Opinions of Science Teachers who are Graduate Students on Teaching Socio Scientific Issues

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Abstract

This study was carried out in order to determine what postgraduate science teachers perceive when socio scientific issues are mentioned, how they teach these subjects, what difficulties they encounter during teaching the subjects and what they need during the teaching of socio scientific issues. For this purpose, three groups of interviews were conducted over ZOOM with 14 science teachers working in different provinces and doing a master's degree in science education at Faculty of Education, Siirt University in the 2021-2022 academic year. Focus group interview, one of the qualitative research methods, was used in the research. Research data were collected with a semi-structured interview form. In the analysis of the data, the thematic content analysis was made. According to the answers given to the questions, themes, categories, and codes were created and frequency values were given. According to the results obtained, teachers can define socio scientific issues, give enough examples, explain the reasons for discussing the issues in detail, follow current developments especially on social media and the internet, use traditional teaching methods such as lecture methods and question-answer, and draw upon student-centred methods such as discussion and debate while teaching some subjects. It was understood that they need domestic materials and foreign resources, a reduction in the class size, and teacher training, have difficulties due to reasons such as the lack of a clear answer to the subjects, religious beliefs, prejudices and lack of sufficient time for the subjects, mostly benefit from the textbooks while teaching the subjects, and could give examples of socio scientific issues in their close environment.

Keywords: Socio scientific issues, Science education, Science teachers, Focus group technique

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Introduction

One of the most significant objectives of science teaching is to support the development of scientific literacy, which includes students' decision-making skills, reasoning, critical thinking skills, and the knowledge necessary to implement their decisions. Today, scientific literacy not only includes scientific knowledge, but also requires the production, interpretation, communication, discussion, and examination of the impact of science on society and the environment (OECD, 2006).

The developments in science and technology have also created some dilemmas for social life. Today, there are still open-ended moral-ethical debates on issues such as population growth, genetic screening, genetic engineering, cloning, reproductive technologies and vaccination, and climate change (Saunders & Rennie, 2013). In addition to these issues, there are also examples of waste processing and recycling (Kortland, 1996), environmental problems (Patronis, Potari and Spiliotopoulou, 1999), mines and their effects on the environment (Pedretti, 1999), genetics of farm animals, the increase of chicken farms and their effects on nature (Jimenez -Aleixandre, Rodriguez and Duschl, 2000), energy transplantation, leukemia (Kolstø, 2001), animal rights (Zeidler, Walker, Acett and Simmons, 2002; Ayvacı, Bülbül and Türker 2019). Despite these large-scale discussions, it is observed in the results of research conducted with teachers that many teachers experience uneasiness in their classes, especially in the process of explaining socioscientific issues with ethical aspects (Lee et al., 2006; Chen & MuiSo, 2017; Küçükaydın 2019).

In recents years, some typical topics have emerged including nuclear power plants, stem cells, flu vaccine, cloning, blood sugar test for the pregnant, genetically modified foods, cosmetic surgery, global warming, cholesterol drugs, and organ transplantation (Sadler and Zeidler 2005: 112). In addition to these topics, reproductive technologies and abortion (Dawson, 2011), use of antibiotics (Friedrichsen, Sadler, Graham, & Brown, 2016); alternative medicine, biodiversity, and human genome project are also considered as socio-scientific issues (Topçu, Mugaloğlu, & Güven, 2014). Sadler (2011) included fluoride addition to water resources in treatment facilities, different diseases such as cystic fibrosis, AIDS or SARS, local and global environmental problems, and water and air quality among socio-scientific issues (Genç and Acar 2021).

In order for students to produce more creative ideas for SSIs, more time should be allocated to related topics in the classroom environment. Ensuring that teachers, who allocate the necessary time for SSIs in the classroom, produce solutions for the identified problems in a critical and democratic environment with their students will have positive effects on both themselves and their students. It will also ensure that individuals who conduct research on SSI display high-level attitudes and behaviors on these and similar

issues (Sürmeli 2008). With the inclusion of SSI in curricula in many countries including Turkey in recent years, the main goal is to carry out teaching activities that meet the reform expectations such as creating an environment for discussion in the classroom and to improve the reasoning skills of students.

As SSIs are situations that can be encountered in daily life, it is very important to understand these issues, teach them effectively, and enable them to make good judgments in the decision-making phase (Sadler, 2004; Kolsuz, 2018). Since it is known that science teachers play the leading role in teaching these subjects in the classroom, it is also important to determine what teachers' views are about these subjects.

In the 21st century, the rapid spread of information and new developments in science contributed to the development of technology along with effects on society. These developments are observed to have negative as well as positive effects on social life. The changes that occurred as a result of these effects resulted in a natural discussion. These are called as socio scientific issues. Socio scientific issues (SSIs) are not only scientifically studied and community oriented but also expressed as complex, open-ended, and generally controversial issues and do not have a definite and clear answer (Sadler, 2004, Aydın and Moçan 2019).

It is understood that the majority of studies on socio scientific issues conducted in Turkey focused on preservice teachers with mostly quantitative research methods used and the attitude variable emphasized. Aydın et al. (2019) carried out a content analysis of the studies on SSI in Turkey and reported that the studies mainly focused on pre-service teachers (n=52) and secondary school students (n=30). They also reported that a small part of the studies were conducted with teachers (n=8), public (n=2), university, high school and primary school students (n=1). The present study is crucial in that it not only reveals the experiences of teachers who have different tenures and workplaces as science teachers and the opinions and suggestions of science teachers but also allows SSIs to be taught more effectively. This study is also expected to contribute to the literature in terms of resources.

The general purpose of this research is to determine the views of science teachers about SSIs. In line with this general purpose, the following sub-problems were addressed:

1. What do science teachers understand when it comes to SSIs and what are the reasons for discussing these issues?
2. How do science teachers handle SSIs in lessons?
3. Do science teachers follow up-to-date information about SSIs, if so, how do they follow such information?
4. Which resources do science teachers use while teaching SSIs in class?

5. What kind of difficulties do science teachers experience while lecturing SSIs?
6. What do science teachers need to teach SSIs more effectively?
7. What do the science teachers have about SSIs in their immediate surroundings?

Method

This study was designed to determine the views of science teachers doing master's degree about the teaching of SSIs. The focus group technique, one of the qualitative research methods, was used in the study carried out for this purpose. The purpose of focus group interviews is to obtain qualitative information by examining participants' perspectives, lives, interests, experiences, tendencies, thoughts, perceptions, feelings, attitudes, and habits in a detailed and multidimensional manner (Stewart & Shamdasani, 1990; Kitzinger, 1994; Krueger, 1994; Gibbs, 1997; Bowling, 2002; Tanhan and Yılmaz 2017).

Working Group

20 students are enrolled in the master' degree program of science teaching at Siirt University. In line with the purpose of the study, those who are work as a science teacher and doing master degree at the same time were selected. The participants constitute the focus of the research.

This research was carried out with the participation of 14 science teachers working in different cities and studying at the Department of Science Teaching Master's Program at Siirt University. The study group consists of 8 female (57%) and 6 male (43%) participants. All participants are in the first year of graduate education. To elaborate on the science teachers' understanding of SSIs and their views on teaching these subjects, maximum variation and criterion sampling methods were used. Purposive sampling is defined as the detailed examination of situations that need to be examined in depth. Therefore, the purposive sampling method is useful in investigating and interpreting a great number of situations, phenomenons, and events (Patton, 2002). Science teachers were preferred purposively in the study. This type of sampling is used if situations that provide certain characteristics or have certain criteria's are investigated (Büyüköztürk, Kılıç, Akgün, Karadeniz, and Demirel 2018). To ensure that the sample group is diverse, teachers from various cities, institutions, environments, and cognitive levels were selected.

As in the sampling method used in this study, maximum diversity sampling is defined as determining different situations related to the research problem and working on these situations (Büyüköztürk et al., 2018). In so doing, interviews were conducted with a group of science teachers enrolled in a master's program in the department of science teaching. This sample selection is also suitable for the criterion sampling method. For, the participants were selected from people with certain characteristics (Büyüköztürk et al.,

2018). Since factors such as internet access, laboratory facilities, class size, and cognitive levels of students are thought to have an impact on SSIs teaching, 14 science teachers working in different cities were preferred. In so doing, the diversity and number of participant groups was also increased. Demographic information about the study group has been given in Table 1.

Table 1
Gender of the teachers, their years of service and employment city

Gender	Year of employment	City of employment	Gender	Year of employment	Employment city
(1.T-F)	3 years	Siirt	(8.T-M)	6 years	Batman
(2.T-M)	9 years	Mardin	(9.T-F)	5 years	Batman
(3.T-F)	6 years	Siirt	(10.T-F)	3 years	Siirt
(4.T-F)	3 years	Mardin	(11.T-F)	11 years	Siirt
(5.T-M)	7 years	Antalya	(12.T-M)	14 years	Batman
(6.T-M)	6 years	Bitlis	(13.T-F)	6 years	Diyarbakır
(7.T-F)	11 years	Diyarbakır	(14.T-F)	4 years	Erzurum

Data Collection Tools

The research is limited to 14 science teachers who are enrolled in a master's degree and semi-structured open-ended questions. The interviews were recorded in groups via ZOOM. Each group interview lasted approximately one hour. The researcher took the opinions of four teachers in the randomly-selected group and the first group, of five teachers in the second group, and of five teachers in the third group. The researcher also used the 'Interview Form (Appendix 1)' developed by the researcher and prepared after receiving the opinions of two academicians who are experts in the field. This form took its final form after the pilot application which was conducted with four teachers. The first question in the interview form was aimed at revealing information about the vocational experience and city where the teacher works. The other questions were prepared to determine how SSI courses are given, the reasons behind discussions, how they follow the current issues related to SSIs, what kind of resources they use, how they explain SSIs in the teaching process, and what is required for a more permanent SSI teaching. In addition, questions related to the subject were included in each question to obtain in-depth information. For example, regarding the question "How do you handle SSIs while teaching?" and where the question is answered with a direct and short answer, the following questions were also asked: "What kind of activities do you do in the classroom while teaching SSIs?" or "How do you ensure active participation of students?", or "How do you prevent students' misconceptions, if any?". In this study, seven questions were prepared not to miss the main focus point, and additional questions were asked in cases where teachers' explanations were thought to be inadequate or the teachers did not understand the question.

Analysis of Data

The thematic content analysis technique was used in analyzing the research data. The purpose of the thematic content analysis is to reach the concepts and relationships that can explain the obtained data. Some of the basic operations in qualitative data analysis are to bring similar data together within the framework of certain concepts and themes and organize and interpret the relevant data in a way that readers can understand (Yıldırım & Şimşek, 2008; Kahyaoğlu & Çetin 2015). A thematic content analysis, which is a qualitative data analysis technique that allows patterns (themes) of a data set to be identified and analysed through a careful process of reading and re-reading the data (Fereday and Muir-Cochrane 2006), was used. The data obtained via ZOOM and a semi-structured interview form were firstly transcribed. During the next stage, the responses of the participants were examined by two expert educationalist independently of each other, and themes, catagories, and codes were created. Without interacting with each other, two independent coders should provide a minimum of 70% consistency by numerically comparing the differences and similarities of the same data set in different environments (Yıldırım and Şimşek, 2016: Çepni and Geçit 2020). In this study, the reliability formula suggested by Miles and Huberman (1994) was used (Reliability = Consensus/Consensus + Disagreement) and when the codes of two field educators and experts were compared, it was found that they were compatible by 88%. In addition, direct quotations from the statements of the teachers were included to increase the reliability of the research, and the order of the participants (1.T, 2.T, 3.T…) and their gender (F, M) were given. To increase the validity of the research, the literature was examined and expert opinions were taken while the form was being prepared. In the analysis of the data, attention was paid to make the subject as detailed and concise as possible. In addition, the participation of teachers was based on volunteerism and the goal was to obtain sincere responses that fully reflect the subject of research. These results show that the findings are reliable for the research.

Results

In the research, the findings obtained as a result of the analysis of the data collected by the semi-structured interview form made for science teachers are given respectively.

As a result of the answers given to each question, themes, categories, and codes were created and the frequency values of the codes were given. In addition, the answers given by some participants were directly presented.

Findings of the first sub-problem are given in Table 2 and Table 3.

Table 2

Theme, categories, codes and frequency values of the opinions about the reasons for discussion

Theme	Category	Codes	f
	Personal opinions	Accuracy varies from person to person	3
		They are matters open to interpretation.	2
		Being issues that create dilemmas	2
		Unsatisfactory answers	1
Reasons for discussing SSIs	Opinions about society	Having sub-dimensions such as ethical, moral and legal	2
		Associated with daily life	2
		Concern community	2
		Having positive and negative sides	1
	Opinions about the topicality of the topics	Continuous development of science and technology	2
		Continuous updating	1

Table 2 shows that SSIs are controversial issues as:

- The accuracy varies from person to person,
- SSIs are open to interpretation,
- SSIs are related to daily life, t
- The subjects are what society is concerned about,
- SSIs have ethical, moral, and legal sub-dimensions,
- Some subjects are controversial,
- The relevant subjects are constantly updated,
- The answers given to the subjects or questions are not satisfactory, and
- SSIs have both positive and negative aspects.

Teachers believe that SSIs are controversial because the accuracy of subjects such as Covid-19 vaccine, GMO, stem cells, organ donation (organ transplantation), global warming, nuclear power plants varies from person to person. They also reported that subjects such as design babies, animal rights, zoos, euthanasia are discussed due to their ethical, moral and legal dimensions, and subjects such as artificial intelligence, space exploration, biofuels, cloning are controversial issues due to the continuous development of science and technology and the constant updating of the subjects. Finally, they reported that the answers given to issues such as alternative fuels, vaccines, blood donation, and environmental pollution were not satisfactory.

Table 3

Theme, categories, codes and frequency distributions of the opinions about the examples related to SSI

Theme	Category	Codes	f
Examples of SSI	Views on humanity	Organ transplant	6
		Stem cells	4
		Vaccine	3
		Blood donation	3
		Gender discrimination	2
		Design babies	2
		Artificial intelligence	2
		AIDS	1
		Sugar load during pregnancy	1
		Euthanasia	1
		Child abuse	1
	Environmental views	Environmental issues	4
		Climate changes	3
		Global warming	2
		Waste Control	2
		Land use	1
		Ozon layer	1
		Transferring nature inact	1
		Space Researches	1
		Sustainability	1
	Opinions on biology	GMO	9
		Cloning	5
		Biotechnological issues	2
		Most biology subjects	1
	Opinions on energy resources	Nuclear power plants	7
		Alternative energy	3
		Dams	1
		Biofuels	1
	Opinions about animals	Animal rights	2
		Zoos	1

Table 3 highlights that mainly GMOs, nuclear power plants, organ transplantation (organ donation), and cloning were reported as examples of SSIs. Since GMOs appear in all areas of life, the relevant answer was actually expected.

Some of the teachers' answers are as follows:

SSIs are open to interpretation and often do not have a definite answer. At the same time, we do not encounter such issues in social life. Yet their discussion improves science literacy. For example, GMOs, stem cells, global warming, environmental

problems, cloning, and nuclear power plants, which are in the 8th-grade curriculum and explained in other classes, can be given as examples of SSIs. (1.T.-F.)

At the same time, scientific issues concerning the society are possible, but they are controversial issues because of their positive and negative aspects. These are the subjects I mentioned especially under the sub-headings of the Science, Technology and Society. Environmental pollution, vaccines, nuclear power plants, organ donation, biotechnology can be given as examples. In addition, artificial intelligence, space studies, and dams are examples of SSIs. (6.T-M.)

Findings of the second sub-problem are given in Table 4

Table 4

SSI, narration methods explained in the lectures and frequencies

Lectured SSI	Method	f
Environmental pollution	Lecture method	9
	Question answer	8
	Case study	4
	Animated movies	4
Vaccine	Lecture method	9
	Question answer	8
	Argument	5
	Six hats	2
Blood donation	Lecture method	9
	Question answer	5
	Argument	4
	Concept map	4
Organ transplant	Discussion	6
	Question answer	6
	Newspaper pages	2
	Case study	1
	Problem scenarios	1
Biotechnology	Argument	7
	Question answer	7
	Lecture method	7
	Dilemma cards	1
	Argumentation	1
Global warming	Lecture method	12
	Question answer	2
	Concept map	2
	Problem-based learning	1
GMO	Lecture method	11
	Real materials	5
	Discussion	4
	Brain storming	3

As a result of the interview, it was understood that nine of the teachers made a lesson plan while five of them fail to make a lesson plan.

Table 4 reveals that straight lectures and question-answer methods are preferred more in the explanation of subjects such as environmental pollution, vaccine, blood donation, global warming, and GMO, and debate and discussion techniques are used more in subjects such as biotechnology and organ transplantation. In addition, while explaining SSIs, it is also methods or techniques such as case study method, animated films, six hats technique, concept maps, newspaper pages, dilemma cards, argumentation, problem-based learning, and brainstorming are used.

Some of the teachers' answers are as follows:

Yes, I teach SSIs in my classes. First of all, I present a video about the subject at the beginning of the lesson, then we altogether go into a discussion about the relevant video they watch and evaluate the subject with its positive and negative aspects.(9.T-F)

I'm talking about GMO, biotechnology, and organ donation. For example, I encourage them to have a discussion while talking about organ donation by asking "Would you donate your organs?". Since these issues are mostly subjective, I prefer a medium of talking and discussing. As part of yet another activity about organ donation, I help them to empathize by asking whether there is anyone around you waiting for an organ. I usually use the lecture method in my lessons, but I mostly use the discussion and question-answer method in SSIs. (6.T-M)

Findings of the third sub-problem are given in Table 5.

Table 5
Theme, categories, codes and frequency distributions which SSI-related developments are followed

Theme	Category	Codes	f
	Technology resources	Social media	9
		Internet	6
		Television	3
	Printed resources	Scientific journals	4
Resources which were followed developments		Scientific studies	1
		Textbook	1
	Social resources	Friends (Social environment)	2
		Non-governmental organizations	1

Table 5 reveals that most of the teachers follow the developments related to SSIs and prefer social media as a source. In addition, they benefit from the internet, scientific journals, television, friends (social environment), scientific studies (articles, thesis, papers), non-governmental organizations, and textbooks.

Some of the teachers' answers are as follows:

Our elders can learn SSIs by watching them on television, but people of our age, including me, can do research with the help of computers and the internet. There are many places we can follow on social media regarding these issues. I mostly follow the developments on social media. (7.T-F)

I do research on the internet. I also follow a lot from social media. Sometimes, I can learn the subjects that I could not follow or that I learned at a later stage by discussing them with my friends. Since most of my friends are teachers, I exchange ideas about SSIs and follow current developments. (4.T-F)

As the fourth question, the science teachers were asked the question "Do you use any sources related to SSIs while teaching the lessons? (Which resources do you use?)", and the codes for the answers given and the frequency distribution of the codes are given in Table 6.

Findings of the fourth sub-problem are given in Table 6.

Table 6
Theme, categories, codes and frequency distributions which of SSIs used while being taught in class

Theme	Category	Codes	f
Resources used in the lessons	Technological tools	Internet	7
		Animation videos	7
		Smart board	5
		Education Information Network (EBA)	4
		Computer	3
		Projection	1
	Printed resources	Textbook	14
		Resources books	8
		Newspaper news	3
		Scientific journals	2
	Materials	Real objects	1

Table 6 reveals that all teachers primarily benefited from the textbooks when SSIs were taught during courses as well as from source books, the internet, animation videos, smart boards, EBA, newspaper news, real objects, scientific journals, and projection machines.

Some of the teachers' answers are as follows:

I follow SSIs from textbooks, the internet, and scientific journals. Because SSIs consist of conflicting topics, I do not want to be tied to an idea or a source. I want to have more than one idea by following several sources. (10.T-F.)

I use textbooks, and there are additional resources that I have benefited from. I benefit from videos and documentaries on websites. When I benefit from documentaries on the subject, children who usually get bored quickly get bored at a later stage following the course. I bring real objects to the lesson while teaching topics such as GMO. (3.T-F.)

Findings of the fifth sub-problem are given in Table 6.

Table 7
Themes, categories, codes and frequency distributions for the difficulties experienced while explaining SSIs in the classroom

Theme	Category	Codes	f
	Student welded problems	Religious beliefs	4
		Creating a discussion environment	4
		Insufficient readiness	3
Difficulties experienced while teaching lessons		Prejudices	3
		Inability to empathize	2
	Problems about physical facilities	Insufficient time	3
		Crowded classroom environment	3
	Problems about the content of the subjects	Lack of clear answers	4
	I'm not forced	I'm not forced	2

Table 7 reveals teachers' reports of having difficulties due to reasons such as lack of clear answers to the problems related to the subjects, some false religious beliefs on issues such as organ transplant, discussions between groups in the classroom, prejudices about the subjects, crowded classes, insufficient time allocated to the subjects, insufficient readiness of some students, and the inability of the students to empathize on some issues

such as organ transplantation. In addition, two teachers reported that they did not have difficulty in explaining the subjects.

Some of the teachers' answers are as follows:

Since SSIs are controversial issues, there may not be a clear answer to the problems. For example, I find it difficult to explain because there are some wrong religious beliefs about organ transplantation. Students may have some prejudices on such matters. Students ask questions such as "Why would I give my own organ to someone else" because they cannot empathize. And I have to explain them all the time. (13.T-M.)

I think that the discussion technique should be used a lot while teaching SSIs. Since the classes are crowded, it becomes difficult to use this technique. In addition, since some subjects do not have a clear answer, students can discuss among themselves in the classroom. For this reason, classroom management becomes difficult. I think that the time allocated for the treatment of these issues is also insufficient (11.T-F.).

Findings of the sixth sub-problem are given in Table 8.

Table 8

Themes, categories, codes and frequencies of the needs in teaching of SSIs

Theme	Category	Codes	f
Needs in teaching SSIs	Needs to improve physical conditions	Materials	4
		Specialized classes	4
		Additional domestic and foreign resources	4
		Reducing class size	3
		Real objects and concrete examples	2
		School boards about SSIs	2
	Needs for educators	Teacher education	4
		Pre-made lesson plans	3
		Expert tutorials on SSI	3
		Conferences	2
		Interdisciplinary communication	2
		Argumentation studies	1

Table 8 reveals that teachers mostly have difficulties in finding materials related to SSIs, have problems due to the lack of specialized classrooms, and need domestic and foreign resources. They report problems such as deficiencies in teacher education, expect a reduction in class sizes, need already-prepared lesson plans and expert trainers about SSIs. They also report that conferences and panels, real object, and concrete examples may help since the subjects include more than one field and there is a need for interdisciplinary communication, boards about SSIs in schools, and argumentation studies.

Some of the teachers' answers are as follows:

If we have enough materials for effective teaching of the subjects, we can explain the subjects more effectively with readiness. In addition to the lack of sufficient materials, there should be specialized classes related to the subject. I also need real objects to prevent misconceptions. For example, while explaining the GMO issue, I bring real plant examples to eliminate misconceptions. These examples should be brought more. (8.T-M.)

SSIs are what society and science care about. These issues are also about more than one discipline. Multidisciplinary studies related to the subjects are crucial in teaching the subjects. Expert instructors should gather on a common ground and evaluate the subjects together. In addition, we need expert instructors or field experts to organize events such as conferences, seminars, or panels on the subject. (5.T-M.)

Findings of the seventh sub-problem are given in Table 9.

Table 9

Theme, categories, codes and frequency distributions of the examples given by science teachers about SSIs in their immediate environment

Theme	Category	Codes	f
Examples of SSI in their close circle	Examples of the environment and environmental problems	Environmental issues	5
		Disposal of waste	4
		Use of plastic	3
		Reclamation of streams	2
		Garbage dump sites	2
	Examples of energy production	Dams	5
		Alternative fuels	4
		Hydroelectric power plant	2
	Examples that directly concern people	Organ transplant	1
		Increasing use of GMOs in agriculture	1
	Examples involving animals	Violation of animal rights	1

Table 9 reveals that most of the teachers mention dams and environmental problems as examples of SSIs in their immediate surroundings. Among the other examples are alternative fuel use, waste disposal, use of plastics, hydroelectric power plants, river improvement, garbage dumps, violation of animal rights, organ transplantation, and the increase in the use of GMOs in agriculture.

Some of the teachers' answers are as follows:

In the city where I live, they exploit some animals in the summer and leave them on the street in the winter. The animals used in transportation are actually the animals I have mentioned in this group. This is a socio scientific issue related to animal rights that I see around me. (8.T-M.)

Today, the concept of far or near is not so much. For example, GMO, organ donation, environmental pollution are general issues and these are issues that concern everyone. Apart from these, water pollution and garbage dumping areas can be given as examples in the city where I live. (6.T-M.)

Discussion and Conclusion

This study sheds light on the views of science teachers doing a master's degree about SSIs and how they teach these subjects in their classes, what problems they experience while teaching the subjects, what kind of needs they have, what they do to solve these discussed issues, and examples of SSIs in their immediate surroundings.

According to the results of the study, it was determined that science teachers constructed another definition of SSIs. This result differs with the studies of Han-Tosunoğlu and İrez (2017) and Aydın, Sarıbaş, Özalp and Yılmaz (2021). One may also notice that most of the teachers not only have knowledge about these issues but also define SSIs. This shows that the examples given by the teachers were sufficient. Sadler and Zeidler (2005) reported that SSIs are scientifically based, controversial, and contradictory in nature, and are discussed under political and social norms by individuals who make up the society. In addition, Aslan (2019) suggested that there is no clear and single solution to the issue, especially regarding hydroelectric power plants, and that it is open to discussion. In addition to these studies, Çepni and Geçit (2020) suggested that there exists a perception that SSIs are controversial issues due to their association with social issues, their association with science subjects, and their ethical dimensions. They further suggested that science teachers are of the opinion that the reasons for discussing the subjects are discussed because the accuracy of the subjects varies from person to person and because they are open to interpretation, related to daily life, are what society is concerned about, and are considered to have ethical, moral, and legal sub-dimensions. They also reported that science and technological developments cause discussion, that some subjects are controversial subjects, that the relevant subjects are constantly updated, that the answers given to the subjects or questions are not satisfactory, and that SSIs are controversial because they have positive and negative aspects. This study shows similarities with other studies mentioned in this respect.

At this stage, science teachers have a great responsibility. It is necessary to identify the sources of difficulties, to eliminate the misconceptions that may occur, and to

provide the students with the ability to empathize. Teachers should take a role in reducing the reasons for discussing the issues, evaluate the issues from an objective point of view, and transfer them to their students in this way.

Türkmen, Pekmez, and Sağlam (2017) also mentioned in their studies that starting from basic education; more socio-scientific issues should be covered in the context of science and technology within the courses using student-centered methods and techniques. Atalay and Çaycı (2017) reported that the most recommended method for SSIs is the discussion method. Akbulut and Demir (2020) also put forward that science teachers mostly use group teaching techniques and discussion techniques. In this study, it was observed that teachers mostly used traditional methods such as lecture method and question and answer method and the discussion method on subjects such as vaccine, blood donation, and biotechnology, while other SSIs were taught via student-centered methods, albeit to a lesser extent. The use of traditional methods by almost all of the teachers differs from the studies mentioned in this respect. The use of appropriate methods based on a student-centered approach in teaching SSIs is of great importance in teaching the relevant subjects more permanently. SSIs should be taught using student-centered methods instead of traditional teaching methods.

It was determined that all of the teachers primarily benefited from textbooks and additional resources other than textbooks while SSIs were being taught in the course. In addition, they benefited from the internet, animation videos, smart boards, EBA, newspaper news, real objects, scientific journals, and projection machines. It is of great importance to increase the diversity of resources to teach SSIs more effectively. In this study, it was determined that teachers used a sufficient number of various resources in their lessons.

Another result of this study was that while the teachers were explaining the subjects, they had difficulties because of some problems such as the lack of a clear answer to the problems related to the subjects, the false religious beliefs on some subjects, the spontaneous discussions between groups in the classroom, the prejudices of the students towards the subjects, the crowded classes, the insufficient time allocated to the subjects, the insufficient readiness of some students, failure to be able to empathize on some subjects such as the organ transplant. Öztürk and Erabdan (2019) reported that the majority of teachers had difficulties because the subjects were controversial. They further suggested that some teachers had difficulties due to the prejudice of some students, insufficient course time and materials. Finally, some teachers did not encounter any difficulties. The results in other studies have correlation with the results of this study.

Nida, Mustikasari, Eilks (2021) reported that teaching is difficult due to the lack of knowledge of teachers (Nida, Mustikasari, Eilks 2021). Some studies in the literature

have shown that there are issues such as the lack of relevant materials, insufficient teaching time among the factors that make the teaching of SSIs difficult and there is a need to solve these issues (Lee, AbdEl Khalick, & Choi, 2006; Kara, 2012). In addition, it has been shown that teachers need some materials, specialized classrooms, domestic and foreign resources, reduced class sizes, conferences, and school boards. If such needs of the teachers are met, it is thought that a more effective education will be given about SSIs.

It is important for the teachers to give examples for the subjects in their immediate environment and evaluate SSIs in terms of more effective teaching of the lessons. It is known that learning will be more permanent by giving examples from near to far while educational activities are being carried out. This study has made it clear that the teachers have knowledge about SSIs in their immediate environment.

Recommendations

To eliminate deficiencies in teacher knowledge, it is necessary to increase the number of elective or compulsory courses related to SSIs, especially in higher education institutions.

It is thought that it would be more beneficial for students to learn SSIs in detail at all levels of primary and secondary education. In addition, it is thought that teaching the subjects with an interdisciplinary approach is important for the teaching of SSIs.

For a more effective education, the current problems of teachers should be identified and their needs should be met. It has been observed that teachers mostly teach with traditional methods and thus, if student-centered and group work methods are preferred to traditional methods, teaching SSIs will be more effective.

In this study, the opinions of science teachers were taken. In future studies, a common evaluation can be made by taking the opinions of other branch teachers and classroom teachers.

The qualitative research method was used in the research and the data were collected with a semi-structured interview form. More detailed research on SSIs can be done with mixed-pattern studies in which quantitative and qualitative research methods are used together. In addition, perspectives on SSIs can be investigated in terms of different variables.

In this study, 14 teachers were used as a sample. Increasing the number of samples may provide an advantage in terms of obtaining more and in-depth information. In addition, similar studies can be conducted with teacher candidates.

In addition to these, deficiencies on the subject can be determined by working with primary and secondary school students about SSIs.

Preservice teachers should be given more effective education about SSIs at the undergraduate level. This study found that there is a need to eliminate the knowledge deficiencies of teachers.

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