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The Relationship between the Attitude Towards Socioscientific Issues and Views on COVID-19 and Vaccine

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ABSTRACT

With the pandemic, conspiracy theories about the COVID-19 began to spread rapidly in the virtual environment. It is not difficult for these conspiracy theories to replace scientific knowledge, particularly those with low scientific literacy. This study aimed to examine whether there is a relationship between university students' attitudes towards socioscientific issues (viz. their views on conspiracy theories) and their views on the COVID-19 process and vaccination. 1275 university students from different universities studying at various departments participated in the study. "The Attitude Scale towards Socioscientific Issues" developed by Topcu (2010) and the "COVID-19 process and Vaccination Questionnaire" developed by the researchers consisting of 20 questions were used as data collection tools in the study. In analysing the data obtained from the application, the continuous variables with two categories were analysed using the independent groups' t-test since the research data showed normal distribution and provided the preconditions. A one-way ANOVA test was used in the analysis of continuous variables with more than two categories. The chi-square test was used in the analysis of categorical variables, and a multinominal logistic regression was performed when examining the relationship between main variables and categorical variables. As a result of the analysis, it was observed that students with a high attitude towards socioscientific issues were more scientifically oriented to conspiracy theories, the existence of the COVID-19 and its origin, and their ideas about vaccination were more positive. In the post-pandemic period, a restructuring of science education in which socioscientific issues are concentrated upon to increase health literacy and scientific literacy arguably appears urgent.

Keywords:
Socioscientific issues, COVID-19 process and vaccination, scientific literacy, science education

1. Introduction

We live in an age where data and opinions on any topic can instantly turn into conspiracy theories involving misinformation. This era in which individuals disagree about the facts and act according to personal beliefs and emotions rather than in light of tested and validated information in making decisions is called *Post-Truth* (Sinatra & Lombardi, 2020). It becomes increasingly difficult to distinguish between correct information and false information in this age (Wineburg & McGrew, 2017). The main reason is the internet and social media content that has no limit or control. From students to academics, everyone immediately questions a subject they do not know about and check it through Google. The best example of this is the COVID-19 pandemic we are experiencing right now. Although the problem has become a real life-or-death issue, the environment created by the pandemic has spawned plentiful misinformation and conspiracy theories. Three of the top 10 Google search trends of 2020 are related to the *coronavirus, coronavirus symptoms, and current coronavirus numbers*. When we include *Zoom* and *Google Classroom as the terms in the search trends,* which are educational environments resorted to the most due to the situation caused by the corona pandemic, the first five of the top

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ten of the Google search trends of 2020 are all the concepts pertaining to the pandemic (Google, 2021). This situation is an indicator that *Socioscientific Issues* have the power to affect the scientific content and social life. In the face of this pandemic that leaves people desperate, the world of science immediately took action, measures were announced to protect people from the consequences of the pandemic, and vaccine development studies, which are an effective way to get rid of the issue, have been initiated. Science affects society and directs the production of Scientia, addressing social needs (Sadler & Zeidler, 2005). With the pandemic, misinformation, disinformation, and malinformation that can change people's decisions, which in return will negatively affect their health, have spread rapidly on the internet. This situation is likely due to political, economic, or cultural agendas (Waisbord, 2018). While fighting the pandemic, we are also fighting infodemics (Pennycook et al., 2020). Misinterpretation of information and rejection of scientific evidence is a characteristic of the Post-Truth era (Kienhues et al., 2020). It is crucial to raise scientifically literate individuals to be victorious in this war with infodemics at the same time as the pandemic itself (Kienhues et al., 2020; Saribas & Cetinkaya, 2021). Scientific literacy is also the ability to correctly and effectively interpret and construct science-based ideas in popular media (Cavagnetto, 2010).

In the post-truth era, it is deemed important to make a critical evaluation of online scientific information (Sinatra & Lombardi, 2020). In school settings, students and teachers favour precision in science; they do not like uncertainty. The main problem here is not that science is not understood but that the inherent ambiguity of science cannot be understood (Durnali & Ayyildiz, 2019). Uncertainty advances science. Therefore, explaining what uncertainty is becomes very important for science education (Kampourakis, 2018). Especially for science under construction, uncertainty, which is natural to exist when a/the solution is being sought as part of the process, increases, and the environment is left to misinformation and conspiracy theories, mostly owing to the inability to understand the ambiguity (Nguyen & Catalan-Matamoros, 2020). Therefore, learners must understand what uncertainty means in science (Kienhues et al., 2020). Uncertainty affects individuals' decisions about health problems, as can be seen from the pandemic we are currently experiencing. Thereupon, it is necessary to focus on explaining the nature and effects of uncertainty in science to improve individuals' understanding of science (Kampourakis & McCain, 2019). Students' ability to cope with such uncertainties they encounter depends on their ability to solve problems (Chen, 2020; Yilmaz, 2021). Traditional science classes emphasise the final state of particular knowledge, namely its results. However, students are given little opportunity to evaluate how this knowledge has been developed (Chen et al., 2019). The traditional school tends to present science as positivist knowledge and an unshakable truth that is unaffected by sociocultural factors. Since scientific knowledge is taught as a series of unshakable facts, individuals perceive science as a magic wand that will solve all problems when touched. It should be realised that this is not the case; scientific knowledge is powerful for generating a solution but cannot change everything at once (Christensen, 2009). Socioscientific issues provide a context in which a sceptical outlook can be developed on everyday scientific claims or data that can help understand the complexity of a topic (Lee et al., 2020). Raising scientifically literate individuals can easily become possible within the framework of real socioscientific issues (Zeidler, 2014).

Socioscientific issues are critical for individuals to gain scientific literacy (Hofstein et al., 2011; Karisan & Zeidler, 2017; Powell, 2021), and they provide scientific explanations for current issues (Sadler et al., 2011). It then turns out to be critical to have socially important and scientifically based topics such as epidemics as part of science education content (Yahaya et al., 2015). To date, studies have shown that the implementation of the curriculum guided by socioscientific issues, including health problems at many levels from primary school to university, has produced positive results, encouraging students' interest and participation in science learning (Arnold, 2018; Ekborg et al., 2013; Lee et al., 2013). There seems to be a similarity in the measures taken against COVID-19 and the influenza pandemic from 1918-1919. In the influenza pandemic, masks were used, public gatherings were banned, schools were closed, hygiene rules were recommended, and efforts were made to develop a failed vaccine. But it was herd immunity that ultimately ended the epidemic (Reiss, 2020). Instead of vaccination, which is one of the most important and successful public health interventions for the prevention of infectious diseases (Andre et al., 2008; Salerno et al., 2019), if we are to wait for the COVID-19 outbreak to end with herd immunity, we may need to tolerate millions of deaths. To successfully deal with the present pandemic or a different epidemic that is likely to occur later (Karpudewan & Chan, 2020), we need to be aware that we have no other way than to refer to science. For this, it is necessary to raise society's awareness, especially that of students, and to increase scientific literacy. Although research shows that societies have high confidence in science and believe that science brings great benefits to the world, we can

say that many people still do not acknowledge the role of science when it comes to socioscientific issues such as climate change and vaccination (Dillon & Avraamidou, 2020). Furthermore, a situation of rejecting arises. In today's science and technology-centred society, we encounter more socioscientific issues affecting our daily lives. Therefore, it has been emphasised for a long time that it is fundamental for science educators and policymakers to investigate further and understand individuals' attitudes towards socioscientific issues (Chang & Chiu, 2008).

Socioscientific issues consist of socially important real-world problems based on science, as evident from the pandemic we are experiencing now (Tyrrell & Calinger, 2020). It will be possible for individuals to realise that these real-world problems inherently have a problematic nature awaiting to be solved. To understand the content of socioscientific issues, they need to do more research and questioning on these issues (Sadler et al., 2007). Socioscientific issues are essential to gain a critical science literacy vision that prepares individuals for responsible citizenship in the society they live in (Sjöström & Eilks, 2018). Scientific literate individuals with this vision are expected to make conscious decisions about world problems, which include socioscientific content that society constantly faces (Zeidler & Lewis, 2003). It is of utmost importance to prepare students for the decision-making processes to be carried out on socioscientific issues. The importance of this was found in the educational recommendations made by organisations such as the *American Science Development Association (AAAS)* and the *National Research Council (NRC)* (Kolstø, 2001). Studies have also emphasised that the gradual implementation of socioscientific issues activities in the classroom improves students' decision-making based on scientific evidence (Karpudewan & Chan, 2020). The importance of socioscientific issues for science education has been accepted in many countries, and such issues have taken place in primary and high school programs to create this decision-making situation as desired (Topcu, 2019). Socioscientific issues in Turkey, with the updates realised by the Ministry of Education in 2013 and 2018, began to take part in training programs. It is seen that socioscientific issues programs increase students' subject area knowledge and critical thinking ability levels (Topcu, 2019). Based on the fact that socioscientific issues are effective on students (in terms of having accurate information about current world problems and making "healthy" decisions), in this study, university students' attitudes towards socioscientific issues and their views on the COVID-19 process and vaccination were comparatively examined.

2. Methodology

This study aimed to determine how the views of students in higher education on socioscientific issues affect their perspectives on the COVID-19 process and vaccination studies. The research process is designed as a case study. Case studies aim to conduct a detailed and in-depth analysis of complex events, which are up-to-date, in which the researcher has little or no control, and which take into account dynamic interactions (Creswell & Poth, 2018; Yin, 2018).

2.1. The Study Design

Data were collected in a cross-sectional process in the study. The research data were obtained over three months through an internet-based scale and questionnaire applications. In this context, the participants' opinions on socioscientific issues, COVID-19, and vaccination were collected. Within the scope of the research, attention has been paid to gathering opinions from people in many different higher education programs to ensure data diversity and to generalise the obtained data to a wider universe.

2.2. Ethical Considerations

In the research, maximum attention was paid to ethical rules, and all practices were carried out in this direction. Before the application, the informed consent form was sent, and those who wanted to participate voluntarily contributed to the application. There was no room for any situation that would disrupt or adversely affect the participants' mood, psychological conditions, or social relations throughout the application. All of the collected data were kept confidential and were not used for other than this scientific study. This research has the ethics committee document issued number 4, dated 25.12.2020, with decision number 32 obtained from the Ethical Board of Kastamonu University.

2.3. The Study Group

The stratified sampling type was chosen among the random sampling types whilst determining the study group of the research. The reason for choosing this sampling is that too many higher education programs were involved in the study and the number of students in these departments was not equal or varied for departments (McMillan & Schumacher, 2009). A total of 1322 people participated in the study. However, 1275 people remained among these participants due to the cleaning of the data belonging to the participants that did not complete the questionnaire or the scale and that of the data which had deficiencies and extreme values during the analysis of normality distribution. The working group has generally been gathered under two categories. The first category includes science, engineering, and medical sciences. Sections included in this category are faculty of education (science and mathematics teaching), faculty of science and literature, faculty of engineering and architecture, faculty of economics and administrative sciences, faculty of health sciences, faculty of medicine, faculty of pharmacy, and faculty of nursing and health vocational schools. The second category includes social sciences and humanities. Sections included in this category are as follows: faculty of education (preschool, classroom, social studies, Turkish, music, painting, special education, and foreign languages teaching), faculty of fine arts, faculty of theology, faculty of communication, faculty of tourism, faculty of sports sciences, faculty of applied sciences, and faculties of social sciences. In addition, the information about participants, i.e., gender, grade level, and others, is divided into five different categories, and detailed demographic data are presented in the findings section below.

2.4. Data Collection Tools

Two different data collection tools were used in the research process. As the first data collection tool, the *Attitudes towards Socioscientific Issues Scale* developed by Topcu (2010), consisting of 30 items and three dimensions (Interest and usefulness of SSI, liking of SSI, anxiety towards SSI), was used to determine the attitudes of the participants towards socioscientific issues. Necessary permissions have been obtained from the owner for the use of the scale. Scale items were grouped between 1-5 and graded between *Strongly Disagree and Strongly Agree* opinions. The lowest score that can be obtained from the scale is 30, and the highest score is 150. The second data collection tool is a questionnaire with 20 questions and *Yes*/*No* options developed by the researchers to determine the views on the Covid 19 process and vaccination studies. The questionnaire questions are divided into direct and indirect questions directed to see the views on being vaccinated.

2.5. Statistical Analysis of Data

IBM SPSS v25.0 for Windows and IBM SPSS AMOS v24.0 for Windows programs were utilised while analysing the application data. In the study, the general significance level was determined as $p<.05$, and in applying the zero-order correlation, it was considered $p<.01$. Independent groups t-test was used to analyse continuous variables, which have two categories because the research data show a normal distribution and meet the preconditions. A one-way ANOVA test was performed in the analysis of continuous variables with more than two categories. In addition, effect sizes and 95% confidence intervals were calculated. The chi-square test was used in the analysis of categorical variables, and a multinominal logistic regression was performed when examining the relationship between main variables and categorical variables. Finally, the results obtained were summarised using the structural equation model.

2.6. Reliability and Validity Applications

For all data collection tools used in the study, expert opinions were first consulted, and their use was ensured in line with expert opinions. As a result of the application for the scale of attitude towards socioscientific issues, which is the first data collection tool within the scope of reliability applications, Cronbach's Alpha reliability coefficient was found as .88. In social sciences, this value is quite good and acceptable (Ayyildiz & Yilmaz, 2021; Flick, 2009). Similarly, expert opinion was received for the questionnaire to obtain views on the COVID-19 process and vaccination. Sentences with semantical problems were arranged, and questions serving a similar purpose were combined. At the same time, checks were made by language experts and then it reached its final version. Confirmatory factor analysis was performed to check the construct validity of the attitude scale to determine validity. As a result of confirmatory factor analysis, the following were found; *NFI*=.90; *CFI*=.92; X^2_{min}/df=2.33; *RMSEA*=.07; *RMR*=.07. These results show that the scale provides the construct validity and the goodness of fit index values are at a good level (Cokluk et al., 2014). The results obtained are consistent

with the original findings of the scale. Expert opinion was consulted as in the reliability phase, and necessary corrections were made in light of the feedback received to ensure the content and appearance validity of the other data collection tool used in the study (Tabachnick & Fidell, 2007).

3. Findings

The findings obtained as a result of the research were examined gradually. Firstly, it was examined whether the opinions of the participants differed under various categories. Table 1 presents participants opinions on socio-scientific issues, and Table 2 presents their views on the COVID-19 process and vaccination obtained by the questionnaire.

Table 1. *Demographic Variables of the Participants for Socio-scientific Issues*

Variables	Sub-variables	N	Mean	Sum of Squares		df	Mean Square	F	*p*	η^2
Gender	Female	953	3.08	Between Groups	115.274	1	115.274	1158.73	.000	.476
	Male	322	3.77	Within Groups	126.641	1273	.099			
	Total	1275	3.26	Total	241.915	1274				
Grade Level	1st grade	407	2.77	Between Groups	191.767	3	63.922	1620.12	.000	.792
	2nd grade	224	3.19	Within Groups	50.148	1271	.039			
	3rd grade	377	3.43	Total	241.915	1274				
	4th grade	267	3.82							
	Total	1275	3.26							
Science Area	Science, Engineering and Medical	626	3.60	Between Groups	141.819	1	141.819	1803.63	.000	.586
	Social and Humanities	649	2.93	Within Groups	100.095	1273	.079			
	Total	1275	3.26	Total	241.915	1274				
Knowledgeable about Socioscientific Issues	Yes	826	3.50	Between Groups	142.476	1	142.476	1823.96	.000	.588
	No	449	2.80	Within Groups	99.438	1273	.078			
	Total	1275	3.26	Total	241.915	1274				
Knowledgeable about COVID-19	Yes	994	3.43	Between Groups	130.054	1	130.054	1480.03	.000	.537
	No	281	2.66	Within Groups	111.861	1273	.088			
	Total	1275	3.26	Total	241.915	1274				

F: F-Value for Independent t-test and ANOVA. η^2= Effect size coefficient.

When Table 1 is examined, the gender variable [$F_{(1\text{-}1273)}$=1158.73, p<.05, η^2=.476], grade level [$F_{(3\text{-}1271)}$=1620.12, p<.05, η^2=.792], science area [$F_{(1\text{-}1273)}$=1803.63, p<.05, η^2=.586], knowledge of socioscientific issues [$F_{(1\text{-}1273)}$=1823.96, p<. 05, η^2=.588], and knowledge of COVID-19 [$F_{(1\text{-}1273)}$=1480.03, p<.05, η^2=.537] were found to be significantly different.

Table 2. *Demographic Variables of the Participants for COVID-19 Vaccine Questionnaire*

Variables	Sub-variables	N	Mean	Sum of Squares		Df	Mean Square	F	*p*	η^2
Gender	Female	953	.56	Between Groups	9.056	1	9.056	961.29	.000	.430
	Male	322	.75	Within Groups	11.993	1273	.009			
	Total	1275	.61	Total	21.048	1274				
Grade Level	1st grade	407	.46	Between Groups	17.294	3	5.765	1951.26	.000	.821
	2nd grade	224	.60	Within Groups	3.755	1271	.003			
	3rd grade	377	.67	Total	21.048	1274				
	4th grade	267	.76							
	Total	1275	.61							
Science Area	Science, Engineering and Medical	626	.71	Between Groups	12.780	1	12.780	1967.72	.000	.607
	Social and Humanities	649	.51	Within Groups	8.268	1273	.006			
	Total	1275	.61	Total	21.048	1274				
Knowledgeable about Socioscientific Issues	Yes	826	.69	Between Groups	14.077	1	14.077	2570.72	.000	.668
	No	449	.47	Within Groups	6.971	1273	.005			
	Total	1275	.61	Total	21.048	1274				
Knowledgeable about COVID-19	Yes	994	.66	Between Groups	13.114	1	13.114	2104.05	.000	.623
	No	281	.42	Within Groups	7.934	1273	.006			
	Total	1275	.61	Total	21.048	1274				

F: F-Value for Independent t-test and ANOVA. η^2= Effect size coefficient.

When Table 2 is examined, the gender variable [$F_{(1\text{-}1273)}$=961.29, p<.05, η^2=.430], grade level [$F_{(3\text{-}1271)}$=1951.26, p<.05, η^2=.821], science area [$F_{(1\text{-}1273)}$=1967.72, p<.05, η^2=.607], knowledge of socioscientific issues [$F_{(1\text{-}1273)}$=2570.72, p<.05, η^2=.668], and knowledge of COVID-19 [$F_{(1\text{-}1273)}$=2104.05, p<.05, η^2=.623] variables were found to be significantly different.

Table 3. *Zero-Order Correlations for All Variables*

Variables	1	2	3	4	5	6	7
1. Gender	-						
2. Grade level	.73**	-					
3. Science area	.59**	.88**	-				
4. Knowledgeable about socioscientific issues	.43**	.84**	.72**	-			
5. Knowledgeable about COVID-19	.31**	.65**	.52**	.72**	-		
6. Overall mean for socioscientific issues	.69**	.88**	.76**	.76**	.73**	-	
7. Overall mean of COVID-19 vaccine tendency to be hit	.65**	.89**	.77**	.81**	.78**	.98**	-

**Correlation is significant at the 0.01 level - **p<.01

When the correlation values for the variables are examined, it is seen that all variables have positive correlations with each other. The highest correlation was between *Overall Mean for Socioscientific Issues* and *Overall Mean of COVID-19 Vaccine Tendency to be Hit;* this value was calculated as ($r_{7\text{-}6}$= .98). In addition, these two variables have high relationships with their class levels ($r_{7\text{-}2}$=.89), ($r_{6\text{-}2}$=.88). The lowest correlation was between *Knowledgeable about COVID-19* and *Gender*; this value was calculated as ($r_{5\text{-}1}$=.31). These results show

that the variables participating in the study have consistent relationships with each other. Table 4 below contains the questions and results from the questionnaire that directly reflect the thoughts about getting the COVID-19 vaccine.

Table 4. *COVID-19 Vaccine Questions about the thoughts of Being Shot*

Conspiracy Belief and Attitude Items	**Q8- If a vaccine with an effect of more than 90% is found, would you be vaccinated?**					
		Yes	**No**	**β**	***p***	**Odds Ratio (95% CI)**
Q4- Do you think the COVID-19 virus is a natural virus or an artificial virus produced in a laboratory environment? Tick "Yes" if you think it is natural, "No" if you think it is artificial.	Natural	840 (65.9)	98 (7.7)	3.257	.000	25.962 (16.934-39.803)
	Man-made	88 (6.9)	249 (19.5)			
Q5-What do your closest friends think about question 4? Tick "Yes" if they think it is natural, "No" if they think it is artificial.	Yes	853 (66.9)	188 (14.7)	1.260	.000	3.524 (2.199-5.647)
	No	75 (5.9)	159 (12.5)			
Q1-Do you believe in the existence of the SARS-CoV-2 virus?	Yes	910 (71.4)	319 (25.0)	1.581	.001	4.858 (1.865-12.657)
	No	18 (1.4)	28 (2.2)			
Q2-Do people you know and who are close to you believe in the presence of the SARS-CoV-2 virus?	Yes	709 (55.6)	186 (14.6)	.881	.001	.414 (.251-.685)
	No	219 (17.2)	161 (12.6)			
Q9-Will your best friend get vaccinated if a vaccine with an effect of more than 90% is found?	Yes	818 (64.2)	154 (12.1)	1.155	.000	3.174 (2.046-4.923)
	No	110 (8.6)	193 (15.1)			
Q10-Does the possibility of having a side effect of the COVID-19 vaccine change your opinion of being vaccinated?	Yes	738 (57.9)	172 (13.5)	-.977	.000	2.657 (1.584-4.458)
	No	190 (14.9)	175 (13.7)			
Q12-Do you have a chronic illness?	Yes	92 (7.2)	44 (3.5)	.595	.044	.551 (.309-.985)
	No	836 (65.6)	303 (23.8)			
Q13-Have you become ill with COVID-19 disease?	Yes	91 (7.1)	127 (10.0)	.930	.000	.395 (.244-.638)
	No	837 (65.6)	220 (17.3)			
Q14-Have any of your relatives caught COVID-19 disease?	Yes	530 (41.6)	43 (3.4)	1.304	.000	3.686 (2.319-5.858)
	No	398 (31.2)	304 (23.8)			

β: Beta coefficient. For categorical variables, we used chi-squared tests. CI: Confidence interval (95%). For Odds Ratio Value, we used multinomial regression analysis. The first reference category is: Man-made; The second reference category is: No.

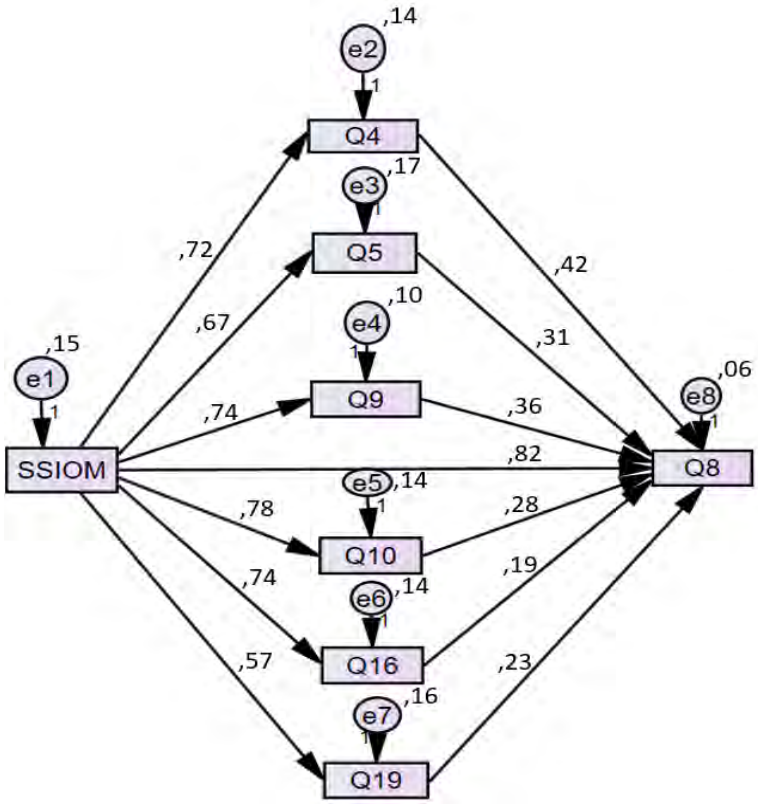
When Table 4 is examined, it is seen that all questions that are directly related to the COVID-19 vaccine are meaningful. In addition, when the β coefficients and confidence intervals are examined, it is seen that the effect levels of Q4, Q1, Q14, Q5, and Q9 are high. It can be stated that the Q10 coded problem has a negative charge value; thus, the direction of thinking follows the pattern from "yes" to "no". Table 5 below contains the questionnaire questions and results that indirectly reflect the thoughts about being shot with the COVID-19 vaccine.

Table 5. *Questions Indirectly Related to the Thoughts of Being Shot with the COVID-19 Vaccine*

Conspiracy Belief and Attitude Items	Q8- If a vaccine with an effect of more than 90% is found, would you be vaccinated?					
		Yes	No	β	*p*	Odds Ratio (95% CI)
Q3-How did the COVID-19 outbreak affect your belief in science? Tick "Yes" if it affected positively, "No" if negatively.	Positive	709 (55.6)	186 (14.6)	.790	.002	.454 (.275-.748)
	Negative	219 (17.2)	161 (12.6)			
Q6-Do you believe you will find an effective vaccine for COVID-19?	Yes	840 (65.9)	98 (7.7)	3.226	.000	25.186 (16.451-38.560)
	No	88 (6.9)	249 (19.5)			
Q7-Does your best friend believe he/she will find an effective vaccine for COVID-19?	Yes	853 (66.9)	188 (14.7)	1.327	.000	3.768 (2.317-6.130)
	No	75 (5.9)	159 (12.5)			
Q11-Have you ever had a flu shot before?	Yes	530 (41.6)	43 (3.4)	1.294	.000	3.646 (2.272-5.849)
	No	398 (31.2)	304 (23.8)			
Q15-Would you like to be a subject in COVID-19 vaccine studies?	Yes	336 (26.4)	97 (7.6)	.223	.304	.800 (.523-1.224)
	No	592 (46.4)	250 (19.6)			
Q16-Could new scientific data about the COVID-19 vaccine change your mind on being shot?	Yes	753 (59.1)	265 (20.8)	.449	.043	1.566 (1.249-2.469)
	No	175 (13.7)	82 (6.4)			
Q17-Would you describe yourself as an anti-vaxxer?	Yes	91 (7.1)	127 (10.0)	.960	.000	.383 (.237-.618)
	No	837 (65.6)	220 (17.3)			
Q18-Do you plan to get the COVID-19 vaccine and continue your education?	Yes	818 (64.2)	154 (12.1)	1.073	.000	2.924 (1.898-4.506)
	No	110 (8.6)	193 (15.1)			
Q19-Do you trust COVID-19 vaccines?	Yes	738 (57.9)	172 (13.5)	1.044	.000	2.839 (1.681-4.795)
	No	190 (14.9)	175 (13.7)			
Q20-Do you support the COVID-19 vaccine studies developed in your country?	Yes	791 (62.0)	307 (24.1)	.592	.042	.553 (.284-.886)
	No	137 (10.7)	40 (3.1)			

β: Beta coefficient. For categorical variables, we used chi-squared tests. CI: Confidence interval (95%). For Odds Ratio Value, we used multinomial regression analysis. The first reference category is: Negative; The second reference category is: No.

When Table 5 above is examined, it is seen that the questions with indirect relation to the shooting of the COVID-19 vaccine are meaningful; only Q15 is meaningless. In addition, when β coefficients and confidence intervals are examined, it is seen that the effect levels of Q6, Q7, Q11, Q18, and Q19 are high. Figure 1 below presents the structural equation model that summarises the research process and shows the relationships between variables.



Regression Weights		β	S.E.	C.R.	P
Q4	<--- SSIOM	,720	,142	29,623	***
Q5	<--- SSIOM	,667	,174	25,478	***
Q8	<--- SSIOM	,823	,062	4,648	***
Q9	<--- SSIOM	,738	,100	35,911	***
Q10	<--- SSIOM	,777	,141	32,830	***
Q16	<--- SSIOM	,740	,144	30,878	***
Q19	<--- SSIOM	,567	,162	21,884	***
Q8	<--- Q4	,422	,018	20,963	***
Q8	<--- Q5	,311	,014	9,948	***
Q8	<--- Q9	,361	,029	8,624	***
Q8	<--- Q10	,284	,019	9,916	***
Q8	<--- Q16	,191	,019	9,122	***
Q8	<--- Q19	,233	,018	5,805	***

Goodness of Fit Indices	Value	Relevance
X^2_{min}/df	2.89	Good fit
p	.00	-
RMSEA	.06	Good fit
NFI	.92	Good fit
NNFI	.93	Good fit
CFI	.91	Good fit
RMR	.07	Good fit
SRMR	.06	Good fit
AGFI	.92	Good fit
GFI	.94	Good fit

SSIOM: Socioscientific Issues Overall Mean. Q4, Q5, Q8, Q9, Q10, Q16, Q19: COVID-19 Vaccine Items. β: Beta coefficient. S.E: Standart Error. C.R.: T-Value>1.96 for $p<.05$

Figure 1. *Structural Equation Model Summarising the Research Process*

When Figure 1 above is examined, trends towards socioscientific issues seem to have a positive and direct effect on the idea of being shot with the COVID-19 vaccine (β=82, *p*=.00). On the other hand, the tendency of the participants with high attitude level to be vaccinated (β=.58, *p*=.00), when compared to the individuals with medium (β=-.37, *p*=.00) and low (β=-.40, *p*=.00) attitude, was found positive and higher. This is an expected situation because the tendencies towards socioscientific issues create a situation that affects the preferences of individuals during the decision-making process. Within the scope of the research, some thoughts (Q4, Q5, Q9, Q10, Q16, Q19) that affect the participants' preferences (Q8) to be shot with the COVID-19 vaccine were examined as a mediator variable, and their effects on the process were observed. It is understood from the β coefficients that there is a high level of positive significance between the views on socioscientific issues and the mediator variables (β=.57-.78). Similarly, there is a positive and significant relationship between mediator variables and the thought of being shot with the COVID-19 vaccine (β=.19-.42). The results show that participant views can be influenced by mediator variables and can change views on vaccination. When the construct validity results for the research model are examined, it is seen that the index values of the model's goodness of fit are quite good.

4. Conclusion and Discussion

Socioscientific issues consist of real-world problems with scientific content and carry importance that has a societal dimension (Karisan & Turksever, 2017; Tyrrell & Calinger, 2020). Health issues are also considered significant for the future of humanity and are a component of socioscientific issues directly related to education (Arnold, 2018). Within this framework, health literacy is important to cope with health issues such as epidemics successfully. Gaining health literacy can be achieved in the context of science education, which integrates scientific literacy and socioscientific issues in itself (Dillon, 2012; Roth, 2014; Zeyer, 2012). The role of science education in health education is to help students make informed decisions about their future lives and health. However, health education has been neglected in science education in schools and science education research of academics (Zeyer & Dillon, 2014). In our research, we attempted to study the perspectives and attitudes of university students that emerged with the COVID-19 pandemic, such as the thoughts about the existence of SARS-CoV-2, beliefs in conspiracy theories claiming the virus is originally

artificial, being against vaccination, which is proved to be the prominent means to stay safe during the pandemic (Andre et al., 2008; Salerno et al., 2019), and the attitudes towards socioscientific issues by checking if there is a relationship between the topics mentioned above.

When we look at the general vaccine acceptance rate of the students participating in our research, 78.2% say that they are thinking of being vaccinated. Although this indicates a higher level than what Lazarus et al. (2021) shared in their study that analysed the acceptance of COVID-19 vaccination levels (namely 71.5%) in 19 countries, bearing in mind that the participants were university students and that they were inclined to be vaccinated proved 90% effectiveness or more; this finding suggests a low level of vaccination acceptance. Harapan et al. (2020) found that the vaccination rate increased to 93.3% in the case of a 95% effective vaccine, while the desire to be vaccinated fell to 67% if the vaccine was 50% effective in the same study. In our study, a detailed examination of the socioscientific issue attitudes of the students according to their department and grade levels, vaccination behaviours and the origin of the virus was carried out. According to our results, it was seen that the socioscientific issue attitudes, vaccination behaviours, and thoughts about the origin of the virus were more favourable to scientific literacy than the students studying in the departments grouped as science, engineering, and medical. Likewise, it was concluded that the students in the fourth grade approached the situations mentioned above more scientifically than the students in the other grades. We can say that this situation is because the students studying in the science fields receive an integrated science education of the socioscientific issues and thanks to the science-oriented education they receive at the university. Our study found that as students' attitudes towards socioscientific issues increased, their opinions about vaccination were positive.

Both in the pre-COVID-19 vaccine hesitations studies (Piedrahita-Valdés et al., 2021; Sarathchandra et al., 2018) and the studies conducted in the COVID-19 process (Čavojová et al., 2020a), it was concluded that people with high scientific logic had a more positive attitude towards vaccination. The similarity between the results of our study and other studies is that socioscientific issues are critical for individuals to gain scientific literacy (Hofstein et al., 2011) and help them to provide a scientific explanation for current issues such as the epidemic of public health (Sadler et al., 2011). One of the important findings of our study is that believing in conspiracy theories that have spread rapidly since the beginning of the COVID-19 process (ones saying that the coronavirus is not real and that it is a laboratory-developed virus etc.) is highly correlated with attitudes towards socioscientific issues. According to our results, students with a high attitude towards socioscientific issues think that the virus's origin is natural. Another finding is that the vaccination behaviour of students who think that the source of the virus is natural is more positive. It is observed that the vaccination behaviours of the students who think that the virus is of laboratory origin are low. This finding corresponds to the results of other studies (e.g., Salali & Uysal, 2020). This type of behaviour can be explained as individuals who believe in conspiracy theories or false scientific claims may be more prone to accepting new misinformation (e.g. side effects of the vaccine). Hence, they exhibit anti-vaccine behaviour (Čavojová et al., 2020b; Kose et al., 2020; Lobato et al., 2014).

Discussion of the side effects of the vaccine, which is the subject of discussion every day on social media and TV programs during the pandemic process, and the discussion of new scientific data on the virus and the vaccine, affect individuals' decisions about their health (Lyu et al., 2020). That said, it is very important to raise scientifically literate individuals to be victorious in the fight against infodemics (Pennycook et al., 2020) simultaneously in the fight with the pandemic (Kienhues et al., 2020). Following the results of our study, since the vaccination has side effects and new scientific data comes into play that might interfere with the idea of being vaccinated, the participants accentuated that they would change their views on getting the vaccination. It is known that scientific literacy can correctly and effectively interpret and construct science-based ideas in popular media (Cavagnetto, 2010; Sinatra & Lombardi, 2020). It is emphasised that an integrated science education of socioscientific issues is important for scientific literacy development (Sjöström & Eilks, 2018). An important finding of our study is that there is a high level of positive significance between students who have a high attitude towards socioscientific issues, side effects, and new scientific data changing the idea of vaccination. In other words, students with high attitudes towards socioscientific issues can scientifically interpret new data on epidemics and vaccines and make their decisions accordingly. It is the main function of scientists to take the necessary measures to prevent the spread of the epidemic in cases such as epidemics that directly affect public health and develop vaccines, which are the best method known to be protected from the

epidemic. However, in addition to developing vaccines, another important issue is to win the fight against infodemics, such as conspiracy theories about the epidemic and possible vaccine oppositions. It is challenging to achieve this after health problems such as epidemics occur. Therefore, we should be aware that there is a higher probability of a more dangerous outbreak than the COVID-19 pandemic itself, which we are currently being exposed to (Karpudewan & Chan, 2020). We need to realise the urgent need to increase scientific literacy among the general public and school-age children in particular (Powell, 2021).

As a result, the findings of our study overlap with previous studies, and it is seen that the attitude towards the socioscientific issues is effective in preventing conspiracy theories, combating vaccine opposition, and gaining health literacy and scientific literacy. More emphasis should be placed on teaching socioscientific issues integrated into science education to improve scientific literacy.

5. Practical Implications

The highlights obtained within the scope of the research as to implications are listed below:

- University students' views on socioscientific issues and the COVID-19 process may differ in terms of several variables. The research results showed that male students are more inclined, class level and the field of science are determining factors. It was found out that students in upper classes and those in the field of science have a higher attitude.
- It can be stated that the level of interest in socioscientific issues and decision-making mechanisms in the COVID-19 process has a logical and positive relationship.
- It is seen that most participants will develop a positive attitude towards a vaccine with an effect of more than 90%. In contrast, it is seen that they are hesitant or unwilling to be a test subject in the vaccination process or contribute to it.
- It can be said that the participants have confidence in vaccination studies and science and are in a hopeful wait. However, the side effects of vaccines, the tendency to be a subject, to believe in lies and false information, can have a negative effect on COVID-19 vaccines and vaccination ideas.

6. Disclosure statement

No potential conflict of interest was reported by the author(s).

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Appendix-1

COVID-19 process and Vaccination Questionnaire

1. Do you believe in the existence of the SARS-CoV-2 virus?
2. Do people you know and who are close to you believe in the presence of the COVID-19 virus?
3. How did the COVID-19 outbreak affect your belief in science? Tick "Yes" if positively, "No" if negatively.
4. Do you think the COVID-19 virus is a natural virus or an artificial virus produced in a laboratory environment? Tick "Yes" if you think it is natural, "No" if you think it is artificial.
5. What do your closest friends think about question 4? Tick "Yes" if they think it is natural, "No" if they think it is artificial.
6. Do you believe you will find an effective vaccine for COVID-19?
7. Does your best friend believe he/she will find an effective vaccine for COVID-19?
8. If a vaccine with an effect of more than 90% is found, would you be vaccinated?
9. Will your best friend get vaccinated if a vaccine with an effect of more than 90% is found?
10. Does the possibility of having a side effect of the COVID-19 vaccine change your opinion of being vaccinated?
11. Have you ever had a flu shot before?
12. Do you have a chronic illness?
13. Have you become ill with COVID-19 disease?
14. Have any of your relatives caught COVID-19 disease?
15. Would you like to be a subject in COVID-19 vaccine studies?
16. Could new scientific data about the COVID-19 vaccine change your mind on being shot?
17. Would you describe yourself as an anti-vaxxer?
18. Do you plan to get the COVID-19 vaccine and continue your education?
19. Do you trust COVID-19 vaccines?
20. Do you support the COVID-19 vaccine studies developed in your country?