials and so on. In the present study, some of the participants also emphasized revising science curriculum and creating a more flexible program in

order to integrate SSI to science lessons and providing materials for successful lessons as the roles of stakeholders.

It came into prominence that the participants generally did not have sufficient self-efficacy beliefs. In their studies, Muğaoğlu et al. (2016), Sönmez and Kılınç (2012), Alaçam-Akşit (2011) and Lee et al. (2006) also pointed out that the participants did not have sufficient self-efficacy beliefs. The present study found that lack of experience, teaching practice in real settings, and content knowledge were top reasons for such findings. Similarly, Alaçam-Akşit (2011) found that lack of content knowledge and pedagogical knowledge about appropriate teaching method were reasons for less self-efficacy beliefs while Lee et al. (2006) found lack pedagogical expertise and content knowledge the reasons of less self-efficacy beliefs.

To conclude, we found that although some participants were aware of SSIs and through an elective course that they had a chance to practice teaching through those issues while others did not have such opportunities, most of the participants did not have adequate knowledge about SSIs and SSI-based instruction and did not have enough self-efficacy beliefs towards their skills to integrate SSIs into real classroom settings. Therefore, we suggest that during university education, courses in which PSTs can learn more about SSIs and have more teaching opportunities in microteachings and real teaching practices should be added by revising the science education programs of universities. As Muğaloğlu et al. (2016) stated that by providing PSTs opportunities towards integrating SSIs in different teaching settings, they might develop positive self-efficacy beliefs towards integrating SSIs into their future classes. Additionally, for science and elementary education teachers, in-service training opportunities for teaching SSIs should be provided. In future research, with the same participants, new interviews might be conducted to get their ideas towards SSIs after gaining more teaching experiences. In addition, self-efficacy beliefs of PSTs and science teachers towards SSIs and SSI-based instruction might be examined in detail and the reasons of low self-efficacy might be investigated.

Scientific Ethics Declaration

The author(s) declare that the scientific ethical and legal responsibility of this article published in JESEH journal belongs to the author(s).

Disclosure Statement

No potential conflict of interest was reported by the author.

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Author Information

Okan Sıbıç
İstanbul University-Cerrahpaşa, Hasan Ali Yücel Faculty of Education
Büyükçekmece, İstanbul, Turkey
Contact e-mail: *okansibic@istanbul.edu.tr*
ORCID iD: 0000-0001-7241-274X

Mustafa Sami Topçu
Yıldız Technical University, Faculty of Education
Davutpaşa-Esenler, İstanbul, Turkey
Contact e-mail: *mstopcu@yildiz.edu.tr*
ORCID iD: 0000-0001-5068-8796