

Preservice Science Teachers' Opinions and Argument Quality regarding COVID-19 Vaccines

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Abstract

This study aims to identify preservice science teachers' opinions and argument quality regarding the COVID-19 vaccines. The research was conducted with 18 4th year preservice science teachers studying at the Department of Science Education. The study was conducted with phenomenological design and the data were obtained using focus group interview and dilemma cards. The data obtained from the focus group interview were analyzed with content analysis. The argument components in the dilemma cards were analyzed using the "Argumentation Model Rating Scale" developed by Hiğde and Aktamış (2017). The findings obtained from the focus group interview showed that the majority of preservice science teachers were undecided about vaccination. The minority of the participants who expressed positive views on COVID-19 vaccines mentioned the health, social and scientific aspects of the vaccine (protection, reducing the rate of disease, facilitating the fight against epidemic, contributing to the advancement of science, etc.). On the other hand, it was underlined by the preservice science teachers that the COVID-19 vaccines still contained uncertainties (side effects, lack of protection on its own, lack of confidence, etc.) and created feelings of unease due to the new technological products. The results obtained from the dilemma cards demonstrated that the preservice science teachers were able to present their opinions (claims) and evidence successfully and were partially successful in supporting them. However, it was concluded that the preservice science teachers could not achieve the same level of success in the rebuttal part while presenting their arguments.

Keywords: COVID-19 Vaccine, Socio-scientific Issues, Preservice Science Teacher, Argument Quality

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INTRODUCTION

The COVID-19 epidemic, described as a global trauma, has affected all areas of human life (Chen & Bonanno, 2020). It is crucial to regard the epidemic not only as a health problem, but as a socio-scientific issue with multifaceted effects (Sadler et al., 2020). Discussing the social, political, economic and ethical dimensions of the epidemic creates a rich socio-scientific context. As with many such issues, there are points of agreement (hygiene, social distance, etc.) as well as points of disagreement. One of the subjects of disagreement that falls within the scope of socio-scientific issues is related to the COVID-19 vaccines. On one hand, studies for the vaccines are continuing rapidly. On the other hand, there are studies and news expressing the negative effects of the vaccines. Therefore, people cannot decide easily about the vaccines regardless of the wide coverage in the media and the scientific world. The World Health Organization (2020) uses the term "vaccine hesitancy" to express this type of indecision terminologically. Vaccine hesitancy is defined as "delays or refusals in accepting vaccines despite the availability of vaccine services". Vaccine hesitancy is a complex phenomenon that can be influenced by many factors and may vary according to time period, geography, age, trust in the government, the origin of the vaccine and even the religious beliefs (Erkekoğlu et al., 2020; Sallam et al., 2022). There are studies in the literature that focus on this phenomenon. A study conducted by Salali and Uysal (2020) concluded that vaccine hesitancy rate for COVID-19 vaccines is 31% in Turkey, while it is 14% in the United Kingdom. The study conducted by Lazarus et al. (2021) reported that elderly individuals are more willing to be vaccinated than young people, and young people experience higher vaccine hesitancy. This situation is similar for Turkey as well. For example, while the vaccination rate for the 18-25 age group was 53%, in the last months of 2021, this rate was around 84% for adults (25 years and over) (Ministry of Health, 2022). While some of the unvaccinated young people take an anti-vaccine (opposition) position, the majority of the youth is simply hesitant.

Vaccine hesitancy is getting stronger with the effect of news on social media as well as scientific studies. Höttecke and Allchin (2020) stated that, worryingly, social media is where fake news spreads the most. The study conducted by Pulido et al. (2020) examining COVID-19 related news on Twitter is a concrete example of this. The study showed that vaccine misinformation was tweeted more than science-based evidence or fact-checking tweets. In other words, untrue but interesting news about vaccines can spread faster than a statement made by a scientist. Reporting the research results of their study which examined the news contents about COVID-19, Topsakal and Ferik (2021) supported the above view and stated that too much and inconsistent information of the news contents has laid the groundwork for misinformation and conspiracy theories. From this point of view, it can be argued that this issue will be on the agenda for a while due to the influence of the media and the controversial nature of the issue. In this context Loomba et al. (2021) reported that vaccine acceptance is as important as the development of vaccines. Similarly, WHO (2020) reported that addressing the anti-vaccination movement is one of the top ten measures in the fight against COVID-19. Factors such as uncertainties regarding the vaccine, its side effects, conspiracy theories are some of the reasons that create the anti-vaccination movement (Megget, 2020).

At this point, the following question becomes significant: Is being vaccinated an individual freedom or is it civic duty that affects public health? This question constitutes the starting point of the current research. This controversial issue on the agenda is also reflected in science education and curriculum (MoNE, 2018). In fact, it is predicted that it has more comprehensive reflections in science education in the long run. The studies in the current literature support this prediction. In the last decade, studies on socio-scientific issues focused on themes such as nuclear power plants (Demircioğlu & Uçar, 2014), GMO (Khishfe, 2012) and global climate change (Herman, 2015). However, studies in the context of socio-scientific issues are centered more on the COVID-19 epidemic process and controversial situations in the last few years (Evren Yapıcıoğlu, 2020).

In order to make informed decisions on controversial issues, individuals must first reach information, share their arguments, and undergo a reasoning process. Many studies cited argumentation as an important factor in individuals' decision-making process on issues where there is

information pollution and confusion (Erduran, 2020; Lee, 2007) because argumentation is a mental activity laying the groundwork for realistic discussion. Argumentation is an effective scientific thinking method enabling individuals to reach a clear conclusion using key concepts such as claim, evidence, data, justification and reasoning based on existing knowledge (Chen et al., 2019). In particular, the literature presents studies dealing with the effectiveness of argumentation on controversial socio-scientific issues (Dawson & Carson, 2020; Evagorou & Osborne, 2013; Gülhan, 2012) that reflect positive results. Argumentation skills and its sub-components (reasoning, scientific thinking, decision making, etc.) are also in the realm of most socio-scientific issues and acquisitions (MoNE, 2018). At this point, it is considered that teachers and preservice science teachers play a key role in teaching students the argumentation process since making students think “like a scientist” is an important science literacy component which falls under teachers’ responsibility (Kim, Anthony & Blades, 2014). All the key concepts previously mentioned (such as epidemic vaccine, science literacy, argumentation, etc.) are closely related to the teacher factor. A socio-scientific issue such as a epidemic vaccine has a multidimensional structure. In this complex process, teachers have important duties such as raising awareness of their students and supporting them to make informed decisions. In fact, teachers’ duty and responsibility in this regard is not limited to socio-scientific issues. For example, teachers are believed to play key roles in many aspects during the COVID-19 epidemic (Daniel, 2020). In this process, teachers have shared scientific information announced by health authorities with their students, provided information about vaccination, social distance and hygiene rules, and guided the parents (Çakın & Akyavuz Külekçi, 2020).

With this regard, examining preservice science teachers’ opinions and arguments about the COVID-19 vaccines is important for three reasons: First, preservice science teachers’ argument quality will affect students’ argument quality and scientific decision making (Zhao et al., 2021). Second, since COVID-19 vaccines are a current and scientific issue, preservice teachers can be effective in developing a scientific perspective in their students and their parents (Kampourakis & McCain, 2019). Third, the subject of vaccines, indirectly included in the science curriculum before the epidemic, will now be directly included in the curriculum. The present study may contribute to the literature for these reasons. Some studies investigated the epidemic in relation to education (Cömert & Şahin Çakır, 2021; Görgülü Arı & Hayır Kanat, 2020; Maia, Justi & Santos, 2021; Saribaş & Çetinkaya, 2021). However, limited studies were found during literature review about the epidemic in the context of a socio-scientific issue (Dalyot et al., 2022; Evren Yapıcıoğlu, 2020; Ke et al., 2021; Rosawati & Rahayu, 2020) and there were two other studies that investigated the education and vaccine dimensions of the epidemic in connection with each other (Atabey, 2021; Salman et al., 2021). In addition, it was observed that teachers (Cömert & Şahin Çakır, 2021; Çakın & Akyavuz Külekçi, 2020) and students (Görgülü Arı & Arslan, 2020) were generally included in educational research about the epidemic. The studies (Ding et al., 2020; Seyhan, 2021) which included the preservice teachers’ as the study group is rather limited (sample). The number of studies which used dilemma cards as a data collection tool is rather limited as well (Cenk, 2020). In this respect, the study will be a valuable contribution to the literature. The purpose of using dilemma cards is to negotiate and discuss different human behaviors by drawing attention to the social effects of a scientific event. Akerson and Oldfield (2012) reported that as a technique, dilemma cards encourage students to question and support their decisions and to reveal their beliefs and actions. In this context, using dilemma cards was considered to be an appropriate data collection tool in revealing both the decisions and argument qualities of the participants. Evren Yapıcıoğlu (2016) did not use dilemma cards as a data collection tool as was the case in the current research but preferred to use them as a teaching technique and stated that dilemma cards are an effective way in teaching socioscientific issues. The pre-service teachers’ argumentation skills on socioscientific issues were examined within the context of the subject in Cenk’s (2020) study and 9 dilemma cards were developed. Hence, argument quality could also be presented while determining pre-service teachers’ opinions through dilemma cards.

This study aimed to establish preservice science teachers’ opinions and decisions about the COVID-19 vaccines and also to reveal the quality of preservice science teachers’ arguments. For this purpose, the research questions can be listed as follows:

1-What are the opinions of preservice science teachers regarding the COVID-19 vaccines?

2-What are the argument qualities of preservice science teachers regarding the COVID-19 vaccines?

METHOD

Research Design

This study was carried out with phenomenological design. According to Creswell (2013), phenomenological studies reveal how participants perceive and describe a certain phenomenon. In this study, it is thought that this research is suitable for the phenomenological pattern, as how the participants perceive the vaccines developed for the COVID-19 epidemic about the vaccine are discussed in detail.

Study group

This research was conducted with the participation of 18 preservice science teachers (15 females, 3 males) studying their 4th year in Mersin University Faculty of Education, Department of Science Education and enrolled in the socio-scientific issues in science teaching course. Participants were included in the research process according to criterion sampling, one of the purposive sampling methods. Criterion sampling is the process of determining participants according to a set of criteria predetermined by the researcher (Yıldırım & Şimşek, 2016). Here, the criterion was identified as registering to "Socioscientific issues in science teaching" course.

Eighteen preservice science teachers who participated in the study on a voluntary basis did not take another course that directly addressed argumentation and socio-scientific issues before taking the relevant course for this study.

Data Collection Tools

The data were obtained through a focus group interview and dilemma cards. First, participants' opinions and decisions on COVID-19 vaccines were established in the focus group interview defined as "a series of planned discussions held in a democratic and genial setting to reveal participants' perceptions about a specific issue" (Krueger & Casey, 2000). The researcher acted as the moderator and tried to create the right setting for all participants to present their views. Focus group interview was used because the issue of COVID-19 vaccines is open to dispute and the study aimed to reveal the quality of arguments used by the participants. The question "What do you think about the vaccines developed for the COVID-19 epidemic?" was the primary question during the focus group interview. The interview lasted about two hours and was recorded with a camera. Then, the participants were asked to fill in the dilemma cards (Annex 1) individually.

Data Analysis

In the first analysis phase, the results obtained from the focus group interview were analyzed with content analysis to reach concepts and relationships that can explain the collected data (Miles & Huberman, 1994). First, participant statements in the interview were written down and raw data were obtained. Then, codes and themes were created by recurrent readings of the raw data. Matrices were used in the generation of codes and themes. Then, tables and concept maps were generated to present the findings in a more understandable and visual manner. Table 1 presents an example of content analysis obtained during the analysis phase of the dilemma card.

Table 1. Codes and Themes

Theme	Code	Subcode	Participant opinion
Positive Opinions	Health Dimension	Protective Effect	<i>Vaccination should be used in prevention of the disease. (P11)</i>
		Reducing the Disease	<i>We know that vaccines alleviate the epidemic and reduce the case numbers. (P2)</i>
	Social Dimension	Strengthening Immunity	<i>Although the vaccine doesn't provide 100% protection, I think it would be good for boosting immunity. (P9)</i>
		Shortening the Epidemic	<i>How much longer can we stay at home? We need to normalize the process and we can achieve it with a vaccine. (P17)</i>
	Scientific Dimension	Facilitating the Fight against the Epidemic	<i>When there is vaccination, the transmission rate will decrease and the fight against the disease will be easier. (P2)</i>
		Trusting Science	<i>We must adapt to the innovations in science and technology. Scientists won't try to kill us. (P17)</i>
Undecided Opinions	Vaccine+ Other Methods	Not Sufficient	<i>Vaccination alone is not the solution. (P1)</i>
		Not a Definitive Solution	<i>We can overcome the disease without vaccination. (P7)</i> <i>What is important is obeying the rules. Vaccine isn't a definitive solution anyway. (P8)</i>
	Uncertainty	Existence of Unvaccinated People	<i>Unless all people in the world are vaccinated, we won't be able to get rid of this virus (P13)</i>
		Limited Information	<i>We don't know much about the results of the vaccine, but now we want to get rid of this issue (P16)</i>
	Side effect	New Technological Product	<i>The vaccine is a new technological product and we can look at this innovation as the invention of the century. We can also regard it as an invention with many side effects. Time will show that. (P3)</i>
		Cause of Death	<i>There may be people who cannot tolerate the side effects of the vaccine and may die. (P6)</i>
		Permanent Damage	<i>The side effects of the vaccine may appear after a long time and leave permanent damage. (P4)</i>
		Distrust towards the Vaccine	<i>We don't know exactly what the vaccine will cause or for what purpose it's actually made (P8)</i>
		Distrust towards Leaders and the Media	<i>The effects of the vaccine may appear after a long time and leave permanent damage (P5)</i> <i>Vaccination isn't a definitive solution and the possibilities aren't very reliable. (P15)</i> <i>I think that the crisis hasn't been managed well in the 2-years period and the vaccination rate is quite low (P2)</i>
		Lack of Trust	Following the Rules
Capitalism	<i>It could be the game of the capitalist system to sell vaccines. There are even those who say that there is a project to reduce the population (P15).</i>		
Game of China			
Negative Opinions	Natural Methods without Vaccines Conspiracy Theories	Following the Rules	<i>What is the need for vaccination when the rules are followed? (P1)</i>
		Capitalism	<i>It could be the game of the capitalist system to sell vaccines. There are even those who say that there is a project to reduce the population (P15).</i>
		Game of China	

Coding was used to present the data in a visual format with the help of figures and quotations. Coding frequency is provided in parentheses. In the second analysis phase, the argument components in the dilemma cards were analyzed through the “Argumentation Model Rating Scale” developed by Hiğde and Aktamış (2017), which used a rating scale with 3 different levels to evaluate individuals’ argumentation quality, similar to the basic components in Toulmin’s (1958) model (Aktamış & Hiğde, 2015). The rating scale is scored between 0 and 2. The rubric contains claims, evidence, supporting, and rebuttal components and rated as follows: 0 = not existent, 1 = weak, and 2 = strong.

The research process was described as in detail as possible to ensure validity, reliability, plausibility and transferability. Before data collection, opinions were sought from experts in science education and qualitative analysis to determine the suitability of the focus group interview method and the dilemma card.

While presenting the text on the vaccine (newspaper article) in line with the expert opinion, efforts were made to find an impartial text in order not to create bias in participants. In this process, it was concluded by the experts that the text content and length in the dilemma card were appropriate. On the other hand, it was concluded that the number of options should be increased to represent the opinions regarding the vaccine in a wider range.

The raw data, findings, comments and suggestions were recorded and inspected recurrently. To increase the validity, reliability and verifiability, participant confirmation was employed to avoid researcher's subjective assumptions and misinterpretation of the data. During participant confirmation, the researcher presented the data to participants and asked them to express their thoughts on its accuracy. The research process was explained in detail to ensure credibility and transferability.

Research Ethics

Ethics committee approval was obtained before the research process in line with the legislative research ethics. Participants were informed about the research and the voluntary nature of participation at the beginning of the process. In the reporting phase, the names of the participants were not used for privacy. Codes such as P1, P2 were used for the participants. It was emphasized by the researchers that the participants could easily express their opinions and should not have grade concerns in this process. In addition, it was stated that when participants talked about religious, political, cultural issues in the argumentation process, the researchers would not make any intervention. Researchers also have an ethical responsibility to the reader. The research content was described in as much detail as possible and the data was adhered to during the reporting process of the research. As a result of all these actions, it can be said that ethical rules are adhered to.

The Role of the Researcher

When the focus group interview was conducted, the researcher acted as a moderator and tried to create a suitable setting for all participants to express their opinions freely. When dilemma cards were filled by participants, the researcher emphasized that a right or wrong answer did not exist in the dilemma cards. In this context, the researcher stated that scoring was not based on the selected answer and asked the participants to pay attention to the components (claim, evidence, justification, supporting, rebuttal, etc.) while expressing their opinions.

FINDINGS

Findings Regarding the Focus Group Interviews

The majority of the 18 participants (11 people) expressed that they were undecided. Five participants had positive statements about the vaccines while two expressed negative opinions. Figure 1 presents the participants' opinions in detail.

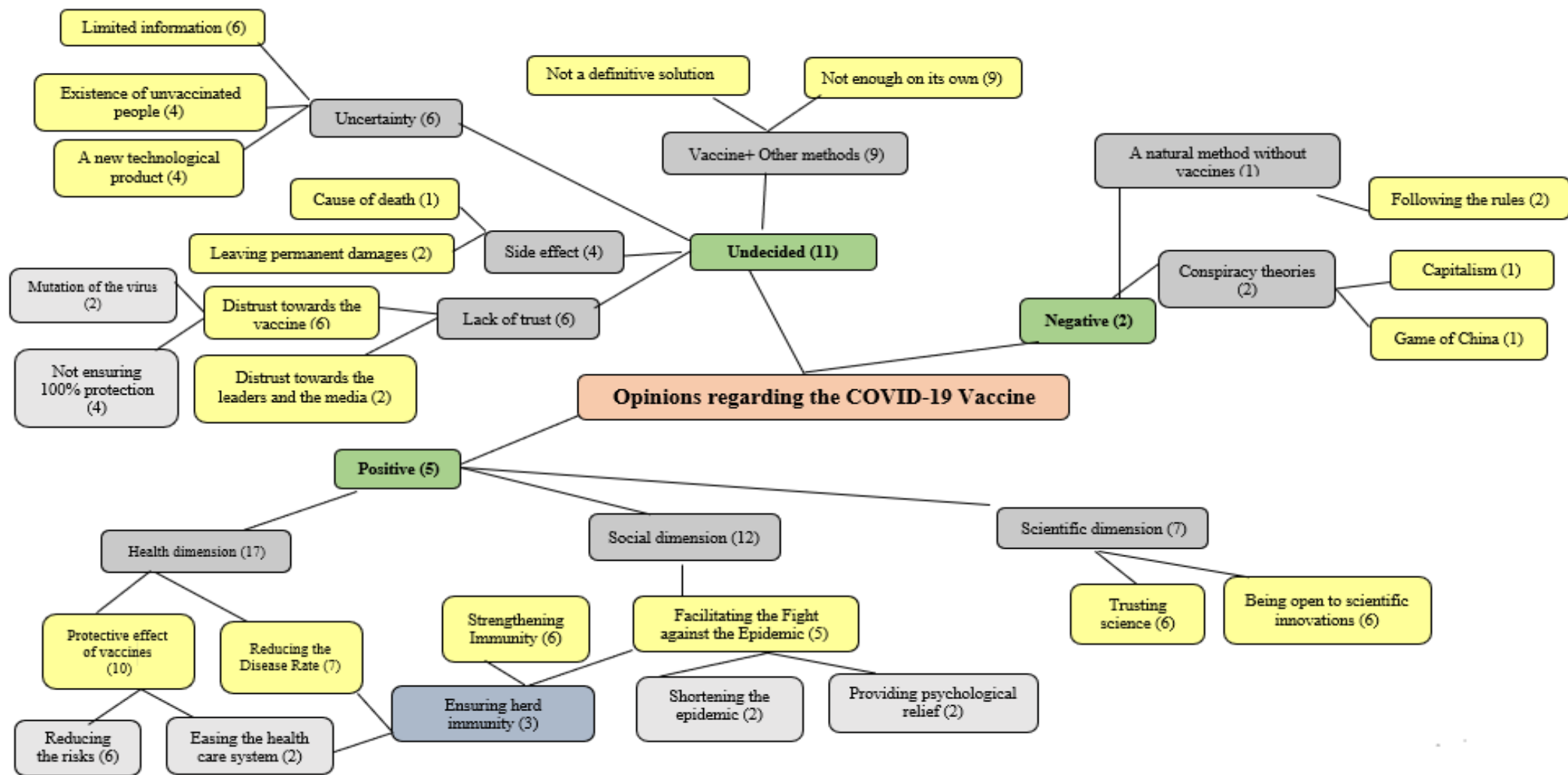


Figure 1. *Opinions Regarding the Covid-19 Vaccines*

The majority of participants was undecided about the COVID-19 vaccines and believed that the vaccine alone would not be a sufficient or definitive solution. They expressed that the vaccine should be included in the process alongside other protection methods: *“I do not think that the vaccine alone will be sufficient where there are no measures. However, the fact that it is protective also helps me to regard the vaccine positively in a way. That's why I'm undecided.”* (P3)

Emphasizing the uncertainties about vaccination, six participants believed that the epidemic would not be over as long as there were unvaccinated people. They stated that they had limited information about the vaccine as it was a new technological product. By emphasizing the uncertainties P10 stated: *“We don't know much about the results of the vaccine. Work on the vaccine continues and it is too early to talk about the effects of a new technology.”*

Participants who were undecided due to the possible side effects of the vaccines used the expressions "causing death" and "leaving permanent damage" when expressing their opinions. Touching on the theme of lack of trust, six stated that the vaccine did not provide 100% protection: *“The risk of contracting COVID-19 doesn't disappear 100% with vaccination. At this point, I don't see it positively, but the fact that it is mostly protective makes me indecisive.”* (P14).

Some participants stated that which vaccines were completely suitable for the virus couldn't be fully determined due to the constant mutation of the virus: *“A vaccine is being developed according to the current virus, but when you think about mutations, there are thousands of possibilities. I don't think the current vaccines will really help. If a vaccine that is resistant to all possibilities is produced in the future, then I can consider to be vaccinated.”* (P13)

In addition, participants who found the leaders to be unsuccessful crisis managers and the news to be biased also stated that they experienced trust issues: *“Even when we want to view the vaccine positively, the lack of clear explanations about it, as well as the distrust towards the media and leaders, makes us prejudiced against the vaccine.”* (P16)

Five participants with positive opinions about the vaccine declared that it had positive effects on health, social and scientific dimensions. All participants, whether they were positive, undecided or negative about the issue of vaccination, addressed the health dimension. Ten participants mentioned the protective effect of the vaccine; seven stated that the vaccines reduced the disease rate and six emphasized that the vaccines strengthened immunity. At this point, participants expressed that the vaccines could reduce the risk and rate of disease. Some participants who mentioned that the vaccines boosted immunity addressed herd immunity and discussed the health and social dimensions of the vaccine in conjunction. P2's contribution to the discussion on this point is found to be significant: *“The purpose of vaccination is to provide herd immunity. When most of the society is vaccinated, the rate of transmission will decrease and the fight against the disease will be easier.”* (P2)

Participants who emphasized the social dimension of the vaccines stated that it could stop the epidemic. P18, who referred to the positive effects of the vaccines in terms of shortening the process and relieving society psychologically, said: *“We have been at home for about 1.5 years now and everyone wants to return to normal life. We are overwhelmed and especially the healthcare workers are exhausted. I think that with the discovery of the vaccine, our time at home will not be prolonged and the society will feel relieved sooner. For this reason, I am positive about the vaccines.”* (P18)

Six participants who referred to the scientific dimension stated that it was necessary to trust science and be open to scientific developments: *“We have to trust the scientists. We must act according to scientific data and be open to innovations. I don't understand why ordinary citizens view the vaccines negatively when scientists are positive.”* (P9)

Two participants with negative opinions believed that the epidemic would be over when the rules (mask, social distance and hygiene) were followed and natural methods were used: *“I had COVID-19. It was possible to get better without vaccination. Frankly, I think that other measures*

(hygiene, mask, etc.) are more important than vaccination. What is the need for a vaccine when the rules are followed?” (P1)

Two participants, who argued that the capitalist order and conspiracy theories were the leading forces in this epidemic, regarded the vaccines as a part of this order: *“From past to present, people are engaged in many immoral activities to get rich. Strangely enough, China sells the vaccine for the virus that originated in China. Also, the rate of COVID-19 cases in China right now is very low. I think China deliberately started everything in this game. A new world order is trying to be created.” (P4)*

When focus group interview findings are evaluated in general, the majority of the participants were undecided. Uncertainty about the vaccines, possible side effects, and feelings of insecurity were cited as sources of indecision. Participants who had positive opinions constituted approximately one-third of the participants. Participants in this group talked about the positive effects of the vaccine in regards to social, scientific and health aspects. Participants with negative opinions about the vaccine were in the minority. Two participants in this group believed that the process could be controlled with natural methods and this epidemic was a conspiracy to create a new world order.

Findings Regarding the Dilemma Card

There are eight options in the dilemma card. The first seven options are the statements created by the researcher. The 8th option (other) was included for participants who could not find a suitable option. Table 2 presents the general results obtained from the dilemma cards. The opinions of the participants regarding the vaccines were classified and tabulated.

Table 2. General Results Obtained from Dilemma Cards

Options	Opinions	Participants
1.Option	Negative	P ₁
2. Option	Negative	P ₄
3. Option	Positive	P ₂ , P ₉ , P ₁₁ , P ₁₈
4. Option	Positive	P ₁₇
5. Option	Undecided	P ₁₀
6. Option	Undecided	None
7. Option	Undecided	P ₃ , P ₇ , P ₈ , P ₁₃ , P ₁₄
8. Option	Undecided (Other)	P ₅ , P ₆ , P ₁₂ , P ₁₅ , P ₁₆

Table 2 shows that eleven participants were undecided about the vaccines, five had positive opinions and two had negative opinions. Findings obtained from the focus group interview and the dilemma cards were consistent. The dilemma cards allowed us to observe the choices of participants and their justifications. For example, participants who chose options 1 and 2 reported negative opinions about the vaccines. However, the starting points (reasons) of these opinions were found to differ. Based on this, options 1 and 2 indicated negative opinions; options 3 and 4 indicated positive opinions and options 5, 6 and 7 indicated indecision. Five participants who chose option 8 expressed vaccine hesitancy and stated that this was not a black and white issue, but contained gray areas. Thus, Option 8 can also be considered in the category of indecision. Nearly half of the participants selected options 7 and 8.

While filling out the dilemma card, participants were asked to present their arguments in written form and pay attention to the components of the argumentation process. After determining the general opinions of the participants through dilemma cards, the answers were analyzed in line with argument components. In this way, the views of the participants could be determined in detail and the quality of their arguments could be evaluated. Table 3 demonstrates the results of the argument components obtained through the dilemma cards.

Table 3. Components of the Arguments for and against the Vaccines

Participant	Claim	Evidence	Supporting	Rebuttal
P ₁	1	1	2	0
P ₂	2	2	2	2
P ₃	2	2	0	0
P ₄	2	2	1	1
P ₅	2	2	2	1
P ₆	2	2	2	1
P ₇	2	2	2	1
P ₈	2	1	1	0
P ₉	2	1	1	0
P ₁₀	2	1	2	1
P ₁₁	2	2	1	1
P ₁₂	2	1	1	2
P ₁₃	2	2	2	2
P ₁₄	2	2	1	2
P ₁₅	2	2	2	1
P ₁₆	2	2	2	0
P ₁₇	2	2	2	2
P ₁₈	2	2	1	1
Mean	35/18= 1,94	31/18=1,72	27/18=1,50	18/18=1,00

According to Table 3, participants were able to successfully put forward their claims by choosing one of the options in the dilemma card (Max point. 2, mean claim 1.94): *“I am undecided about the vaccines. There is currently an unknown side to this issue. Side effects are not mentioned. That's why I can't fully trust it. I also don't see it as a definitive solution. Other measures are as important as the vaccine.”* (P15, Claim, 2 points)

The participants had a mean score of 1.72 (max. 2 points) while talking about evidence using the template:” because.....”: *“I think we need to take precautions to avoid getting COVID-19 and infecting others.”* (P1, Evidence, 1 point)

It can be said that participants who were asked to support their claims by making use of scientific data had lower means at this point and achieved partial success with a mean of 1.50: *“I do not support the vaccines. To people who claims the opposite, I would give the example that epidemics in the past disappeared by themselves. The disease disappears after companies sell their vaccines. Is this a coincidence?”* (P4, Supporting, 1 point)

It was determined that participants’ partial success so far had decreased even further in the rebuttal portion, the last step of the argumentation process, and they were only able to make weak rebuttals with a mean of 1.0: *“I support the vaccines. But a friend who opposes the vaccines may confute me because, at the moment, we don't know the effectiveness of each vaccine. If the scientific data or the course of the epidemic changes, my opinion may change as well. If there are no visible positive effects (for example, if the number of cases does not drop), my opinion may change.”* (P2, Rebuttal, 2 points) *“I trust science. Those with unfounded thoughts cannot refute me.”* (P9, Rebuttal, 0 points)

Two general findings emerged when the findings were evaluated. First, the majority of participants were undecided about the COVID-19 vaccines. Second, participants were more successful in presenting their claims and evidence, and were moderately successful in presenting supporting opinions. It was also identified that the participants were weak in rebuttals.

DISCUSSION AND CONCLUSION

This study investigated the opinions, decisions and arguments of preservice science teachers about COVID-19 vaccines. Based on the results of the focus group interviews, the majority of the participants were undecided about the vaccines. There are studies with similar results (Edwards et al., 2021; Salali & Uysal, 2020). Positive participants stated that the vaccine would have positive effects

on social, health and scientific aspects. When the positive aspects were examined more in-depth, several key concepts emerged such as gaining herd immunity, relieving the health system, reducing the rate of disease and risk and relieving the society emerged. As a matter of fact, some researchers (Handebo et al., 2021; Salman et al., 2021) think like the participants in this study and believe that the vaccine is the most important factor that changes the epidemic process. In addition, the participants who expressed a positive opinion about the vaccine were around 27% (partially low) in this study. There are research findings in line with these results (Campo-Arias & Pedrozo-Pupo, 2021) in the literature, as well as research findings that argue the opposite (Saied et al., 2021). For example, a study conducted by Campo-Arias and Pedrozo-Pupo (2021) with university students in Colombia concluded that 79% of the participants distrusted the vaccine and 14% viewed it positively. Contrary to this, the study conducted by Saied et al. (2021) with university students in Egypt found that 90% of the participants viewed the vaccine positively. These differences in results may be related to participant profiles and the geography where the research was conducted. The large-scale study conducted by Sallam et al. (2022), which collected data from 114 different countries, reported that in addition to geographical factors; the media, trust in the government or even religious structure may be effective in making decisions about the COVID-19 vaccine.

Although some participants argued that people should be open to scientific developments and new technologies, it was also reported that ongoing uncertainty with continuing innovation and studies generated concerns. This concern or caution towards the vaccines may be related to the participant profile. Participants' perspectives on scientific developments are thought to be shaped by the "nature of science" course they took one year before this study. The course covered the principles that scientific knowledge progresses cumulatively and that science has a subjective nature; it is assumed participants knew these principles based on the principle that science knowledge can change over time. This can explain trust in science coexisting with concerns about new scientific information. It was found that the concerns of the undecided participants were also partially present in negative participants. Participants believed that the epidemic can be fought without vaccination if rules were followed. Erkekoğlu et al. (2020) reported results supporting this view and cited the reasons for vaccine hesitancy as the distrust for the content of the vaccine, being influenced by the statements of anti-vaccine opponents, and negative news in the media. Obtaining parallel results in a conducted with a large sample, Yılmaz et al. (2021) concluded that the participants distrusted the vaccine and vaccine companies and reported the reasons for vaccine hesitancy as not believing that the vaccine would protect them, experiencing fear, distrusting the vaccine because it is imported and waiting for the domestic vaccine. Similarly, Gök and Güzel Baydoğan (2022) concluded in their research that the most important factor causing vaccine hesitancy was related to the fear of side effects and believing that the vaccine was not protective. In addition to providing the reasons for vaccine hesitancy, this study also addressed conspiracy theories.

Although not high in number, some participants were found to believe in conspiracy theories. This was also confirmed in other studies (Douglas, 2021; Sarıbaş & Çetinkaya, 2021; Yılmaz et al., 2021). For example, the study conducted by Salman et al. (2021) with preservice teachers found that 70% of the participants believed that the COVID-19 virus was artificially produced. The same study reported the rate of vaccine acceptance as quite low. Similarly, the studies of Salali and Uysal (2020) reported that there is a segment of population (12%) in the UK who thought that the virus was produced artificially.

Based on the evaluation of the results of the first sub-goal in general, it can be stated that the participants were mostly undecided. It can be argued that vaccine acceptance by people is as important as the development of the vaccine in determining the progress of the epidemic. In other words, unity between science and society is the most important element in the process and it certainly ensures their safety as well.

Findings regarding the argumentation process were analyzed qualitatively in context of the second sub-goal (see Table 3). It was concluded that participants could not develop an argument paying attention to all the components of the process. It was observed that the participants in the

argumentation process were partially more successful in presenting claims and evidence; they were moderately successful in finding supporting ideas, and they were not very successful with rebuttals. The relevant studies in the literature reported that most individuals experienced difficulties in the rebuttal portion and could not utilize all components in the argumentation process (Cenk, 2020; Kuhn & Udell, 2007; Topçu, 2008). This finding may be associated with the fact that argumentation is a high-level intellectual mental skill. Therefore, argumentation skills may not be developed in all individuals. Türköz and Öztürk (2020) found that preservice science teachers could present their arguments on socio-scientific issues using simple claims and had difficulties in refuting arguments. Anisa et al. (2019) reported that rebuttal was a more complex skill because a high quality rebuttal required knowing all sub-components. Acquisition of argumentation skills may be considered difficult when the literature is considered. However, most researchers agreed that it is possible to develop. However, the findings of this study were worrying since they showed lack of argumentation skills in 4th year students. The fact that the argument components were not developed may be related to the content knowledge. Although no clear consensus was found in the literature, most studies reported a positive relationship between content knowledge and argument level (Cenk, 2020; Sampson & Clark, 2011). It is possible that participants experienced confusion due to ongoing vaccine studies and news reports. Thus, the results obtained in the first sub-goal may have affected the results of the second sub-goal. It is stated above that the participants experienced mental confusion or hesitancy as a result of being influenced by the discussions on the agenda. However, this has an advantage as well. The participants were observed to address the issue holistically (in regards to science, society, economy, health and ethics) in both the focus group interviews and the expressions on the dilemma cards. Türköz and Öztürk (2020) and Topçu (2008) describe this as an opportunity and emphasize that the multidimensional perspective of the participants on socio-scientific issues will be effective in decision making.

The focus group interview findings showed that the participants with positive and negative opinions about COVID-19 vaccines were in the minority and the undecided participants were in the majority. Positive participants expressed that the vaccines would offer a solution for the epidemic and that people should trust technology and science. Negative participants stated that other measures (social distancing, masks, hygiene) were as important as the vaccines and could be as protective. These participants also didn't disregard conspiracy theories. On the other hand, undecided participants stated that although they trusted science and technology, the uncertainties due to the ongoing studies and possible side effects were worrying and created distrust. The fact that the vaccines did not offer protection from the disease on their own and cannot offer a final end to the epidemic contributed to participants' indecisiveness.

RECOMMENDATIONS

The current study identified the opinions and decisions about epidemic vaccines first and then focused on the quality of the arguments in the decision-making process. However, since epidemic vaccines are a socio-scientific issue, it is possible to argue that they have complex and multifaceted dimensions. In this context, many factors (demographic, political, cultural, religious, ethical, etc.) that affect individuals' vaccine acceptance or vaccine refusal should be examined in depth. Hence, conducting further studies on this subject will be important and it is recommended to researchers to conduct studies on related themes.

The findings obtained from the dilemma cards are not satisfying. Since the study was conducted with a small study group, the results cannot be generalized. Therefore, two recommendations are given. First, argumentation skills can be examined with larger samples to carry out studies with high representativeness. Secondly, courses and activities to improve argumentation skills can be included in undergraduate programs in faculties of education to increase preservice teachers' quality of argumentation.

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Annex 1: Dilemma Card Used as Data Collection Tool

<p>Will the coronavirus vaccine bring back our previous life? WHO Director-General Tedros Ghebreyesus stated that “The vaccine will not replace our current measures, but will supplement them” adding that “Vaccines alone cannot end an epidemic. We need to continue monitoring, testing, follow-up, quarantine and precautions.”</p> <p>This disparity between the optimism of some of the public and politicians and the realism of scientists may be due to the inability to fully understand how difficult the task is to vaccinate sufficient number of people. What many of us don’t realize is that a large number of people are required to be vaccinated in order to truly protect everyone from diseases transmittable from human to human. This is the social dimension of this disease. There is also a medical dimension. For example, the efficiency rate of COVID-19 vaccines from Pfizer/BioNTech and Moderna has been announced as over 90 percent. We do not know whether this rate will decrease when the experimental conditions are over. This means that about one in 10 people who get vaccinated will continue to be unprotected against COVID -19.</p> <p>Taking into account that not everyone in the society will be vaccinated, the rate of people who are unprotected against COVID -19 will be more than 10 percent. (BBC, 11 December 2021)</p> <p>The news above points out the role of vaccines in the epidemic. From this point of view, what do you think about getting the COVID-19 vaccine?</p>	<p>I do not want to be vaccinated. When I take care of my health and follow the rules, I am already protected.</p> <p>I do not want to be vaccinated. Vaccine is one of the reflections of the capitalist regime. I wouldn’t be a pawn in this game. The people who presented the virus and the vaccine are the same people.</p> <p>I would like to be vaccinated. The vaccine will strengthen my immunity against a deadly disease.</p> <p>I would like to be vaccinated. It is necessary to be open to innovations in science and technology.</p> <p>I am undecided. I believe and trust that scientists work in good faith, but I can’t look kindly upon the vaccines due to the new technology.</p> <p>I am undecided. Maybe I will never get sick. Getting vaccinated for a possible condition doesn’t seem very appropriate.</p> <p>I am undecided. I believe that the vaccine alone will not be enough and I do not lean towards it. However, their protective aspect makes me look at the vaccines favorably.</p> <p>Other.....</p>
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I choose option

Evidence

Supporting evidence

Rebuttal.....