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REVIEW ARTICLE

Determining the Argument Quality of Pre-service Science Teachers Regarding to Socio-scientific Issues: YouTube as a Source of Argumentation

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ABSTRACT

The aim of this study was to examine the quality of the written argument of pre-service science teachers on certain socio-scientific issues (SSI) and their opinions about the process of something. The study group consisted of 26 pre-service science teachers (18 females and 8 males) studying in their 3rd year of a state university. The purposeful sampling method was used for the study. In the study, a case study pattern was adopted from qualitative research designs. The study was instructed with the YouTube social media supported classroom discussion process. The data sources of the study consisted of sugar loading in pregnancy, raw/loose milk, and processed/pasteurized milk, written arguments for the SSI of the nuclear power plant, pre-service science teachers' journals, researcher notes, and semi-structured focus group interviews. The data obtained in the study were analyzed based on descriptive and content analysis techniques. The results of the study indicated that the quality of argument increased significantly during the implementation of something when the written arguments of pre-service science teachers were examined after class discussion. In the evaluation of the research process, it was determined that pre-service teachers' awareness of the SSI and the YouTube supported classroom discussion process contributed positively to life skills and science process skills such as decision-making, hypothesis building, discussion, and analytical thinking.

KEY WORDS: argumentation; pre-service science teachers; socio-scientific issues; YouTube

INTRODUCTION

Socio-scientific issues (SSI) are subjects, which deal with social issues that are related to science in a conceptual way (Sadler et al., 2007). SSI frequently deals with cloning, stem cells, and genetically modified organisms (GMOs), and biotechnological developments addressing environmental issues such as global climate change, land use areas, and foreign substances (both biotic and abiotic) (Sadler & Zeidler, 2005). It has been emphasized in many studies that SSI is an important context for individuals to make informed decisions by taking into consideration social, political, and scientific dimensions of social problems and developing their skills of discussion, reasoning, and decision-making (Hodson, 2003; Zeidler & Keefer, 2003; Zohar & Nemet, 2002; Sadler & Zeidler, 2005). An individual who does not have the characteristics of expected science literacy can be convinced by the news in the popular media about a particular SSI subject and ignore the different arguments on the subject (Cooper, 2011). Therefore, many countries have highlighted the importance of SSI in being part of their science program and emphasized the necessity of students' awareness of these issues (Oulton et al., 2004). In the light of this information, it is thought that before pre-service teachers start their profession, they not only need to gain awareness on SSI but also they need to be included in the learning environments where these issues are discussed.

LITERATURE REVIEW

SSI

The issues which provide dynamics between science and society and which have different perspectives for the individual (Sadler, 2004) generally include those ethical, moral, and legal dilemmas considered to be non-consensus are called SSI (Kolstø, 2001; Nielsen, 2012; Sadler, 2004; Sadler & Zeidler, 2005; Sadler et al., 2006). SSI are complex and controversial issues that concern society with scientific views and principles (Zeidler, 2014). In this respect, SSI integration in science courses provides students with rich opportunities to reach scientific knowledge, to approach to controversial issues critically, to discuss different solutions for solving problems, and to participate in decision-making processes (Oulton et al., 2004). In this process, since SSI are open-ended and prone to debate, it is quite difficult for individuals to negotiate on issues and to reach a final decision (Sadler & Zeidler, 2005). Therefore, the use of different methods and techniques in the implementation processes where SSI are discussed can be effective in making appropriate decisions. In the teaching process of SSI, argumentation is an important method for students to look at these issues from different perspectives, to present arguments about the subject, to evaluate the opinions, and to make decisions about the issues (Driver et al., 2000; Martin & Hand, 2009).

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SSI and Argumentation

When the literature is reviewed, the argumentation method is thought to be one of the appropriate and effective methods of teaching SSI (Acar et al., 2009; Kolstø, 2001; Topçu & Atabey, 2017). Argumentation is considered important to improve students' conceptual understanding of subjects and to help them make conscious decisions (Jiménez-Aleixandre & Pereiro-Muñoz, 2002; Sampson & Clark, 2009; Von Aufschnaiter et al., 2008). The arguments put forward by individuals in the process of post-trial debate on issues related to SSI have a meaning in terms of supporting the claims or refuting the claim of the opponent's side. In fact, the argument is created for students to defend their claims by making explanations and to reach judgment (Erduran & Jiménez-Aleixandre, 2007). Individuals experiencing the argumentation process have a final decision on the critical issues when they encounter a subject related to SSI (Sadler & Zeidler, 2005). In the process, a decision/claim is the simplest component of elements of argument, whereas refutation is the most distinguishing element in determining the quality of students' arguments (Foong & Daniel, 2013). All argument elements (such as data, claims, justification, and refutations) are both the basic elements of analyzing the quality of arguments in education and the basic building blocks of the argumentation process to reach a general opinion on a subject (Erduran et al., 2004; Venville & Dawson, 2010). At this point, students are expected to use their critical thinking skills to make critical and informed decisions about the SSI discussed (Sadler & Zeidler, 2005). Teachers should support the students in this process and encourage them to be active in the discussion applying their prior knowledge (Venville & Dawson, 2010). Participation of pre-service science teachers in the argumentation process used in the teaching of SSI before they start the profession and transferring their knowledge and experiences to their classes can be considered as a significant opportunity for their professional careers (Zeidler, 1997; Zohar, 2007). However, it is said that the popular media which play an active role in transferring the SSI to the public agenda are the most important tool that is considered to have a significant impact on the individual in reaching the individual (Klosterman et al., 2012; Öztürk et al., 2017; Öztürk & Erabdan, 2018).

SSI and Media

Mass media tools attract more and more attention from modern society and play an important and effective role of mediator between science and society (Klosterman et al., 2012). In the present century, individuals can easily access the information they want through the media and even prefer many social media applications (such as Facebook, Instagram, and YouTube). In fact, individuals who use the media actively share information about themselves, news, and from photos to writings on social media tools and they also participate in various scientific groups or activities, communicate among groups, conduct discussions, and play various social media games (Boyd & Ellison, 2007; Klosterman et al, 2012). Through many media sources, which occupy a significant part of our lives, such as television, Internet, newspapers, and social media, enable us to access SSI (Ratcliffe and Grace, 2003). In this respect, using media in SSI based science courses constitute an important dimension of the teaching process of SSI (Klosterman et al., 2012). In recent studies, media are a preferred resource, especially in the teaching practices of SSI (Dimopoulos & Koulaidis, 2003; Kachan et al., 2006; Klosterman et al., 2012; Öztürk et al., 2017). Actually, media are only a tool for teaching SSI and it is one of the easiest sources of information available to the individual. Klosterman et al. (2012) have found the impact of media in teaching SSI. They pointed out that teachers and students had access to information about SSI through the media. In a study, Dimopoulos and Koulaidis (2003) concluded that media were frequently used in getting individual's opinions on the issues, such as SSI, the social impacts of science and technology. Öztürk et al. (2017) conducted a research study with special talented students. Six different socio-scientific topics in the implementation process were discussed on the social media tool Twitter, and the pre-service science teachers' quality of the argument was determined. In the study, it was found that pre-service science teachers' quality of the arguments increased positively at the end of the implementation. In light of all this information, in the present study, a social media tool YouTube was chosen because it is an important media source preferred by individuals (Öztürk et al., 2017). It should be noted that as one of the channels of access to information about SSI, the social media tool YouTube was preferred by pre-service science teachers in terms of accessing different sources of information, listening to information over and over again, watching internationally published videos, commenting, liking videos, or disliking videos, as well as giving them the opportunity to share videos in social networks such as on Facebook, Instagram, Twitter, and allowing them to make connections between social networks (Thelwall, 2018).

The Purpose of the Study

This research aimed to identify pre-service science teachers' views about SSI and their views about the implementation process. In this regard, the findings of this study are important in terms of guiding the original studies that will contribute to the field related to the SSI based classroom implementations where different media and social media tools are included in the field.

The following questions were investigated in this study:

1. How are the argument levels/argument qualities of pre-service science teachers?
2. How does the YouTube-based classroom discussion process contribute to the quality of pre-service science teachers' argument?
3. What are the views of pre-service science teachers about the implementation process?

METHODOLOGY

Model of Research

In this study, the case study pattern of the qualitative research methods was chosen as the research model. The case study is

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used to evaluate a program or to conduct in-depth research in which the focus is on an event in detail (Marshall & Rossman, 2006). In other words, the case study can be defined as an in-depth representation of a completely limited system and its analysis (Merriam, 2009). Therefore, considering the purpose of the present study, the case study was appropriate for the study and each student participating in the implementation process was considered as an analysis unit.

Participants

Twenty-six (18 female and 8 male) pre-service science teachers studying at a state university were selected as participants. Fourteen (7 female and 7 male) pre-service science teachers were selected from 26 pre-service science teachers on a volunteer basis for the purpose of general evaluation in the implementation process. When determining the study group, the criterion sampling of the purposive sampling method was preferred. In criterion sampling, some important predetermined criteria were designated in-depth analysis of a situation (Patton, 2002). The criterion used in a research study can be created by the researcher, or a list of previously prepared criteria can be used (Marshall and Rossman, 2006). The criteria discussed for the participants were as following. The participants would (a) be the pre-service science teachers, (b) had taken a media literacy course, (c) received theoretical and practical courses related to the argumentation and its elements in the previous academic year; (d) have not taken any courses in the previous periods which including the topics of sugar intake during pregnancy, raw-processed milk, and nuclear power plant issues; and (e) have not been involved in any implementation process related to SSI.

The Implementation Process

The implementation process of the research took 10 h/week for a total of 10 weeks. In the 1st week of the study, the pre-service teachers were asked about the SSI discussed in society to determine the SSI to be discussed during the implementation process. A feedback from the pre-service science teachers was respectively written on the board (such as GMOs, influenza vaccine, nuclear power plant, and organ donation). After voting, sugar intake during pregnancy, raw/loose milk and processed/pasteurized milk, and nuclear power plants were determined as the most preferred subjects to discuss. Information about the implementation process of an SSI in the classroom is presented in Figure 1.

As shown in Figure 1, after the topics included in the implementation process were determined, teacher argumentation method was, and argument elements were explained as a reminder of the issue. Afterward, in-class discussions were respectively held about each SSI, and the arguments/opinions were taken to determine what they think about the subjects before they started the implementation. In this study, the social media tool YouTube was used in the implementation process, which included both positive and negative opinions and those create contradictions about the SSI were incorporated in the study. The criteria to determine the videos were the most clicked/viewed on YouTube social media tool, and the content length was 2–10 min.

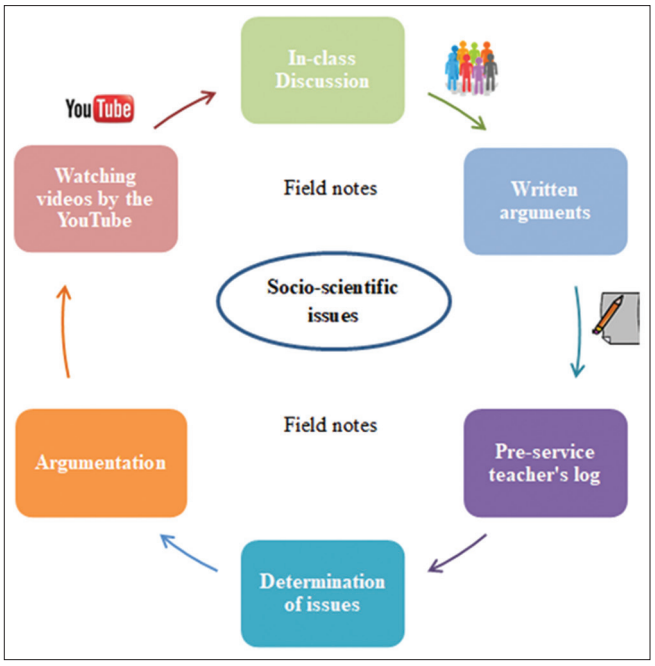

Figure 1: Socio-scientific issue's teaching process

Data Sources and Data Analysis

In the research process, written arguments of pre-service science teachers, their journals, focus group interviews, and field notes were used as data sources.

Written arguments

Throughout the research process, the arguments of the pre-service science teachers about the SSI were taken in a written form to enable the pre-service teachers to express their ideas more easily and clearly. Before starting the implementation process, the opinions of the pre-service science teachers about the subjects were recorded to determine their general profiles. During the implementation phase, i.e., after the YouTube-supported classroom discussion, the arguments were again recorded. The quality of written arguments of the candidates was independently analyzed with descriptive analysis by two researchers based on the evaluation criteria formed by Erduran et al. (2004), and the argument of each candidate was ranked from level 1 to level 5. When the analyzing process was completed for the two researchers, they came together, and the analysis was continued until the different opinions were resolved, and the agreement was reached. Pre-service science teachers were evaluated as at Level 1 with a simple claim and counterclaim; at Level 2 with claim, data, reason, and promoter; at Level 3 with claim, data, justification, promoter, and weak refutation; at Level 4 with claim, data, reason, a promoter, and clear refutation; and, at Level 5 with claim, data, reason, promoter, and more than one clear refutations.

Pre-service science teachers' journal

In the research, pre-service teachers were encouraged to keep journals to record their feelings, thoughts, and perceptions about

the process. In the implementation phase, titles were recorded, the method used, evaluation of the process (to include both the strengths and weaknesses), and suggestions were included each week after the implementation applicants were expected to comment on their experiences about the activities. The journals were designed by the researchers and reviewed by a science education specialist and were determined to be suitable for the purposes of this study. Data obtained from pre-service teachers' journals were subjected to content analysis technique by two researchers. According to Patton (2002), content analysis can be expressed as scanning the text for recurring words or themes. In the analysis process, pre-service science teachers' feedback forms were representatively named as (for example, pre-service science Teacher PST1 and pre-service Science Teacher PST2). The two researchers examined the data for common words and sentences (Patton, 2002), and then the data were independently named by the two researchers and classified under a specific category (Bogdan & Biklen, 2000; Gay et al., 2006).

Focus group interview

The other data source for evaluating the implementation process of the research was the focus group interviews conducted at different times with two different groups at the end of the implementation. The focus group interview form included features of the SSI related to the assessment of the implementation process, examples, methods, and techniques used in the teaching of the SSI, the contributions of the YouTube-supported implementation process to the pre-service science teachers, and the questions. After the interview questions were prepared, the opinions of two experts in the field of science education were taken and examined by a language expert in terms of language and expression, and then the form was finalized by considering the feedback given by the experts. The form consisted of questions such as (i) the SSI, (ii) science curriculum, and (iii) general assessment of the process in which media and argumentation take place. The focus group interviews were carried out at different times with two different groups of seven people. Before and after the practice, the groups were selected from among the pre-service science teachers on a voluntary basis regarding to the groups who changed the decision in the written arguments about the SSI, and whose quality of argument showed differences classified as those who indicated change in their quality of argument (PST1, PST6, PST10, PST12, PST13, PST22, PST23, and PST24), those whose argument quality has remained stable (PST9, PST14, PST19, and PST20). and those showing changes in their argument quality in all three subjects (PST2 and PST21). The data obtained from the focus group interviews were analyzed independently by two researchers in a similar way to the analysis of the pre-service science teacher's journals and subjected to content analysis technique by forming category and code list.

Researcher field notes

In the study, the whole implementation process (physical environment, study group, speech, etc.) was observed by the lead researcher and a science education specialist. The whole process was video recorded. In order not to affect the implementation process adversely, the researcher sat at the back of the classroom and noted the observations. In fact, it was important for the researcher to take notes during the observation and to record his observations in detail to interpret the findings (Merriam, 2009).

FINDINGS

Findings Related to Qualities of Pre-service Science Teachers' Arguments

The general views of the pre-service science teachers about the SSI gathered before the implementation and the argument quality of each pre-service science teacher is presented in Figure 2.

In Figure 2, it was found that at the beginning of the implementation process of pre-service teachers' intended argument quality related to the SSI on the subject of sugar intake during pregnancy, the majority of candidates were at level 1, (n = 20), i.e., they asserted a simple claim or opposing claim. Some of them were at level 2 (n = 6), i.e., they contained simple claim, data, justification or supporting argument elements. However, it was determined that they did not make any explanations for arguments other than levels (3, 4, and 5). It was determined that on raw/processed milk consumption, while some of the pre-service teachers were at Level 1 (n = 6), most of them were at Level 2 (n = 12) and eight pre-service teachers were at Level 3, i.e., they allowed for claim, counter-claim, data, justification, supportive, and weak refutation elements. As looking at the argument quality of pre-service science teachers, it was seen that the 4th and 5th levels of raw/processed milk consumption were not observed. In the case of nuclear power plant, half of the teacher candidates were in Level 1 (n = 13), then in order at Level 2 (n = 7), at Level 3 (n = 5), and one person was at Level 4, i.e., they used claim, data, justification, and supporter with a clear refutation. There was no pre-service science teacher producing arguments at Level 5 on the subject of nuclear power plants. At the end of the class discussion, the quality of the pre-service science teachers' arguments about the SSI is presented in Figure 3.

In Figure 3, the pre-service teachers claimed on the first discussed topic of sugar intake during pregnancy was determined two each at Levels 1 and 5, most of them were at Level 2 (n = 14), with

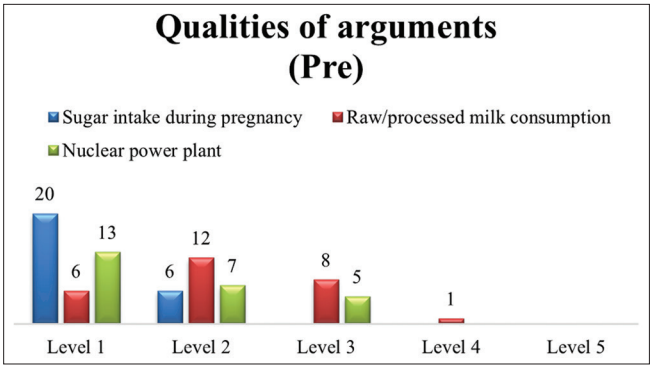

Figure 2: Frequencies of argument qualities for the socio-scientific issues before the implementation

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seven at Level 3, and one participant at Level 4. On the topic of processed milk pre-service science teachers were Level 1 (n = 7), most of them were at Level 2 (n = 8), and three of them were at Level 4. Finally, on the topic of nuclear power plant it is seen that four pre-service science teachers were at Level 1, six at Level 2, the majority of them were at Level 3 (n = 10), three of them were at Level 4, and two at Level 5.

When we look at the quality of the pre-service teachers' argument after the classroom discussions, the majority of the participants on the topic of sugar intake during pregnancy were at Level 1 (n = 20). Before the implementation and after classroom discussion, the number decreased to only two of them at Level 1. Based on this finding, it was indicated that there was a positive increase in the quality of arguments after the YouTube-supported classroom discussion and that most of the pre-service science teachers were at Level 2 (n = 14) as they included argument elements. Whereas there was no pre-service teacher at Level 3, 4 or 5 in their preliminary views, after the discussion seven of the participants were at Level 3, one of them was at Level 4, and two of them at Level 5.

Before the implementation, it was observed that the majority of the pre-service science teachers were at Level 2 (n = 12) on the subject of raw/processed/pasteurized milk, and none of them were at Levels 4 and 5. After the discussion, it was determined that most of the pre-service science teachers were at Level 2 and Level 3 (n = 8). The arguments of three pre-service teachers were at Level 4. Based on these findings, it can be said that pre-service science teachers' quality of argument has positively increased after the implementation.

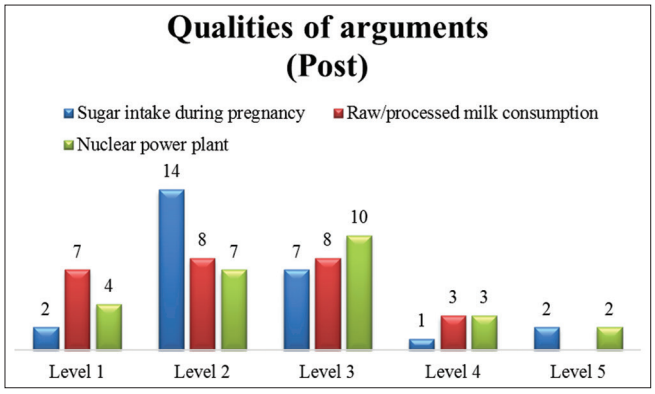

Figure 3: Frequencies of argument qualities for the socio-scientific issues after implementation

It was observed that half of the pre-service teachers were at Level 1 (n = 13) on the topic of the nuclear power plant and none at Level 5 in the pre-implementation process. After the discussion, asserted arguments of the participants were determined that only four pre-service teachers were at Level 1, seven of them were at Level 2, the majority were at Level 3 (n = 10), three of them were at Level 4, and two of them were at Level 5. Based on these findings, it can be seen that before the implementation and after the class discussion, supported by YouTube, the quality of the pre-service teachers' argument increased positively.

Even though at the beginning of the implementation, no arguments were observed at Level 5 in the arguments written by pre-service teachers about the subjects, at the end of the study, it was determined that two pre-service teachers on the subjects of sugar intake during pregnancy and nuclear power plant produced Level 5 threshold arguments.

Findings Related to the Student views about the Implementation Process

To refer to the opinions of the pre-service science teachers about the evaluation of the YouTube-based classroom discussion process, pre-service science teachers' journals were used as the data source, and focus group interviews were made at the end of the implementation. Table 1 presents the findings of the pre-service teachers about the opinions that they wrote in their journals during the implementation phase.

In Table 1, it was found out that the pre-service science teachers, on the subject of sugar intake during pregnancy, positively reported that *it allows to exchange ideas* (f=7), *it is participation oriented* (f=6), *it provides argumentation and class discussion* (f=6), and *the topic is up-to-date*. It was determined that in terms of the weaknesses of the process pre-service science teachers had difficulties *to express themselves* (f=4) *and to do research* (f=2).

The sample expressions of the pre-service teachers regarding the strengths and weaknesses of the implementation of sugar intake during pregnancy are as follows:

> *Thanks to being an active student and doing research with his/her own knowledge to have the right to speak help*

Table 1: Journals of pre-service science teachers and their views about the implementation process

General category	Category	Code	Sugar intake during pregnancy	Raw/processed milk	Nuclear power plant
			f	f	f
Strengths	The nature of the socio-scientific issues	Exchange of ideas	7	6	6
		Participation oriented	6	1	2
		Up-to-date	5	-	-
		Class discussion	6	4	7
Weaknesses	Personal Development	Self-expression	4	1	2
		Prospecting	2	2	-
		Decision-making	4	6	3

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students remember the information provided during the class and having the subjects which are closely related to the daily life increases the attention to the lesson (PST1).
The subject is very contradictory, I'm a little confused, and especially the experts in their field have different views and opinions (PST17).

As the strengths of the process, the pre-service teachers stated on the subject of raw/processed milk on the SSI that they *exchanged opinions* (f=6) and thought that *class discussion is effective* (f=4) and *participation oriented* (f=1). On the other hand, for the weaknesses of the process, it was seen that the pre-service science teachers had difficulty *in decision-making process* (f=6), *in doing research* (f=2), and *in self-expression* (f=1).

An example of the strengths and weaknesses of pre-service teachers about raw/processed milk is given as follows.

The whole class is included in the course and we learn about the subject by researching itself. The information that we learn becomes permanent by reaching out these interesting subjects; thus, we can easily defend our ideas (PST10).
I've had trouble with writing the arguments after listening to the examples that give a contrasting opinion about the topic that I'm struggling with (PST17).

It has been observed that pre-service science teachers on the subject of nuclear power plant have emphasized on *argumentation and class discussion* (f=7), *exchange of ideas* (f=6), and *participation-oriented* (f=2) about the strengths of the process. For the weaknesses of the implementation process, they stated that they have difficulty in the cases of *decision-making* (f=3) and *self-expression* (f=2).

Exemplary expressions of pre-service science teachers about the strengths and weaknesses of the nuclear power plant implementation process are as follows:

Implementation process was very fun and important issues were mentioned. It was very useful to have knowledge of the nuclear power plant and defend our opinion (PST17).
Although I have scanned a lot of articles, videos, and so on during the discussion, I have experienced difficulty in expressing myself (PST8).

When the journals written throughout the implementation process were examined, it was determined that the pre-service science teachers generally received more detailed information about the subject after the exchange of ideas with their friends and the lead researcher. In the process, it was determined that the pre-service science teachers for the use of YouTube social media tools in the teaching process of the SSI expressed their opinions. They found that the YouTube tool and the argumentation method were effective in teaching of the SSI and the process was useful. Furthermore, the observing researcher noted that pre-service science teachers were satisfied due to being active participants in the implementation process. A statement by one of the participants (PST17) is a representative statement; "… *I think that I have more ideas about sugar intake during pregnancy by attending class and expressing my own opinions. It was important for me that the implementation process allowed us to feel comfortable.*"

It was found out in their journals that having difficulty in making decisions on a contradictory subject and being able to express their thoughts and ideas were among the difficulties experienced by the pre-service science teachers. Once again, a pre-service science teacher's views (PST24) about the difficulties during the process included in the notes of participant observer were that *"...I had a hard time deciding about the nuclear power plant, I did research but still had difficulty.*" As a result of this finding, it can be interpreted that the SSI, which is defined as polemic and contradictive subjects due to its form, leads students to challenges in decision-making.

In the focus group interviews conducted with pre-service teachers at the end of the implementation and in their journals similar findings were indicated, such as half of the candidates were (f=13*) open to discussion*, some proportion were (f=5) *scientific issues related to the society*, and then, respectively, (f=3) *up-to-date*, (f=2) *directing to research*, and (f=2) *including different dimensions*. Based on this finding, it can be said that pre-service science teachers described different characteristics of the nature of the SSI and that they have had knowledge about the SSI and have gained awareness about these issues. Sample expressions from the focus group interview are as follows:

PST12: SSI *are open to discussion, having social dimensions, religious, and psychological dimensions that address the social issues that concern society, for example; issues related to organ transplantation, surrogacy, and blood donation.*
Researcher: Why did you mention about different dimensions?
PST12: *While we were discussing, we looked at the issue in many ways. For example, I looked at nuclear energy from an environmental and financial point of view.*
PST19: *They are the subjects that are related to science and society and that direct the individuals to do research by leaving them in contradictions.*
Researcher: So, were there any topics that you were in between?
PST19: *Yes, sir, for example, I found it difficult to decide on the establishment of a nuclear plant.*

It was also found out that pre-service teachers considered the subjects (such as organ transplantation, and surrogacy) as socio-scientific except for the subjects discussed in the implementation process. This finding indicates that pre-service teachers are able to make a sweeping statement and give different examples based on the characteristics of the SSI. The findings containing the pre-service science teachers' views about the contribution of the implementation process are presented in Table 2.

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In Table 2, pre-service science teachers who participated in the implementation process expressed their skills developed by the classroom discussion process as decision-making (f=6), analytical thinking (f=3), creative thinking (f=1), and communication (f=1) for life skills category; hypothesize (f=4), make an observation (f=2), and problem-solving (f=1) for science process skills category. Based on these findings, it can be said that the implementation process has a positive effect on the decision-making skills of pre-service science teachers. Sample expressions from the focus group interview are as follows:

PST21: *Discussion of* SSI *enabled us to develop our ability to express ourselves by seeing different ideas together.*
Researcher: How do you think you've developed your ability to express yourself?
PST21: *You have constantly given us the opportunity to talk and chance for all to talk to you about issues. Whether it is wrong or right, we were able to express our thoughts, we also listened to our friends.*

It was determined that pre-service teachers focused on the discussion in the process of implementation and that some of the skills emerged as a result of these discussions.

Pre-service science teachers for the evaluation of the argumentation method used in the classroom discussion process in teaching the SSI stated their opinions that they were provided with research and questioning (f=6) and the decision-making process (f=5) and realizing different opinions (f=2). This situation is similar to the attitude of the participants in class discussions. The field notes included that in the implementation process of the observer researcher, a student wants to tell his ideas during the discussion, and once again, a student states that "*the argument is very challenging as everyone questions each other's opinion.*" It also overlaps with students' emphasis on the difficulties in decision-making in their journals. Sample expressions from the focus group interview are as follows:

PST24: *It has enabled us to fill out the question by investigating and questioning the accuracy or inaccuracy of our thoughts on the issues that cannot be built a consensus.*
PST1: *Our perspective on* SSI *has expanded.*
PST23: *We experienced the difficulty of making decisions about* SSI.
Researcher: What sort of difficulties, for example?
PST23: *This time we have seen different views and I had difficulties in decision-making, but I could finally make a decision.*

The findings obtained from the opinions of pre-service science teachers on the methods and techniques that can be used in class practices of the SSI are presented in Table 3.

Table 3 shows that pre-service science teachers who emphasized the necessity of using the argumentation method (f=5) in the classroom implementation of the SSI reported that using the question-answer technique (f=6) and the debate technique (f=5) were appropriate in teaching the SSI. Sample expressions from the focus group interview are as follows:

PST2: *Discussion is a very effective method in teaching these subjects in the classroom.*
PST14: *I definitely prefer argumentation.*
PST24: *The most appropriate method for* SSI *is discussion.*
Researcher: Why?
PST14: *Because I think that different views will be revealed only by this method.*
PST1: *It can be the question-answer technique because the time given is not enough.*

It has been determined that pre-service teachers indicated that argumentation/discussion method and debates and question-answer techniques should be used in class implementations to discuss due to the implementation process. The findings obtained from the views of the pre-service science teachers about the general evaluation of the implementation process are shown in Table 4.

In Table 4, it is seen that pre-service science teachers gave positive remarks about the process related to the YouTube-based classroom discussion process. In terms of seeing different opinions (f=12), being able to express themselves comfortably (f=10), having the opportunity to discuss, the decision-making process (f=8), allowing them to practice, and do research. It was determined that three pre-service teachers had difficulty in writing arguments and journals, and two pre-service teachers had difficulty in expressing themselves in the process. Sample expressions from the focus group interview are as follows:

Table 2: Pre-service science teachers' views about the contribution of the implementation process

Category	Code	f
Science process skills	Hypothesize	4
	Problem-solving	2
	Make an observation	2
Life skills	Decision-making	6
	Analytical thinking	3
	Creative thinking	1
	Communication	1

Table 3: The views of pre-service science teachers about the methods and techniques to be used in teaching the socio-scientific issues

Category	Code	f
Method	Argumentation/discussion	5
	Project-based	3
	Drama	2
Technic	Question-answer	6
	Debate	5
	Station	2
	Brainstorming	2
	Fishbone	1

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Table 4: The views of the pre-service science teachers on the general evaluation of the implementation process

Category	Code	f
Positive	Different opinions	12
	Self-expression	10
	Providing with discussion opportunity	10
	Decision-making process	8
	Doing research	4
Negative	Writing	3
	Difficulty in expression	2

PST10: *Thanks to the implementation of argumentation as I learned how to do research.*
PST20: *I had the opportunity to listen to different thoughts.*
PST22: *My ability to express myself has improved.*
PST9: *Having the arguments in written form was tiring.*
Researcher: Why?
PST9: *Because I was a little bored of writing because I'm not someone who likes writing. I love talking more, but I still wrote what I thought.*

DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS

The Quality of Pre-service Science Teachers' Arguments

For the purpose of the study, the pre-service science teachers' argument qualities related to the SSI on sugar intake during pregnancy, raw/processed milk, and nuclear power plant were determined based on the argument evaluation rubric which was divided into levels ranging from 1 to 5. When the findings of the research were investigating, the following has been determined. Whereas the majority of pre-service science teachers suggested a simple claim before the implementation of the SSI of sugar intake during pregnancy, after the support of the YouTube-supported classroom discussion and the arguments with their reasons included the other argument elements (data, justification, supportive, or refutation). The reason for this is that some pre-service science teachers' who participated in the study gained sensitivity toward encountering similar situations in their immediate surroundings/acquaintances. Zohar and Nemet (2002) applied to field trips and found that students could offer more than one defense for their claims by living in daily life to determine how socio-scientific subject-based unit teaching affects students' arguments.

In the research, it was found that the pre-service science teachers had 1, 2, and 3 levels argument elements in general views about raw/processed milk before the implementation, but no argument elements were found at Levels 4 and 5. In the written arguments of pre-service science teachers, it was determined that three pre-service teachers applied to a net refutation element in addition to the claims, data, justification, and promoter elements which means they reached Level 4. Regarding the nuclear power plant, it was determined that before the implementation, pre-service science teachers could produce arguments at Levels 1, 2, 3, and 4. Even though most of them are at levels of 1 and 2, they did not have argument at level 5. After the class discussion, it was found that pre-service science teachers mostly wrote arguments at Level 3, three pre-service science teachers wrote arguments at Level 4 and two pre-service science teachers at Level 5. As the findings were examined, it was concluded that there was a decrease in the number of participants applying to the claim element in the written arguments of the pre-service science teachers and that the participants often used elements such as claims, data, promoters, justifications, and a net refutation, or even two pre-service science teachers presented more than one net refutation. Based on this finding, it can be said that after the implementation process, there was an increase in the quality of arguments of pre-service science teachers and the number of arguments they have used. In the present study, it is also noted that in the argumentation-assisted teaching process where YouTube social media tool is used, pre-service science teachers have used argument elements at different levels and effectively. In Aldağ's (2005) study, it was determined that with argumentation supported class implementation, pre-service science teachers were enabled to increase the use of argument elements. Reznitskaya et al. (2001) found similar findings as the study was concluded that the class discussions conducted in accordance with the argumentation process developed the students' argument levels and argumentation skills.

In looking at the results in general, pre-service science teachers were informed about the SSI and gained awareness about the issues at the end of the implementation process conducted with YouTube-supported classroom discussion. This situation also positively affected the change in pre-service science teachers' quality of argument during the implementation. On the SSI of sugar intake in the first pregnancy, pre-service science teachers who mostly wrote arguments at Level 1, after at Level 4, and even on the last issue nuclear power plant they could even write arguments at Level 5. In the literature, there are similar results as in the present study results of the class discussion process in which the SSI is discussed, in other words, the argumentation process has a positive effect on the quality of the pre-service science teachers' argument (Akbaş & Çetin, 2018; Dolan et al., 2009; Erduran et al., 2004; Isbilir et al., 2014; Karışan et al., 2018; Nussbaum & Edwards, 2011; Topcu et al., 2010). For example, Erduran et al. (2004) revealed that the argumentation method in the lessons conducted by the students has created an increase in the quality of the arguments. Nussbaum and Edwards (2011) determined that the quality of the argument has been developed as a result of an in-depth investigation of an argument formed by a student. Isbilir et al. (2014) examined the pre-service science teachers' written arguments about SSI regarding the tendencies to discuss in the online discussion environment showed that pre-service science teachers produced a high level of scientific discussion for each SSI. Karışan et al. (2018) examined the reflective reasoning skills of pre-service science teachers in science laboratory practice based on SSI and showed that the reflective reasoning model scores of

the applicants demonstrated a tendency to increase from the beginning to the end. In the context of SSI, reflective reasoning skills have been found to be effective in terms of active use of information. The results of the study conducted by Dawson and Venville (2009) to determine how SSI-based activities affect the students' argumentation and informal reasoning have also shown that SSI-based activities improve the quality of argumentation and students' informal reasoning. As a result, it has been determined that there is a gradual increase at the level of arguments created by individuals in courses handled with argumentation method. Furthermore, the behavior of producing quality arguments can be gained to the individuals as a result of long-term studies (Torun & Şahin, 2016).

Pre-service Science Teacher's Views on the Implementation Process

As the findings of the research were examined, the evaluations about the implementation process of pre-service science teachers were addressed with journals kept throughout the application, field notes, and interview findings obtained post focus group interviews. When the journals were viewed, it was established that the process was found to be favorable by the majority as the subject of sugar intake during pregnancy, raw/processed milk, and nuclear power plant were contemporary subjects, and they felt active with classroom discussions. They pointed out that the implementation process allowed them to exchange ideas about SSI. By doing so, they used various argumentation elements. In addition, it has been concluded that the discussion on the different SSI provided information about the subjects, and the process has positive contributions to discussion and critical thinking skills. In his research Kutluca (2016) obtained findings on pre-service science teachers' characteristics such as forming an argumentation, producing an argument, and executing a discussion were improved. Some of the applicants expressed themselves as they experienced difficulties in obtaining written argumentations and making decisions within the scope of the SSI while doing research on the subject. It can be said that with the support of field notes, the reason as to pre-service science teachers remaining indecisive is because the SSI are inherently open to discussion and are not conclusive.

At the end of the implementation, it was observed through the focus group interviews that the pre-service science teachers considered the SSI as the issues, which are open to discussion, inconclusive, and interested by the society. It is also supported by the notes taken during the process that they gained insight and awareness on the features of the SSI. On the other hand, the applicants emphasized that the classroom discussion process contributed to the development of scientific process skills (observation, hypothesis, and problem-solving) and life skills (analytical thinking, decision-making, creative thinking, and communication). In the teaching of the SSI, the pre-service science teachers stated remarks suggesting that methods such as argumentation and drama; techniques such as question-answer and debates are the best suitable ones. Venville and Dawson (2010), through their research on which methods and techniques can be used to advance argumentation skills related to SSI in high school genetics courses, reached the conclusion that classroom discussion technique and drama method were the most appropriate one among other techniques and methods. In the study of Dori et al. (2003), the results indicated similarities with the present study; showed that the students have a positive development of critical thinking, discussion, and thinking skills. It was observed and established that when deciding for topics, pre-service science teachers were mostly affected by their immediate surroundings and mostly took on argument elements they felt close to. Torun and Şahin (2016) pointed out that pre-service science teachers use more justification, supportive, or reputational issues in the subjects they feel close to while presenting arguments about a topic.

Based on the research findings, some suggestions are presented below:

- Similar studies can be done with different SSI and different class levels.
- To determine the change in the quality of arguments about the SSI, studies can be done in the mixed model design where both quantitative and qualitative research methods will be used.
- The number of studies using the argumentation method can be increased to improve students' critical thinking, questioning, and scientific discussions to the desired level.
- Social media tools (such as Facebook, Instagram, Twitter, and YouTube), which take an important part in most of the individuals' time, can be included in the teaching process of the SSI by performing different implementations.
- SSI based on argumentation can be applied to pre-service science teachers with different methods and techniques.

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REFERENCES

Acar, O., Turkmen, L., & Roychoudhury, A. (2009) Student difficulties in socio-scientific argumentation and decision-making research findings: Crossing the borders of two research lines. *International Journal of Science Education*, 32(9), 1191-1206.

Akbaş, M., & Çetin, P.S. (2018). Üstün yetenekli öğrencilerin çeşitli sosyobilimsel konulara ilişkin argümantasyon kalitesinin ve informal düşünme becerisinin incelenmesi [The investigation of gifted students' argumentation level and informal reasoning related to socio scientific issues]. *Necatibey Faculty of Education Electronic Journal of Science and Mathematics Education*, 12(1), 339-360.

Aldağ's, H. (2005). *Düşünme Aracı Olarak Metinsel ve Metinsel-Grafiksel Tartışma Yazılımının Tartışma Becerilerinin Geliştirilmesine Etkisi* [*The Effects of Textual and Graphical-Textual Argumentation Software as Cognitive Tools on Development of Argumentation Skills*]. Unpublished Doctorate Thesis. Adana, Turkey: Çukurova University.

Bogdan, R.C., & Biklen, S.K. (2000). *Qualitative Research for Education: An Introduction to Theory and Method*s. 5th ed. Boston, MA: Allyn and Bacon.

Boyd, D.M., & Ellison, N.B. (2007). Social network sites: Definition, history, and scholarship. *Journal of computer-mediated Communication*, 13(1), 210-230.

Cooper, C.B. (2011). Media literacy as a key strategy toward improving public acceptance of climate change science. *BioScience*, 61(3), 231-237.

Dawson, V., & Venville, G. (2009). High-school students' informal reasoning

and argumentation about biotechnology: An indicator of scientific literacy? *International Journal of Science Education*, 31(11), 1421-1445.

Dimopoulos, K., & Koulaidis, V. (2003). Science and technology education for citizenship: The potential role of the press. *Science Education*, 87(2), 241-256.

Dolan, T.J., Nichols, B.H., & Zeidler, D.L. (2009). Using socio scientific issues in primary classrooms. *Journal of Elementary Science Education*, 21(3), 1-12.

Dori, Y.J., Tal, R.T., & Tsaushu, M. (2003). Teaching biotechnology through case studies-can we improve higher order thinking skills of nonscience majors? *Science Education*, 87, 767-793.

Driver, R., Newton, P., & Osborne, J. (2000). Establishing the norms of scientific argumentation in classrooms. *Science Education*, 84(3), 287-312.

Erduran, S., & Jiménez-Aleixandre, M.P. (2007). *Argumentation in Science Education: Perspectives from Classroom-based Research.* Dordrecht, The Netherlands: Springer.

Erduran, S., Simon, S., & Osborne, J. (2004). TAPping into argumentation: Developments in the application of Toulmin's argument pattern for studying science discourse. *Science Education*, 88(6), 915-933.

Foong, C.C., & Esther, G.S. D. (2013). Students' argumentation skills across two socio-scientific issues in a Confucian classroom: Is transfer possible? *International Journal of Science Education*, 35(14), 2331-2355.

Gay, L.R., Mills, G.E., & Airasian, R. (2006). *Educational Research: Competencies for Analysis and Applications*. Upper Saddle River, NJ: Pearson/Merrill/Prenticehall.

Hodson, D. (2003). Time for action: Science education for an alternative future. *International Journal of Science Education*, 25(6), 645-670.

Isbilir, E., Cakiroglu, J., & Ertepinar, H. (2014). Pre-service science teachers' written argumentation qualities: From the perspectives of socio-scientific issues, epistemic belief levels and online discussion environment. *Eurasia Journal of Mathematics, Science and Technology Education*, 10(5), 371-381.

Jiménez-Aleixandre, M.P., & Pereiro-Muñoz, C. (2002). Knowledge producers or knowledge consumers? Argumentation and decision making about environmental management. *International Journal of Science Education*, 24(11), 1171-1190.

Kachan, M.R., Guilbert, S.M., & Bisanz, G.L. (2006). Do teachers ask students to read news in secondary science? Evidence from the Canadian context. *Science Education*, 90(3), 496-521.

Karışan, D., Yılmaz-Tüzün, Ö., & Zeidler, D.L. (2018). Pre-service teachers' reflective judgment skills in the context of socio-scientific issues based inquiry laboratory course. *Turkish Journal of Education*, 7(2), 99-115.

Klosterman, M.L., Sadler, T.D., & Brown, J. (2012). Viral news: Media literacy for the 21st century. *Science Scope*, 35(9), 61-69.

Kolstø, S.D. (2001). To trust or not to trust, pupils' ways of judging information encountered in a socio-scientific issue. *International Journal of Science Education*, 23(9), 877-901.

Kutluca, A.Y. (2016). Fen Bilgisi Öğretmen Adaylarının Sosyo-bilimsel Argümantasyon Kaliteleri ile Bilimin Doğası Anlayışları Arasındaki Ilişkinin Incelenmesi [*The Investigation of the Relationship Between Pre-service Science Teachers' Quality of Socioscientific Argumentation and the Nature of Science Understanding*]. Unpublished Doctorate Thesis. Kastamonu, Turkey: Kastamonu University.

Marshall, C., & Rossman, G.B. (2006). *Designing Qualitative Research*. 4th ed. Thousand Oaks, CA: Sage Publications.

Martin, A.M., & Hand, B. (2009). Factors affecting the implementation of argument in the elementary science classroom: A longitudinal case study. *Research in Science Education*, 39, 17-38.

Merriam, S.B. (2009). *Qualitative Research: A Guide to Design and Implementation*. 3rd ed. San Francisco, CA: Jossey Bass.

Nielsen, J.A. (2012). Arguing from nature: The role of "nature" in students' argumentations on a socio-scientific issue. *International Journal of Science Education*, 34(5), 723-744.

Nussbaum, E.M., & Edwards, O.V. (2011). Critical questions and argument stratagems: A framework for enhancing and analyzing students' reasoning practices. *Journal of the Learning Sciences*, 20(3), 443-488.

Oulton, C., Dillon, J., & Grace, M.M. (2004). Reconceptualizing the teaching of controversial issues. *International Journal of Science Education*, 26(4), 411-423.

Öztürk, N., & Erabdan, H. (2018). Fen bilgisi öğretmen adaylarının gazetelerde yer alan sosyo-bilimsel konulara yönelik farkındalıklarının incelenmesi. [Investigation of pre-service science teachers' awareness of socio-scientific issues appearing in newspapers]. *Sakarya University Journal of Education*, 8(4), 319-336.

Öztürk, N., Eş, H., & Turgut, H. (2017). How gifted students reach decisions in socio-scientific issues? Warrants, information sources and role of media. *International Online Journal of Educational Sciences*, 9(4), 1111-1124.

Patton, M.Q. (2002). *Qualitative Research and Evaluation Methods.* Thousand Oaks, CA: SAGE.

Ratcliffe, M., & Grace, M. (2003). *Science Education for Citizenship: Teaching Socio-Scientific Issues.* Maidenhead: Open University Press.

Reznitskaya, A., Anderson, R.C., Mcnurlen, B., Nguyen-Jahiel, K., Archodidou, A., & Kim, S.Y. (2001). Influence of oral discussion on written argument. *Discourse Processes*, 32(2-3), 155-175.

Sadler, T.D. (2004). Informal reasoning regarding socioscientific issues: A critical review of research. *Journal of Research in Science Teaching*, 41(5), 513-536.

Sadler, T.D., & Zeidler, D.L. (2005). Patterns of informal reasoning in the context of socioscientific decision-making. *Journal of Research in Science Teaching*, 42(1), 112-138.

Sadler, T.D., Amirshokoohi, A., Kazempour, M., & Allspaw, K.M. (2006). Socioscience and ethics in science classrooms: Teacher perspectives and strategies. *Journal of Research in Science Teaching*, 43(4), 353-376.

Sadler, T.D., Barab, S.A., & Scott, B. (2007). What do students gain by engaging in socioscientific inquiry? *Research in Science Education*, 37(4), 371-391.

Sampson, V., & Clark, D. (2009). The impact of collaboration on the outcomes of scientific argumentation. *Science Education*, 93(3), 448-484.

Thelwall, M. (2018). Social media analytics for YouTube comments: Potential and limitations. *International Journal of Social Research Methodology*, 21(3), 303-316.

Topçu, M.S., & Atabey, N. (2017). Sosyobilimsel konu içerikli alan gezilerinin ilkögretim ögrencilerinin argümantasyon nitelikleri üzerine etkisi [The effect of socioscientific issues based field trips on elementary school students' argumentation quality]. *Bartın University Journal of Faculty of Education*, 6(1), 68-84.

Topcu, M.S., Sadler, T.D., & Yilmaz-Tuzun, O. (2010). Preservice science teachers' informal reasoning about socioscientific issues: The influence of issue context. *International Journal of Science Education*, 32(13), 2475-2495.

Torun, F., & Şahin, S. (2016). Determining the student's argument levels in social studies course based on argumentation. *Education and Science*, 41(186), 233-251.

Venville, G.J., & Dawson, V.M. (2010). The impact of a classroom intervention on grade 10 students' argumentation skills, informal reasoning, and conceptual understanding of science. *Journal of Research in Science Teaching*, 47(8), 952-977.

Von Aufschnaiter, C., Erduran, S., Osborne, J., & Simon, S. (2008). Arguing to learn and learning to argue: Case studies of how students' argumentation relates to their scientific knowledge. *Journal of Research in Science Teaching*, 45(1), 101-131.

Zeidler, D.L. (1997). The central role of fallacious thinking in science education. *Science Education*, 81(4), 483-496.

Zeidler, D.L. (2014). Socioscientific issues as a curriculum emphasis: Theory, research and practice. In: Lederman, N.G., & Abell, S.K. (Eds.), *Handbook of Research in Science Education.* Vol. 2. New York: Routledge. p697-726.

Zeidler, D.L., & Keefer, M. (2003). The role of moral reasoning and the status of socioscientific issues in science education: Philosophical, psychological and pedagogical considerations. In: Zeidler, D.L. (Ed.), *The Role of Moral Reasoning on Socioscientific Issues and Discourse in Science Education*. Dordrecht: Springer. p7-38.

Zohar, A. (2007). Science teacher education and professional development in argumentation. In: Erduran, S., & Jimenez-Aleixandre, M.P. (Eds.), *Argumentation in Science Education: Perspectives from Classroom-based Research*. Dordrecht: Springer. p245-268.

Zohar, A., & Nemet, F. (2002). Fostering students' knowledge and argumentation skills through dilemmas in human genetics. *Journal of Research in Science Teaching*, 39(1), 35-62.