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Science Teachers' Argument Types and Supporting Reasons on Socioscientific Issues: COVID-19 Pandemic

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ABSTRACT

This study examines the types of arguments and supporting reasons of science teachers on socioscientific issues. The case study was used in this study conducted with seven science teachers. Data were collected through three scenarios developed about vaccination, curfew and distance education in the context of COVID-19. Within the context of the data obtained, the argument types of the teachers were evaluated through the deductive content analysis, and the supporting reasons they presented for their arguments were evaluated through the inductive content analysis. Study results showed that the science teachers offered more arguments, including a claim and the reasons supporting this claim and that the arguments where the pros and cons analysis was performed and the reasons for the different aspects of an issue are presented in detail could be presented less. In addition, although there were differences in the supporting reasons of the teachers according to the content of the scenario, these reasons were concentrated on the subject areas of health, social, value and personal experience. The findings can contribute to improving the science teachers' argumentation qualifications and increasing the quality of in-class argumentation practices.

Keywords:
Argument types, COVID-19, science teachers, socioscientific issues, supporting reasons

1. Introduction

Scientific literacy has become an educational slogan, a buzzword and a contemporary education goal in the world (Laugksch, 2000). This may be due to the increasing acceptance of the understanding that the primary purpose of science education is to impart science literacy to students (Millar, 2007). It is stated that there are two general perspectives of the scope of science literacy. While from the first perspective, science literacy is about gaining content knowledge, according to the second perspective, it is an element that serves the benefit of society and a necessity to adapt to the challenges of a rapidly changing world (Holbrook & Rannikmae, 2009). Accordingly, it can be stated that science literacy should serve the function of making people prepared and adaptable to the problems brought by scientific and technological advances, to new situations and events, as well as of making them acquire the content knowledge.

Some controversial contents brought about by scientific and technological developments are defined as socioscientific issues (SSIs). For example, contents, such as cloning, genetically modified organisms and global warming are considered to be SSIs as they have both scientific and social dimensions. It is expected that individuals should be able to make informed decisions when confronted with such SSI where conflicts are experienced at scientific and social dimensions (Öztürk, 2011). Therefore, being a science literate also involves the ability to make informed decisions about SSIs (Lee, 2007).

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That SSIs concern and affect society (Sadler, 2004) makes it even more significant to have qualified argumentation processes and to make conscious decisions about these issues. Given the controversial nature of SSIs and that they have both scientific and social dimensions, it can be stated that making decisions on these issues requires conducting pros and cons analyses, using scientific data and considering different perspectives. An important element of the decision-making process is defined as argumentation (Patronis et al., 1999). Therefore, it is advocated that the argumentation strategy should be used to support the understanding of SSIs and to make qualified decisions on these issues (Lee, 2007).

Argumentation is a verbal, social and logical activity that aims to increase the acceptability of a point of view by citing appropriate justifications or rebuttals (van Eemeren & Grootendorst, 2004). In a social context, argumentation requires students to respond to others' claims with their own and counterarguments, form explanations, ask questions, and refute alternative ideas (Chin & Osborne, 2010). For this reason, it is stated that argumentation is an appropriate strategy for addressing SSIs. SSIs do not have a definite answer, they are evaluated from different perspectives; therefore, their controversial nature gives students the opportunity to engage in argumentation processes. However, despite the importance given to argumentation in science education, opportunities for students to participate in argumentation processes in science classes are rare (Sampson & Blanchard, 2012).

It can be stated that one of the factors affecting students' participation in the argumentation processes in classrooms is teachers because teachers are people who apply argumentation in classrooms (Zhao et al., 2021) and students need to be supported by teachers to present arguments (Berland & Reiser, 2010). The results of the study conducted by Zohar and Nemet (2002) revealed the significance of teachers in students' performing a qualified argumentation process. In the study conducted by Zohar and Nemet (2002), the findings showed that students initially tended to deny different perspectives, not to justify their thoughts, to speak with a high tone of voice and not to listen to each other (Zohar, 2007). After they were provided with the appropriate teacher support, it was seen that the students discussed the subject from different perspectives, defended their opinions, refuted each other's thoughts and explained why other people's opinions could be wrong (Zohar, 2007). Teachers can support their students in the process of presenting arguments only if they are well-equipped in this respect. Thus, discovering how science teachers form and support their argumentation is crucial in terms of experiencing qualified argumentation processes in classrooms. In the present study, the argument types presented by the science teachers in the context of COVID-19, which is a current SSI, and their supporting reasons were tried to be revealed.

The COVID-19 pandemic is an issue that has affected the whole world in a short time. This pandemic continues to affect human life not only in the field of health but also in different fields, such as education, economy, and social life. Different data about the pandemic are published in the media every day, new rules that are expected to be followed are announced, and various types of information about ways of protection are shared. This information and the decisions made by governments sometimes cause controversy in society and require citizens to make decisions about their lives. For example, the curfews imposed in the United States cause reactions by some segments of society and can be seen as restrictions of freedoms. On the other hand, practices, such as the order of treatment, not offering treatment at all or discontinuing the treatments that have been initiated, especially against the elderly and vulnerable groups, which are more common in Italy, give rise to ethical issues (Büken, 2020). Hence, the COVID-19 pandemic is considered to be a SSI as it affects society to a great extent; different scholars can express differing opinions about it, different people can make different decisions about it and it may cause disputes in society (Evren-Yapıcıoğlu, 2020).

COVID-19, which induces both health problems and various social difficulties, can be defined as content that can be addressed with subject-based teaching (Sadler et al., 2020). As a subject-based teaching, it is emphasized that SSIs are used in science education with the purpose of improving students' reasoning ability, scientific thinking habits and decision-making skills (Ministry of National Education (MEB), 2018) because, with science education, it is significant to equip individuals with the knowledge and skills necessary to understand multidimensional issues and make evidence-based decisions (Dawson & Carson, 2020). Since the COVID-19 pandemic period is a SSI that has confronted individuals with many scientific, ethical and moral dilemmas, this issue should be included in the curriculum to improve the decision-making skills, scientific thinking habits and reasoning abilities of individuals regarding similar issues (Evren-Yapıcıoğlu, 2020). Thus, it can be stated that besides providing opportunities for students to think sociologically, examining data and question human

practices (Reiss, 2020), it can also serve the function of improving the public understanding of science (Sarıbaş & Çetinkaya, 2021) by focusing on explaining the nature and effects of uncertainty in science. In the current study, the subject of COVID-19 was preferred as an issue that is both current, new and whose effects are still felt in many areas. Research questions that guided this study in the context of COVİD-19 are given below:

a) What are the argument types presented by science teachers within the context of the COVID-19 pandemic?
b) What are the reasons presented by science teachers to support their arguments within the context of the COVID-19 pandemic?

1.1. Rationale of this Study

With science education, it is aimed that individuals have the skills and understanding necessary to make informed decisions about scientific issues that may affect their lives and to participate in social debates (Dawson & Venville, 2010). In this connection, students should be equipped with the skills to use their scientific knowledge in real-life situations, address a subject together with its social, cultural and economic values and evaluate different options related to the subject (Dauer & Forbes, 2016). It can be stated that argumentation processes will contribute to the achievement of the goals of science education, as it gives students the opportunity to present and defend evidence-based claims, as well as engage in the evaluation processes of arguments presented by others (McNeill et al., 2016). Indeed, studies have shown that teachers should engage students in argumentation processes for them to evaluate scientific evidence and have a scientific perspective free of prejudices (Lee, 2007).

Despite the importance given to argumentation in science education, discussions in which students actively participate in the classroom are rarely observed (Roth et al., 2006). One of the reasons for this situation can be attributed to the teachers' inadequacies in this matter. Studies have shown that science teachers and pre-service teachers are insufficient in forming arguments. In the study conducted by Türköz and Öztürk (2019), it was revealed that before any training was given, pre-service science teachers presented more arguments consisting of a simple claim on SSIs and did not adequately address the rebuttal element containing opposing perspectives. Sampson and Blanchard (2012) found that the arguments presented by most science teachers did not comply with the definitions and frameworks proposed in the literature and that teachers could not support their arguments; therefore, they concluded that the science teachers participating in the study should be informed more about the structure of a scientific argument. Zhao et al. (2021) also found that pre-service science teachers had deficiencies in forming arguments and supporting their claims with data from different dimensions. In another study conducted by Yalçın (2018), the pre-service science teachers were observed to give more place to claims and justifications, and they gave little place to opposing opinions and refuting the opposite opinion with evidence in their arguments. In the study conducted by Cebria´n-Robles et al. (2018), the findings showed that the pre-service science teachers were insufficient to provide justification and evidence to support their arguments before implementation of the study. Therefore, there are studies in the literature that suggest that the arguments presented by pre-service science teachers and teachers and their supporting reasons are not at the desired level.

Determining how science teachers form their arguments and how they defend them is significant in terms of influencing the argumentation-based teaching they will give. In fact, science teachers' ability to form arguments is the basis for their science teaching (Zhao et al., 2021). However, there appear to be relatively few studies examining science teachers' understanding of argumentation (McNeill et al., 2016), how they participate in discussions, how they evaluate explanations, or how they form arguments (Sampson & Blanchard, 2012). It is seen that studies conducted have largely concentrated on pre-service science teachers (Cebria´n-Robles et al., 2018; Zhao et al., 2021).

Schwarz et al. (2003) used the concept of type to characterize the features and structure of the arguments (consisting of only one claim and supporting reasons for this claim, presenting contradictory statements besides supporting reasons, and defending the claim by revealing its positive and negative aspects) presented. In the present study, it was deemed appropriate to use the concept of type, as it was aimed to examine the claims of science teachers, who were actively teaching, presented in their arguments on SSIs, their supporting reasons and their state of dealing with the positive and negative aspects of the issue. The present study aimed to investigate the supporting reasons presented by science teachers as well as their argument types. At the end

of this study, it was expected to obtain findings of the argument types and supporting reasons presented by science teachers and how the deficiencies of the teachers, if any, would be eliminated, in terms of which items their arguments should be supported and on which dimensions their supporting reasons were concentrated and should be developed. These findings to be obtained are thought to contribute to the steps to be taken to improve the argument qualifications of science teachers, to increase the quality of argumentation applications of teachers and to guide in-service training programs to be organized in this direction.

2. Methodology

2.1. Research model

The current study employed the case study design, one of the qualitative research methods. Qualitative research method is used in studies conducted to explain an existing situation in detail without any intervention (Fraenkel et al., 1993). Case study is also a qualitative research design that allows in-depth, versatile investigation of complex problems of real life (Crowe et al., 2011). The present study aims to reveal the argument types and supporting reasons of science teachers about the COVID-19 pandemic as a real life issue; it was decided to follow the case study research process.

2.2. Study Group

The data of the study were collected from the science teachers who could be reached using the convenience sampling method. Convenience sampling is a sampling method that saves time, labour, and money (Büyüköztürk et al., 2008) and is widely used in studies in the literature because it offers researchers such conveniences (Baltacı, 2018). Due to the pandemic we are in, face-to-face communication and data collection were thought to be difficult; thus, the convenience sampling method was preferred in this study and it was planned to reach teachers via social media. Science teachers who could be reached via social media tools were informed about the purpose and significance of this study. Seven teachers who volunteered to participate in this study were determined. All the science teachers were working in public schools and five of them are females and two of them are males. One of the teachers has experience for two years, two of them for seven years, one of them for seven and half years, one of them for six years and two of them for 17 years as a science teacher at different middle schools. The demographic features of the science teachers are given in Table 1.

Table 1. *The Demographic Features of the Science Teachers*

Teacher No	Male / Female	Professional experiences	Place of Work
T1	F	7,5	Kocaeli
T2	M	6	Manisa
T3	F	7	Muğla
T4	F	2	Bursa
T5	F	7	Muğla
T6	F	17	Muğla
T7	M	17	Muğla

2.3. Data Collection Tools and Process

Scenarios developed by the researcher were used as the data collection tool. The COVID-19 pandemic was preferred as the SSI to be addressed in the current study because it is defined as one of the most up-to-date SSIs and its effects are still felt in many areas. In this context, as the issues of vaccination, curfew and continuing distance education were found to have the contents causing the hottest and most widespread controversies, it was determined to develop the scenarios on these issues. For example, while vaccination is specified as the most effective method for countries to return to normal life, uncertainties, such as the duration of production and side effects of vaccines, have resulted in people's developing different ideas on vaccines. The curfew has also caused controversy in terms of restricting freedoms, although it is accepted as a solution to reduce the rate of spread of the COVID-19 pandemic. On the one hand, while distance education has been implemented as an option to continue education during the COVID-19 pandemic, it has been criticized for its nature and limitations (such as not having a computer in every home and internet connection problems). For this reason, education, health and curfew have been handled as SSIs that have a multidisciplinary structure,

and cause concerns and debates in society. In addition, since these three issues are among the most controversial issues, directly affecting people's lives and voiced the most in the media, it was decided to develop scenarios in the context of these issues in the current study. Therefore, three scenarios named "Yes or no to vaccination?", "Stop or continue distance education?" and "Are we against or for the curfew?" were developed. In the process of developing the scenarios, firstly, the news about these issues in the media were read and listened and then the contents of the scenarios were tried to be created in the most interesting and up-to-date manner. In the writing of the scenarios, care was taken to include information about COVID-19 that would reveal the controversial aspects, advantages and disadvantages of the situations we encounter in our daily lives. Atabey et al. (2018), in their analysis of the SSI scenarios in the literature, revealed that the scenarios included positive and negative aspects and a question sentence that would create a dilemma. In the current study, at the end of the scenarios, individuals were asked to make a decision about the given issue by associating the content with their daily life and to explain the reasons and justifications for their decisions, taking into account their daily experiences, scientific knowledge and counter-arguments. In this connection, the arguments of the teachers and their supporting reasons were tried to be determined through open-ended questions. Sample scenario contents are presented in the Appendix A and B sections.

After the scenarios were written, they were read by a faculty member, one of his/her fields of study was SSIs and a Turkish teacher. In light of the received feedback, the required corrections were made. The piloting of the scenarios was performed on three teachers and then they were finalized. After the scenarios were finalized, they were sent to seven teachers via e-mail and social media tools, and the teachers' answers regarding the scenarios were collected back through the same ways. This process took an average of 2 weeks.

2.4. Data Analysis

In the present study, it was aimed to reveal the argument types and supporting reasons of science teachers about COVID-19. To this end, both the inductive content analysis and deductive approach were used in this study. The deductive content analysis is used to test or compare an existing theory in a different situation while the inductive content analysis is used when there has been no previous study for the case (Elo & Kyngäs, 2008). In the present study, as the argument types of the teachers were analyzed according to a pre-existing analytical framework, the deductive approach was adopted at this stage. As a pre-existing theory was not used for the reasons that supported teachers' arguments and new analytical units were produced the inductive approach was adopted at this stage. How each analysis was carried out is explained in detail under the related headings below.

2.4.1. Analysis of the data about the argument types: The deductive content analysis was used in the analysis of the teachers' argument types. In the deductive content analysis, a pre-existing code, category, concept, model, theory or hypothesis are tested in the context of new data or content (Kyngäs & Kaakinen, 2020). In the current study, analysing the arguments presented by the science teachers about the COVID-19 pandemic with the criteria previously described by Schwarz et al. (2003) made it necessary to use the deductive content analysis. The criteria developed by Schwarz et al. (2003) are presented in Table 2.

Table 2. *Argument Types and Criteria*

Criteria	Argument type
Arguments unsupported with any reason	First type of argument
Arguments, including conclusions supported with a reason or a series of reasons	Second type of argument
Arguments, including reasons both support and challenge the conclusion. The analysis of the pros and cons on the issue is not clear.	Third type of argument
Arguments in which a conditional statement that redefines or constraints the stated problem is generated and an analysis of the pros and cons is made on the issue and negative and positive aspects of the issue are discussed.	Fourth type (compounded) of argument

Source: Schwarz et al. (2003, pp. 16-17).

According to the criteria determined by Schwarz et al. (2003), the first type of arguments are arguments for which no defense is presented for the idea proposed or the conclusion reached. In the second type of arguments, ideas or conclusions are supported with one or more than one reason. If reasons that contradict

the ideas are presented along with the reasons that defend the conclusions or ideas, then it is considered as the third type of argument. There are no clear pros and cons analysis for the ideas proposed or the problem situation in the third type of argument. If a clear pros and cons analysis is made, if the positive and negative aspects of the issue are addressed, and if the problem situation is redefined and constrained with expressions, such as "it depends, if, but if", such arguments are considered as the fourth type. In this way, Schwarz et al. (2003) tried to reveal whether the arguments are one-sided, two-sided or compounded according to these criteria.

During the data analysis process, 21 responses were obtained from seven teachers for the three scenarios named "Yes or no to vaccination?", "Stop or continue distance education?" and "Are we for or against the curfew?". Three responses for each scenario and thus, a total of nine responses for three scenarios were read and evaluated by two researchers. Between the researchers, an agreement was reached for seven responses out of nine. Then, an agreement was also reached on the remaining two responses through discussion by the researchers. Afterwards, the other responses were analyzed by the researcher. The obtained data were presented together with their frequency values and quotations made from teachers' responses.

2.4.2. Analysis of the data about the supporting reasons: The reasons presented to support their arguments by the science teachers were tried to be revealed using inductive content analysis. Inductive content analysis is used when the preliminary information about the investigated situation is not sufficient and clear (Elo & Kyngäs, 2008). In inductive content analysis, researchers use concepts, categories, or themes to reduce and group data (Kyngäs, 2020) and concepts are derived from the data obtained through this content analysis (Elo & Kyngäs, 2008). Erlingsson and Brysiewicz (2017) defined the following stages for this type of content analysis: reading the interviews repeatedly, identifying or coding names or tags that best explain the unit of meaning emphasized by the participant, grouping the codes that are related to each other concerning content or context and creating categories. In the current study, the answers given by the teachers to the scenarios to reveal the reasons they gave for their arguments were read again and again by the researcher and a researcher specialized in qualitative research, SSIs and argumentation. During this process, firstly, the supporting reasons that the teachers presented to defend their own decisions were determined, then it was determined in which subject areas these reasons could be included. Each supporting reason and subject area was presented together with sample quotations from teacher responses.

2.5. Ethical Procedures

All steps in the present study were carried out by observing ethical rules. Ethics Committee approval (Date and Number: 30.12.2020-15612) was taken for this study.

3. Findings

In this section, findings related to the types of arguments presented by the science teachers regarding the scenarios about COVID-19 and the supporting reasons are presented.

3.1. Findings related to the Argument Types

The frequency values for the types of arguments presented for "Yes or no to vaccination?", "Stop or continue distance education?" and "Are we for or against the curfew?" scenarios were calculated. Then, sample quotations are presented. Frequency values for the argument types are presented in Table 3.

Table 3. *Frequency Values for the Argument Types*

	Argument types		
Teacher	the scenario regarding vaccination	the scenario regarding education	the scenario regarding curfew
T1	2	3	2
T2	2	3	2
T3	2	2	4
T4	4	4	4
T5	3	2	3
T6	3	2	3

T7	2	3	2	
Argument types	**The total argument types presented for the scenarios**			
	for Vaccination Scenario	for Education Scenario	for Curfew Scenario	Total
2nd Type	4	3	3	10
3rd Type	2	3	2	7
4th Type	1	1	2	4

As can be seen in Table 3, from among all the responses given to the scenarios, 10 responses were obtained for the second type of argument, seven responses for the third type of argument and four responses for the fourth type of argument. Another finding as shown in Table 2 was that the first type of argument was not presented for the scenario named "Yes or no to vaccination?" and that four teachers presented second type of arguments, two teachers presented third type of arguments and one teacher presented a fourth type of argument. Some quotations from teacher responses classified within different types of arguments are given below.

Quotations *for the "Yes or no to vaccination?" scenario*

The following quotation was considered to be a second type of argument.

> "I'm afraid of getting vaccinated and I wouldn't because I don't know how long it will protect me. It has been produced in a very short time. I don't know what's inside. I don't know yet on how many people it has been tried and what the effects are on them…. While Chinese products already contain excessive carcinogenic substances, what will be the quality of their vaccine? I think like this. Maybe, we can acquire immunity in natural ways." (T7)

The following quotation was considered to be a third type of argument.

> "My decision would be to get vaccinated because currently, the most scientific and concrete thing to be used against the virus is the vaccine. ... … ... But this vaccine is a virus blocker that has been studied and tested by scientists. It has been produced in a short time, yes. Maybe, there will be health problems in the future, but now I have to trust this. At least, I feel psychologically relaxed."(T6)

The following quotation was considered to be a fourth type of argument.

> "I have heard through social media that there are concerns about the conventional vaccines not providing sufficient immunity. Vaccination of everyone in the same process is a solution that should be applied to end this pandemic because I do not think that the herd immunity method is a very valid way. As someone who has had COVID 19 myself, it is possible for someone who got sick to get sick again after 3-6 months. Thus, even if we have recovered from the disease, permanent immunity cannot be achieved. In this case, I think herd immunity is not a valid solution. ….In this case, vaccination seems to be the only solution and there is no way to escape. However, vaccines should be administered by minimizing the negative effects that may arise in the long term ….... My opinion on this matter is to wait until all necessary studies on the vaccine have been completed and then to start vaccination after it has been ensured that the long-term negative effects are minimized."(T4)

Quotations *for the "Stop or continue distance education" scenario*

The first type of argument was not presented for the scenario named "Stop or continue distance education?", three teachers presented second type of arguments, two teachers presented third type of arguments and 1 teacher presented a fourth type of argument.

The following quotation was considered to be a second type of argument.

> "I would support distance education because especially young children of primary school age are not fully aware of the pandemic. They don't pay enough attention to the rules and they are in the carrier group. Coming to school means that many parents also go out and increase the risk of contact. Currently, the number of cases is very high and the most important thing is

health. It is seen that the pandemic in countries around the world somehow affects education. Millions of students' education process have changed here. Planning for the future can be made by learning lessons from the experiences of other countries. "(T3)

The following quotation taken from the response of Ö1 was considered to be a third type of argument.

"Of course, distance education should be continued ... Although there are some disadvantages of distance education (e.g., connection problem, computer, lack of internet, or lack of necessary infrastructure), students can communicate with their teachers and learn the subjects verbally …. Distance education can be enough for learning as it allows individual learning, provides independence of time and place for learning, and make it possible to receive support from teachers at points where the student has learning difficulties ….. distance education should definitely continue."(T1)

The following quotation was considered to be a fourth type of argument.

"I also agree with the view that distance education does not completely replace face-to-face education. … Yes, distance education may not replace face-to-face education, as there is quite a big difference in terms of the quality of communication. Apart from that, I don't think there is a big difference concerning the solutions of questions and lectures. The most challenging point for students in distance education is that they have to organize their study environment at home and monitor their own study processes. In addition, for younger age groups, spending too much time on the computer can be a problem. Another problem is students who do not have access to the internet. Thus, should education stop completely because of these problems? I think no. I think some of these problems should be tried to be solved instead of completely interrupting education. For children living in villages, points can be created where they can access the internet and their transportation can be provided in compliance with COVID 19 measures. ..In summary, I support the continuation of distance education by trying to solve the problems in distance education. ..When face-to-face education starts, losses having occurred during distance education can be compensated for. " (T4)

Quotation*s for the "Are you for or against the curfew?" scenario*

The first type of argument was not presented for the scenario named "Are you for or against the curfew?", three teachers presented second type of arguments, two teachers presented third type of arguments and two teachers presented fourth type of arguments.

The following quotation was considered to be a second type of argument.

"I would vote for the bans to continue. The individual's thinking that he/she will not catch the disease or that he/she will survive even if he/she catches the disease does not give the right to risk the life of the rest of society. Therefore, it is necessary to comply with the curfew, like other social rules." (T2)

The following quotation was considered to be a third type of argument.

"There must be a ban ... Yes, our freedoms are slightly restricted, but this needs to be done now to be more free and comfortable in the future. Not going to work for a while, not going to the movies, or not visiting the mall will not kill you. But when it's not banned, everyone will flock out. And when carelessness is added. We have already experienced this. We didn't go out in April. Then, the ban was abolished. Now, we are back to the beginning again because not everyone shows the same sensitivity. Of course it will be banned."(T5)

The following quotation was considered to be a fourth type of argument.

"I would vote for the ban. When we look at the summer period when the bans were lifted, we tried this process before, and unfortunately, there was a very high increase in the number of people who got the virus. Employees in hospitals have been negatively affected by this increase and are now quite tired. ... The rules could not be fully followed, especially because of the insufficient precautions in public transportation and the inability of our primary school

children to understand the pandemia process. Even if our children are not affected by the virus, they are carriers. At least, we can wait for the decrease in the number of cases and then continue our social life in a protected way by setting strict rules on masks and gloves. In this way, we are not only protected from the problem of not being able to find enough beds at hospitals but can also immunize our body against the virus during this period. We need to take the virus seriously, which concerns all countries and is so contagious."(T3)

3.2. Findings regarding the Supporting Reasons Presented for the Arguments

In this section, findings related to the supporting reasons of the science teachers about the three scenarios were presented together with sample quotations. Teachers' supporting reasons and subject areas of these reasons for their accepting or rejecting the vaccine are presented in Table 4 with sample quotations.

Table 4. *Supporting Reasons for the Vaccine Scenario*

Subject area	Supporting reasons	Sample quotations
Health	Uncertainty about the side effects to be caused by the vaccine	I think that not knowing what the long-term effects of vaccines produced in a very short time will be is extremely risky for humans. (T1) ….. I think that the consequences of the vaccine developed in such a short time against Corona have not been adequately examined. (T3)
	Not being sufficiently effective	I have heard through social media that there are concerns about conventional vaccines not providing sufficient immunity. (T4) I don't think of getting the vaccine unless there is a 100 percent effective vaccine and this vaccine has been tried for a long time. (Ö1)
	Getting over the disease without a vaccine	I may acquire immunity in natural ways. (T7)
	Future mutations	I am afraid that vaccination could cause mutations in people's DNA in the future. (T3)
Technology	Long time trial	I don't think of getting the vaccine unless there is a 100 percent effective vaccine and this vaccine is tried for a long time. (T1). I don't know yet how many people it has been tried and what the effects are on them. (T7)
	Vaccine production period	Certain steps have been taken for vaccination. .. Because technology has developed too much, I think the time is normal. (T5) While the development period of the vaccines produced in history took between four and 70 years (the influenza vaccine was developed in 14 years), I think that the results of the vaccine developed against Corona in such a short time have not been adequately examined. (T3)
Social	Life's turning to normal	I would prefer to be vaccinated. I think life should return to normal through vaccination. (T2)
Value	Short-term solution Only solution	That's why I see the vaccine as a short-term solution in the next ages. (T3) In this case, vaccination seems to be the only solution and there is no way to escape. (T4)
Personal experience	Catching the disease again	As someone who has had COVID 19 myself, it is possible for someone who got sick to get sick again after 3-6 months. (T4)

As can be seen in Table 4, the supporting reasons of science teachers for their acceptance or rejection of the vaccine are subsumed under subject areas of health, technology, social, value and personal experience. For the supporting reasons under the health dimension, the following categories were obtained: "Uncertainty about the side effects to be caused by the vaccine", "Not being sufficiently effective", "Getting over the disease without a vaccine," "Future mutations". For the supporting reasons under the technology dimension, the following categories were obtained: "Long time trial", "Vaccine production period". For the supporting

reasons under the social dimension, the following category was obtained: "Life's turning to normal". For the supporting reasons under the value dimension, the following categories were obtained: "Short-term solution" and "Only solution." For the supporting reasons under the personal experience dimension, the following category was obtained: "Catching the disease again".

Teachers' supporting reasons and subject area of these reasons for their being for or against the curfew are presented in Table 5 with sample quotations.

Table 5. *Supporting Reasons for the Curfew Scenario*

Subject area	Supporting reasons	Sample quotations
Health	Putting society at risk	Because many people affect the health of society negatively by walking around outside. (T1) The individual's thinking that he/she will not get the disease or that he/she will survive even if he/she catches the disease does not give the right to risk the life of the rest of society. (T3)
	Family dynamics	Because the dynamics of each family are different. The members of the family may be of different ages or differ in terms of having a chronic disease. (T4)
	Deterioration of mental health	In other words, the inability of an individual in the risk group to protect himself/herself and his/her having to be in external environments all the time may lead to anxiety disorders. (T4) So many bans make people's lives difficult. But why am I having trouble because of those who behave carelessly? Who will glue the mental fractures of being home all the time? Our life is passing. Constantly being in the same environment exhausts the human brain. Every day, I know what I will do the next day. (T5)
	Treatment opportunities	Because it has been observed that the number of cases and the hospital occupancy rate increased in a certain period when we released the people, and the mortality rate increased as a result of the failure to receive the necessary treatment. (T1)
	Reducing its spread	Its spread will be prevented. It will slow it down, if not completely. (T6)
Social	Sparing time for yourself and your loved ones	On the contrary, when people stay at home, they can do many things they wouldn't otherwise. They get along with their loved ones, cook and play games together. (T6)
	Characteristics of society	the shortage of conscious and educated individuals in society (T1)
Value	Perception of the pandemic	In other words, if an individual himself/herself is not in the risk group and if he/she does not have an elderly member or a member in the risk group in his/her family, he/she does not perceive the pandemic process as a dangerous process in which he/she can have severe losses. (T4)
Personal experience	Carelessness and social congestion	But when it's not banned, everyone will flock out. And when carelessness is added. We have already experienced this. We didn't go out in April. Then, the ban was abolished. Now we are back to the beginning again. (T7)
	Increasing number of cases	When we looked at the summer period when the bans were lifted, we tried this process before, and unfortunately, there was a very high increase in the number of people who got the virus. (T3)

As can be seen in Table 5, the supporting reasons that the science teachers presented for their being for or against the curfew were subsumed under subject areas of health, social, value and personal experience. For the supporting reasons under the health dimension, the following categories were obtained: "Putting society at risk", "Family dynamics", "Deterioration of mental health", "Treatment opportunities", "Reducing its spread". For the supporting reasons under the personal experience dimension, the following categories were obtained: "Carelessness and social congestion", "Increasing number of cases". For the supporting reasons under the value dimension, the following category was obtained: "Perception of the pandemic". For the supporting reasons under the social dimension, the following categories were obtained: "Sparing time for yourself and your loved ones", "Characteristics of society".

Teachers' supporting reasons and subject area of these reasons for stopping or continuing distance education are presented in Table 6 with sample quotations.

Table 6. *Supporting Reasons for the Distance Education Scenario*

Subject area	Supporting reasons	Sample quotations
Health	Importance of health	The most important thing is health. (T3)
Social	Right to education	There is no excuse for taking away the individual's right to education. (T1)
	Increasing rates of crime	Many frustrated people abandon their goals and social problems will arise; I think the number of thieves, murderers, perverts will increase exponentially. Idle people always turn to harmful things. (T5)
Value	Stealing from life	Stopping the educational/instructional process means stealing from one's life, and distance education should definitely continue. (T1).
Personal experience	Difficulty of enacting learning by doing and experiencing	Based on my own teaching experiences and the experiences shared by my fellow teachers from different schools, I can say that the application of educational processes for learning by doing cannot be very common and easy as long as the assessment method is a multiple-choice exam. (T4)
Technology	Advantage and disadvantage	Although there are some disadvantages of distance education (e.g., connection problem, computer, lack of internet, or lack of necessary infrastructure), students can communicate with their teachers and learn the subjects verbally. (T1)
	Using camera effectively	Moreover, in practical training, the camera can be opened and students can be given the opportunity to practice as much as possible. (T1)
	Quality of communication	There is quite a big difference between distance education and face-to-face education in terms of the quality of communication. (T4)
	Duration of concentration	For younger age groups, spending too much time on the computer can be a problem. (T4)
	Access to the internet	Another problem is students who do not have access to the internet. (T4)
Education	Alternative learning methods and techniques	I do not think that learning should certainly be by doing and living. (T1)

As can be seen in Table 6, the supporting reasons that the science teachers presented for their arguments about the scenario "Stop or continue distance education?" were subsumed under the subject areas of health, social, value, personal experience, technology, and education. For the supporting reasons under the health dimension, the following category was obtained: "Importance of health". For the supporting reasons under the social dimension, the following categories were obtained: "Right to education", "Increasing rates of crime". For the supporting reasons under the value dimension, the following category was obtained: "Stealing from life". For the supporting reasons under the personal experience dimension, the following category was obtained: "Difficulty of enacting of learning by doing and experiencing". For the supporting reasons under the technology dimension, the following categories were obtained: "Advantage and disadvantage", "Using camera effectively", "Quality of communication", "Duration of concentration", "Access to the internet". For the supporting reasons under the education dimension, the following category was obtained: "Alternative learning methods and techniques".

4. Discussion, Results, and Recommendations

This study aimed to reveal the types of the arguments and supporting reasons of the science teachers on SSIs. For this purpose, the answers given by the science teachers to the scenarios related to vaccination, curfew and distance education in the context of COVID-19 were analyzed concerning argument types and reasons. Results showed that science teachers created 10 arguments at the level of the second type, seven arguments at the level of the third type, and four arguments at the level of the fourth type for three scenarios about the COVID 19

pandemic. Given that second type of arguments include a claim and reasons supporting this claim, that pros and cons analyses are conducted and the facts about the different aspects of an issue, including its positive and negative aspects, are presented in detail in the fourth type of arguments, it can be said that there are many studies in the literature that support this finding of the current study. The results of the study conducted by Türköz and Öztürk (2019) which revealed that the arguments presented by the pre-service science teachers on SSIs before the application largely consisted of a simple claim, and the refutation element, which included reasons to refute different and opposite dimensions, was rarely presented, support the results of the current study. The findings of the study conducted by Yalçın (2018), which revealed that the arguments presented by the pre-service science teachers on SSIs before they had received any training generally included claims constructed with simple sentences, that these claims were supported by weakly correlated evidence and that multiple justifications were not presented sufficiently, support the findings of the current study. Moreover, the results of the study conducted by Sampson and Blanchhard (2012), which revealed that most science teachers could not expand their explanations enough and presented arguments that did not contain sufficient support, also concurred with the results of the current study.

In fact, given the scenario contents presented in the current study, the teachers have been expected to present the third and fourth types of arguments more because COVID-19 is a content that is discussed and mentioned a lot in television, newspapers and social media environments, as well as it is a subject that teachers and all people experience the consequences of it in many aspects of the daily lives, such as education, social life and health. Thus, it was expected that the teachers would be able to address the positive and negative consequences of this subject in different areas and to be able to conduct analyses of the pros and cons on the issue because it has been determined that the use of SSIs experienced in real life and frequently appearing in the media contributes to the argument presentation process and supports addressing the positive and negative aspects of the issue (Gutierez, 2015). The finding obtained in the current study can be attributed to the teachers' inability to use them in the process of forming their arguments rather than their lack of knowledge and experience about the positive and negative aspects of the scenario contents because it is stated that it is difficult for individuals to present arguments based on a holistic perspective, which includes considering different dimensions of the subject (Christenson et al., 2012). Therefore, more emphasis should be placed on teachers' developing arguments, including different perspectives of an issue and considering the positive and negative consequences of the issue, rather than developing arguments presenting a simple claim and reason. One way to help teachers learn more about argumentation and the nature of arguments is to engage them with contexts like the ones used in the current study (Sampson & Blanchard, 2012).

Another finding of the current study is that the majority of the arguments presented for the scenario "Yes or no to the vaccine?" are the second type of arguments and that they presented a more third and fourth type of arguments for the scenarios "Stop or continue distance education?", "Are you for or against the curfew?". This finding of the current study is supported by studies in the literature (Yalçın, 2018) reporting that arguments presented vary according to the subject content or that the content of the socioscientific scenario affects the arguments presented. Yalçın (2018) also determined that the pre-service science teachers differed in terms of explaining the reasons they presented, using more than one reason, and considering opposing ideas depending on the SSI content. The presentation of more third type and fourth type of arguments in the scenarios related to the curfew and distance education can be attributed to the teachers' personal experience of prohibitions, limitations or practices regarding the topics in the scenario content. The following quotation shows that teachers made use of their personal experiences in their arguments; "*When we looked at the summer period when the bans were lifted, we tried this process before and unfortunately, there was a very high increase in the number of people who got the virus….*" (T3). Therefore, it can be stated that the subject content of any SSI related to daily life and the experience of its positive or negative dimensions in real life support the argument-formation process. For this reason, it is recommended that the socioscientific scenarios presented to support science teachers to create the desired type of argument should be chosen among life-related, up-to-date and potentially experienced topics whenever possible.

Another finding obtained in the current study is that the supporting reasons presented by the science teachers for their arguments are centered on the subjects of health, social, value and personal experience. This finding shows that the science teachers used their personal experiences, values, social conditions and health factors as reasons to support their decisions on SSIs within the context of COVID-19. Therefore, it can be interpreted that

the science teachers generally made their decisions by considering different subject areas, although there were differences in their supporting reasons according to the content of the scenario. This finding is supported by the finding of Türköz and Öztürk (2019) stating that pre-service science teachers take different dimensions into account when making decisions on different SSIs and try to make a decision by considering the subject in a multidimensional holistic manner. Topçu et al. (2011) also found that the pre-service science teachers were affected by their personal experiences, educational dimensions, ethical and technological concerns and social dimensions in their solutions to SSIs and in their reasoning processes on these issues, which also concurs with the finding of the current study. In the current study, the teachers' ability to consider at least four subject areas for each scenario can be attributed to that COVID-19 is very current and still felt in many areas in real life. Restrictions in the field of education and curfews are practices directly experienced by teachers, and thus it seems to be normal for the teachers to include the effects of these practices in different subject areas in their arguments. For the scenario related to vaccination, it is seen that the teachers who have personally suffered from the disease included their personal experiences, and especially the suspicions regarding the duration in which the vaccine has been produced and uncertainties about the effects of the vaccine have been presented as supporting reasons for the teachers' decisions. It can also be argued that the news in the media about the possible risks, production time and effects of the vaccine affected the decisions and concerns of the teachers. The statement of T4, "I have heard through social media that there are concerns about the conventional vaccines not providing sufficient immunity," shows that media is influential on the decisions of teachers. Işbilir et al. (2014) emphasized that the high-quality arguments of the pre-service science teachers may be the result of the discussion of their daily experiences and the subject contents of SSIs in the media. As a result, the findings of the present study show that the requirement of individuals taking part in the solutions to SSIs discussed in media and making individual decisions on these issues (Osborne et al., 2004) was fulfilled by the participating teachers at least within the context of considering different subject areas. For this reason, it is recommended to use contents that are discussed in media and are likely to be experienced in real life in studies on SSIs.

When the findings obtained in the current study are considered, it is seen that the science teachers presented the second type of arguments the most, but their supporting reasons included different subject areas as desired. These two results can be seen to be contradictory to each other. However, on the contrary, these results complement each other because when the arguments of the science teachers were examined, it was seen that although they presented reasons, including different subject areas, such as social and health in their arguments, they focused only on defending their own ideas and continued to defend them in one direction without mentioning the positive and negative consequences of their decisions. In other words, it was determined that they shared their knowledge and experiences about different subject areas regarding either the positive or negative aspects of the issue in their decisions. The presentation of the second type of argument the most, which is the type of argument that includes a claim and the reasons supporting this claim, also confirms the one-sided defense. Hence, it is recommended that training should be given to science teachers in such a way that they can present arguments that address different subject areas regarding the advantages and disadvantages of the issue and conduct research in this direction. For this purpose, further studies that focus on developing different perspectives in teachers on a SSI and support their expressing their thoughts from both angles rather than focusing only on positive or negative aspects of the issue can be conducted. In addition, similar studies can be conducted with large samples and supported by a quantitative dimension to obtain generalizable and more comprehensive findings.

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Appendix A

Yes or no to vaccination?

COVID-19 is a pandemic that suddenly entered our lives and continues to affect our lives in many ways. The effects of this pandemic on human health are tried to be presented in graphics and numbers all over the world. The numbers show that the pandemic is causing thousands of deaths around the world every day. The good news of vaccines has recently been voiced in television programs. Thus, the hope that the pandemic will end and normal life can be started excites people. While it is debated whether vaccination should be mandatory or voluntary, people who are the advocates of vaccine want this not to be left to the preference because they argue that as long as this disease continues, many people will lose their lives, be unemployed, many businesses will be closed, and neither society nor countries will be able to afford it economically. On the other hand, there are people complaining that visits to parents and celebrations that are important to people, such as marriage, have not been allowed for a long time. They even state that people who have lost their relatives are sad because they cannot attend the funerals as their last duty and that humans as social beings have now started to experience psychological traumas. On the other hand, it is argued that vaccine rejection will endanger people having chronic conditions and the elderly because there is still no antivirus treatment to treat COVID-19. However, some people are skeptical about the vaccine. One of the reasons for these concerns is that the vaccine produced in Germany is produced by using a method different from the methods used in vaccine production until now. While in traditional vaccines, viruses that cause infection are weakened and injected into the human body, a critical part of the RNA chain is injected in RNA-based vaccines. People who are against vaccines argue that there is the possibility that fragments of RNA entering the cell can interact with the human genome and alter human genetics, causing dire consequences. They argue that a period of 7-8 months is a very short time for vaccine development, including vaccines, such as the Chinese vaccine produced with traditional methods and ask the question of who will be held responsible for possible health problems that may arise after 5-10 years, The existence of a laboratory that will inspect the content and quality of the vaccines to be imported and whether these inspections will be carried out are among the issues concerning people who are against vaccines.

What would you decide if your doctor called you now and told you that you have to come to be vaccinated within a week, but you have the right to refuse the vaccination? Why? Explain your reasons by using your daily experiences, scientific knowledge and taking counter-arguments into account.

Appendix B

Are we against or for the curfew?

Different strategies are followed in different countries in the process of combating the COVID-19 pandemic. Some countries, such as the UK and Sweden, tried herd immunity. They argued that as a result of the infection of a certain proportion of the population, a sufficient number of people would be immunized so that the number of cases would naturally decrease and the disease would be taken under control. Some countries, including Turkey, have imposed bans, such as the curfew. It is stated that if the curfew is implemented, the rate of spread of the virus will decrease and people will be saved from unnecessary infections, suffering and deaths. Thus, it is emphasized that the health system can provide adequate services to patients and that the tired healthcare personnel will find the opportunity to rest. The construction of an additional building in a state hospital in Samsun has begun as the intensive care service is full. The number of such hospitals is increasing. It is stated that with the curfew, time will be gained for the vaccine to be available and to reduce the number of patients until treatment for COVID-19 has been found.

On the other hand, in some countries, such as America and France, people argue that curfew means restriction of freedoms and shout slogans as "my body, my choice". They want the restrictions to be lifted as soon as possible and economic activities to be resumed. They argue that if they had to make a choice between freedom and COVID-19, they would prefer their freedom and that people could not be prevented from doing sports or meeting with friends or even relatives. Those who cannot see even their parents who are elderly or sick argue that it is not known when this process will end, so it cannot be continued in this way. It is also discussed in television programs that illnesses, such as muscle loss may occur in the elderly who stay indoors for a long time, and negative experiences, such as separation from friends, boredom and changes in living conditions can cause consequences, such as anxiety, depression, impaired social interaction and decreased appetite in children. It is stated that the feelings of the patience of the adults who constantly stay at home with the children decrease and they have problems in establishing healthy communication with the children. Violence against women and divorce rates have increased significantly during the periods of stay at home.

Now, if there was a vote on the imposition of a curfew every weekend until the COVID-19 disease was no longer a threat, would you vote for the ban or against the ban? Why? Explain your reasons by using your daily experiences, scientific knowledge and taking counter-arguments into account.