Chapter 13
Justification of Decision-Making in Response to COVID-19 Socio-Scientific Dilemmas

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Abstract Argumentation skills are important for informed decision-making, especially in everyday life when engaging with science. The onset of the COVID-19 pandemic is an ideal opportunity to study laypeople's use of argumentation skills when engaging with a scientific issue daily, while making relevant decisions that affect their families and society. This study frames the pandemic as a Socio-Scientific Issue (SSI)—a scientific issue with links to several social science disciplines (economics, politics, and sociology). The current study explores decision making and argumentation in the context of COVID-19 among the Israeli public as well as the connection between demographic characteristics, scientific knowledge and education and the quality of their argumentations. An online survey to examine responses to 2 specifically designed social dilemmas was conducted in April 2020 (n = 439). Our findings suggest that laypeople tend to use justifications that were classified as 'scientific argumentation' but we could not demonstrate a connection between demographic characteristics, scientific knowledge and decision making. We did find a positive connection between peoples' perception of control over the situation and their compliance with the official guidelines. As a relevant Socio-Scientific Issue (SSI), COVID-19 stretched to the limit the need for public argumentation with changing scientific and medical information.

Keywords Argumentation · Socio-Scientific Issues · Decision making · Public engagement with science

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13.1 Introduction

Argumentation skills are an important part of making informed decisions, and they are especially important in everyday life when engaging with science (Erduran et al., 2004; Lazarou et al., 2017; Osborne et al., 2016). Although many studies have dealt with factors influencing levels of scientific arguments, there is no consensus among researchers regarding the impact of these factors. Some argue that the quality of an argument is affected by content knowledge (Driver et al., 2000; Zangori et al., 2017), others point to a direct link between the quality of the argument and the level of education (Kuhn, 1991).

The onset of the COVID-19 pandemic offers a timely opportunity for researchers to study laypeople's use of argumentation skills when engaging with a scientific issue daily, while making relevant decisions that affect their families and society. In this study we frame the COVID-19 pandemic as a Socio-Scientific Issue (SSI)—a scientific issue with links to several social science disciplines, such as economics, politics, and sociology. 'The term 'socioscientific issues' has come to represent controversial social issues with conceptual, procedural, or technological ties to science' (Sadler & Donnelly, 2006, p. 1463). SSI refer to complex, ill structured and controversial social issues that are often value-laden with competing public views. Features that distinguish them from traditional school science are uncertainty and acceptance of different types of knowledge, rather than only scientific knowledge (Simonneaux, 2008). For over a year now, people globally have been faced with the need to make daily decisions that are related to health (how do I keep from contracting the virus and stay healthy?), to economics (how do I keep my job?), education (should my children study from home or go to school? Is online learning working for them?) and politics (are my representatives promoting appropriate relief policies?). Moreover, all these important decisions were made with very scattered information and a high level of uncertainty regarding many aspects of the pandemic.

The COVID-19 pandemic is a telling example, but people also encounter SSIs in many situations throughout their lives, such as when having to make decisions about childhood vaccinations, diet or even purchasing a mobile phone. When engaging with SSIs, social, economic, and cultural factors enter into play, and often they have more influence over decision making, than scientific factors (Dalyot et at., 2019; Weeth Feinstein et al., 2013).

SSIs are of interdisciplinary nature and often several alternative and viable decisions exist (Sadler & Donnelly, 2006). Engaging with them in class and in life requires, among other skills, science literacy alongside the ability to coherently construct arguments (Sadler et al., 2007; Zeidler & Nichols, 2009). Colucci-Gray (2014) points out that SSIs offer an example of the importance of moving from treating 'scientific knowledge as something theoretical and abstract to recognizing that such knowledge is deeply enmeshed with action' (p. 638). Thus, the aim of this study was to explore decision making and related argumentation in the context of COVID-19 governmental guidelines among Israeli public as well as their relation to science knowledge. Specifically, we asked:

RQ1: Which justifications do people use to explain their stance on COVID-19 related dilemmas?

RQ2: What is the connection between demographic characteristics, scientific knowledge and education and decision making (stance and justification)?

13.2 Theoretical Framework

13.2.1 Decision Making in the Context of SSIs

In a world where science and technology have a significant impact on society and culture, there is great importance in cultivating scientific literacy among the public, which will support problem-solving processes and decision-making in daily life (OECD, 2017). The Programme for International Student Assessment (PISA) 2024 strategic vision, published at the onset of the pandemic in March 2020, aims to add to this framework relevant competencies for science education, as they acknowledge indirectly that decision making, and knowledge are intimately linked with SSIs, it reads (OECD, 2020).

Using scientific knowledge for decision-making and action, as young people need the capacity to actively use their scientific knowledge to decide on courses of action, and to create new value. These decisions need to be made in complex systems, taking into account economic, political, and ethical considerations (p. 7).

There is broad support within the science education community for the inclusion of decision-making in the context of SSI as an integral component of scientific literacy (Sadler & Donnelly, 2006) as well as its evaluation (Allchin, 2011; Romine et al., 2017). The role of argumentation in SSI is specifically emphasized. Scientific argument is a complex form of reasoning requiring domain-specific knowledge to construct and critique claims and their relationship to supporting evidence (Osborne et al., 2004, 2016).

Decision making and action in scientific issues is thus gaining more attention and becoming an important issue within science literacy studies, also encompassing argumentation skills and capacities. The PISA 2024 document states that some of the main objectives of science education are transferring knowledge and skills to daily life, using science for personal or social needs and making informed decisions (OECD, 2020). However, there is no consensus among researchers about the role of scientific knowledge in the decision-making process and there is conflicting evidence on the subject (Kahan, 2014; Sharon & Baram-Tsabari, 2020). Some studies have demonstrated a complex relationship between science knowledge and science-based decision making, explicating how social or political and economic concerns as well as trust in science and scientists mediate engagement and decision making (Dalyot et al., 2019; Drummond & Fischhoff, 2017; Heyd-Metzuyanim, 2021; Jho et al., 2014; Orr & Baram Tsabari, 2018; Plohl & Musil, 2021; Shauli & Baram-Tsabari, 2019; Taragin-Zeller et al., 2020). Moreover, making decisions on SSIs ‘is probably

the most common instance where science and the public interest come into contact with one another' (Rudolph & Horibe, 2016, p. 811). For example, when governments needed to make lockdown decisions during the pandemic, while balancing economic and health needs of the population.

Many non-scientific personal factors influence the decision-making process in SSIs. These factors include emotion, religious belief, personal experiences and tendencies, and traits of the individual including skepticism (Sadler & Zeidler, 2009; Jho et al., 2014). For example, on the issue of climate change, people are known to use their cultural and political perspectives to filter information on the issue and interpret evidence in a way that is consistent with their initial positions (Drummond & Fischhoff, 2017; Howarth et al., 2020; Sherkat, 2011).

Similar findings were also discovered in the context of COVID-19. A recent study in the United States concerning public knowledge and behavior in the context of the pandemic, found that while knowledge about COVID-19 was found to be connected to public behavior, this knowledge was mainly related to the political affiliation of the participants. According to Clements (2020), Republicans are more likely to ignore expert recommendations regarding behavior in the context of COVID-19, while Democrats tend to behave in line with these recommendations (Clements, 2020). In addition, there is an underlying assumption that public exposure to knowledge about scientific topics is not sufficient to create behavioral change, that relies heavily on personal stances and affiliations (Howarth et al., 2020; Sharon & Baram-Tsabari, 2020). Engaging with COVID-19 requires a certain grasp of science alongside mathematical and geographical understanding, while engaging with uncertainty in personal and public health issues (Heyd-Metzuyanim et al., 2021; Lammers et al., 2020; Plohl & Musil, 2021). The literature points to the complexity of the intricate relations between scientific knowledge and decision making when confronted with science in daily life. Here we focus on their interaction also with argumentation skills.

13.2.2 The Importance of Argumentation Skills in Engagement with SSIs

We started with the premise that decision making in the context of socio-scientific issues involves argumentation skills, but how do we define and study these skills? Osborne et al. (2016) write that 'Argument and critique are, therefore, at the very center of science—connecting the 'hands-on' work of scientific inquiry with the 'minds-on' work of developing scientific ideas and theories' (p. 822). Argumentation is thus a critical skill in the development of explanations, models, and theories (Erduran et al., 2004). This conceptualization of argumentation emphasizes links between claims (or warrants) and data through justifications or an assessment of knowledge claims (Jiménez-Aleixandre & Erduran, 2007).

Driver et al. (2000) have long emphasized that opportunities for argumentation are pathways to learning socio-scientific issues and indeed argumentation in science is studied widely in K-16 educational contexts, with children, teenagers, college student and pre-service teachers (Driver et al., 2000; Jiménez-Aleixandre & Erduran, 2007; Lazarou et al., 2017; Osborne et al., 2016). Similar to studies on SSIs in classrooms, studies on argumentation suggest that basic science knowledge influences student's ability to engage in meaningful and complex discussion (Driver et al., 2000; Lewis & Leach, 2006; Zangori et al., 2017).

Some researchers suggest that positive emotions towards the issue may affect high quality reasoning, but further research is required to fully understand this complex relationship (Fischer et al., 2014). In the context of COVID-19 the rise in the prevalence of misinformation and conspiracy theories has fueled a cycle of anxiety, powerlessness, and helplessness feelings that are detrimental to emotional well-being (Van Prooijen & Van Dijk, 2014).

Šrol et al. (2021) thus suggest that in this climate, where "people are strongly motivated to preserve the sense of control of their lives" (p. 2) making sense of control is an important issue when analyzing argumentation in this context. Psychologists refer to "cognitive control and cognitive flexibility" as playing an important role in our ability to respond to uncertain and changing situations (Gabrys et al., 2018). Relevant here is the definition of cognitive control as 'the ability to focus on information that is currently relevant to a particular goal, while inhibiting information that is not relevant' (p. 2), as well as the cognitive flexibility to respond and change response strategies when circumstances require.

Socio-scientific decision making characterizes many situations adults face in their daily lives; from deciding on what to eat to maintain a healthy lifestyle, through deciding what kind of car to buy as well as what types of public policy or energy to support. During the COVID-19 pandemic global crisis, adults were faced with not only the need to make constant daily decisions (should I go out? should I visit other people? do I need to wear gloves?) but also making these decisions with very uncertain information, abundance of conflicting policy solutions and while being exposed to an array of opinions (and news) promoted on social networks. In this amplified situation actively searching for information online may contribute to confirmation bias (Meppelink et al., 2019) as 'people will tend to seek out information and make judgments and decisions that are consistent with what they want to believe' (Dieckmann & Johnson, 2019, p. 18). Our study is focused around two leading questions that investigate argumentation in the context of living during the initial stages of an unfolding world Socio-Scientific drama—the spread of COVID-19 pandemic. We examined the justifications and arguments that people use to explain their stance

on COVID-19 social dilemmas (Braund, 2021).[1] We also looked at the connection between demographic characteristics, scientific knowledge and education and people's decision making (stance and justification) in the dilemmas.

13.3 Methodology

The aim of the current study is to explore decision making and argumentation in the context of COVID-19 among the Israeli public as well as the interactions between the justifications they offer for these decisions and science knowledge.

13.3.1 Context of Study

The first case of COVID-19 in Israel was discovered on February 21, 2020. On March 14, the Israeli government introduced drastic social distancing measures, which included, the closure of the economy and restrictions on gatherings. These measures culminated in a full lockdown in March 25. During the lockdown, people were forbidden from leaving their living area, except in cases of emergencies, or for helping the elderly. The most severe restrictions were during Jewish holiday Passover, when it was forbidden to move more than 1000 m from the place of residence or to stay in another person's house. Passover is one of the major Jewish holidays, which takes place during the months of March or April. Typically, the celebration begins with a large family meal including the entire extended family. The number of confirmed COVID-19 cases increased rapidly during the last week of March, from 1442 cases on March 23rd, to 6857 cases by April 2nd, which was the day we began to distribute our survey. During the first half of April, when the data in this study were collected, the Israeli media concentrated heavily on news related to the spread of the virus, with daily news editions devoted to press conferences with Ministry of Health officials and the Prime Minister. At the time of the study, scientific knowledge, recommendation, and regulations changed weekly. For example, at the time of data collection masks were not recommended or enforced but using gloves outside the house was recommended (recommendations that were later flipped).

[1] See also Tomasi (2022, this volume) for an analysis of social dilemmas from a legal perspective, and Puppo et al. (2022, this volume) for a case study of argumentation in official decisions regarding COVID-19—which somewhat mirrors our own study of people's reasoning in deciding whether to comply with official guidelines or not.

13.3.2 Research Tool

During the early stages of the COVID-19 pandemic in Israel (2nd–12th, April 2020), an online survey was distributed among a representative sample of Hebrew-speakers in Israel (n = 439). The questionnaire included two parts. The first was constructed around public understanding of the mathematical and quantitative aspects of the COVID -19 pandemic (Heyd-Metzuyanim et al., 2021). This chapter focuses on the second part, that dealt with personal decision making in the context of COVID-19. This section of the survey is based on a questionnaire developed within our research group that used real life dilemmas and collected measures of general science knowledge, deference to the governmental guidelines and demographic characteristics (Baram-Tsabari et al., 2020; Taragin-Zeller et al., 2020). The measurements used in this analysis included:

The dilemmas were designed to assess how the Israeli public make COVID-related decisions amidst changing guidelines and uncertainty. Respondents were asked to decide on two policy-related and socially relevant dilemmas:

> (15) Visiting elderly family members. A dilemma about which no formal guidelines existed at the time (but recommendations were issued). Respondents were asked 'Suppose you have an adult parent / grandparent living alone. Will you visit them in the coming days?' The respondents had to choose only one of the following options: Yes / Yes, but while keeping a distance / Yes, but I will only place objects near the door / No.
>
> (16) Celebrating Passover. A dilemma regarding a situation where strict formal guidelines existed. Respondents were asked 'Will you celebrate Passover dinner with your elderly family members?'. The respondents had to choose only one of the following options: Yes / Yes, but while maintaining distance (without physical contact) / No. In both dilemmas, the closed-ended question was followed by an open-ended question: 'If you had to convince your parents or spouse of your decision, what would you tell them? What arguments would you use?'.

General Knowledge about Science. Scientific knowledge was measured based on two close-ended questions, taken from a widely used research tool to assess public understanding of science (National Science Board 2018). One point was given for each correct answer (range 0–2, average 1, SD. 0.6).

Demographics. The demographic variables included self-reports of gender, age group, place of residence, occupation, highest level of completed formal education, income level and level of religious affiliation, all as close-ended items (Table 13.1).

Perception of control over the situation. We asked participants to rate their degree of agreement (on a scale between 1–5) with three statements regarding their perception of their cognitive control over the situation: 'I can follow developments regarding COVID-19 and understand them', 'I feel I can anticipate what will happen in the coming days regarding COVID-19' and 'I understand what I need to do to deal with COVID-19'. Perception of control was expressed as the average of answers to the three statements (range 1–5, average 3.7, SD. 0.7).

Content validity. The content validity of the research tool was determined by expert professional judgment. The questionnaire received feedback from ten experts in science communication and science education.

Table 13.1 Selected demographic characteristics variables of the sample (n = 439) and comparison to the general population (Benchmark data)

Variables	Categories	Sample (%)[a]	Benchmark Data (%)
Gender	Women	44	51
	Men	55.8	49
Age	18–22	9.8	11
	23–29	18	15
	30–39	20	22
	40–49	18	19
	50–70	34.2	32
Religiosity	Secular	56	44.3
	Traditional[b]	27.6	33.6
	Religious	12.1	11.5
	Ultra orthodox	3.4	10.2
Highest education	No high school matriculation certificate	12.1	28.4
	High school matriculation certificate	23.9	21.3
	Post-secondary program, without academic degree	18.2	15.6
	Academic degree	45.8	34.6

[a] Percentages do not add to 100% due to a small percentage of incomplete answers
[b] Traditional Jews observe only a few of the religious customs. Usually, this is due to the preservation of Jewish tradition, rather than adherence to Jewish law (as opposed to religious).

Pilot. A pilot version was tested among a sample of 31 respondents. Respondents were purposely selected to ensure variation in level of education. Cognitive interviewing, a qualitative method used to evaluate survey questions from the perspective of potential participants (Drennan, 2003) was then used to assess the clarity of the questions (Heyd-Metzuyanim et al., 2021). The questionnaire was modified based on their feedback.

Ethics The study was reviewed and approved by the Institutional Review Board at the Technion—Israel Institute of Technology (Approval #2020–032).

13.3.3 Sample

Participants were recruited by the market research company Ipanel, from an online representative panel of Hebrew speaking Israeli internet users (participants answer surveys for a modest reward given by Ipanel). In total, 439 participants completed

the questionnaire. Average completion time was 15.73 min (SD 50 min, range 3–281 min). Table 13.1 compares the demographics of the sample to the general Israeli population.

The survey was launched on April 2nd and closed on April 12th, 2020.

13.3.4 Data Analysis

Careless versus Careful index. This variable was based on respondents' claims in the two dilemmas and on their response to the direct close-ended question asking about general adherence to the guidelines. Calculation of the index used an average of the scores of these 3 questions (as detailed in Table 13.2). Table 13.2 shows the distribution of respondents' claims for each of the questions (0–2 for each of the dilemmas and 0–3 for the closed question). A score of 0 indicates carelessness, and an increase of this score indicates higher levels of careful behavior regarding the COVID-19 governmental guidelines and recommendations (range 0.33–2.33, average 2 SD. 0.3).

Justification. This variable is based on Osborne's (2010) components of an argument, specifically data and warrant. Respondents' formed justifications for their claim about the COVID-19-related dilemmas and these were coded based on a codebook, that was developed to analyze COVID-19 related dilemmas (OECD, 2020; Taragin-Zeller et al., 2020). The codebook included the following 3 categories:

(17) Justification of claim. These included two codes: first we coded for justification theme (Table 13.3) and then we coded for spontaneous reference to sources of authority. In case of multiple justifications, up to three different themes were coded.

(18) Spontaneous reference to sources of authority. These included mass media, social media, government websites like the Ministry of Health, university, and research institutes websites and more. However, respondents only referred to the Ministry of Health as a source of authority.

(19) Health-related justification. The proportion of health-related justifications (Table 13.3) was calculated out of the total number of justifications for each respondent. This included five themes: Health, Reference to high-risk populations, National institutions and authority, Responsibility and concern for immediate environment and Public concern (range 0-1 average 0.6 SD. 0.35).

(20) Argument quality. The quality of argumentation was scored based on (1) providing a justification of claim (1 point), (2) the number of health-related justifications (up to three points), and (3) 1 point to those referring to a relevant information source, such as The Ministry of Health, (range 0-4, average 1.96 SD. 0.76).

Coding procedure and intercoder reliability. Coding was conducted by two individual coders. Reliability test was run for 10% of all answers (50 answers for each dilemma). Cohen's Kappa results for the justification $K = 0.8$, and for source of authority $K = 0.86$.

Table 13.2 Careful versus Careless Coding scheme and distribution of respondents' stance for COVID-related dilemmas and general adherence to governmental guidelines and recommendations. Range of score on the index run 0–2.33 (average)

Dilemmas	0 points (Careless)		1 point		2 points		3 points (Careful)	
	Claim	Frequency	Claim	Frequency	Claim	Frequency	Claim	Frequency
Visiting elderly family members (n = 438)	'Yes, I will visit the elderly family members'	4 (0.9%)	'Yes, but while keeping distance'	32 (7.3%)	'No' or 'Yes, but I will just drop things (such as groceries) outside the door'	402 (91.8%)	NA	
Celebrating Passover with elderly family members (n = 435)	'Yes, I will celebrate Passover with the elderly family members'	14 (3.2%)	'Yes, but while keeping distance'	13 (3%)	'No'	408 (93.8%)	NA	
Self reported general adherence to the guidelines (n = 439)	'I don't follow the guidelines'	4 (0.9%)	'I partial fulfill the guidelines'	34 (7.7%)	'I apply the restrictions when they come into force'	290 (66.1%)	'I apply the restrictions even before they enter into force'	111 (25.3%)

Table 13.3 Coding scheme and distribution of respondents' justification's theme for their claims on COVID-related dilemmas[a]. 'n' refers to the number of respondents for each dilemma[b]

Justification theme	Example	Visiting elderly family member's claims (n = 426)				Celebrating passover claims (n = 386)				Total
		'No' or 'Yes, but I will just drop things outside the door'	'Yes, but while maintaining distance'	'Yes'	Total	'No'	'Yes, but while maintaining distance'	'Yes'	Total	
Health, medicine and science										
Health	'Health comes before everything'	283	14	2	226 (42.6%)	242	8	2	325 (52.1%)	551 (47.6%)
Reference to high-risk populations	'My mother has cancer, so it is dangerous for her'	70	3	1	74 (14%)	51	1	0	52 (8.3%)	126 (10.9%)
Responsibility and concern for immediate environment	'It is important to me to keep my family healthy'	19	2	0	21 (4%)	65	0	1	66 (10.6%)	87 (7.5%)
Public concern	'To protect the public'	37	1	0	38 (7.2%)	16	0	0	16 (2.6%)	54 (4.7%)
Other										
Personal reasons	'Helping my parents clean up for Passover'	75	8	0	83 (15.7%)	74	1	4	79 (12.7%)	162 (14%)

(continued)

Table 13.3 (continued)

Justification theme	Example	Visiting elderly family member's claims (n = 426)				Celebrating passover claims (n = 386)				Total
		'No' or 'Yes, but I will just drop things outside the door'	'Yes, but while maintaining distance'	'Yes'	Total	'No'	'Yes, but while maintaining distance'	'Yes'	Total	
National institutions and authority	'These are the instructions of the Ministry of Health'	31	5	1	37 (7%)	48	2	0	50 (8%)	87 (7.5%)
Decision making in the face of uncertainty	'I don't know if I was exposed to an undiagnosed Corona patient and whether I can then infect others'	32	3	1	36 (6.8%)	19	0	1	20 (3.2%)	56 (4.8%)
Religion	'Taking care of parents is a mitzvah'[c]	9	3	0	12 (2.3%)	11	0	1	12 (1.9%)	24 (2.1%)
Lack of concern	'The corona is not a severe disease'	3	0	0	3 (0.6%)	3	0	1	4 (0.64%)	7 (0.6%)

As some people offered more than one justification (up to 3), the total number of justifications is higher than the number of respondents

[a] The percentages are from all the respondents who chose the claim in any dilemma

[b] The n described in this table refers to the number of participants who answered both the open ended (arguments) and close ended questions (behavior)

[c] 'Mitzvah' is a religious commandment in Judaism

13.3.5 Statistical Analysis

The association between the Careless versus Careful index and characteristics of the justifications (Health related justification and Argument quality) were tested using a Pearson correlation. The association between demographic characteristic, Careless versus Careful index and justifications were tested using a Chi- square test. The analyses were conducted using SPSS version 24.

13.3.6 Methodological Limitations

Compared to the general population, our sample was male dominant, was more educated and more secular. In addition, there were more responses to the close-ended questions than to the open-ended questions (an average of 437 responses compared to 407).

13.4 Findings

First, argumentation patterns for each of the COVID-19 dilemmas will be presented, followed by the interactions between the variables.

13.4.1 RQ1. Which Justifications Do People Use to Explain Their Stance on COVID-19 Related Dilemmas?

Visiting Elderly Family Members: Government Recommendations.

438 respondents replied to this question. Over 90% of them adhered to the recommendations and said they will not meet in person their elderly family members, of them 66.2% declared they would completely adhere to the recommendations and not visit elderly family members and 24% declared that they would only put items near their door. The remaining respondents were divided up between two claims: 7.3% declared they would partially adhere to the recommendation were visiting elderly family members while maintaining social distancing, and only 0.9% bluntly declared that they will visit (Table 13.2).

The respondents' justifications were classified into eleven themes (n = 426) (Table 13.3): Health justifications, were the most prevalent, e.g. 'We need to keep distance, because we cannot know who carries the virus' Among the respondents who claimed that they will adhere to the recommendations, health arguments highlighted the threat of the virus. For example, 'The virus is very contagious, so it is best to avoid meetings'. Among those who said they would not fully adhere to the recommendations,

the health justification contained reservations. For example, 'Although the virus is dangerous, it is difficult for my parents because they are lonely'. In addition, other justification themes were: Personal reasons and thinking about populations at risk were both rather prevalent themes, followed by thinking about public health, Law and guidelines, and decision making in the face of uncertainty.

Only 1.2% of the respondents spontaneously referenced sources of authority in their justifications, and all of them said that they will adhere to the recommendations. The only source the respondents referred to was the Ministry of Health, and it appeared in two themes: *health* e.g. 'It is about the health of people in addition to the regulations of the Ministry of Health which are laws to which we are bound' and *concern for the immediate environment* e.g. 'Ministry of Health regulations are designed to protect those who are close to me'.

Celebrating Passover with Elderly Family Member: Government Guidelines

Over 93% of the participants adhered to the guidelines and declared that they will not celebrate Passover dinner with their family, including the elderly family members. Over 6% said they would not follow the guidelines. Of them half declared that they would celebrate Passover dinner with their family members, but would maintain distance and another half declared that they would celebrate as usual (Table 13.2).

The respondents' justifications were classified into eleven themes (n = 386) (Table 13.3): Health justifications, were the most prevalent, e.g. 'We need to keep our family healthy and if one Seder night without them is what is needed then it is worth it and we will celebrate together many more things in the future'. Among the respondents who claimed that they will adhere to the guidelines, health justifications highlighted the threat of the virus. Among those who said they would celebrate Passover dinner while maintaining social distancing, the health justifications contained a reference to the fact that social distancing mitigates the risks of the virus. For example: 'As long as you keep a distance the virus is less dangerous'.

In addition, other justification themes were: Personal reasons, that emphasized the difficulty of the respondent's parents in celebrating Passover alone, concern for immediate environment and reference to high-risk populations, followed by, law and guidelines, decision making in face of uncertainty, public concern, religion and lack of concern (Table 13.3).

Only 2.5% of responded spontaneously referenced sources of authority, and again all of them adhered to the guidelines and referred to the Ministry of Health in two ways: *Health.* e.g. 'High chance of being infected according to the Ministry of Health' and *Law and guidelines* e.g. 'Because these are Ministry of Health guidelines'.

13.4.2 *RQ2. What is the Connection Between Demographic Characteristics, Scientific Knowledge and Education and Decision Making (Stance and Justification)?*

What are the variables that interact with the characteristics of the justifications?

After reviewing the responses to each of the dilemmas separately, we analyzed the level of conformity with health guidelines (Passover dilemma and how do you usually behave in regard to limitations) and recommendations (visiting the elderly family members). We then calculated the percentage of health-related justifications and the quality of argumentation and examined what variables are associated with them.

The Health-related justification is an index that presents the proportion of health justifications (Table 13.3) out of the total justifications given by the respondent. A low level of Health-related justifications includes such themes that were classified as unrelated to health issues, e.g., 'because I miss them', 'COVID is global conspiracy headed by Bill Gates'. A medium level of Health related justifications included such themes that were classified as both related and unrelated to health justifications, e.g., "on the one hand my parents are lonely, on the other hand it puts them at risk". A high level of Health related justifications included health related justifications exclusively e.g., "this disease is dangerous for elderly people, and a person that gets infected can infect additional people'. The proportion of health related justifications were associated with the respondents' level of Careless versus Careful index ($r = 0.164$, $p < 0.001$) (Fig. 13.1). Meaning that the more respondents follow the guidelines, the more likely they were to give health justifications for their claims.

Another aspect examined was argument quality index. A low-quality argument usually consists of one justification unrelated to health, without reliance on sources of information, e.g. 'this is an opportunity to celebrate alone'. A high-quality argumentation, consists of a number of justifications related to health., e.g. 'It is necessary to be careful and follow the guidelines. To maintain our health and theirs so that we can celebrate together in holidays to come' or contained reference to a source of authority, such as the Ministry of Health. The argument quality index was associated with the respondents' level of Careless versus Careful index ($r = 0.219$, $p < 0.0001$) (Fig. 13.1). Meaning that the more respondents follow the guidelines, the more likely they were to give a high- quality argument.

Comparing the Health-related justifications and the quality of the argument in the first dilemma (visiting the elderly, Fig. 13.1a) and in the second dilemma (Passover, Fig. 13.1b) indicated that the average Health related justifications as well as the quality of argument are higher for the first dilemma.

Moreover, in the first dilemma (visiting the elderly), those who claimed they will follow the guidelines gave, on average more health related and quality argumentation, compared to those who claimed they follow the guidelines in the second dilemma (Passover) (Fig. 13.1a, b). On the other hand, those who answered that they will not follow the guidelines in the first dilemma gave less health related and quality argumentation compared to those who claimed this for the second dilemma.

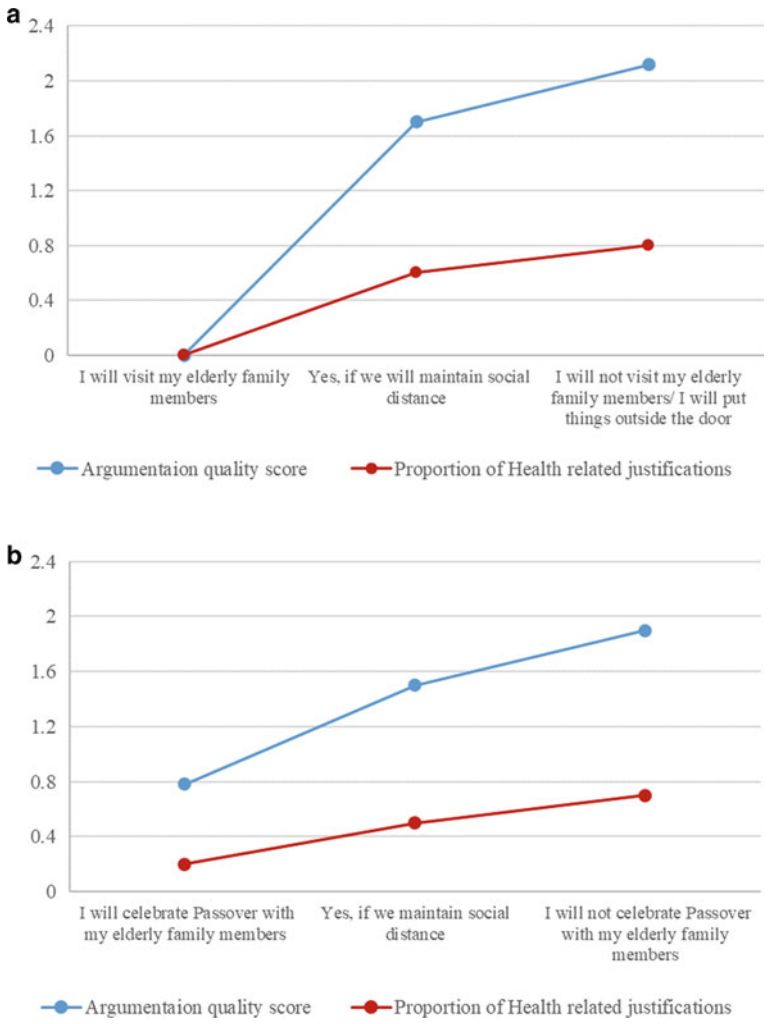

Fig. 13.1 Proportion of health-related justifications and argumentation quality on COVID-related dilemmas. **a** Visiting elderly family members (n = 429) **b** Celebrating Passover with elderly family members (n = 386)[2]

The Careless versus Careful index was associated with the perception of control over the situation ($r = 0.105$, $p < 0.05$) (Fig. 13.2). The higher the respondent's perception of control was the more they tended to comply with the guidelines.

[2] Health related justifications include the following themes: Health; Reference to high-risk populations; Responsibility and concern for immediate environment; National institutions and authority, and Public concern. The quality of argumentation sums scores for: Providing justification of the claim, The number of Health related justification and spontaneously reference to source of authority.

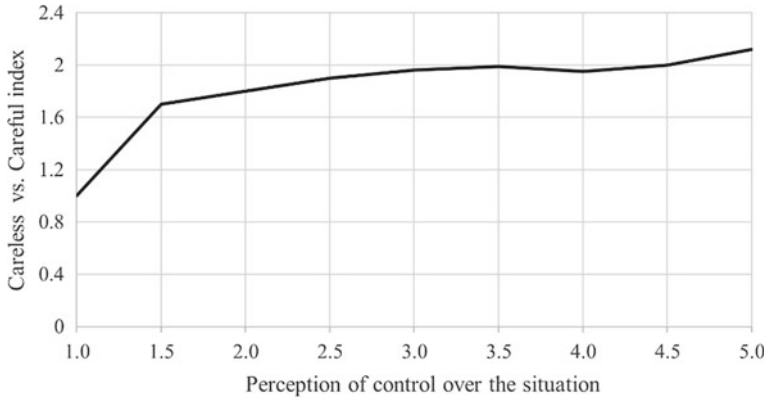

Fig. 13.2 Association between perception of control over the situation and Careless versus Careful index (n = 427)[3]

Our findings did not indicate a significant association between the level of education and scientific knowledge and the argumentation.

13.5 Discussion

This chapter provides a snapshot of public engagement in the initial stages of the COVID-19 pandemic. Our findings demonstrate that most of the public follow official guidelines and recommendations, however, adherence to formal guidelines (Passover dilemma) was higher than the adherence to the recommendations (visiting elderly family members). The survey was conducted during the first lockdown that was followed by 2 more lockdowns. After the subsequent lockdowns data showed that public tendency to follow strict guidelines deteriorates (Academia IL, 2020; Chen et al., 2020). Our data reinforces these surveys to suggest that policy makers have a window of opportunity to gain public trust and obedience, but these will probably be eroded over time. The reasons for this are varied and are beyond the scope of this study.

Globally, societies were faced with a variety of social dilemmas related to COVID-19, often these were similar to the dilemmas faced by Israelis. People wanted to visited family members, celebrate together momentous events all while trying to maintain the health of their families (and communities).

In our survey, frequently used justification themes (Table 13.3) were health-related, demonstrating use of scientific or health argumentation that is not related to

[3] Careless versus. Careful index was calculated according to the respondents' claims regarding how they would have behaved in the two dilemmas and the closed question dealing with their behavior regarding the guidelines. The higher the score in the index, the more careful the respondent is. The perception of control is the average of their answers to three closed questions on a scale of 1 to 5.

science knowledge nor to education levels. In addition, rarely do participants refer to experts and authority spontaneously when justifying their stance, and this is a consistent finding (Taragin-Zeller et al., 2020). We also found a positive association between respondents' Careful versus careless stance and their health-related justification and argument quality. When people are more careful (tend to follow guidelines and recommendations) they are more likely to use high quality arguments and more health-related justifications. It seems that people tend to follow guidelines when they make sense of them—i.e. when they are able to make coherent health-related arguments. Overall, the public in Israel in these early stages of the pandemic probably believed public messages and felt some sense of felt control that contributed to their use of relevant health-related arguments (Dieckmann & Johnson, 2019).

Our findings do not point to an association between science knowledge and decision making (either in the claims or justifications). These findings add to existing studies demonstrating that scientific knowledge is not enough when looking at daily decision making and argumentation, especially when engaging with complex SSIs (Feinstein & Meshoulam, 2014; Jho et al., 2014; Taragin-Zeller et al., 2020). This is especially crucial since SSIs usually involve dilemmas that combine knowledge, values and beliefs that are often contradictory for the individual (Jho et al., 2014). Moreover, determining what scientific knowledge people need when making such decisions is still widely debated (Feinstein, 2011).

Crowell and Schunn (2016) examined whether studying science leads to applying it to situations in peoples' daily lives—the transfer of science from classroom to real life. Their study on adults in the American Midwest found little impact on environmental conservation action. Our study provides another demonstration of this—science knowledge gained in formal setting is not relevant to observing COVID-19 guidelines. However, our findings do demonstrate that overall people tend to understand the health context of our dilemmas and thus frame their justifications (and claims) within a health-related framework.

Moving forward we believe that policy makers, especially in the field of health and education need to understand that argumentation skills in SSIs may not come naturally to lay-people. This means that '… that argumentation is a form of discourse that needs to be appropriated by children and explicitly taught through suitable instruction, task structuring, and modeling (Erduran et al., 2004)'. Thus, the implications of our study apply to different arenas and different locations. First, we must dive more in-depth into argumentation process in the context of daily decision making during a pandemic. Second, we must continue with curricular reform in school science so that future citizens are better prepared for engaging with SSIs. Lastly, policy makers at the time of a pandemic need to be aware of how people form arguments and make decisions and how their engagement changes over time so that they can form better policy solutions and responses.

Further studies will need to examine scientific knowledge in the context of relevant and real-life dilemmas (i.e., COVID-19) as some researchers suggest that contextual knowledge augments the effect of general scientific knowledge in different ways (Sturgis & Allum, 2004). Another aspect of argumentation that needs to be explored is the social component – since it has been claimed that 'social-discursive and dialogic

argumentation is an integral component of many scientific reasoning processes' (Fischer et al., 2014, p. 35). Thus, looking at social dialogues and discourse, for example in social networks, in the context of negotiating decisions in COVID-19 related dilemmas can be an important step forwards in our understanding of how the public engages with relevant science.

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References

Academia IL collective impact: Covid19. (2020). Retimat ha'tzibur lehitmodedut im magefatha'Corona [Recruiting the public to withstand the Corona pandemic]. Retrieved from https://drive.google.com/file/d/1cE1FGYuSwEDJRf3PvRO8-gGNFcYpfs45/view

Allchin, D. (2011). What do we mean by science education for civic engagement? *Journal of Research in Science Teaching, 53*(6), 805–820. https://doi.org/10.1002/tea.21303

Baram-Tsabari, A. Bronshtein, J., Rozenblum, Y., & Barel-Ben David, Y. Swirski, H. (2020). Sports fans' science knowledge is relevant to their stance on COVID-19 guidelines, but only if they don't care who wins. In *Public communication of science and technology (PCST) 2020+1 Conference.*

Braund, M. (2021). Critical STEM literacy and the COVID-19 pandemic. *Canadian Journal of Science, Mathematics and Technology Education*, 1–18.

Chen, K., Bao, L., Shao, A., Ho, P., Yang, S., Wirz, C. D., Brossard, D., Brauer, M., & Brown, L. (2020). How public perceptions of social distancing evolved over a critical time period: Communication lessons learnt from the American state of Wisconsin. *Journal of Science Communication, 19*(5), A11. https://doi.org/10.22323/2.19050211

Colucci-Gray, L. (2014). Beyond evidence: A critical appraisal of global warming as a socio-scientific issue and a reflection on the changing nature of scientific literacy in school. *Cultural Studies of Science Education, 9*(3), 633–647. https://doi.org/10.1007/s11422-013-9556-x

Crowell, A., & Schunn, C. (2016). Unpacking the relationship between science education and applied scientific literacy. *Research in Science Education, 46*(1), 129–140. https://doi.org/10.1007/s11165-015-9462-1

Dalyot, K., Sharon, A. J., Orr, D., Barel Ben-David, Y., & Baram-Tsabari, A. (2019). Public Engagement with science in everyday life: Perceptions of Wi-Fi radiation risks in schools. *Research in Science Education.* https://doi.org/10.1007/s11165-019-09894-w

Dieckmann, N. F., & Johnson, B. B. (2019). Why do scientists disagree? Explaining and improving measures of the perceived causes of scientific disputes. *PLoS ONE, 14*(2), 1–23. https://doi.org/10.1371/journal.pone.0211269

Drennan, J. (2003). Cognitive interviewing: Verbal data in the design and pretesting of questionnaires. *Journal of Advanced Nursing, 42*(1), 57–63. https://doi.org/10.1046/J.1365-2648.2003.02579.X

Driver, R., Newton, P., & Osborne, J. (2000). Establishing the norms of scientific argumentation in classrooms. *Science Education, 84*(3), 287–312. https://doi.org/10.1002/(SICI)1098-237X(200005)84:3%3c287::AID-SCE1%3e3.0.CO;2-A

Drummond, C., & Fischhoff, B. (2017). Individuals with greater science literacy and education have more polarized beliefs on controversial science topics. *Proceedings of the National Academy of Sciences of the United States of America, 114*(36), 9587–9592. https://doi.org/10.1073/pnas.1704882114

Erduran, S., Simon, S., & Osborne, J. (2004). TAPping into argumentation: Developments in the application of Toulmin's argument pattern for studying science discourse. *Science Education, 88*(6), 915–933. https://doi.org/10.1002/sce.20012

Feinstein, N. (2011). Salvaging science literacy. *Science Education, 95*(1), 168–185. https://doi.org/10.1002/sce.20414

Feinstein, N. W., & Meshoulam, D. (2014). Science for what public? Addressing equity in American science museums and science centers. *Journal of Research in Science Teaching*, *51*(3), 368–394. https://doi.org/10.1002/tea.21130

Fischer, F., Kollar, I., Ufer, S., Sodian, B., Hussmann, H., Pekrun, R., Neuhaus, B., Dorner, B., Pankofer, S., Fischer, M., Strijbos, J.-W., Heene, M., & Eberle, J. (2014). Scientific reasoning and argumentation: Advancing an interdisciplinary research agenda in education. *Frontline Learning Research*, *5*, 28–45. https://doi.org/10.14786/flr.v2i3.96

Gabrys, R. L., Tabri, N., Anisman, H., & Matheson, K. (2018). Cognitive control and flexibility in the context of stress and depressive symptoms: The cognitive control and flexibility questionnaire. *Frontiers in Psychology*, *9*(2219). https://doi.org/10.3389/fpsyg.2018.02219

Heyd-Metzuyanim, E., Sharon, A., & Baram-Tsabari, A. (2021). Public understanding of the mathematical aspects of the COVID-19 pandemic and its relation to school mathematics education. *Educational Studies in Mathematics*.

Howarth, C., Parsons, L., & Thew, H. (2020). Effectively communicating climate science beyond academia: Harnessing the heterogeneity of climate knowledge. *One Earth, 2*(4), 320–324. https://doi.org/10.1016/j.oneear.2020.04.001

Jho, H., Yoon, H. G., & Kim, M. (2014). The relationship of science knowledge, attitude and decision making on socio-scientific issues: The case study of students' debates on a nuclear power plant in Korea. *Science and Education, 23*(5), 1131–1151. https://doi.org/10.1007/s11191-013-9652-z

Jiménez-Aleixandre, M. P., & Erduran, S. (2007). Argumentation in science education: An overview. In M. P. Jiménez-Aleixandre & S. Erduran (eds.), *Argumentation in Science Education* (pp. 3–25). Springer. https://doi.org/10.2505/4/tst13_080_05_30

Kuhn, D. (1991). *The Skills of Argument*. Cambridge University Press. https://books.google.co.il/books?hl=iw&lr=&id=q0ra0DxRTNEC&oi=fnd&pg=PA1&dq=the+skills+of+argument&ots=v4EHXLJyl4&sig=svnX8Bwl1kF38JRMK6K302A6nj4&redir_esc=y#v=onepage&q=theskillsofargument&f=false

Lammers, J., Crusius, J., & Gast, A. (2020). Correcting misperceptions of exponential coronavirus growth increases support for social distancing. *Proceedings of the National Academy of Sciences of the United States of America, 117*(28), 16264–16266. https://doi.org/10.1073/pnas.2006048117

Lazarou, D., Erduran, S., & Sutherland, R. (2017). Argumentation in science education as an evolving concept: Following the object of activity. *Learning, Culture and Social Interaction, 14*, 51–66. https://doi.org/10.1016/j.lcsi.2017.05.003

Lewis, J., & Leach, J. (2006). Discussion of socio-scientific issues: The role of science knowledge. *International Journal of Science Education, 28*(11), 1267–1287. https://doi.org/10.1080/09500690500439348

Meppelink, C. S., Smit, E. G., Fransen, M. L., & Diviani, N. (2019). "I was right about vaccination": Confirmation bias and health literacy in online health information seeking. *Journal of Health Communication, 24*(2), 129–140. https://doi.org/10.1080/10810730.2019.1583701

OECD. (2017). *OECD digital economy outlook 2017*. OECD. https://doi.org/10.1787/9789264276284-en. Retrieved from: https://www.oecd-ilibrary.org/science-and-technology/oecd-digital-economy-outlook-2017_9789264276284-en

OECD. (2020). *PISA 2024 strategic vision and direction for Science* (Issue March). OECD. https://www.oecd.org/pisa/publications/PISA-2024-Science-Strategic-Vision-Proposal.pdf

Orr, D., & Baram-Tsabari, A. (2018). Science and politics in the polio vaccination debate on Facebook: A mixed-methods approach to public engagement in a science-based dialogue. *Journal of Microbiology & Biology Education*, *19*(1). https://doi.org/10.1128/jmbe.v19i1.1500

Osborne, J., Erduran, S., & Simon, S. (2004). Enhancing the quality of argumentation in school science. *Journal of Research in Science Teaching, 41*(10), 994–1020.

Osborne, J. F., Henderson, J. B., MacPherson, A., Szu, E., Wild, A., & Yao, S. (2016). The development and validation of a learning progression for argumentation in science. *Journal of Research in Science Teaching, 53*(6), 821–846. https://doi.org/10.1002/tea.21316

Plohl, N., & Musil, B. (2021). Modeling compliance with COVID-19 prevention guidelines: The critical role of trust in science. *Psychology, Health & Medicine ISSN, 26*(1), 1–12. https://doi.org/10.1080/13548506.2020.1772988

Puppo, F., Corradi, S., & Zoppellari, L. (2022, this volume). Rhetoric and argumentation in the pandemic legislation: The Italian case. In S. Oswald, M. Lewiński, S. Greco, & S. Villata (Eds.), *The pandemic of argumentation* (pp. 161–182). Springer. https://doi.org/10.1007/978-3-030-91017-4_9

Romine, W. L., Sadler, T. D., & Kinslow, A. T. (2017). Assessment of scientific literacy: Development and validation of the quantitative assessment of socio-scientific reasoning (QuASSR). *Journal of Research in Science Teaching, 54*(2), 274–295.

Rudolph, J. L., & Horibe, S. (2016). What do we mean by science education for civic engagement? *Journal of Research in Science Teaching, 53*(6), 805–820. https://doi.org/10.1002/tea.21303

Sadler, T. D., Barab, S. A., & Scott, B. (2007). What do students gain by engaging in socioscientific inquiry? *Research in Science Education, 37*(4), 371–391. https://doi.org/10.1007/s11165-006-9030-9

Sadler, T. D., & Donnelly, L. A. (2006). Socioscientific argumentation: The effects of content knowledge and morality. *International Journal of Science Education, 28*(12), 1463–1488. https://doi.org/10.1080/09500690600708717

Sadler, T. D., & Zeidler, D. L. (2009). Scientific literacy, PISA, and socioscientific discourse: Assessment for progressive aims of science education. *Journal of Research in Science Teaching, 46*(8), 909–921. https://doi.org/10.1002/tea.20327

Shauli, S., & Baram-Tsabari, A. (2019). The usefulness of science knowledge for parents of hearing-impaired children. *Public Understanding of Science, 28*(1), 19–37. https://doi.org/10.1177/0963662518772503

Sharon, A. J., & Baram-Tsabari, A. (2020). Can science literacy help individuals identify misinformation in everyday life? *Science Education, 104*(5), 873–894. https://doi.org/10.1002/sce.21581

Sherkat, D. E. (2011). Religion and scientific literacy in the United States. *Social Science Quarterly, 92*(5), 1134–1150. https://doi.org/10.1111/J.1540-6237.2011.00811.X

Simonneaux, L. (2008). Argumenttaion in socio-scientific context. In S. Erduran & M. P. Jiménez-Aleixandre (Eds.), *Argumentation in science education: Perspectives from classroom-based research* (pp. 187–199). Springer.

Šrol, J., Ballová Mikušková, E., & Čavojová, V. (2021). When we are worried, what are we thinking? Anxiety, lack of control, and conspiracy beliefs amidst the COVID-19 pandemic. *Applied Cognitive Psychology*. https://doi.org/10.1002/acp.3798

Sturgis, P., & Allum, N. (2004). Science in society: Re-evaluating the deficit model of public attitudes. *Public Understanding of Science, 13*(1), 55–74. https://doi.org/10.1177/0963662504042690

Taragin-Zeller, L., Rozenblum, Y., & Baram-Tsabari, A. (2020). Public engagement with science among religious minorities: Lessons from COVID-19. *Science Communication, 42*(5), 643–678. https://doi.org/10.1177/1075547020962107

Tomasi, S. (2022, this volume). The case of Coronavirus Contact-Tracing Apps: Arguments for trust. In S. Oswald, M. Lewiński, S. Greco, & S. Villata (Eds.), *The pandemic of argumentation* (pp. 183–198). Springer. https://doi.org/10.1007/978-3-030-91017-4_10

Van Prooijen, J. W., & Van Dijk, E. (2014). When consequence size predicts belief in conspiracy theories: The moderating role of perspective taking. *Journal of Experimental Social Psychology, 55*, 63–73.

Weeth Feinstein, N., Allen, S., & Jenkins, E. (2013). Outside the pipeline: Reimagining science education for nonscientists. *Science, 340*(6130), 314–317. https://doi.org/10.1126/science.1230855

Zangori, L., Peel, A., Kinslow, A., Friedrichsen, P., & Sadler, T. D. (2017). Student development of model-based reasoning about carbon cycling and climate change in a socio-scientific issues unit. *Journal of Research in Science Teaching, 54*(10), 1249–1273. https://doi.org/10.1002/tea.21404

Zeidler, D. L., & Nichols, B. H. (2009). Socioscientific issues: Theory and practice. *Journal of Elementary Science Education @BULLET Spring Journal of Elementary Science Education*, *21*(2), 49–58. http://files.eric.ed.gov/fulltext/EJ849716.pdf