

THE INVESTIGATION OF INFORMAL REASONING IN PROXIMAL AND
DISTAL CONTEXTS OF SOCIO-SCIENTIFIC ISSUES

by

Özlem Özdemir

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Dedicated to my dear family and to my advisor Devrim Güven

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ABSTRACT

THE INVESTIGATION OF INFORMAL REASONING IN PROXIMAL AND DISTAL CONTEXTS OF SOCIO-SCIENTIFIC ISSUES

The purpose of this study is to investigate pre-service science teachers (PSTs) informal reasoning, the factors considered by PSTs and the utilization of the nature of science (NOS) understanding in two contexts of socio-scientific issues (SSI): proximal (Use of Processed Foods in Turkey) and distal (Production and Use of Golden Rice in Vietnam). Nineteen PSTs were selected purposefully. They participated in this multi-case study and were individually asked to respond to the same interview questions about two SSI scenarios prepared to be paralleled to each other in terms of general theme, balanced evidence, and structure. Data was analyzed deductively by using three patterns (rationalistic, emotive, and intuitive) established by the (Zeidler & Sadler, 2005) to determine informal reasoning. Also, factors considered by PSTs in resolving the issues were categorized into five: health, economic, moral and ethical, personal, and environmental considerations. The utilization of four aspects of NOS understanding: risk analysis in science, social embeddedness of science, tentative and subjective nature of scientific knowledge were examined and specified as naive, mixed, and informed. Findings indicated that PSTs displayed more rationalistic thinking (logic-based) in resolving the issue in distal context of SSI while displaying more emotive (care-based) thinking in proximal one. Also, in distal context, PSTs used concerns written in the text while they used personal experiences in the proximal one. PSTs utilized more informed belief about four aspects of NOS understanding in distal context than in proximal one. This findings are discussed to have implications for preparing effective SSI cases to be used in classroom instruction.

ÖZET

SOSYOBİLİMSEL KONULARIN YAKIN VE UZAK BAĞLAMLARINDA KRİTİK DÜŞÜNME YETENEĞİNİN İNCELENMESİ

Bu çalışmanın amacı, fen bilgisi öğretmen adaylarının kritik düşünme yeteneklerini, problemi çözerken dikkate aldıkları faktörleri ve bilimin doğası anlayışlarını nasıl kullandıklarını iki sosyo-bilimsel konu (SBK) bağlamında araştırmaktır: yakın (Türkiye’de İşlenmiş Gıda Kullanımı) ve uzak (Vietnam’da Altın Pirinç Üretimi ve Kullanımı). 19 fen bilgisi öğretmen adayı bilinçli olarak seçilmiş ve genel tema, dengeli kanıt ve yapı açısından birbirine paralel olacak şekilde hazırlanan iki SBK senaryosu hakkında aynı görüşme sorularını bireysel olarak yanıtlamaları istenmiştir. Katılımcıların kritik düşünme yeteneklerini belirlemek için Sadler ve Zeidler (2005) tarafından oluşturulan üç kritik düşünme örüntüsü (rasyonel, duygusal ve sezgisel) kullanılarak veriler tümdengelsel olarak analiz edilmiştir. Sorunların çözümünde dikkate alınan faktörler beş kategoriye ayrılmıştır: sağlık, ekonomik, ahlaki ve etik, kişisel ve çevresel hususlar. Son olarak, bilimin doğası anlayışının: bilimde risk analizi, bilimin sosyal yerleşikliği, bilimsel bilginin geçici ve öznel doğası özelliklerinin nasıl kullanıldığı incelenip naif, karma ve bilgili şekilde sınıflandırılmıştır. Bulgular, uzak bağlamda sorunu çözerken daha rasyonel (kanıt ve mantığa dayalı), yakın bağlamda daha duygusal kiritik düşünme sergilediklerini göstermiştir. Uzak bağlamda, katılımcılar metinde yazılan faktörleri kullanırken yakın bağlamında kişisel deneyimlerini kullanmıştır. Katılımcılar, uzak bağlamda, bilimin doğası anlayışlarını daha bilinçli bir şekilde kullandılar. Bu bulguların, sınıfta kullanılacak etkili SBK hazırlanmasına yönelik çıkarımları olduğu tartışıldı.

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LIST OF ACRONYMS/ABBREVIATIONS

3D	Three Dimensional
AAAS	American Association for the Advancement of Science
FRA	Family Resemblance Approach
FOS	Features of Science
FRN	Reconceptualized Family Resemblance Approach to NOS
GMOs	Genetically Modified Organisms
GR	Golden Rice
MoNE	Ministry of National Education
NGSS	Next Generation Science Standards
NOS	Nature of Science
NRC	National Research Council
P	Participant
PF	Processed Food
PST	Pre-service Teacher
SSI	Socio-scientific Issue
SSR	Socio-scientific Reasoning
STS	Science – Technology - Society
STSE	Science – Technology – Society - Environment
OMC	Ordered Multiple-Choice
VNOS	Views of Nature of Science
QuASSR	Quantitative Assessment of Socio-scientific Reasoning

1. INTRODUCTION

In today's world, there is an irrevocable mutual relationship between science, technology, and society. Scientific knowledge and technology are always evolving and reinventing itself to develop understanding about the world and to address the needs of society. With the development of scientific knowledge, there have been new challenges influencing individuals in society. Individuals as citizens in society need to obtain scientific understanding, which promotes them to play an active role for dealing with these new challenges and to make decisions about these challenges (Lederman & Lederman, 2012; Sadler & Zeidler, 2005b). The internationally well-known goal of science education is raising students who use scientific knowledge to make decisions on social, personal, and scientific issues, as well as understanding how science works (e.g., American Association for the Advancement of science [AAAS, 1989]; National Research Council [NRC, 1996]). In other words, in a highly competitive society increasingly invaded by the products of technology and science, it is extremely important to raise scientifically literate individuals.

Over the decades, the meaning of scientific literacy as a concept has evolved. It basically refers to the ability of utilizing scientific understanding of social or personal aims (NRC, 1996). Individuals who are scientifically literate have sufficient awareness of science and scientific processes to make informed decisions about science-society-technology issues (Saunders & Rennie, 2013). In addition to the emergent view, Roberts (2007) mentioned that there are two visions of the concept of scientific literacy that have different meanings but are often used interchangeably: science literacy (Vision I) and scientific literacy (Vision II). It is important to distinguish both. Vision I points out how to handle the aspects of content within scientific disciplines. It focuses on academic content of science. On the other hand, a broader approach focusing on personal decision making about social and science issues is emphasized by Vision II (Roberts & Bybee, 2014). It focuses on scientific knowledge contextualized in a personally relevant way.

Vision II was extended and publicized as a term “*functional scientific literacy*” by giving attention to ethical and moral points, social and scientific issues (Zeidler et al., 2011). Experts had introduced these issues as socio-scientific issues (SSI) (Sadler et al., 2004; Zeidler et al., 2005). These issues are open-ended and ill-structured technological and scientific issues that have influence on society. Since SSI can potentially create dilemmas because of having no definitive solutions, individuals can reveal multiple perspectives in engaging and discussing the issues (Sadler, 2004a; Zeidler et al., 2002). Moreover, because of ethical dilemmas, the moral and ethical evaluation may be revealed while making judgement about scientific data by considering environmental preservation of the biological and psychological worlds and the quality of people in society’s well-being (Zeidler & Kahn, 2014).

Science educators focused on these kinds of conflicting ideas that lay at the intersection of science and society and conceptualize them as socio-scientific issues (SSI). There are many topics as instances of SSI such as ecology (genetically modified organisms (GMOs) genetic engineering (stem cell, cloning, gene therapy) and environment (nuclear power plant, land use decisions). For instance, the idea of building nuclear power plants in some countries that use a source of nuclear energy has risen with the population growth and advancements in science. Nuclear power plants provide more cost-effective energy at a constant capacity throughout the year and less harmful energy to the environment in terms of greenhouse gas emissions. On the other hand, even if the nuclear power plants are set up with strong safety precautions, radioactive waste due to accidents in nuclear power plants is highly polluted and potentially lethal for living organisms. When individuals are engaged with a well-designed scenario of building nuclear power plants in specific regions, some of them might promote that nuclear power plants should be built because more energy can be provided with less emission of greenhouse gases. Others might consider the life of living creatures and do not want to take the risk of any accident that may occur in nuclear power plants. Briefly, this issue can provide conflicting ideas among individuals in the society as well as among students when SSI are carried to science classrooms. Dealing with these controversial issues in the classrooms provides

opportunities to raise individuals with the development of cognitive, personal, and moral (Zeidler & Schafer, 1984). In this manner, the integration of SSI into science classroom provides students to make informed judgements and decisions related to the issue, which enables one of fundamental aims of science education, functional scientific literacy to be promoted in science classroom (Karisan & Zeidler, 2017). Many science educators agreed that all students should be functionally scientifically literate to make well-informed decisions about issues that affect the physical, biological, and social environment in the world (DeBoer, 2000; Holbrook & Rannikmae, 2009; Ryder, 2001; Zeidler & Kahn, 2014).

In addition to functional scientific literacy, when the SSI literature is examined, it is claimed that SSI-based instruction in science education can improve students' science content knowledge (Barab et al., 2007; Genel & Topcu, 2016; Sadler et al., 2016), motivation for learning science (Romine & Sadler, 2016; Romine et al., 2017), and argumentation skills (Khishfe, 2012b; Khishfe et al., 2017; Yacoubian & Khishfe, 2018) as well as their understanding of the nature of science (NOS) (Eastwood et al., 2012; Khishfe, 2012b; Khishfe & Lederman, 2006). Challenged with the SSI, individuals try to provide potential solutions to these issues by evaluating scientific evidence. They employ informal reasoning in their cognitive processes when resolving and negotiating the issues in making decisions (Romine & Sadler, 2016; Sadler & Zeidler, 2004; Sadler & Zeidler, 2005a; Zeidler et al., 2009).

In the one of popular research areas in 1980s, named Science-Technology-Society (STS) education, there was various studies that represent the interconnection of science, technology, and society. Later, studies had started to cover the issue of morality and environment in this connection. The area was changed to Science-Technology-Society- Environment (STSE) education in 1990s. Afterward, socio-scientific issues (SSI) approach has been introduced to declare some key elements of the connection with science, society, and technology such as personal experiences, argumentation skill, emotional and cultural issues, and nature of science conceptualization (NOS) during 2000s (Zeidler et al., 2005). In other words, as the contributions of socio-scientific issues

into science education were mentioned above, various skills of students as future citizens contributing to the society can be developed during making decisions in the context of SSI. Individuals try to negotiate and to resolve these issues related to real life that can potentially create scientific dilemmas among society. They may face these kinds of problems in real life, so they need to have ability to read, think, and criticize evidence related to issues and make decisions about the issues. More precisely, involving SSI instructions into science classroom aims to motivate students and to raise scientifically literate students by engaging controversial issues related real life problems.

Socio-scientific issues are already components of existing science curricula and are involved into science classrooms. The numbers of various SSIs that can be used in science classrooms had been increased with the changes in science and technology. Experts and science educators focused on how these can be designed and framed to support an effective learning environment. The content of SSI can be considered in preparing scenarios related scientific and societal issues such as environment, ecology, land use, gene therapy, stem cell or genetically modified foods. Moreover, the context of SSI can be generated differently. When the instances of SSI scenarios are examined, SSI can be the issue in one region: local one and the issue in all over world: global.

For this study, two local SSIs were selected and designed. These were the consumption of Processed Food in Turkey and the production and the consumption of Golden Rice in Vietnam. By considering the categories about the nature of science understanding suggested by Hogan (2000), these issues were categorized as distal and proximal contexts of SSI. According to Hogan (2000), the knowledge of NOS understanding can be categorized as the epistemology of professional science (distal knowledge) and the epistemology of science perceived and experienced by people (proximal knowledge). In this study, the issue about Processed Food in Turkey can be observed and experienced by participants in Turkey. As in resolving this issue their decisions potentially affect directly their own lives, this context of SSI was specified as proximal. The other issue that was related to the production and consumption of Golden Rice in Vietnam cannot be experienced by the participant of this study. They

were not familiar with the society that was distant from the participants, so their decisions about this issue do not influence their lives. This context was specified as the distal context of SSI. These SSI contexts included scientific and societal points and required risk analysis related to the issue but were given under different contexts. There is scarcity of studies that consider designing and preparing SSI contexts for classroom use in the literature. This study aimed to investigate learners' informal reasoning, factors considered in resolving the issue, and utilization of their scientific epistemology in distal and proximal context of socio-scientific issues.

1.1. The Purpose of the Study

Developing scientific thinking habits, reasoning skills and the abilities of decision- making through SSI are significant aims of science education as illustrated in the Turkish Ministry of National Education curriculum (MoNE, 2018). Moreover, studies showed that the integration of SSI into science classrooms can reinforce not only learning content knowledge, but also developing critical thinking, communication, argumentation, decision making and reasoning skills (Eastwood et al., 2012; Klosterman & Sadler, 2010; Zeidler et al., 2009). Moreover, SSI instruction provides students to be more motivated in participating in the discussion in science classrooms (Sadler & Dawson, 2012).

When the contributions of SSI are considered, it can be stated that SSI can construct an excellent context to reach democratic goals such as improving students' citizenship and social skills. These skills are precisely the aims of science education programs around the world, namely scientific literacy. Given the crucial role of SSI portrayed by the aim of scientific literacy, determining how the context and the design of SSI issues should be becomes important. To address the gap in the existing knowledge base about designing and preparing contexts of SSI, more research is needed. Respectively, since the purpose of this study is to investigate pre-service science teachers' informal reasoning, factors considered in resolving the issues, and their scientific epistemology in distal and proximal contexts of SSI, the findings of

this study provides to show the importance of designing the context of SSI regarding participants' informal reasoning, and utilization of their scientific epistemology.

1.2. Research Questions

The study aims to investigate pre-service science teachers' informal reasoning skills in resolving the issues in the proximal and distal contexts of SSI and factors considered by them while resolving the issues. Moreover, another aim of the study is to determine utilization of the nature of science (NOS) aspects by pre-service science teachers during resolving the issues in both contexts. The following three research questions guided the present study:

1. What are pre-service science teachers' informal reasoning patterns while resolving socio-scientific issues (SSI) in distal (Golden Rice) and proximal (Processed Food) contexts?
2. What are the factors considered by pre-service science teachers while resolving socio-scientific issues (SSI) in distal (Golden Rice) and proximal (Processed Food) contexts?
3. What nature of science understandings are utilized by pre-service science teachers while resolving socio-scientific issues (SSI) in distal Golden Rice) and proximal (Processed Food) contexts?

1.3. Significance of the Study

In this study, there were two contexts of socio-scientific issues, distal (The Production and consumption of Golden Rice in Vietnam) and proximal (The Consumption of Processed Food in Turkey). These contexts were designed regarding whether the issue includes a problem-solving process that will potentially affect the lives of the participants of this study. The informal reasoning in these contexts of SSI

was investigated. While participants were trying to resolve these controversial SSIs, they considered some factors related to issues. It also examined these factors considered by participants in distal and proximal contexts of SSI. This study has been devised to contribute to designing the context of SSI for instructional purposes. If there is any difference between participants' informal reasoning in resolving the issue at different contexts, it might be argued that context has influence on informal reasoning. In other words, the findings of this study may provide information about how socio-scientific issues scenarios should be prepared for promoting the learning environment and for motivating students in the classroom. Moreover, any difference in participants' informal reasoning in two contexts helps science educators to realize how to organize the context for effective learning and how to integrate them into the classroom for contributing to functional scientific literacy. In short, educators may realize how to determine an effective context to reveal students' informal reasoning.

In addition to informal reasoning skills, the researcher determined which aspects of the nature of science (NOS) can be revealed and utilized while preparing two contexts of SSI. The participants can use NOS aspects as a resource to analyze, evaluate, and make decisions about two contexts. Since two scenarios structurally are parallel to each other, questions about scenarios aim to reveal the same aspects of NOS. If there is any difference among NOS aspects utilized by the participants, it helps to establish the influence of the context of SSI on epistemological thinking. Thus, the result of the study may contribute to the design of the context and content of SSI. In general, the results of this study will contribute to the learning environment with SSI and the implication of SSI to the classroom. It will help to prepare SSI contexts to promote scientific literacy and engage students with democratic citizenship skills. The necessity of conducting more research studies to fill the gap in the current knowledge base about the designing of the context of SSI.

2. LITERATURE REVIEW

This chapter's fundamental goal is to review the literature relevant to the current study. This chapter includes six sections: socio-scientific issues (SSI) in science education, informal reasoning in the context of SSI, the factors considered in resolving the SSI, the nature of science understanding and science education, and the nature of science understanding and SSI and the preparation of the context of SSI. In brief, this chapter serves as a prologue to the following chapters by providing context for the research.

2.1. Socio-scientific Issues in Science Education

Socio-scientific issues (SSI) are controversial, and open-ended science-society concerns with economic, political, environmental, ethical, and cultural implications (Sadler & Zeidler, 2004; Evagorou et al., 2014). These controversies have uncertain solutions, so there is no definitive solution related to the issue (Evagorou & Mauriz, 2017). Incorporating SSI into science education can provide individuals to think and try to solve these controversies, so they can make links between science and their daily lives as future citizens. It promotes scientific literacy in the classroom. (Eastwood et al., 2012; Evagorou et al., 2014; Zeidler et al., 2002). Also, using socio-scientific topics in learning environments, according to Yakob et al. (2015), is an effective technique to assist students to enhance their critical thinking, and reasoning skills, improving their argumentation abilities, and increase their skills in decision-making. This environment with SSI creates a learning atmosphere where learners share their ideas related to the problematic issues, discuss them, evaluate others' ideas, and make decisions about these issues in science classrooms. Also, it is stated that SSI investigation entails scientific interpretation and epistemology (Barab et al., 2007), so scientific epistemology can be improved with well-prepared SSI instruction, which provides a better understanding of science's nature and how science works.

The links between science, technology, and society first became prominent in scientific education in the 1970s, prior to the SSI framework (Zeidler et al., 2005). Studies have continued to investigate this relationship between science, technology, and society and discussed how this relationship should be included in science lessons (Fowler et al., 2009; Zeidler et al., 2002). Moreover, scientific understanding would be more compelling in the context of technology and society, it was said (Yager & Akcay, 2008). In other words, the context in which scientific understanding is performed with its relationship with society and technology becomes more meaningful.

In this manner, the science-technology-society (STS) strategy was recommended and defined as a multidisciplinary approach that emphasizes the relationship between science, society, and technology with the identification of scientific problems, technical advancements, and societal difficulties (Mansour, 2009). This strategy included the development of the students in the process of science, the applications and use of science knowledge of students, the relevance of science knowledge to the students' lives and to society. Therefore, it affected science classrooms in the 1980s because it aimed to improve scientific literacy (Yager & Tamir, 1993; Solomon & Aikenhead, 1994). The STS approach, on the other hand, has been criticized for not putting enough attention on personal concerns relating to scientific and societal issues because it is crucial to include decision making process on personal issues as well for promoting scientific literacy (Shamos, 1995). In the 1990s, researchers then proposed a new method known as science, technology, society, environment (STSE) that granted scientific education in a cultural, political, and social context (Zeidler & Keefer, 2003; Yilmaz-Tuzun & Topcu, 2008). Even though the STSE approach concentrated on conflicts and ethical challenges such as nuclear power, climate change, and cloning, it did not mention instructional issues such as argumentation, discourse, students' learning, or comprehending the nature of science in the decision making process (Topcu, 2008). These instructional issues are significant elements for creating an effective learning environment (Sadler et al., 2007; Sadler, 2009). As a

result, researchers developed a comprehensive strategy known as the socio-scientific issue (SSI) approach. It includes both these instructional issues that STSE approach did not include, emotion, morality, culture, and personal experiences as well. Topcu (2008) detailed the historical development of these approaches as illustrated in Figure 2.1 below.

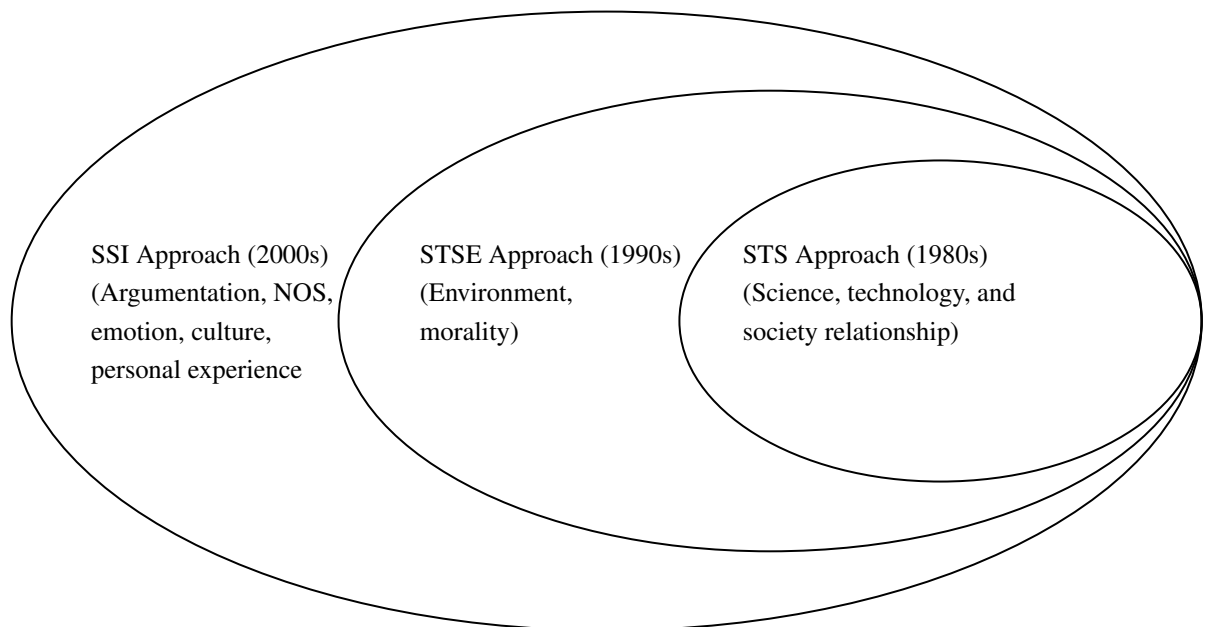


Figure 2.1. The Relationships Conceptually and Historically Among Science-Related Social Approaches.

Since prior techniques were critiqued for lacking a theoretical foundation (Zeidler et al., 2005), and since science-related social issues became more prevalent, scholars focused more on the SSI approach. Because the STS approach did not place enough emphasis on ethical aspects of science and learners' emotional development (Zeidler et al., 2002), and STSE approach did not involve instructional issues (Topcu, 2008). SSI-based science education has gained popularity as an inclusive approach. The SSI method emphasized functional scientific literacy that includes making decisions regarding personal and societal challenges (Zeidler et al., 2005). Therefore, engaging students with SSI provides them to challenge the issues that they may confront in their daily lives, which promotes to raise scientifically literate individuals.

Respectively, scientific literacy is defined as the ability to think critically, make informed decisions, and make ethical decisions (Zeidler et al., 2002; Sadler & Zeidler, 2003; Fowler et al., 2009). People must present information and grasp the nature of knowledge to make decisions, therefore their critical thinking skill is essential for this process (Simmons & Zeidler, 2003). It is claimed that by participating in controversial scientific challenges, students might improve their reasoning skills and obtain a better understanding of the nature of science. As a result, including socio-scientific issues in science classrooms can help students acquire social, ethical, and cognitive skills through conversation about controversial and open-ended issues (Zeidler & Keefer, 2003). Ethical concerns, as well as political, religious, and economic aspects, influence on negotiating and understanding of socio-scientific issues (Zeidler & Keefer, 2003). These skills are necessary for citizenship education and making well-informed judgments related to SSI. Since SSI in educational contexts should ideally assist students in dealing with dilemmas that they may confront in their daily life, the decision making process in the contexts of SSI promotes democratic citizenship through science education.

Furthermore, it is claimed that SSI-based instruction in science education can improve students' science content knowledge (Barab et al., 2007; Genel & Topcu, 2016; Klosterman & Sadler, 2010; Sadler et al., 2016) and motivation for learning science (Romine & Sadler, 2016), as well as their understanding of nature of science (Allchin et al., 2014; Bell & Lederman, 2003; Eastwood et al., 2012; Khishfe & Lederman, 2006), reasoning skills (Romine & Sadler, 2016; Yilmaz-Tuzun & Topcu, 2008; Zeidler et al., 2009) and argumentation skills (Khishfe et al., 2017; Sadler et al., 2007; Yacoubian & Khishfe, 2018).

When the contributions of SSI on science education, science educators need to connect SSI discourse to relevant ideas to engage students in a relevant problem-based conversations that fosters evidence-based reasoning, cognitive and critical thinking skills, and conceptual comprehension (Klosterman & Sadler, 2010). Also, it is critical to contextualize disciplinary content knowledge in an investigation of socially credible scientific concerns when realizing learning outcomes, so students have an opportunity to participate in authentic SSI-based learning and obtain a better knowledge of scientific topics (Barab et al., 2007; Sadler, 2011).

2.2. Informal Reasoning in the Context of Socio-scientific Issues

Decision making process in the context of socio-scientific issues provides the ability to develop people' higher-order skills such as reasoning, critical, and problem-solving skills (Sadler, 2009). Since this process enables people to reflect on their ideas about real life problems that they encounter in their lives, they need to make informed decisions about problems by using higher-order skills, which is sufficient for providing democratic societies (Kolstø, 2001b). When a controversial point of view is granted in case of choices among alternatives, decision making simply exists. Therefore, the question having more than one answer and not involving the definitive answer is needed to create this process (Bell & Lederman, 2003). Socio-scientific issues can provide the learning environment to discuss social problems including science and technology issues when the controversial structure of SSI mentioned above is considered. When people are dealing with these issues, they try to develop claims, arguments, ideas, and conceivable solutions to these complicated issues. In the process of discussing these problematic issues, people need to use informal reasoning skills that encompass both affective and cognitive processes (Sadler & Zeidler, 2005).

Cerbin (1988) defined informal reasoning as the relationship between claim and support. Informal reasoning involves the process of the establishment of arguments with supportive reason, so it occurs in the discourse of problematic issues like SSI. Specifically, it is related to how people use evidence to support their decision in discourse about controversial issues. Problems that are complex and open-ended, i.e., not having a sole correct answer but having different perspectives and solutions can be used to reveal and assess individuals' informal reasoning (Sadler & Zeidler, 2005; Venville & Dawson, 2010; Wu & Tsai, 2007; Yılmaz-Tuzun & Topcu, 2008). Contrary to informal reasoning, by formal reasoning people can resolve noncontroversial scientific issues, which means that it requires the solving of well-defined scientific issues using provided information. Also, Sadler (2004) mentioned that the establishment of formal reasoning is settled and not shaping. For example, force is one of the scientific concepts. People can compute by using the formula: mass multiplied by gravitational acceleration ($F = mg$). Without discussion, more information and generating claims, people can reach the solution. However, people use informal reasoning to create the position for responding to the problematic issues which do not have absolute solutions in a discourse environment (Sadler, 2004). In other words, the discussion about controversial issues provides people to display their informal reasoning in trying to resolve the issues.

Furthermore, Zohar and Nemet (2002) highlighted that informal reasoning includes the analysis of advantages and disadvantages, and of alternative decisions or of precise propositions about ill-structured problems. Wu and Tsai (2007) mentioned that the use of informal reasoning processes helps evaluate data related to issues that create dilemmas like SSI. This process enables students to operate what they learn in science classes to resolve the issues facing in their daily life. One of the objectives of science education is that individuals can find more rational explanations for real-life issues by handling science knowledge (Sadler, 2004; Atabey & Topcu, 2020). Therefore, it can be said that in making decisions in the context of socio-scientific issues people' ability of informal reasoning has a major role for solving SSI that people face in their daily life. When the nature of SSI is considered before: being

ill-structured and having different decisions, alternatives and positions, informal reasoning is a more appropriate framework in the debate about SSI compared to formal reasoning.

There are many research studies showing the features of informal reasoning in the context of socio-scientific issues (Sadler & Zeidler, 2005). Sadler (2004) focused on some specific subjects such as the relationship between socio-scientific informal reasoning and nature of science conceptualizations, informal reasoning' expression through argumentation, patterns of interpretation of data, the evaluation of information and the significance of conceptual understanding of components related to SSI and informal reasoning. These studies examined informal reasoning in the context of SSI by using different paths of assessments and different categorizations of informal reasoning. These assessment paths present how researchers examine, define, and categorize people's informal reasoning in the context of SSI. Particularly, people' informal reasoning was assessed as '*pattern*' by some studies (Liu et al., 2011; Sadler & Zeidler, 2005) in the time others as '*modes*' (Patronis et al., 1999; Yang & Anderson, 2003; Wu & Tsai, 2007). Moreover, other research has combined learners' thinking about SSI with other constructs that are not particular to SSI and may thus be understood broadly. Argumentation, for example, has been used to evaluate competencies related to creating and advancing SSI perspectives and reasoning skills (Dawson & Venville, 2010; Evagorou & Osborne, 2013). In other words, the ideas revealed in thinking and resolving the controversial issues include claim and support, which is defined as informal reasoning. Since the claim and support are elements of argument, argumentation can be an outstanding tool for evaluating informal reasoning.

To be more specific, Patronis et al. (1999) divided the informal reasoning revealed by students into four modes: economic, social, ecological, and practical. In their studies, the reasons released in resolving the issues were investigated and reported. The researcher tried students to face specific socio-scientific issues and categorized their informal reasoning: personal happiness versus benefits for all,

human versus money values and social versus nature values. Moreover, Yang and Anderson (2003) investigated high school students' reasoning modes about the use of nuclear energy. How students figure out and negotiate the scientific and social prospects of the complex issue was examined, and they created a framework that classified participants' informal reasoning modes into three categories: socially oriented, scientifically oriented, and equally disposed reasoning (both social and scientific). Authors tried to examine what students persuade using scientific information or social factors or equally use of different perspectives in pointing out the issue. This framework, reasoning mode, gives three essential criteria for assessing informal reasoning because SSI includes dilemmas with social and scientific perspectives. Moreover, Wu and Tsai (2007) used same socio-scientific issue, the use of nuclear energy, and they categorized high school students' informal reasoning five modes as: economic-oriented arguments, ecology-oriented arguments, social-oriented arguments, technology-oriented arguments, and science-orientation arguments. It investigated how high school students use evidence to make arguments in resolving the issues in the context of SSI, in other words, which aspects of the issue were emphasized.

A different framework belonging to Liu et al. (2011) identified four patterns: ethical, scientific-technological, ecological, and socio-economical. They underlined which reasons were given by participants to solve the issues in the context of SSI. Unlike other researchers Sadler and Zeidler (2005) focused on how college students speculate about some genetic engineering conflicts, and categorized their informal reasoning in general, not social, or ecological. They separated students' informal reasoning into three for creating patterns by regarding the way to give reason: rationalistic, emotive, and intuitive. Specifically, rationalistic informal reasoning refers to the consideration of logic. For instance, people emphasize scientific evidence related to the issue: the rights of patients, side effects of diseases, and accessibility issues in decision making related to genetic engineering. Emotive informal reasoning pattern refers to the consideration of care-based, which means that people highlight rational arguments, also rooted in moral emotion related with themselves or other

people. People use their empathy and sympathy for negotiating and resolving the issue. Thus, in the pattern decision involves the influence of emotion of the people, unlike rationalistic informal reasoning. Finally, an intuitive informal reasoning pattern includes immediate reactions to the scenarios about genetic engineering. In this pattern, participants can use logic, but they try to make arguments without evaluating and negotiating the issue.

Sadler and Zeidler (2005a) also pointed out that while individuals resolve even a single SSI, they can show multiple informal reasoning patterns together. In other words, they found that people can use multiple informal reasoning patterns that occurred in a coordinated manner while resolving the same issue. Sadler and Zeidler (2005a) called the term “integrated patterns” for this multiple reasoning. There are also four integrated patterns which are rationalistic and intuitive, rationalistic, and emotive, intuitive, and emotive, and rationalistic, intuitive, and emotive. They developed a graphic for illustrating these informal reasoning patterns and redrawn by the researcher, seen in Figure 2.2. In addition, they highlighted that the context, and content of socio-scientific issues have influenced participants’ informal reasoning patterns. People can show different informal reasoning patterns in different contexts of SSI, which provides science educators to design the context of SSI by regarding informal reasoning of the learners.

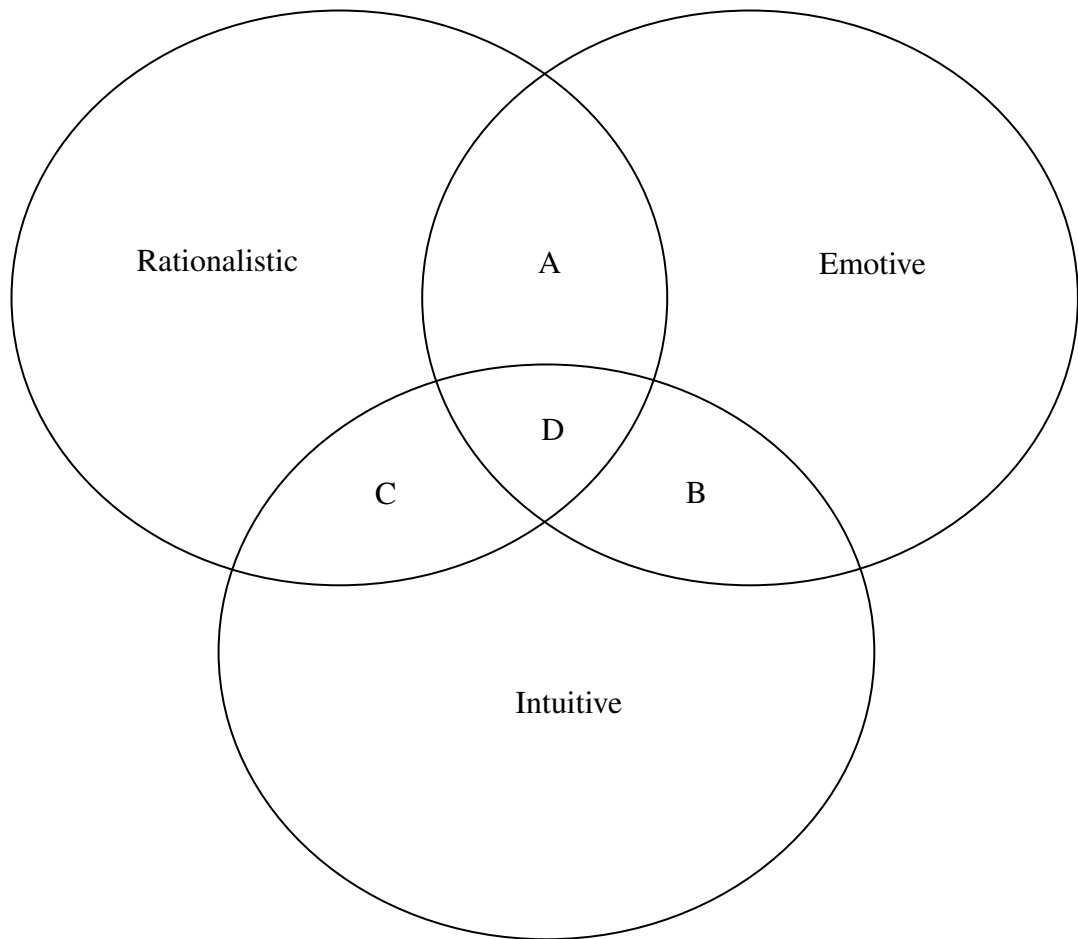


Figure 2.2. Graphic Display of Emergent Patterns of Integrated Informal Reasoning in the Context of Socio-scientific Issues.

While these classifications were useful for qualitatively describing students' informal reasoning, they had limited potential for increasing efforts to quantitatively quantify reasoning skills of individuals (Romine et al., 2020). In contrast to other studies, socio-scientific reasoning (SSR) can be conceptualized as a construct that could be quantified and operationalized (Sadler et al., 2007). SSR is critical for assisting students in taking informed positions on socio-scientific issues. SSR was described in terms of four skills and knowledge, each of which reflected a skill required for understanding, negotiating, and taking informed opinions on SSI: complexity, inquiry, multiple perspectives, skepticism. Complexity refers to recognizing the underlying complexity of topics and, as a result, refraining from drawing rash conclusions. Understanding that SSI is the subject of the ongoing

investigation and being able to spot missing information are the aspects of inquiry. Multiple perspective aspects of SSR mean analyzing SSI from a variety of angles and considering the distinct concerns of many stakeholders. Lastly, it includes processing and analyzing information regarding SSI from potentially biased sources with reflective skepticism. Interviews and surveys with open-ended response items were used to quantify SSR (Sadler et al., 2007), which precluded the gathering of large data sets related to SSR of the participants. The Quantitative Assessment of SSR (QuASSR), which uses ordered multiple-choice (OMC) items, was created to address this issue (Romine et al., 2017). The QuASSR gives students a scenario that quickly defines a specific SSI and then asks them ten questions, each of which focuses on a different SSR ability. The result of this study showed that SSR was examined and revealed by using quantitative data set. The summary of the different categorizations of informal reasoning found in literature, is presented in Table 2.1.

Table 2.1. The representation of analysis and categorization of informal reasoning on SSI in historical order.

The studies about informal reasoning in the context of SSI	Analysis and Assessment of Informal Reasoning
Patronis colleagues (1999)	Four modes: economic, social, ecological, and practical
Yang and Anderson (2003)	Modes into three categories: socially oriented, scientifically oriented, and equally disposed reasoning (both social and scientific)
Sadler and Zeidler (2005)	Three patterns: rationalistic, emotive, and intuitive informal reasoning
Wu and Tsai (2007)	Five modes: economic-oriented arguments, ecology-oriented arguments, social-oriented arguments, technology-oriented arguments, and science-orientation arguments
Sadler and colleagues (2007)	The Quantitative Assessment of SSR (QuASSR), multiple choice (OMC) items: complexity, inquiry, multiple perspectives, skepticism
Liu and colleagues (2011)	Four patterns: ethical, scientific-technological, ecological, and socio-economical

2.3. The Factors Considered in Resolving the SSI

When considered the literature related to socio-scientific issues (SSI) and informal reasoning, some academics focused on what can be related to informal reasoning in the context of SSI (Bell & Lederman, 2003; Hogan, 2002; Sadler et al., 2004; Sadler & Zeidler, 2004; Topcu, 2008; Topcu et al., 2011; Walker & Zeidler, 2007; Zeidler et al., 2002). By considering existing literature on informal reasoning in the context of SSI, the factors influencing reasoning are classified into four: science content knowledge, moral and ethical perspectives, personal experiences, and nature of science conceptualization.

2.3.1. Science Content Knowledge and Informal Reasoning

There are several studies focused on informal reasoning and science content knowledge. It is suggested that science content knowledge may be a factor related to informal reasoning (Albe, 2008; Fleming, 1986; Hodson, 2009; Hogan, 2002; Sadler & Zediler, 2005; Zeidler & Schafer, 1984). In resolving the issue, individuals need to reveal what they learned and know about the scientific content of SSI to evaluate the scientific evidence. The conceptual understanding related to genetics and ecology of the participants had influenced their informal reasoning in the context of socio-scientific issues: gene therapy, genetic engineering, environmental issues, and cloning (Fleming, 1986; Sadler & Zediler, 2005; Zeidler & Schafer, 1984). The research investigations of the relationship between conceptual science understanding and informal reasoning findings showed that conceptual understanding of the participants has a significant role in informal reasoning. They utilized science knowledge that they know in resolving the issue. Based on the reviewed socio-scientific literature, it could be argued that content knowledge was a significant factor in informal reasoning in learning settings. In addition to these, Albe (2008) conducted a study with 11th grade students to investigate their scientific knowledge in making decisions related to the effect of mobile phone use on human health. The result of this study showed that participants did not reveal their conceptually scientific and technological knowledge in trying to resolve the issue. However, it was

underlined that the significance of conceptual knowledge was utilized by participants in making decisions in the context of SSI because when science content knowledge was used to resolve the issue, students made informed arguments about the issue.

2.3.2. Moral and Ethical Perspectives and Informal Reasoning

Moral and ethical perspectives are crucial factors related to informal reasoning of the individuals in the socio-scientific decision-making because of the structure of SSI: involving moral dilemmas. While studies showed that college students integrated their morality for resolving environmental and genetic engineering issues (Sadler & Zeidler, 2004; Zeidler & Schafer, 1984), one study regarding high school students' informal reasoning in making decisions for nuclear power and genetic engineering issues found that they revealed their morality as effective factor for response to SSIs (Fleming, 1986a; 1986b). Bell and Lederman (2003) pointed out that moral and ethical perspectives are the most critical factors to identify individuals' informal reasoning by regarding their study conducted with university professors in response to multiple SSIs. Consistent with previous studies, it was supported that the morality of the individuals has influence on their informal reasoning in making decisions regarding SSI (Sadler, 2011; Topcu, 2008; Walker & Zeidler, 2007; Zeidler et al., 2002; Zeidler, 2014). As a result, socio-scientific issues also include moral and ethical dimension, as previously stated. While engaging with SSI and trying to resolve the issue in the context of SSI, moral perspectives of the individuals are revealed as factors influencing their informal reasoning.

2.3.3. Personal Experiences and Informal Reasoning

Personal experience is one of factors considered by individuals in negotiating and pointing out the issue in the context of SSI in the literature (Albe, 2008; Bell & Lederman, 2003; Sadler & Zeidler, 2004; Sadler et al., 2004; Sadler et al., 2010). The controversial issues can include daily life problems that individuals may confront in their lives. Therefore, they may consider their personal experiences and the life of people living in their society while resolving the issues. In other words, they are looking for solutions to these issues by giving examples from their or relatives' life that they observe or experience. Some studies highlighted that the interpretation of scientific evidence was done by using their personal experiences and concerns (Dawson & Venville, 2010; Sadler, 2009; Zeidler, 2014). As a result, the researchers who discovered this link appeared to agree that personal experience played a significant role in shaping students' socio-scientific reasoning.

2.3.4. The Nature of Science Understanding Conceptualization and Informal Reasoning

The nature of science (NOS) conceptualization is also a feature studied regarding informal reasoning in the contexts of socio-scientific issues. Several investigations explored the relationship between NOS conceptualization and informal reasoning (Bell & Lederman, 2003; Herman et al., 2019; Sadler et al., 2004; Schwartz et al., 2004; Walker & Zeidler, 2007; Zeidler et al., 2002). NOS aspects included understandings that scientific knowledge is *(a) tentative (subject to change)*, *(b) empirically based (derived from observations of the natural world)*, *(c) subjective (theory-laden) to a degree*, *(d) partially based on human inference, imagination, and creativity*, and *(e) socially and culturally embedded*, according to Bell and Lederman (2003)(p. 356).

Therefore, understanding these NOS aspects encourages students to make informed decisions and to resolve SSIs (Driver et al., 1996). It was proposed that NOS perspectives may influence students' valuation of knowledge formed through scientific methods and evidence selection while explaining their positions about the SSI context (Topcu, 2008; Zeidler et al., 2005). Bell et al. (2000) conducted a study to investigate how pre-service teachers (PSTs) translate their NOS understanding into teaching practices, and PSTs mentioned the importance of NOS understanding for students to engage in resolving the scientific issues they faced in their social lives. Specifically, participants underlined social, cultural, and empirical nature of scientific knowledge, and the differences between personal beliefs and scientific knowledge while resolving the issues: animal rights and global warming (Sadler et al., 2004; Zeidler et al., 2002).

On the other hand, there is no consensus among researchers examining NOS understanding and informal reasoning in the context of SSI. For instance, Bell and Lederman (2003) carried out a study with 21 research scientists and professors, some of whom were studying science and others in other fields such as sociology. To assess participants' NOS understanding and informal reasoning about SSIs which are fetal tissue implantation, global warming, the relationship between diet and cancer, and the relationship between cigarette smoking and cancer, a questionnaire and an interview were used for investigating the impact of NOS understanding on decisions and positions about SSIs. According to the findings, NOS views did not make a significant difference in participants' informal reasoning in making decisions about SSIs because there was no difference among the informal reasoning of people in two groups. Similarly, Walker and Zeidler (2007) studied with high school students. The result of this study showed that students did not utilize their NOS understanding in discussion and resolving the issue about genetically modified foods.

When the literature related to NOS understanding and informal reasoning was considered, more research may be conducted to examine the disagreement related to the effect of NOS understanding on informal reasoning.

2.4. Nature of Science Understanding in Science Education

Science education has included not just teaching of scientific events, objects, or abstract and theoretical concepts, but as well as the development of knowledge through how and why questions about scientific facts (Erduran et al., 2004; Kolstø & Mestad, 2005). One of the worldwide agreed-upon goals of science education is to develop scientifically literate citizens. That is possible if science education includes teaching science practice and methods in addition to science concepts, specifically referring to the nature of science (NOS) understanding (Driver et al., 2000; Lin & Mintzes, 2010).

For a long time, the nature of science has dominated discussions among researchers. They have been questioning what it is, why it is significant, and how to teach and assess it in science classrooms. With the development of science, the concept of NOS has been influenced. Therefore, it was attempted to describe NOS by various scientific communities, but they were unable to come to an agreement on the description of NOS (AAAS, 1990). Even though there was no agreed definition of NOS, it was described as a way of knowing, or a set of beliefs and values that influence the development of scientific knowledge or the epistemology of science, in a broad sense (Abd-El-Khalick & Lederman, 2000a; Alters, 1997).

Different characterizations of the nature of science had been recommended by some academics (McComas & Olson, 1998; Osborne et al., 2003; Clough, 2007; 2011; Allchin, 2011; Irzik & Nola, 2011; Erduran & Dagher, 2014). They tried to develop definitions of NOS and to determine a tool for how the understanding of science can be assessed. It is extremely difficult to teach and assess the abstract concepts of science that are essential for producing scientifically literate students, Abd-El-Khalick et al. (1998) proposed consensus view involving 7 tenets for teaching and assessing NOS in science classrooms: *“the tentative nature of scientific knowledge,” “observation, inference, and theoretical entities in science,” “the theory-laden nature of scientific knowledge,” “the creative and imaginative nature of scientific knowledge,” “the social and cultural embeddedness of scientific knowledge,” “scientific theories and laws,” and*

“myth of the scientific method.” (Abd-El-Khalick et al., 1998; Eastwood et al., 2012; Lederman & Abd-El-Khalick, 2002).

Most scholars have established their studies with relation to consensus view framework (Abd- El-Khalick & Lederman, 2000b; Akerson & Donnelly, 2008; Alters, 1997; Lederman et al., 2002; McComas, 1998), but many have also decided to add other consensus view descriptive terms to evaluate understanding of NOS or investigate the illustration of NOS in textbooks (McComas et al., 1998; Osborne et al., 2003). Moreover, this classical approach to NOS has been persuasive in developing science curriculum documents (AAAS, 1993), which enables science educators to adopt this framework for both assessment and instruction (Lederman & Abd-El-Khalick, 2002). However, this framework has been criticized by some researchers (Allchin, 2011; Duschl & Grandy, 2011; Erduran & Dagher, 2014a; Osborne, 2014; Yacoubian, 2012).

The consensus view is not comprehensive, specifically it only focuses on the nature of scientific knowledge and what is the knowledge about science. This view did not include practical science learning like argumentation and discussion. Due to its limitations, various frameworks had been proposed by some researchers (Allchin, 2011; Erduran & Dagher, 2014; Irzik & Nola, 2011; 2014; Matthews, 2012). In this manner, Allchin (2011) was required to suggest a new framework known as whole science because the consensus view had a limited reference to personal and social decision making and contradicted the nature of social NOS practice. It was proposed that the context-based analysis and tools for assessment may provide NOS understanding better than an informative list of aspects of NOS because the consensus view framework is not adequate to furnish a context-based NOS understanding. To grasp the nature of science, it was stated that a variety of dimensions should be considered, including how reliability is provided while scientific knowledge is generated and how it is protected while being transferred from one location to the other (Allchin, 2011).

Another researcher, Matthew (2012), suggested an alternative approach to the consensus view called “*Features of Science*” (FOS). Science, according to Matthew (2012), is “*a historically embedded truth-seeking enterprise with many features: social, commercial, cognitive, political, ethical, and psychological*” (p.4). Since it critiqued the consensus view for emphasizing scientific knowledge over the processes, organizations, and cultural context that facilitate scientific knowledge development, Matthew (2012) tried to argue that the seven consensus view tenets appear to be different features of science (FOS) rather than parts of the nature of science. The extra items to the NOS tenets mentioned by consensus view were introduced such as “experimentation”, “idealization”, “models”, “values and socio-scientific issues”, “mathematization”, “technology”, “explanation”, “worldviews and religion”, “theory choice and rationality”. It was referred to those items as a feature of science (FOS) because of their capacity to alter in different contexts.

Even if the consensus view was criticized, research was still conducted by considering the consensus view. Therefore, new approach had tried to propose by researchers (Irzik & Nola, 2011; 2014; Erduran & Dagher, 2014). Irzik and Nola (2011) demanded that consensus view does not include the aims of science and its methodological issues and does not show the similarities and differences among scientific disciplines. To fill the null of consensus view, the Family Resemblance Approach (FRA) may be a favorable alternative. They highlighted that understanding some universal aspects of scientific disciplines is significant to differentiate science and non-science, which provides a more general science image for educators and learners. The four elements which are “activities”, “aims and values”, “methodology and methodological rules”, and “products” were put forward for fully NOS understanding (Irzik & Nola, 2011; 2014; Erduran & Dagher, 2014). FRA is more open-ended and progressive than the consensus view of NOS because it focuses on reliability and objectivity of issues, scientific inquiry, science’ empirical nature and testability (Erduran & Dagher, 2014). In their later work, science as a cognitive-epistemic and social institutional system was defined by Irzik and Nola (2014). The significance of comprehending these categories for understanding NOS

was highlighted in their study. Erduran and Dagher (2014a) suggested a further framework that criticizes the consensus view in different scientific disciplines, expanding and integrating Irzik and Nola's FRA to NOS (2011; 2014) in science education. The Erduran and Dagher's version of FRA to NOS was then labeled "Reconceptualized Family Resemblance Approach to Nature of Science (RFN)" by Kaya and Erduran (2016). Focusing on contextualized NOS understanding allows learners to be willing, but Dagher and Erduran (2017) criticized FRA and FRN due to being complex. Also, such ethical and moral perspectives in doing science, reliability of scientific knowledge do not have a significant emphasis in FRA, but they are significant for today's public discourse about science.

In conclusion, NOS understanding is one of the significant elements of scientific literacy. There are different frameworks that researchers proposed for assessing and teaching NOS understanding. They were also used in studies related to NOS understanding. In the following section, the studies related to NOS understanding in the contexts of socio-scientific issues (SSI) was explained in detail because of one of the aims of this study.

2.5. The Nature of Science Understanding in the Context of SSI

Learning environment in which students are engaged with socio-scientific issues encompasses processes of the nature of science (NOS) understanding and provides numerous opportunities for explicit connections to NOS understanding aspects. On the grounds that realizing how science works and scientific process helps to deal with societal and science issues. While the decision making process about society, science and technology, students as future citizens are influenced by a variety of factors related to NOS understanding such as the relationship between society and science, scientific knowledge, data interpretation, and personal beliefs (Sadler et al., 2004). It is convinced that understanding how science works and the relationship between science and society are significant in evaluating scientific data and making arguments about societal issues in today's world (Zeidler et al., 2011). For these reasons,

researchers have emphasized links between NOS understanding and the decision-making process, individuals need to evaluate whether the evidence is reliable, sufficient, and relevant to resolve the SSIs (Osborne et al., 2003). Educators and researchers focused on engaging students to think critically and improve problem solving skills, which enables students to figure out the sources, methods, and evidence of scientific knowledge (Khishfe & Lederman, 2006; Walker & Zeidler, 2007; Zeidler et al., 2002).

In this manner, researchers have nominated a close connection between SSIs and NOS understanding (Kolstø, 2001; Zeidler et al., 2002; Zeidler & Zeidler, 2003). SSIs are highly probable to generate students' interest due to their relevance to society and compliance with multiple points of views (Eastwood et al., 2012). Therefore, it has been argued that SSIs may provide an ideal context for discussing students' understandings of NOS (Khishfe, 2012a; Matkins & Bell, 2007; Zeidler et al., 2002). Since these issues expose students to the values, assumptions, and concepts embodying NOS understanding (Bell & Matkins, 2003; Sadler et al., 2002), they provide various opportunities to carry out scientific process (Khishfe & Lederman, 2006; Khishfe et al., 2012) while engaging with these issues are related to social science-based challenges that are open-ended, ill-structured, questionable, and entail multiple perspectives and interpretations.

Thanks to socio-scientific contemporary issues, science lessons may be more socially relevant and NOS understanding can be better represented in real-life situations in the science classroom. In other words, the context of SSI can be a useful and ideal context for teaching and assessing NOS understanding (Abd-El-Khalick, 1999; Bell & Lederman, 2003; Walker & Zeidler, 2007; Sadler, 2009; Khishfe, 2012). It was argued that these issues have appropriate structures which are highlighting conflicting evidence, encouraging alternative perspectives of solutions or positions and different interpretations of data to reveal the aspects of (NOS) understanding in the decision-making process. Specifically, Eastwood and colleagues (2012) studied the effects of SSI-based and content-based instruction on the NOS conceptions of high

school students by administering both SSI-based and content-based groups at the beginning and end of the semester. The result of this study showed the effectiveness of engaging with resolving the issues in the contexts of SSI in developing NOS comprehension.

Exploring the effects of SSI as learning contexts on developing learners' nature of science understandings is one way to look at this relationship (Karisan & Zeidler, 2017; Lederman et al., 2014; Sadler, et al., 2007). There is VNOS questionnaire included six open-ended questions adapted from Lederman and O'Malley (1990) and Abd-El-Khalick, et al. (1998). This questionnaire concentrated on many aspects of the nature of science thought to be relevant to K-12 students and their associated with decision as adults in a democratic society (Bell, 2003; Bell & Lederman, 2003; Lederman et al., 2002). Understandings that scientific knowledge is *(a) tentative (subject to change), (b) empirically based (derived from observations of the natural world), (c) subjective (theory-laden) to some extent, (d) partially based on human inference, imagination, and creativity, and (e) socially and culturally embedded are among these aspects.* Two other aspects of the nature of science advocated by the VNOS are the notions that scientific knowledge is the result of observation and inference, as well as the functions and relationships between theories and laws. Most of the studies used VNOS questionnaire to investigate participants' NOS understanding (Bell & Lederman, 2003; Chung & Kim, 2015; Khishfe, 2017). The result of studies showed that participants' NOS understanding may be revealed, assessed and developed by engaging with SSIs.

For realizing the whole picture of science, contextualization can be useful for understanding NOS. The importance of disagreements among different scientists, ethical and moral dimensions of science, the importance of scientific community, cultural factors such as religion, ethnicity issues in doing science and methodological issues can be promoted by case-based learning (Allchin, 2011). Therefore, contextualized NOS can enlarge the depiction and understanding of sociology, history, and philosophy of science, which enables people to facilitate their public

decision-making process. They can discuss and reflect on their own ideas about specific contexts and determine NOS themes. Also, they can apply their critical thinking and problem-solving skills in dealing with societal and scientific problems. In conclusion, although the consensus view creates a beneficial ground for some aspects of NOS, it does not give a meaningful impression without context. That's why historical cases, contemporary news and using daily life examples as context can be appropriate learning settings for promoting the functional NOS understanding (Allchin, 2011). Specifically, he states that "*NOS instruction needs to engage students in problem-solving and decision making in context-rich case studies.*"(p.525). When Allchin's prospective approach and the aim of science education that is promoting scientific literacy are considered, accurate assessment tools should be selected and integrated into NOS instruction.

As mentioned previously, declarative list-based instructional approaches and evaluation systems lack context and authentic aspects of the NOS (Allchin, 2011; Clough & Olson, 2008; Osborne et al., 2003). Learners must be engaged in NOS instruction through problem-solving scenarios; therefore, the NOS evaluation must be authentic (Allchin, 2011; 2014). Also, Allchin made a list of characteristics for future instruments for assessing functional NOS comprehension given the current arguments in the literature. Allchin (2011) identified six essential elements for assessing NOS analytical skills and knowledge: authentic contexts, well-informed analysis, adaptability to diagnostic, formative, or summative evaluation contexts, adaptability to performance-based assessment, respect for relevant stakeholders and adaptability to single and mass and local and large-scale comparative use. Moreover, he asserts that assessment techniques that go beyond these features exist, and he provides prototype questions for assessing NOS based on recent circumstances or examples from history.

2.6. The Preparation of the Context of Socio-scientific Issue

The actual definition of scientific literacy envisions its functional application in order to enable students to improve knowledge, skills, attitudes, and scientific epistemic understandings through science education, as well as to make decisions in a conscious, rational, and ethical decisions regarding the complex situations created by the intersection of science-technology-society in the personal and social field. Socio-scientific issues create an effective context in which science education can be conducted in terms of being current, meaningful, and interesting, as well as providing students with sufficient learning opportunities (Sadler et al.,2016; Zeidler et al., 2002; Zeidler & Nichols, 2009). Therefore, it is critical to prepare the SSI contexts to enrich science classrooms, so SSI-based instructions are fed from diverse disciplines such as psychology and sociology, and which have a different structure than teaching only science content knowledge. With the literature about NOS understanding and SSI, dimensions of the science may be determined firstly to create SSI contexts.

Kolstø (2001) suggested a framework about specific four dimensions of science on socio-scientific issues to construct SSI-based instruction, represented in Table 2.2. As these issues involve science, its processes, and its relation with society, it is crucial to determine the dimensions of the science.

Table 2.2. A Framework for analyzing the science dimension of socio-scientific issues.

Science's limitations	<ul style="list-style-type: none"> a. One of several social domains is science. b. Statements that are both descriptive and normative c. Calls for evidence to back up claims d. Context-sensitive scientific models
As a social process, science	<ul style="list-style-type: none"> a. The function of consensus in research and science-in-development

Table 2.2. Sample table that spans multiple pages. (cont.)

Science's values	a. Suspension of beliefs based on scientific facts b. Scientific evidence
A critical mindset	a.Examine knowledge claims based on science.

In addition to the framework of Kolstø (2001), Sadler et al. (2016) used multiple empirical frameworks. Their strategy involves concentrating on students' science content knowledge to create a contextual educational environment, which enables SSI contexts created by this framework to be integrated into science education and studies related to SSI conveniently (Friedrichsen et al., 2016; Zeidler & Nichols, 2009). Specifically, according to their framework, five aspects are essential to provide an excellent context of SSI:

- 1) *A compelling problem is centered as instruction and emphasized from the start.*
- 2) *The problem is prepared by emphasizing learners' understanding of basic science concepts.*
- 3) *A task of collecting and analyzing data related to the problem is assigned.*
- 4) *A discussion environment is provided to reveal the social implication of the problem.*
- 5) *The use of communication technology and media.* (Sadler et al., 2016)(p.121).

By regarding these frameworks suggested by Kolstø (2001) and Sadler et al. (2016), various approaches that aim to prepare learners to engage in discussing and making decisions on social issues related to science have been developed. Some researchers have focused on how SSI contexts enhance reasoning skills and decision making in the context of SSI (Rocard, 2007), the relationship between SSI decision-making and an understanding of the nature of science or content knowledge (Lederman et al., 2014) and related issues with assessment of SSI learning outcomes and as part of important classroom learning (Saunders & Rennie, 2013; Presley et al., 2013; Sadler et al., 2017).

Various SSI-based instructions that can enhance scientific literacy had been suggested. One of them is project-based learning (Krajcik et al., 2008). With the task, students can be engaged with researching about the SSI, and analyzing scientific evidences. SSI can be prepared as scenario- or case- based (Sadler et al., 2006; Yadav et al., 2007) and as context-based learning (Allchin, 2011) to enrich science classroom.

The various contents of SSI research findings in different countries around the world. The issues are as follows: environmental pollution, biodiversity, biology, ecosystem, genetics, genetic screening, cloning, animal rights, and land use (Grace et al., 2015; Yacoubian, 2018). These prepared issues can be given in different contexts such as global and local contexts. Specifically, if an issue is given in a way that affects a particular region, it is called local context like; an issue that affects the whole world is called global context. Hydroelectric power plant projects can be local/regional, such as the Istanbul Canal Project, or SSI can be global, encompassing issues such as nuclear energy and biotechnology. There are various issues in existing literature that can be integrated into local and global contexts. In addition, science educators and researchers can determine which global and local topics by reading current newspaper articles, popular science publications, internet resources, movies, science education resources, and scientific publications (Zeidler & Kahn, 2014).

When the studies related to informal reasoning and socio-scientific issues are investigated (Zeidler & Schafer, 1984; Hogan, 2002; Tytler et al., 2001; Kolstø, 2001b; Bell & Lederman, 2003; Sadler et al., 2004b), it was concluded that SSI contexts have influence on informal reasoning and NOS understanding utilization. In this study, the researcher and the advisor specified two local issues and prepared two contexts: one context involving a problem solving process that directly affects participants' life and other context involving a problem-solving process that has no effect on participants' life. Specifically, one of these contexts is related to Turkey and the other context is related to Vietnam. For specifying these contexts, the researcher and the advisor

claimed a different definition from SSI literature: distal and proximal in the light of the study (Hogan, 2000). This study was to examine how various kinds of knowledge about the nature of science may have influenced science learning of students in schools. It was proposed to determine conceptual framework and differentiate students' NOS knowledge. For this aim, Hogan (2000) defines proximal knowledge of the NOS as an individual's beliefs, promises, perspectives, or personal theories about epistemology of the science. This knowledge can be thought of as the NOS conceptual model closest to an individual. These proximal beliefs arise from experience about one's own science learning as well as scientific knowledge produced and encountered by the person (who is not a scientist). On the other hand, distal knowledge of the NOS has defined conceptual understanding about the assumptions, values, and processes of professional science. Being capable to separate and express the differences between an observation and an inference, or a scientific law and a theory, can be examples of an individual's distal knowledge of the NOS (Schalk, 2012). It was stated briefly that *"distal and proximal refer simply to distance from personal, lived experience, not to distant and near causes of behavior."* (Hogan, 2000) (p.57).

By considering the definitions of distal and proximal by Hogan (2000), it is claimed that if the issue affects the participants' life and they can experience and face the issue in their real life, it can be defined as proximal context. On the other hand, if participants cannot experience and face the issue in their lives and the issue does not potentially affect their lives, it can be defined as distal context. Therefore, one of the local issues that is the use of Processed Food in Turkey was specific as proximal context of SSI. Another local issue was that the production and consumption of Golden Rice was specified as distal context of SSI. In this study, participants' informal reasoning, factors considered by them, and the utilization of NOS understanding in resolving the issues in proximal and distal contexts of SSI were investigated.

3. METHODOLOGY

The aim of this study is to investigate pre-service science teachers' informal reasoning in distal and proximal contexts of socio-scientific issues (SSI). In this section, the method of this study was explained in detail. The design of the study, sampling, data collection tools, data collection procedure, the quality of the study, ethical considerations, the role of researcher, and data analysis were all addressed in the following subsections of this chapter.

3.1. Design of the Study

The current study makes use of a qualitative method design (Biklen & Casella, 2007). Creswell (2011) argues that when literature is insufficient to address the study's phenomenon, qualitative research is the best way to investigate it. This allows researchers to delve deeper into participants' perceptions, feelings, thoughts, experiences, and meanings concerning real-life situations (Creswell, 2003; Gay et al., 2009). As a result, when the aims of this study are considered, it's critical to comprehend deeply how participants express themselves. This research utilizes instrumental multi-case study which involves detailed descriptions of cases to investigate a phenomenon in a context to insight the problem (Creswell, 2011). Specifically, cases were used to describe participants' informal reasoning and utilization of their epistemological understanding in the context of two specific SSIs. Through these descriptions, the aim is to illustrate the differences, if there are any, and compare them to identify if context of SSIs has any influence on the informal reasoning of the participants, and NOS utilization.

3.2. Sample

By considering the aims of this study, a purposeful sampling was used to select participants as cases. Purposive sampling, despite its limitations in generalizability, is often utilized in qualitative research (Berg & Lune, 2017) because it allows identifying informative cases whose study will illuminate the questions under investigation (Patton, 1990; Creswell, 2011). In this study, participants needed to read two SSI scenarios that involved scientific knowledge, evaluate scientific evidence related to the issues, then answer semi-structured interview questions to explain their way of thinking and feelings while resolving the issues. This required that participants have a certain level of academic background about science, scientific processes and have the ability to clearly explain their thinking and reasoning. As a result, pre-service science teachers (PST) were chosen as participants of this study for satisfying the criteria explained. All junior and senior students studying at a state university located in Istanbul, Turkey were invited by sending an e-mail. Nine-teen of them were willing to participate in this study. As a result, the researcher conducted semi-structured interviews with nine teen pre-service science teachers who are studying at a university located in İstanbul, Turkey.

3.3. Data Collection Tool

Data from pre-service science teachers was collected by conducting a semi-structured interview. During these interviews, participants read two socio-scientific issues scenarios and answered the questions posed. In this section, the design of scenarios regarding two SSIs and the detailed information regarding semi-structured interview protocol were represented.

3.3.1. Socio-scientific Issues Scenarios

Two socio-scientific issues scenarios were used for data collection to examine informal reasoning, factors considered in resolving these issues and scientific epistemology, regarding NOS understanding. For this aim, the researcher and the advisor decided to select two local SSIs. One of them was related to using and consuming Processed Food in Turkey. Therefore, this scenario included a problem-solving process that can have a potential effect on participants' own life and everybody's life living in Turkey. In this study, this scenario was named as the proximal context of SSI because of the potential effect on participants' life. Another scenario was related to the production and consumption of one of genetically modified foods, Golden Rice, in Vietnam. It involved a problem-solving process that does not immediately affect participants' own life. It was distant from the Turkey context, so they needed to think about people's life in Vietnam (another country) while resolving the issue, which provided it to be named as distant context of SSI.

As a first step of designing these scenarios, the researcher and the advisor tried to decide the general topics of issues by reviewing SSI literature and considering the contexts which should be proximate to Turkey and distal from Turkey. For the proximal context of SSI, the researcher and the advisor started to study a scenario about diet/exercise and cancer used in Bell and Lederman (2003). They revised its topic, called Processed Food. In this scenario, participants need to resolve the issue by regarding people living in Turkey including themselves. A scenario named Genetically Modified Food: Golden Rice that was used originally in studies (Allchin et al., 2014; Khishfe, 2021; Khishfe et al., 2017) was selected as distal context of SSI. In this scenario, participants needed to resolve the issue by thinking about people living in Vietnam, which means that decisions that they made did not affect themselves, only affect people in Vietnam.

For these two SSIs, the general theme is the same: human health, so they involved health concerns related to the issues such as diseases related to obesity as a result of consuming Processed Food and weak immune system related to deficiency of vitamin A that Golden Rice has. In addition to health concerns, Processed Food includes economic concern, while Golden Rice also includes environmental concern. To be revised in being parallel to each other, the researcher and the advisor reorganized these two contexts in terms of general theme, and balanced scientific evidence. Moreover, the researcher and the advisor also redesigned scenarios grammatically for being parallel to each other such as the number of words, the structure of sentences and the words that they used. The similarities and differences of two contexts were represented in Table 3.1

Table 3.1. Similarities and differences of SSI contexts.

Similarities	General Theme Balanced Evidence The General Structure
Differences	Genetically Modified Food: Golden Rice (Distal): involves decisions that do not potentially have influence on participants Processed Food (Proximal): involves decisions that potentially have influence on participants

While working on the designs of two SSI scenarios, advantages and disadvantages related to issues were considered. In more detail, both had two advantages and two disadvantages related to issues. Scenarios were separated into paragraphs regarding these advantages and disadvantages because it is crucial to represent different positions in text by ordering the data sets in an impartial, balanced and non-overpowering manner (Can et al., 2021). The order was arranged to be one advantage and then one disadvantage related to the issue. To comprehend the general structure of these contexts, the order of advantages and disadvantages related to issues can be seen in Table 3.2.

As a summary, the purpose was to examine how PSTs' informal reasoning, and factors considered by them in distal and proximal contexts of SSI, so the researcher and the advisor aimed to give scenarios to participants in different contexts: distal and proximal by trying scenarios to be parallel to each other in other ways. Therefore, it was aimed to examine whether informal reasoning of PSTs and the factors considered by PSTs differ or not in distal and proximal contexts of SSI.

Table 3.2. Structure of both scenarios.

	Genetically Modified Food:Golden Rice (as Distal Context)	Processed Food (as Proximal Context)
Related question about scenarios	The Vietnamese government should or should not allow the production and marketing of Golden Rice?	The Turkish government should or should not charge more money for the Processed Food in Turkey?
First Paragraph	The description of Golden Rice	The description of Processed Food
Second Paragraph	Public health justification & No studies suggest any threat to health (SHOULD –ADVANTAGES)	Accessibility and Economic Justification (SHOULD NOT -ADVANTAGES)
Third Paragraph	Difficult to control if any threat is present & No studies related to how affect plant as whole (SHOULD NOT- DISADVANTAGES)	Public Health Justification (SHOULD-DISADVANTAGES)
Fourth Paragraph	Public health justification (SHOULD - ADVANTAGES)	Accessibility for wider population (SHOULD NOT-ADVANTAGES)
Fifth Paragraph	Environment justification (SHOULD NOT- DISADVANTAGES)	Public Health (SHOULD – DISADVANTAGES)

3.3.2. Semi-structured Interview

One of the purposes of this study is to investigate pre-service science teachers' informal reasoning in distal and proximal contexts of SSI. The researcher and the advisor prepared six questions related to each issue that were asked during the semi-structured interviews. These questions aimed to reveal how pre-service science teachers resolve social and scientific dilemmas, specifically disclosing their informal reasoning and factors considered by them in resolving the issues.

In addition to their informal reasoning, there is another aim of the study which is the utilization of the nature of science (NOS) understanding in proximal and distal contexts of SSI. Since it is aimed to examine the utilization of NOS in the proximal and distal context of SSI, the researcher also reshaped questions for revealing pre-service science teachers' NOS understanding that can be utilized. Especially, contemporary NOS scenarios focused on context were chosen to assess pre-service science teacher' NOS understanding because they illustrate the issue of risk perception as well as the ethical components of SSI in and social interaction of science. The following NOS understanding dimensions are present in all two SSI cases: (1) rational risk perception in science, (2) social embeddedness of science, (3) tentativeness of scientific knowledge and methods, (4) subjective interpretation of the evidence. These questions and utilization of NOS aspects that may potentially be revealed in decision making processes related to Golden Rice and Processed Food scenarios are shown in Table 3.3.

Table 3.3. The questions about scenarios and which aspects of NOS includes.

Main Questions about Process Food	Main Questions about Golden Rice	Potential aspects related to NOS understanding
1. Do you think that Turkish government should increase the taxes on the Processed Food in Turkey? (yes/no) Explain and justify your decision.	1. Do you think the Vietnamese government should allow production and marketing Golden Rice? (yes/no) Explain and justify your decision.	<ul style="list-style-type: none"> • Risk Analysis in Science (emotional/evidence-based perceptions of the risk)
2. Considering the evidence presented in the scenario and your previous knowledge about Processed Food how would you convince someone who thinks differently from you?	2. Considering the evidence presented in the scenario and our previous knowledge about Golden Rice how would you convince someone who thinks differently from you?	<ul style="list-style-type: none"> • Risk Analysis in Science (emotional/evidence-based perceptions of the risk)
3. What do you think about the effects of your decision on society?	3. What do you think about the effects of your decision on society?	<ul style="list-style-type: none"> • Social Embeddedness of Science
4. How would you think about someone in your family using Processed Foods?	4. How would you think about someone in your family using Golden Rice?	<ul style="list-style-type: none"> • Risk Analysis in Science (emotional/evidence-based perceptions of the risk)
5. Do you think that your decision about increase the taxes on Processed Food might change in the future? Please explain why.	5. Do you think that your decision about Golden Rice might change in the future? Please explain why.	<ul style="list-style-type: none"> • Tentativeness of Scientific Knowledge • New Evidence
6. Even though scientists look at the same data, they have different perspectives on Processed Food. How would you evaluate it?	6. Even though scientists look at the same data, they have different perspectives on Golden Rice. How would you evaluate it?	<ul style="list-style-type: none"> • Subjective Interpretation of the Evidence

After completing two scenarios by the researcher and the advisor, they were sent to three experts to get feedback about the appropriateness of two scenarios for the aim of this study and research questions, thus how accurately scenarios measure the aims of the research. The researcher prepared a table (see in Appendix F) to send it with two scenarios to experts for examining and comparing scenarios. Experts provided suggestions and feedback by filling the table to develop scenarios for reaching research aims. After getting feedback from experts, the method and tools were redesigned and regarded as valid. In this manner, the researcher ensured the validity of the scenarios. Specifically, the experts examined the appropriateness of scenarios' content for research goals (face validity), completely representative of what it's supposed to measure (content validity).

After revision by considering experts' views, the final version of scenarios was created. Since getting deeper information about feelings and thoughts from participants is crucial for this study, in general for qualitative studies, participants need to read and think in their mother tongue. That's why these scenarios that participants read during semi-structured interviews were Turkish (see in Appendix C and D). Also, the English versions of two scenarios are in Appendix A and B.

3.4. Data Collection Procedure

After getting feedback from experts and creating a final version of the scenarios, the researcher prepared a timetable for participants. It involved date and time intervals, so participants who wanted to attend this study had chosen available time. The researcher reached e-mail addresses of PSTs who were studying at a specific university thanks to the advisor and one instructor at the same university. The researcher sent an e-mail including the timetable, and the information related to the general purpose and process of the study to all PSTs (all junior and senior pre-service science teachers). Due to covid pandemic situation, the researcher met with each participant who was willing to participate in this study individually via Zoom. Before conducting semi-structured interviews, the researcher informed the general process of

these interviews and shared consent form (see in Appendix E) and allowed them to be read and accepted. If there was any question related to the general process of this study, the researcher answered and clarified for the participants. Later, signed consent forms were obtained from the participants.

During the semi structured interviews, the order of scenarios read by each participant was managed by the researcher. For example, the first participant read the Golden Rice scenario and answered the questions about it. This participant read Processed Food later and answered the questions about it. Then, the second participant read Processed Food first and answered the questions about it. The participants later read Golden Rice and answered the questions about it. This continued like this till conducting semi-structured interviews with 19 pre-service science teachers. This was crucial to account for any differences that may have occurred because of the effect of the first scenario that participants read and interviewed about.

Also, before starting the interviews, the researcher got permission from each participant to record the interview. During these interviews, the researcher recorded all meetings with a recorder. All participants were interviewed about both scenarios. Each interview with each participant lasted around half an hour. After the interview, the researcher transcribed the voice recordings to analyze.

3.5. Data Analysis

To conduct a qualitative study, systematic and in-depth data analysis is required. A qualitative researcher collects from various sources such as interviews, field notes, and written transcripts to analyze data in detail (Glaser & Strauss, 1967; Yin, 2011). In this study, since researchers did semi-structured interviews with PSTs related to two SSIs, the written transcripts of the interviews were examined as a data analysis tool. In the transcribed interviews, the researcher identified units of data that are “potentially meaningful segments” (Merriam, 1998) of the participants’ responses. To be more specific, the researcher first transcribed all interviews and analyzed these written transcripts to reveal variables, codes, or themes that are directly related to conceptualizations regarding the purposes of this study: participants’ informal reasoning, considerations related to their informal reasoning, and lastly the utilization of NOS understanding in distal and proximal contexts of SSI.

In examination of meaningful segments from the written transcripts, the constant comparison method, created by Glaser and Strauss (1967) for grounded theory but widely utilized in other qualitative investigations, were employed. The constant comparison method is a data-analytic procedure in which each interpretation and finding as it arises from the data analysis is compared to previous discoveries. In short, the process of data analysis is defined as the act of searching and organizing a data source to arrive at conclusions (Biklen & Casella, 2007).

First of all, the researcher read all interviews to understand and get familiar with research data. To start coding, the researcher focused on analyzing one scenario of all participants separately, Processed Food. Then, another scenario, Golden Rice was analyzed, too. If there is any possibility of the effect of reading one of the scenarios, the researcher firstly wanted to highlight it. Thus, while making this evaluation about scenarios, the researcher proceeded by paying attention whether the participant had read it first or not.

For the first question, the researcher examined nine teen pre-service science teachers' informal reasoning in light of the performed interview technique. For open coding stage of the analysis, the researcher examined and highlighted phrases or statements in each response that can possibly make conclusions. After completing one participant's interview, the researcher also compared the new emergent codes to the old emergent codes. The researcher frequently proceeded by comparing the old codes with the new codes since the existence of any conflict between the new and old codes affected the reliability of the analysis. In other words, similar and common meanings of participants' sayings were found by reading and analyzing repeatedly, which provided the researcher to create appropriate and consistent codes for participants' informal reasoning. After examining all written transcripts, data were divided into seven parts and mark them with "codes": economic consideration, health consideration, environment consideration, personal consideration, moral and ethical consideration, thinking based on scientific evidence in scenarios, thinking based on people's feelings.

The goal of breaking up data and labeling it with codes is to compare various instances in the data. After classifying and organizing codes created in open coding, the researcher did axial coding to make connections across codes. For axial code, the researcher read over codes to see how these codes were categorized into groups, or categories. Thanks to axial codes, the researcher had a list of categories that were promoted by sorted out of supportive codes. In other words, these categories were evolved from the supporting codes. When these emerging categories were examined, they were extremely consistent with the framework of Sadler and Zeidler (2005a), which is informal reasoning pattern framework. In accordance with data of this framework, the researcher decided to categorize participants' informal reasoning by considering these patterns.

This framework was the most appropriate analytic tool for the ongoing investigation among other frameworks conceptualizing informal reasoning in the context of socio-scientific issues. In the studies, the patterns and modes regarding informal reasoning were mostly related to the content of SSI such as economic, social or ecological (Patronis et al., 1999); economic-, social-, technological-, science- and ecology- orientation arguments (Wu & Tsai, 2007); ethical, scientific-technological, ecological, and socio-economical (Liu et al., 2011)(reviewed and discussed above in detail).

On the contrary to studies in the literature, the framework of Sadler and Zeidler (2005a) concentrated on participants' general way of thinking (evidence or emotion based thinking) while in resolving the SSIs. Since two parallel SSIs used in this study involved similar concerns like health, it was appropriate to examine how these concerns are used in pointing out the issues (rationally or emotionally). In addition to these, another consideration related to selecting this framework, it was concentrated on undergrads as this study in opposition to other researchers studying informal reasoning in the contexts of SSI: conducting research with middle or high school students. Following the thinking and discussion about informal reasoning patterns, three basic categories as patterns: rationalistic, emotive, and intuitive informal reasoning were decided to choose for data analysis of PSTs' informal reasoning. As mentioned in the literature part, rationalistic informal reasoning involves the resolving process related to issues by considering scientific data (evidence-based informal reasoning). Emotive informal reasoning involves highlighting the well-being of others (care-based informal reasoning). Lastly, intuitive informal reasoning involves immediate reactions to the issues.

The researcher reread the written scenarios from the beginning to categorize them as rationalistic, emotive, and intuitive informal reasoning. For specifying rationalistic informal reasoning pattern, the researcher focused on how participants use scientific data or evidence from written text or participants' own knowledge about Golden Rice and Processed Food while pointing out the issues. Specifically, it was underlined that health issues in written scenarios are instances of rationalistic informal reasoning in trying to reach the conclusion. While participants focused on health issues related to obesity in the Processed Food scenario, they focused on disease related to weak immune system resulting from deficiency of vitamin A in the Golden Rice scenario. Moreover, there was economic concern in the Processed Food scenario and environmental concern in Golden Rice. The researcher categorized phrases regarding these environmental and economic concerns as rationalistic pattern. Moreover, in resolving the issues, few participants mentioned other studies about the harm of genetically modified foods on human health in Golden Rice while few underlined negative development of agriculture in Turkey related to Processed Food.

Thanks to semi-structured interviews and written transcripts of all sayings of the participants, the researcher had a chance to concentrate on participants' emotions and feelings. For emotive informal reasoning pattern, the researcher determined phrases including participants' emotions and categorized them as emotive informal reasoning. Specifically, empathy for poor people living in Vietnam or Turkey, the wish for other people' well being were given, and the wish to make life conditions of poor people better as instances of emotive pattern. The important point was that participants can evaluate scientific evidence in written text with their emotion. In Processed Food, participants used their emotions and feelings in resolving the issue even if they firstly referred to economic concerns in written text.

Lastly, the researcher focused on participants' immediate negative or positive reactions in response to two SSIs. Some participants tried to make a solution without negotiating the issues and evaluating scientific data in the texts, and the researcher categorized these instances as intuitive informal reasoning pattern.

As a result, the researcher reread and reanalyzed the phrases of all participants underlined before to categorize and to determine informal reasoning patterns. The researcher frequently proceeded by comparing the old with the new since the existence of any conflict between the new and old one affected the reliability of the analysis. In other words, similar and common meanings of participants' sayings were found by reading and analyzing repeatedly, which provided the researcher to select appropriate and consistent patterns for participants' informal reasoning. In this manner, using both interview transcriptions of scenarios, the researcher assessed each participant's informal reasoning patterns in relation to each SSI.

While analyzing informal reasoning patterns, the research also specified categories regarding factors considered by pre-service science teachers in resolving the issue, which is another aim of this study. Precisely, what PSTs used the considerations related to issues were specified and categorized while negotiating and resolving the issues. For this reason, the researcher used open code to analyze the 19 written transcripts at the same time and took notes regarding what participants considered related to issues and how they tried to solve the issues. The emergent codes were contrasted to prior emergent codes by the researcher. The researcher coded considerations potentially regarding informal reasoning on the two transcripts (Golden Rice and Processed Food) for one participant. Several codes surfaced during the open coding of the transcripts. Based on these codes, the researcher attempted to create categories. These codes were divided into five groups by the researcher. These categories: health consideration, personal consideration, economical consideration, moral-ethical consideration, environmental consideration. Also, technological and psychological considerations were utilized, but by only one participant. Therefore, the researcher eliminated these two categories. As a result, based on the findings, health consideration, personal consideration, economical consideration, moral-ethical consideration, and environmental consideration were all related to participants' informal reasoning.

For the third research question, the researcher aimed to examine pre-service science teachers' scientific epistemology, specifically the utilization of nature of science (NOS) understanding while resolving the issues in the distal and proximal contexts of SSI. While preparing two scenarios and their probing questions, the researcher and the advisor determined which aspects of NOS understanding can be potentially revealed by PSTs: risk analysis in science, social embeddedness of science, tentative nature of scientific knowledge, and subjective interpretation of scientific knowledge. For data analysis of these NOS aspects, the researcher checked firstly whether pre-service science teachers reveal any aspects of NOS understanding in both contexts or not. After underlying whether they reveal aspects, the researcher categorized participants' NOS understanding.

While resolving the issues in both contexts, participants revealed their NOS understanding and utilized NOS aspects. The researchers determined and categorized each answer related to two scenarios as naive, mixed, and informed. If someone's view is categorized as "naive", the view is not consistent with the contemporary views of NOS understanding. A mixed view is neither naïve nor informed. It includes multiple forms where fragmented views exist together and might contradict each other. Specifically, Lederman et al (2014) described mixed in case that if a response is only partially explained and thus not completely consistent with the targeted response, or if a contradiction in the response is obvious, a score of "mixed" is assigned. The last category of the existing view is an "informed" view that represents a desirable view that corresponds with contemporary views of NOS understanding accepted by science philosophers, scientists, and science educators.

As a result, data was reanalyzed deductively by using the categories established by the framework of (Zeidler & Sadler, 2005a) to identify informal reasoning patterns of PSTs. It was determined the factors considered by them in response to specific two issues: Golden Rice and Processed Food. In these contexts of SSI, PSTs' NOS utilization was analyzed and categorized as naïve, mixed, and informed. After completing data analysis, the researcher randomly selected the data set and sent it to

independent researchers to code the data set. Their findings were compared to analysis of the researcher, and the inter rater agreement among them exceeded 85%. As a last step of data analysis, the advisor and the researcher examined data together to eliminate conflicts related to the determination of the informal reasoning patterns and NOS utilization in both contexts. By regarding these goals of this study, they discussed conflicts until they were 100% agreed.

3.6. The Quality of the Study

Subjectivity issues are common in qualitative research because the focus of qualitative research is observed in its natural setting (Moschkovich & Brenner, 2000). Some academics defined quality in the traditional terms and proposed strategies to improve quality of the studies because it is considered one of the most important criteria for qualitative studies (Firestone, 1993; Lincoln & Guba, 1985; 1993; Moschkovich & Brenner, 2000). In quantitative research, validity, reliability, and objectivity can be demonstrated with numerical indicators. Contrary to quantitative studies, it was difficult to analyze validity, reliability, and objectivity in qualitative studies since there was no numerical data to prove this.

In qualitative investigations, Lincoln and Guba (1985) employed four concepts like credibility (internal validity), transferability (external validity), dependability (reliability), and confirmability (objectivity) to indicate the quality of the study, which provides a study to be considered worthy of readers' attention (Moschkovich & Brenner, 2000). In this section, it is explained how the researcher ensured the quality of this study.

Credibility examines how the research reflects reality (Merriam, 1998). For credible analysis, it is crucial and necessary to build an in-depth understanding of what happened through all processes of this study. Therefore, thick, and rich descriptions of all steps of this study were used.

Transferability means the ability to apply qualitative study findings in different circumstances or environments (Lincoln & Guba, 1986). Even though transferability is an unsuitable target for qualitative studies due to natural settings, it can be provided. Throughout this study, the researcher took frequent notes on the progress, which allowed the researcher to write each step clearly and transparently. In other words, rich and thick descriptions were used to describe the whole process of this study in detail.

Dependability affirms the findings of the study as consistent and repeatable (Lincoln & Guba, 1986). The semi-structured interviews were recorded using a device that helped the researcher to have detailed transcriptions of conversations between researcher and participants. Also, through this study, the researcher took notes frequently related to every detail of this study including what is being learned, what are conclusions, thoughts. It helped to provide all the process of this study deliberately. Lastly, the researcher randomly selected a data set and sent it to the advisor to code the data set for ensuring dependability of this study. By discussing different coding, the researcher and the advisor were agreed related to emerging code.

The final criteria, confirmability, includes a detailed explanation of all the steps, from the beginning of the study to the end of the presenting of findings (Lincoln & Guba, 1986). A comprehensive definition of the role of the researcher and an audit trail were provided to improve confirmability of this study.

3.7. Ethical Consideration

Several essential considerations should be made when conducting qualitative research. Confidentiality, anonymity of participants, and willingness to engage in a study are among these considerations (Creswell, 2014). Firstly, the researcher applied to the ethical committee and got the ethical permission for this study from Boğaziçi University Fen Bilimleri ve Mühendislik Alanları İnsan Araştırmaları Kurulu (FMINAREK). The consent form prepared by the researcher was examined and

approved by the committee. Before starting the data collection process, the researcher obtained informed consent from (see in appendix E) all individuals to participate in the study which enabled them to be informed of the study's goal and process. The researcher also underlined again that if participants feel uncomfortable, they can leave this study and they can be free to quit. Also, the researcher answered and clarified for participants when there was any question about the process of this study. The researcher also obtained permission from the participants to save audio recordings of interviews before starting to read scenarios and answer questions.

As an ethical consideration, all participants' names were replaced with numbers throughout the study to protect their confidentiality and identity. The researcher knows each participant's real identity while collecting data, but when reporting the study's conclusions, numbers were used for each participant in the cited speech or any reference to specific individuals.

Furthermore, the findings of this study are influenced by the individuals' personal thoughts, feelings, and experiences. In other words, the researcher's perceptions about the study's nature may have an impact on participants' sayings and the case's uniqueness. Therefore, the researcher paid attention not to direct or discuss any of his or her personal beliefs or ideas with the participants.

There were no negative consequences to participating in this study. On the contrary, reading and engaging with these scenarios helped the participants better understand socio-scientific issues as pre-service science teachers. After finishing semi-structured interviews, most of them wanted to be interested in and to learn more about socio-scientific issues.

3.8. The Role of the Researcher

During this study, my fundamental role as a researcher was as an interviewer. For this study, the sole tool for data collection was semi structured interviews, so I asked questions to participants during the semi-structured interviews. Since pre-service science teachers who are studying at university located in İstanbul, Turkey were selected purposefully, I needed to reach out and ask about attending this study. My instructors shared all pre-service science teachers' e-mail addresses. I wrote an e-mail including the general process and information about this study to them. This e-mail also included a timetable. Participants who were willing to attend this study filled a timetable by considering their available time. Before the time, it was sent to e-mail including a Zoom link because due to the pandemic, all interviews were conducted online. Before starting the interview, I talked about the general process of interviews. Also, the consent form (see in Appendix E) was shown in Zoom and explained, which enabled me to ensure participants' confidentiality and anonymity. During interviews, it was thought that they are collaborators, and we are here to work together.

4. FINDINGS

In this section, the findings obtained during the multi case study carried out in line with the general purpose of this study. The presentation of the findings was based on the order specified in the purposes of the research. With each research question, qualitative data was analyzed and was tried to be given in integrity. The answers to the interview questions, which are thought to be related to the purpose, are also included in the findings. These answers form pre-service science teachers (PSTs) constitute the qualitative data of this study. The aim of this study was to investigate PSTs' informal reasoning patterns and factors considered by PSTs while resolving the issues in distal and proximal contexts of SSI. Moreover, it aimed to examine which aspects of the nature of science (NOS) are utilized by the participants during this decision-making process in both contexts of SSI. There were three research questions: 1) What are pre-service science teachers' informal reasoning patterns in the context of distal (Golden Rice) and proximal (Processed Food) socio-scientific issues, 2) What are the factors considered by pre-service science teachers' while resolving socio-scientific issues (SSI) in distal (Golden Rice) and proximal (Processed Food) contexts, 3) What nature of science understandings are utilized by pre-service science teachers while resolving socio-scientific issues (SSI) in distal (Golden Rice) and proximal (Processed Food) contexts?

Considering the qualitative nature of this research, the data of this research are presented alongside a description of the findings. The researcher presented participants' informal reasoning, the factors considered by participants in resolving the issues and NOS utilization by using quotations from the interviews. To specify the quotations, an alpha-numeric identifier was used. The participant, and the scenario in which he or she is responding were given before the quotations. Respectively, the first number, which can range between 1 and 19, was used to define a particular participant. For instance, P1 refers to participant 1. One of the two scenarios was represented by the two letters of the code after the number, which are placed pronominal. "PF" denotes responses to the Processed Food scenario; and "GR" denotes responses to the Golden Rice scenario.

In line with the purpose of this study, the answer of PSTs to questions in semi-structured interviews were examined. This section was separated into 3 parts by considering the aims of this study: informal reasoning of the PSTs, the factors considered by PSTs in resolving the issue, and the utilization of nature of science understanding, linked to scientific epistemology.

4.1. Informal Reasoning

RQ1: What are pre-service science teachers' informal reasoning patterns in the context of distal (Golden Rice) and proximal (Processed Food) socio-scientific issues?

For considering research questions, the researcher firstly determined pre-service science teachers' informal reasoning patterns (rationalistic, emotive, and intuitive). Then, the variation of these informal reasoning patterns across two SSIs were analyzed and presented in this section.

In this study, the term “informal reasoning” refers to general procedures of negotiating and resolving socio-scientific challenges, as previously stated. Specifically, the researcher focused on how participants tend to solve social and scientific dilemmas across socio-scientific issues. Therefore, both cognitive and affective processes can be included in this dialogue. The phrases or words that participants made in resolving the issue were determined and named as instances of informal reasoning patterns. The instances that referred to this process were highlighted and categorized by the researcher.

In the process of resolving the issue, participants deliberated and utilized reason to discuss and settle specific issues related to scenarios, and they displayed three patterns: rationalistic, emotive, and intuitive. As a result, the evaluation of informal reasoning of the participants was done in terms of rationalistic, emotive, and intuitive reasoning patterns. These patterns were described separately by giving examples from participants in the following. In general, participants depended only on logic and reason to create and justify their positions in certain cases of cognitive informal reasoning, which was classified under the category of rationalistic informal reasoning. Moral emotions such as empathy and sympathy were incorporated in emotive informal reasoning, while intuitive informal reasoning includes an immediate positive or negative reaction or behavior to the situation, and these reactions aided them in negotiating and eventually resolving the issue.

4.1.1. Rationalistic Informal Reasoning

While resolving problems and making decisions in the contexts of socio-scientific issues (SSI), participants utilized rational and logical thoughts. In both scenarios, there was scientific evidence related to human health. These health concerns about the issue were underlined to convince others or deal with issues by the PSTs. They used this scientific evidence from scenarios to solve the issue. In other words, they focused on data in prepared scenarios. Moreover, some of the participants mentioned scientific evidence that they read or knew before, especially related to genetically

modified foods (GMOs). In the Golden Rice scenario, there was information related to environmental concern, so some participants used this information to make an argument. In the Processed Food scenario, there was information, which is availability of these foods to everyone who has different socio-economic levels as economic concerns. This information was used by some participants in solving the issue. In this section, for each scenario what this pattern includes was explained in detail by giving quotations.

4.1.1.1. Processed Food Scenario. In this scenario, all participants utilized rationalistic informal reasoning by regarding some issues such as health concerns related to obesity, availability for everybody living in different areas in Turkey, availability for everybody from different socio-economic levels, and longer shelf life, used from written text of Processed Food. Also, participants living in Turkey encounter these foods in their lives or in supermarkets. Even if they do not use it, they know someone using these foods. Therefore, since some were aware of using these foods and its effects on the human body, they used these information in resolving the issue. Some instances from participants for rationalistic informal reasoning were presented below.

P11(PF): *As mentioned in the text, the practicality of processed foods is obvious. Open the package and consume most of them immediately. For example, after putting it in the oven, you can eat. I think it's something that everyone uses in their life, including the person I talked to. It's both cheap and practical to prepare in a short time, so people use it. Also, the price is reasonable for everybody.* (see Appendix G, Q1)

P8 (PF): *Organic food is very expensive for most people, so accessing to these foods are difficult. The changes that the scientists made to these foods made the foods accessible to everyone, even for a person who cannot live in a village. That's why I think these changes can be seen as beneficial for every person in the society.* (see Appendix G, Q2)

4.1.1.2. Genetically Modified Food: Golden Rice Scenario. In this scenario, all participants made use of health issues related to deficiency of vitamin A, health issues about weak immune system, environment concerns, unknown side effects, and uncertainty of the results of the research: no research about the effects. Even if there were participants who have no idea about Golden Rice or any GMOs, they reread the scenario, evaluated scientific data in this scenario and used them to resolve the issue. It was mentioned that trusting science and scientific studies, which enabled some to resolve the issues by using scientific data. Some instances from participants were given below.

P5 (GR): *...Because for people that have vitamin A deficiency, this is seen as an option, a solution for healing. You know, scenario says, it can be offered as a solution to childhood blindness or if there is an immune system problem caused by a subsequent deficiency of this vitamin, it is predicted that it will be able to solve it. If Golden Rice will not be produced, these people's medical treatments might last longer and might be more expensive. If this rice is going to offer a solution for these people, the government should take this risk.* (see Appendix G, Q3)

P15(GR): *Of course, it will have a positive effect on society, because most of the people in society have health problems due to poverty or due to insufficient nutrition. We are talking about a scientifically produced food that will be the solution to [health problems]. Also, it could be a solution to the blindness that children can have, so I think this is a development that will positively affect the society.* (see Appendix G, Q4)

4.1.2. Emotive Informal Reasoning

Participants used their empathy and sympathy for resolving the issues in this informal reasoning pattern. The well-being of others, especially poor people, were considered in resolving the SSIs. They felt responsible to make the life conditions of the people living in Turkey or Vietnam better. In other words, the living conditions of people in Vietnam or Turkey who have especially financial difficulties were considered and were compared in accordance with rich people's life conditions. PSTs tried to understand these conditions and to make them better for the poor. Some of them underlined an equality for all people.

Specifically, if any poor people cannot reach any foods including vitamin A, these participants thought that we must produce Golden Rice for these people. Therefore, producing Golden Rice provides equal opportunity to take food. In summary, the participants tried to solve the problem by feeling responsibility towards other people in the society and trying to make conditions better for them. For each scenario what this pattern includes was explained separately by giving quotations.

4.1.2.1. Processed Food Scenario. In this scenario, all participants displayed emotive informal reasoning. They underlined some issues by thinking about people living in Turkey such as living conditions of people in Turkey, already increased taxes of products in Turkey, economic situations in Turkey, and empathy for poor people living in Turkey. In general, by considering the economic situation of the country, it was necessary that everything will be better for the poor and equal for everybody living in the country. Some instances related to emotive were represented below.

P18(PF): *It is obvious how life is in Turkey. People are hungry and we must think about it. I'm not hungry, thank goodness. However, we see these poor people, we need to empathize, let's think about those who consume this type of foods, no matter how unhealthy these foods are. I think everyone wants fresh organic food, but we see that it is very difficult to get food in Turkey.* (see Appendix G, Q5)

P17(PF): *I don't know, our starvation line has been increased. With the prices in the market, it is not possible for everyone to eat as they want and need. Many people buy these products because they are hungry and do not have enough nutrition. If we increase these foods' taxes, how can they be fed. I think raising the tax would be a cruel act. This situation not only upsets people but can even cause them to die of hunger. That's why I don't want to support increasing the taxes of these foods, otherwise I don't want to think about people's, emotional state and physical conditions.* (see Appendix G, Q6)

4.1.2.2. Genetically Modified Food: Golden Rice Scenario . For this scenario, participants utilized emotive informal reasoning pattern by highlighting some issues related to topics such as living conditions in Vietnam and empathy for poor people living in Vietnam. Specifically, 10 participants out of 19 participants displayed emotive informal reasoning. It was underlined why the production of Golden Rice is needed by the scientists. Even if PSTs did not know the society and culture, they ensured that it will be done for poor people living in this area by considering the need of Golden Rice. Participants focused on these poor people' well-being and having equal life conditions like rich people. In short, they tried to empathize with the situation. Two instances are represented below.

P8(GR): *The changes that the scientists made to these foods made the foods accessible to everyone. This rice is like solution for poor people.. We as human beings should think and wish those people's well being.* (see Appendix G, Q7)

P15(GR):*...Moreover, rice is always produced in countries like Vietnam because the climate is suitable for the rice. Since the rice can be produced by Vietnam government, its cost will not be expensive. In this case, it is a product that will reach people from all socio-economic status. Rich and poor people alike can consume it. We have to think other people living there. Like processed foods.* (see Appendix G, Q8)

4.1.3. Intuitive Informal Reasoning

This pattern involves immediate reaction to resolve issues. This can be a negative or positive reaction to specific points of issues. When participants read scenarios, they gave prompt answers to solve issues. There can be logical thinking, but not depended on scientific evidence or data. Some of them associated their feelings. They said that it should not or should be done because they do not like it. For each scenario what this pattern includes was explained separately by giving quotations.

4.1.3.1. Processed Food Scenario. For this scenario, 11 participants utilized intuitive informal reasoning. It was underlined that the increasing taxes on Processed Food makes them unhappy. It was not based on scientific data or knowledge. It was claimed that if someone wants to increase taxes on Processed Foods, they are probably rich, which means that increased taxes do not have influence on these rich people. Some instances from participants were presented below.

P6(PF): *I just went to the market the other day and I was going to buy some snacks. Their prices were so high. Of course, I eat unhealthily because I am living in dorm as student. I don't like this situation. I do not like this increased price, so I definitely think that tax should not be increased by the government...* (see Appendix G, Q9)

P3(PF): *I will say to people [who think differently] that you don't buy these foods, what can I say, there is nothing that affects you, guys.* (see Appendix G, Q10)

4.1.3.2. Genetically Modified Food: Golden Rice Scenario. In the Golden Rice scenario, 11 participants out of 19 participants displayed intuitive informal reasoning. It was underlined mostly that they had no idea about what they should say. One of them who focused on the disadvantages of Golden Rice said that people should eat carrot for deficiency of vitamin A. Some of them did not negotiate the issue. For instance, it was argued that normal rice can take for deficiency of vitamin A, but normally rice does not involve vitamin A. These instances were given below.

P3(GR): *I guess the average lifespan of the society will increase because we do not allow Golden Rice to be produced. It would have been good. I guess. I don't know what to say.* (see Appendix G, Q11)

P7(GR): *Do you realize that there is still normal rice, take it, so if it is seen that Golden Rice does not solve health problems. I would say that maybe normal rice should be consumed instead of GMO.* (see Appendix G, Q12)

P1(GR): *In case of vitamin A deficiency, I guess, I say that you should take and eat carrots...* (see Appendix G, Q13)

4.1.4. Variations of Informal Reasoning Patterns Across SSIs

After determining and classified informal reasoning patterns of each participant in distal and proximal contexts of socio-scientific issues (SSI), the researcher compared both contexts in terms of overall patterns of informal reasoning. In this section, the differences, and similarities of these patterns of the participants across two contexts of SSI were presented.

All participants' informal reasoning patterns were examined, and they utilized various patterns in resolving the issue in the same scenario. Thus, the researcher firstly counted how many instances of three informal reasoning patterns: rationalistic, emotive, and intuitive displayed by each participant for each scenario. It enabled to examine the number of instances of each pattern revealed by one participant in distal and proximal contexts of SSI, and to investigate the variation of these patterns utilized by each participant in these contexts. For this reason, there are two figure below showing the number of instances of these patterns for each scenario by each participant.

When examining the Figure 4.1 below, for the Processed Food scenario 11 participants utilized all patterns: rationalistic, emotive, and intuitive informal reasoning in response to the issue while 8 participants utilized both rationalistic and emotive informal reasoning. In other words, all participants displayed rationalistic and emotive informal reasoning in response to Processed Food, but only 11 participants utilized intuitive informal reasoning.

When the Figure 4.2 below is examined, how many instances of informal reasoning patterns displayed by each participant for the Golden Rice scenario can be seen. Not all participants demonstrated all patterns of informal reasoning, but all participants demonstrated rationalistic informal reasoning. Moreover, 5 participants only utilized rationalistic informal reasoning to resolve the issue. 4 participants utilized both rationalistic and intuitive informal reasoning while 3 participants utilized both rationalistic and emotive informal reasoning. 7 participants showed all patterns together for pointing out the issues. In other words, all participants displayed rationalistic informal reasoning. 10 participants showed emotive informal reasoning while 11 participants displayed intuitive informal reasoning in the distal context of SSI.

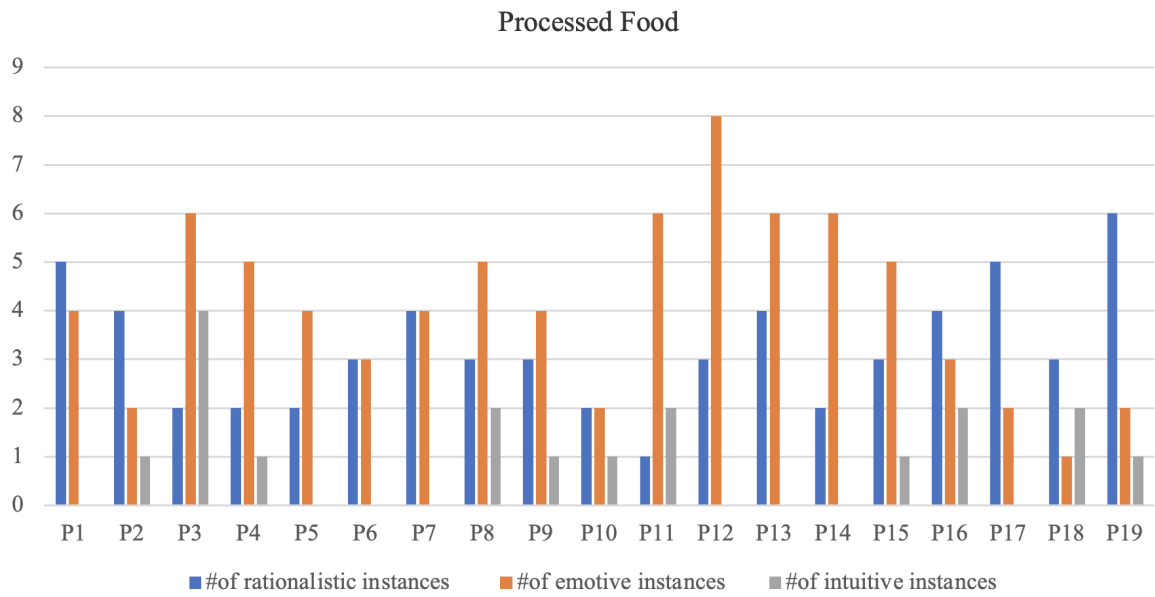


Figure 4.1. Number of Instances of Informal Reasoning Patterns for Processed Food Scenario.

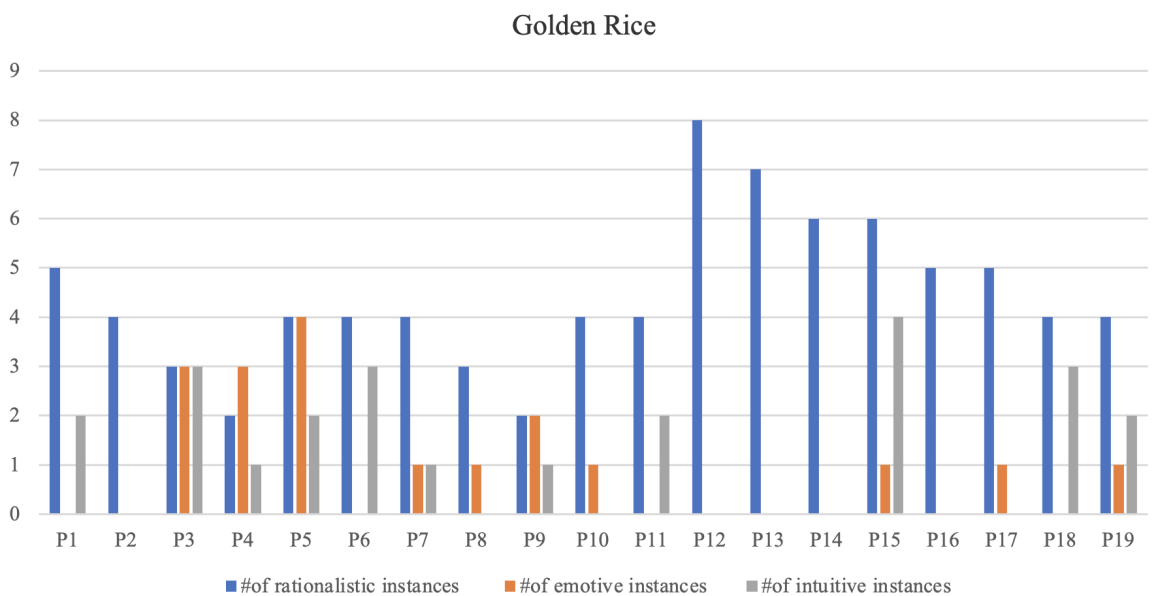


Figure 4.2. Number of Instances of Informal Reasoning Patterns for Golden Rice Scenario.

Furthermore, after determining the number of instances for each pattern of each participant, the researcher calculated the percent distribution of informal reasoning patterns that each participant displayed for resolving the issue in Processed Food and Golden Rice. Thus, it is coherent to examine the distribution of patterns of each participant individually. Percent distribution is a frequency distribution in which individual frequencies are represented as a percentage of total frequencies. To find the percentage of informal reasoning patterns of one participant, the researcher divided the number of this pattern's instances by the total number of all patterns' instances displayed by the participant and then, multiplying by 100. The researcher did the same processes for each participant and prepared Figure 4.3 and Figure 4.4 below to show the percent distribution of informal reasoning patterns that each participant displayed for solving the issue in Processed Food and Golden Rice.

By examining the distribution of informal reasoning patterns of participants, the researcher had the opportunity to investigate which patterns that participant displayed in total in resolving the issue related to Processed Food and Golden Rice separately. To be more specific, while 6 participants displayed rationalistic informal reasoning pattern more than other patterns for Processed Food, 15 participants displayed rationalistic informal reasoning pattern more than other patterns for the Golden Rice scenario. Moreover, while 10 participants displayed emotive informal reasoning pattern more than others for the Processed Food scenario, no one showed emotive informal reasoning more than other patterns for the issue related to Golden Rice. Then, 3 participants for Processed Food and 2 participants for Golden Rice displayed rationalistic and emotive informal reasoning equally. Unlike the processed food scenario, one participant showed three informal reasoning patterns together and equally distributed in resolving the issue related to Golden Rice. In addition to these, informal reasoning patterns of the participants were diverged in Processed Food.

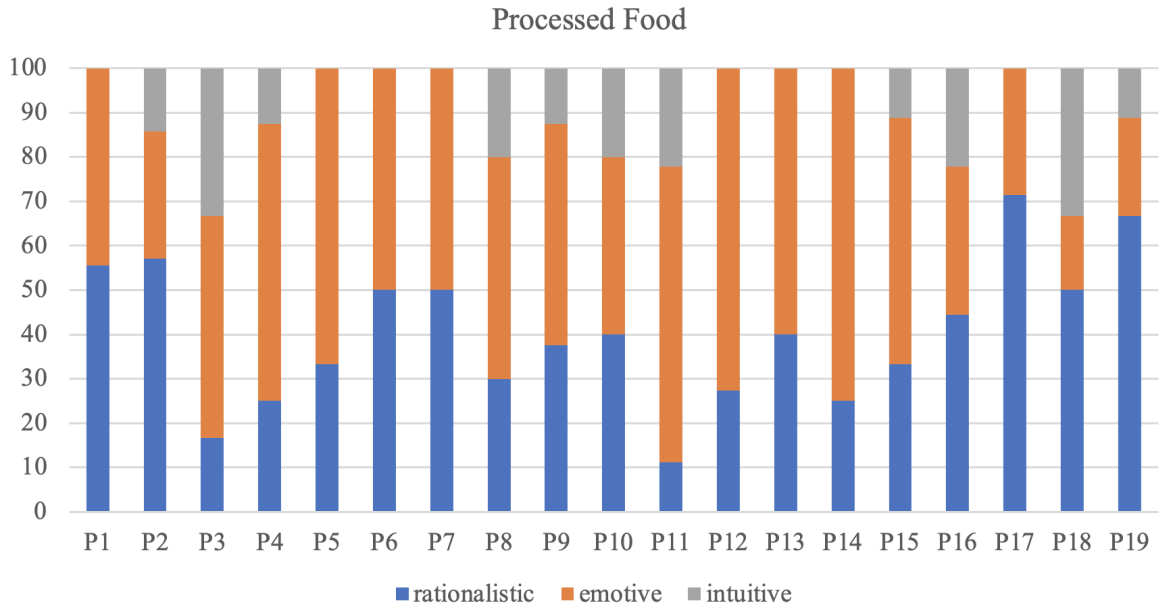


Figure 4.3. The Percent Distribution of Informal Reasoning Patterns of Each Participant for Processed Food Scenario.

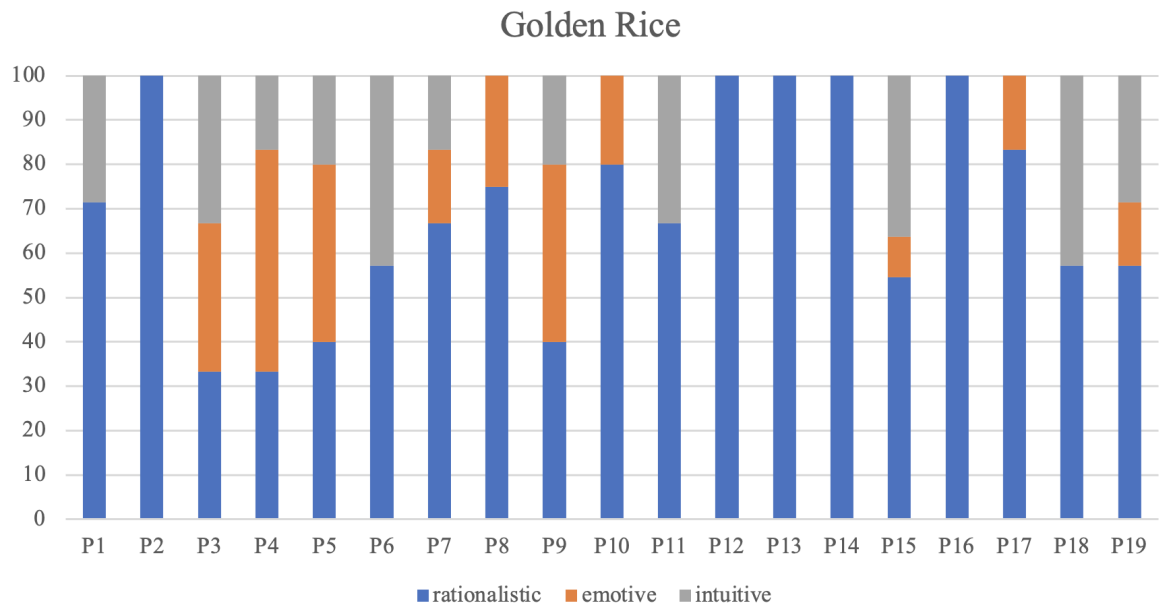


Figure 4.4. The Percent Distribution of Informal Reasoning Patterns of Each Participant for Golden Rice Scenario.

Additionally, the Table 4.1 showing the total number of instances of all patterns is presented below. It enables the researcher to investigate total number of arguments related to each informal reasoning pattern revealed by each participant in both contexts. By considering total number in Table 4.1, in the distal context (Golden Rice) of SSI participants (67%) displayed more instances of rationalistic informal reasoning pattern in total than other patterns: emotive (14%) and intuitive (19%). In proximal context (Processed Food), participants (50%) displayed emotive informal reasoning pattern more in total while they displayed rationalistic informal reasoning (39%) and intuitive informal reasoning (11%).

Table 4.1. The number of emerging informal reasoning patterns in both contexts by each participant.

Participant	Processed Food Scenario				Golden Rice Scenario			
	R	E	I	Total	R	E	I	Total
1	5	4	0	9	5	0	2	7
2	4	2	1	7	4	0	0	4
3	2	6	4	12	3	3	3	9
4	2	5	1	8	2	3	1	6
5	2	4	0	6	4	4	2	10
6	3	3	0	6	4	0	3	7
7	4	4	0	8	4	1	1	6
8	3	5	2	10	3	1	0	4
9	3	4	1	8	2	2	1	5
10	2	2	1	5	4	1	0	5
11	1	6	2	9	4	0	2	6
12	3	8	0	11	8	0	0	8
13	4	6	0	10	7	0	0	7
14	2	6	0	8	6	0	0	6
15	3	5	1	9	6	1	4	11
16	4	3	2	9	5	0	0	5
17	5	2	0	7	5	1	0	6
18	3	1	2	6	4	0	3	7
19	6	2	1	9	4	1	2	7
Total	61 (39%)	78 (50%)	18 (11%)	157	84 (67%)	18 (14%)	24 (19%)	126
Average				8,3				6,6

*R: Rationalistic Informal Reasoning *E: Emotive Informal Reasoning *I: Intuitive Informal Reasoning

After calculating the total number of instances and dividing by the number of participants to find the average number of instances for each scenario, see in Table 4.1 above. When investigating the average number of instances of scenarios, this number for Golden Rice is approximately 6.7 while it is approximately 8.3 for Processed Food scenario. Participants utilized more informal reasoning instances in resolving the issue in the proximal context of SSI, Processes Food. In other words, they made more arguments while resolving the issue in proximal context.

Participants utilized more than one informal reasoning pattern for the same issue. In addition, some participants utilized the same pattern several times for the same issue. After calculating the number of three patterns that the participants utilized in resolving the issues, two 3-D plots were developed for each context of SSI by using the MATLAB software. In those 3-D plots, there are 19 data points that represent three informal reasoning patterns in distal and proximal context of SSI. The surfaces in the plots are generated using thin plate spline interpolation of the surveyed data. By using curve fitting application was applied to show the distributions of the informal reasoning patterns of each participant. To be more specific, the data points were placed by considering the number of each informal reasoning pattern utilized by each participant. Specifically, in 3-D plot, x-axis represents the number of rationalistic informal reasoning pattern utilized by each participant; y-axis represents emotive informal reasoning pattern; and z-axis represents intuitive informal reasoning patterns.

The placement of these patterns provides an opportunity to investigate the total distribution of these patterns revealed by the participants. The different colors of the curve are related to the number of intuitive informal reasoning pattern (z-axis). As the number of this pattern increases, the data is placed on from the purple area to the blue area, and then the yellow area of this curve.

As seen in Figure 4.5, the data points of the participants were placed over a large area because participants showed various informal reasoning patterns in Processed Food. However, in Golden Rice the data points of the participants representing their informal reasoning patterns were placed in a certain section as seen in Figure 4.6. All PSTs utilized informal reasoning patterns; and some of them only utilized this pattern. Therefore, the data points were situated in the area where the value of x is high.

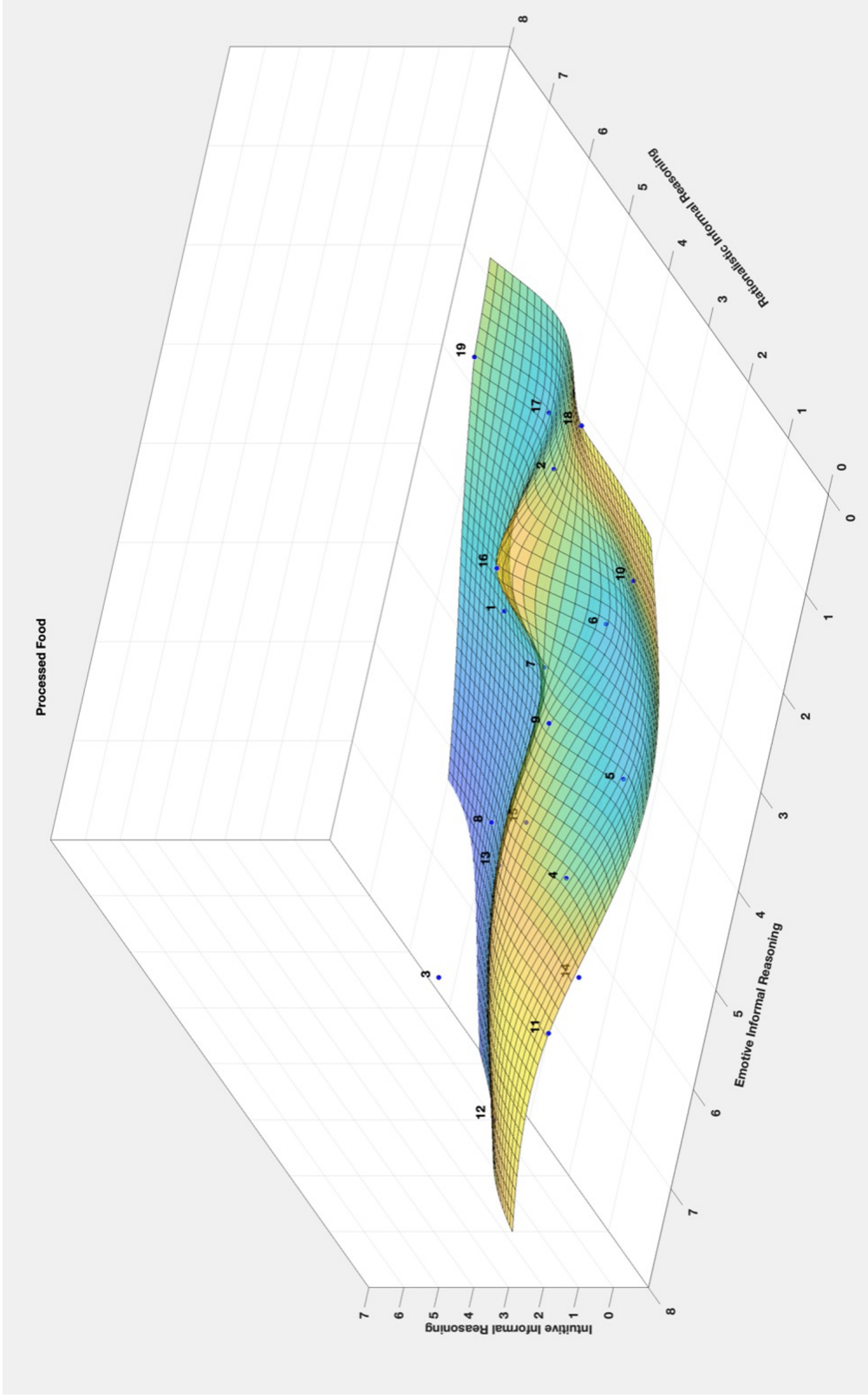


Figure 4.5. 3D-Plot of Informal Reasoning Patterns in Processed Food.

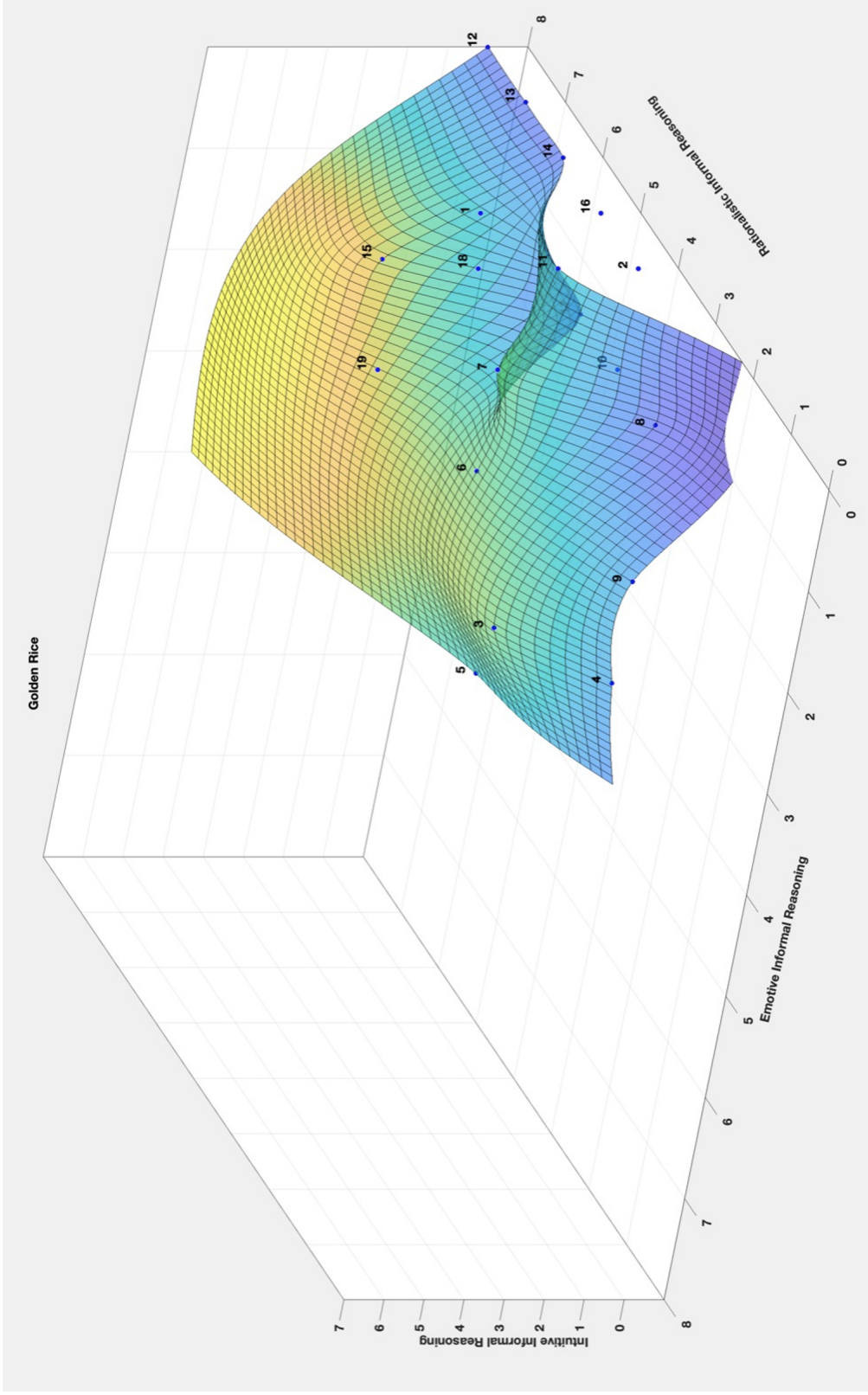


Figure 4.6. 3D-Plot of Informal Reasoning Patterns in Golden Rice.

4.2. Factors considered in resolving the SSIs

RQ2: What are the factors considered by pre-service science teachers' while resolving socio-scientific issues (SSI) in distal (Golden Rice) and proximal (Processed Food) contexts?

The other goal of this study was to investigate and explain factors considered by participants in resolving the issues in the contexts of SSI. Several studies in the socio-scientific literature investigated the factors that influence informal reasoning and socio-scientific decision-making (Bell & Lederman, 2003; Hogan, 2002; Sadler et al., 2002; Sadler, 2003; Topçu et al., 2008; Tytler et al., 2001; Zeidler et al., 2002). For instance, Sadler (2003) examined the impact of content knowledge about science and morality on informal reasoning in the context of SSI. Bell and Lederman (2003) likewise studied how NOS conceptualization affects socio-scientific decision-making. Although there were a few discoveries in socio-scientific literature regarding the variables influencing people's informal reasoning, Topçu (2008) specialized research on the factors influencing informal reasoning. The factors influencing PST's informal reasoning in response to multiple SSI were investigated. After classification of factors influencing informal reasoning, four categories were explained: personal experiences, moral-ethical consideration, technological concern, and social considerations that are separated also into three categories: economic, educational, and religious aspects.

The researcher and the advisor decided to focus on the factors shaping and building participants' informal reasoning. Although the proximal context of SSI: Processed Food involved health and economic consideration and the distal one: Golden Rice involved health and environmental dimensions of the issue, participants also revealed moral and ethical, and personal factors in resolving the issues. The key elements related to participants' informal reasoning were grouped into five categories based on the qualitative analyses: personal, moral-ethical, environment, health, and economic consideration. Table 4.2 shows descriptions of these factors revealed in resolving the issues.

Table 4.2. The factors considered in resolving the issues, and their description.

Factors considered in resolving the issues	Descriptions of the Factors
Personal Consideration	Drawing on prior and personal experiences to resolve challenges raised by the issues.
Moral-Ethical Consideration	Using moral and ethical perspectives in judgement of dilemmas related to issues.
Health Consideration	Employing health concerns and people' health in resolving the issues
Economic Consideration	Putting forward the socio-economic level of people, and economic situations in a country.
Environmental Consideration	Underlying environmental points related to issues.

4.2.1. Personal Consideration

In the case of some SSI, participants used their prior and personal experiences to address the issue. Several scholars in the socio-scientific literature suggested that personal experiences served as a guide to resolving and negotiating socio-scientific difficulties (Bell & Lederman, 2003; Sadler, 2003; Zeidler et al., 2005). In general, researchers found that a person's informal thinking concerning SSI is influenced by their personal domain and experiences (Sadler, 2004; Yılmaz-Tuzun & Topcu et al., 2011). In this study, participants gave some examples from their own lives. Some of them shared experiences related to their relatives regarding consuming Processed Foods. While 12 participants utilized personal experiences for resolving issue in the proximal context of SSI, none of participants did not use personal experiences for the issue in the distal context of SSI.

4.2.1.1. Processed Food Scenario. In this scenario, 12 participants shared their experiences and tried to solve by considering these experiences. For instance, they thought that these kinds of foods provide people to consume whatever they want to eat even though it is not an appropriate season to farm due to preservatives in their structure. One of the participants focused on eating peas in winter. One of them mentioned that it is really hard to give up eating these kinds of foods as students. There is an instance for personal consideration from the Processed Food scenario.

P8(PF): *I live with my mother. If she cooks peas in winter and I get a different taste from meal. I can understand and asked like is this canned? Because I immediately recognize the taste, I don't like it. However, she says that I wanted to cook this peas today, so I had to used it... In this case, of course, my mom should use something whatever she wants for meal. Did you understand? Sometimes cans can be savers. We can use these foods, sometimes.* (see Appendix G, Q14)

P14(PF): *I am a student. That's so bad. Going to the market is even a little nerve-wracking. I simply do not want increasing prices for myself. I'm consuming these foods as a student, so it's hard for me to give up on these kinds of foods in my life.* (see Appendix G, Q15)

4.2.2. Moral-Ethical Consideration

According to the socio-scientific literature, moral-ethical standpoint was a crucial factor in resolving and negotiating socio-scientific challenges (Cebesoy, 2020; Evans, 2002; Ozden, 2020; Topcu, 2008; Zeidler & Keefer, 2003). Since SSI involves dilemmas and morality, moral and ethical concerns are seemed to factor that affecting the process of resolving the issues. In line with prior studies, moral-ethical concern was identified as one of the different factors considered by participants' in resolving the issues in both contexts. In other words, participants applied moral ethical considerations to SSI in attempt to resolve these challenges.

4.2.2.1. Processed Food Scenario. 7 participants utilized these concerns in the Processed Food Scenario. Participants highlighted that this decision related to increasing taxes on Processed Food cannot be done by themselves because this decision affects other people living in Turkey. It should be considered that everybody has their own choice on whether to consume these foods or not. The following are some examples of moral-ethical factors considered by participants from the Processed Food Scenario.

P2 (PF): *...It's up to us to choose it. Why would this be about tax increases? People living in Turkey can make this choice for themselves. We cannot choose for other people. It's accessible so more people can reach these foods, after all. There should be accessibility for everybody and everybody should decide on whether to consume them or not.* (see Appendix G, Q16)

P10 (PF): *I think that I can present the proof that this obesity is real, even if there are few examples in Turkey. However, it seems that people are not very convinced. One person has to think about the people living in Turkey, one must understand the situation and living condition in Turkey.* (see Appendix G, Q17)

4.2.2.2. Golden Rice Scenario. In this scenario, 6 participants considered moral and ethical in resolving the issue. Participants focused on taking the risk to save people's lives. They preferred to trust scientific data and concentrate on the advantages of producing Golden Rice. They thought that it is a moral choice to want to save people living in Vietnam. Some examples from the participants were given below.

P2(GR):*Even if you [the person that think that Golden Rice should not be produced] don't consume it, I would say it's worth taking the risk for people looking for solutions. There are people who can recover with it. I would say you should trust in science. I will give example from drugs. Drugs can use for healing in most cases. For most people, the effects of the drugs are okay but there are also side effects about drugs. I think this could be a side effect of Golden Rice as well.* (see Appendix G, Q18)

P7(GR):*I focused directly on saving children or people living in the community. Even if it's worse, it seems like a must-have innovation to save the day, considering the people you can save, it's worth taking the risk.* (see Appendix G, Q19)

4.2.3. Health Consideration

With the consideration of two contexts of SSI that were prepared for this study, both involved regarding health issues such as diseases related to obesity in the Processed Food scenario and diseases related to deficiency of vitamin A in Golden Rice scenario. The researcher and the advisor predicted that participants may use these health concerns to resolve the issues. Most of participants, 18 participants, used health concerns to solve the issue in the distal context of SSI, Golden Rice scenario. However, only 3 participants utilized health concerns for the Processed Food scenario. The examples of health consideration from both scenarios were given below.

4.2.3.1. Processed Food Scenario. 3 participants used health considerations from prepared text in working out the issue. They emphasized how unhealthy these kinds of foods are for human bodies, increasing taxes on those foods can be precautions for not consuming. Some of them underlined that taking more sugar, salt, and oil is harmful like smoking. They supported tax increases to consume less by people living in Turkey. These examples of participants' sayings were represented below.

P1(PF): *It's actually good for people, because processed foods are unhealthy. Thus, people may not buy these kinds of food, and people tend to cook and eat healthy foods. In this sense, it can be a meaningful action to protect their health. (see Appendix G, Q20)*

P17(PF): *I support that taxes of these foods should be increased to have an effect on not buying these foods by people living in Turkey. Therefore, maybe people would consume less. Because it's really harmful. Some articles say it is as harmful as cigarettes. Too much fat and sugar on these foods. When you look at it like that, you really shouldn't consume it. It is very normal for the government to increase taxes on such products. After all, it is not more important than people's health. (see Appendix G, Q21)*

4.2.3.2. Golden Rice Scenario. Almost all participants, 18 participants, underlined health concerns in solving the issues. In addition, participants used data from prepared text. Some of them concentrated on unknown side effects of genetically modified foods: Golden Rice, so the government should not allow producing and marketing Golden Rice. Others focused on allowing the production of Golden Rice because there is a chance to save the life of children who have childhood blindness and people who have diseases related to deficiency of vitamin A. This is another health concern in written text. There are some examples from participants.

P2(GR): *There are so many unknowns. The health of these people could become worse. I mean their health could be affected even worse. I don't think it's necessary to take such a risk.* (see Appendix G, Q22)

P10(GR): *Vitamin A deficiency is bad for health and it causes people to have a weak immune system. On the other hand, while there are other methods for people such as eating healthy or improving immune system by medicine, producing a substance by changing the structure of rice would lead us to things that we do not know. Instead, we should use the solutions we know, it would be more healthier and the result would not be unknown or dangerous.* (see Appendix G, Q23)

4.2.4. Economic Consideration

When socio-scientific literature is examined, most researchers agreed that economic perspective under social category was a major factor in people's decision-making on a variety of SSIs (Bell & Lederman, 2003; Sadler et al., 2004). The economic situation in society and socio-economic level of people living in Turkey or Vietnam were interacted by participants in the process of resolving the issue. In the proximal context of SSI, 16 participants put forward economic consideration related to the issue whereas only 2 participants showed economic consideration in the distal context (Golden Rice) of SSI.

4.2.4.1. Processed Food Scenario. In this scenario, 16 participants focused on the economic situation in Turkey. While evaluating data in the text, they primarily attracted and underlined the economy of Turkey. Specifically, it was stated that the prices of all products involving foods, technological devices, and clothes had been increasing day by day. Most people living in Turkey must use these foods daily, because organic and healthy food are expensive. If the government decided to increase their prices, people would have difficulties reaching these foods. People will be unhappy and hungry in case of not being able to buy these foods. Some claimed that even if people knew how unhealthy these foods are, they needed to eat something. Therefore, increasing prices of these foods probably causes the families at low socio-economic levels not to feed well. Some examples involving economic consideration were presented below.

P17(PF): *I said that there should be no raise, because if there is, everyone would get angry at first. But this is normal. The economy of Turkey is really bad now. We should think of people living in Turkey and situation of the country. (see Appendix G, Q24)*

P19(PF): *I think there will be many people who will be happy about this situation. Even though they say how unhealthy it is scientifically, people are constantly focusing on the increase in the prices of products. Therefore, they will focus on their own situation rather than scientific data and rejoice. Let's call it psychological relief. In fact, I do not support increasing prices for the sake of the peace of the society. (see Appendix G, Q25)*

P9(PF): *Eating pizza has become a luxury. If the prices are increased, it would mean ignoring a specific part of the society ... [people who have lower socio-economic level]. There is already increasing inflation in Turkey. There is an economic problem. I have to think about families whose economic level is not good. I mean, society is an important criterion for me. (see Appendix G, Q26)*

4.2.4.2. Golden Rice Scenario. In this scenario, only 2 participants considered economic factor in dealing with the challenges of the issue such as people having lower socio-economic status. They argued that Vietnam is a poor country. There are poor people who have diseases related to deficiency of vitamin A due to not reaching food. If the economy of this country is bad, the government and other people living there should think of poor people. One of two examples was represented below.

P2(GR): *Vietnam is a poor country after all, I think we have to think about the poor people there. Government should think. If they can't get food, it means they don't have it. I think that this product can be produced and offered to them in a cheap way. Kind of like processed foods.* (see Appendix G, Q27)

4.2.5. Environmental Consideration

It was discovered that while negotiating with SSI and resolving the issue, participants showed environmental concerns, specifically in the distal context of SSI. Since the Golden Rice scenario involves environmental concern, 5 participants utilized this concern to resolve issue in Golden Rice scenario.

4.2.5.1. Golden Rice Scenario. Participants underlined the idea about environmental concern from the text. In resolving the issue how it can be harmful to the environment was discussed. Specifically, they focused on the contamination of genetically modified rice that can probably affect the organic rice. Thus, people cannot reach normal rice in Vietnam which has huge production of normal rice. None of them showed environmental concern in the proximal context of SSI as expected. These examples from the Golden Rice scenario were shown below.

P2(GR):...*It is also claimed in the text that the gene structure can be deteriorated thanks to gene transfer. Think about it, there has been a gene transfer and we are destroying the structure of normal white rice that most people use. We aim to make a certain part of the society healthy, but it has suddenly turned into a situation that will affect everyone. In fact, I did not find gene transfer beneficial for the environment or for human health.* (see Appendix G, Q28)

P13(GR): *It may be harmful to our environment. There may be contamination mentioned in the text. I'm not usually a risk taker, so it didn't make much sense to me to step into the unknown. It's the same ecosystem after all. If it is produced, if there will be negative consequences, it may affect people in the other country. Animals, bees, even airborne, can also spoil local rice in other areas.* (see Appendix G, Q29)

4.2.6. Variations of Factors Considered by Participants Across SSIs

After establishing and labeling the factors separately in distal (Golden Rice) and proximal (Processed Food) contexts of socio-scientific issues (SSI), the researcher compared both contexts in terms of overall factors considered by the participants in resolving the issues. In this section, the differences, and similarities of these patterns of the participants across two contexts of SSI were presented.

As these scenarios were prepared to be parallel to each other, both included scientific evidence related to health concerns. In addition to these, the Processed Food scenario also included economic concern while Golden Rice included environmental concern. However, all participants displayed different considerations that were determined and classified by the researcher above while solving issues in both contexts. These are personal and moral and ethical considerations revealed by participants in resolving the issues.

To examine the number of these factors that participants displayed for each SSI and to analyze the differences and similarities across SSIs, the researcher prepared pie charts for each scenario in terms of factors that 19 participants revealed in sorting out issues. Some participants elicited more than one consideration. To represent these considerations, the researcher prepared pie charts including the percentages of these specific considerations of all participants in a scenario below.

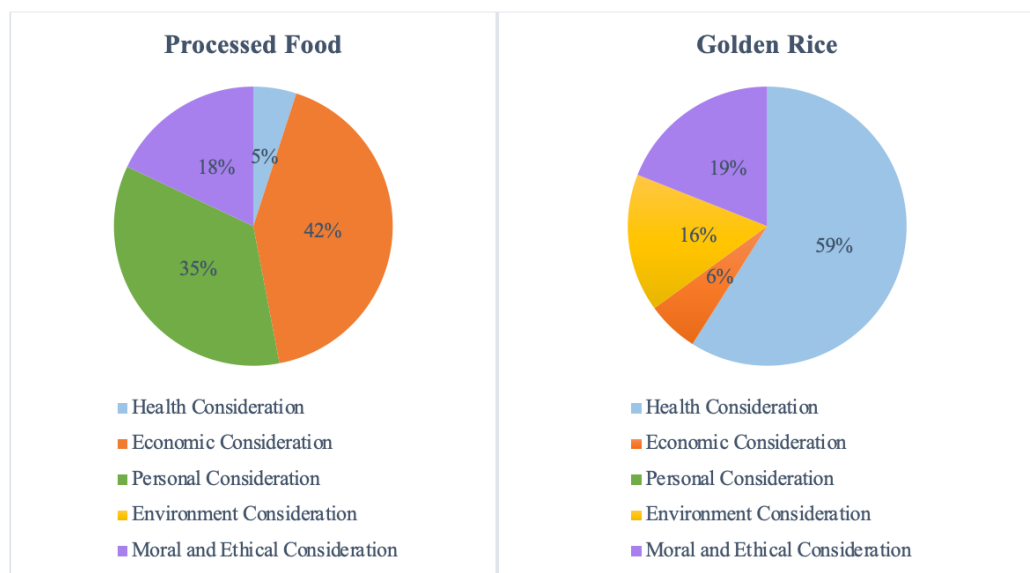


Figure 4.7. The Percentages of Specific Factors Considered in Resolving the Issues in Both Contexts.

When the pie charts related to the Processed Food and Golden Rice scenario are examined in Figure 4.7, there are various considerations in both contexts. It is obvious that participants showed different considerations in resolving the issues in distal and proximal context. In Processed Food, all considerations were given except environmental one. 16 participants (42%) underlined economic conditions in Turkey such as already increased taxes and income of the people. 12 participants (35%) focused on personal experiences related to consuming processed foods. 7 participants (18%) showed moral and ethical consideration and only 3 participants (5%) disclosed health consideration for dealing with the issue even if this scenario included scientific evidence related to human health. In Golden Rice, all considerations were given

except personal consideration. In contrast to the Processed Food scenario, almost all participants, 18 participants (59%) displayed health consideration related to GMOs. 6 participants (19%) displayed moral and ethical consideration. 5 participants (16%) illustrated environmental consideration in solving the issues related to Golden Rice. Lastly, 2 (6%) participants mentioned economic consideration in resolving the issue.

4.3. Utilized Nature of Science Understanding

RQ3: What nature of science understandings are utilized by pre-service science teachers while resolving socio-scientific issues (SSI) in distal (Golden Rice) and proximal (Processed Food) contexts?

In addition to the reasoning pattern and factors considered by participants in resolving the issue, what nature of science understanding are utilized in the context of distal and proximal SSI were examined. The researcher and the advisor identified specific aspects of NOS understanding while preparing scenarios and probing questions asked during semi-structured interviews. Specifically, they reviewed the literature related to SSI scenarios and paid attention to the aspects of NOS understanding that may be revealed by participants in making decisions. The same questions about the issues were asked to reveal NOS understanding.

As mentioned before, there were questions about socio-scientific issues that were asked during semi-structured interviews for revealing these aspects of NOS: the relationship between science and society (social embeddedness of science), how risk analysis is needed for making decisions (risk analysis in science), whether scientific knowledge change or not in time (tentativeness of scientific knowledge), and subjective nature of scientific interpretation (subjectivity of scientific knowledge: scientific interpretation). Firstly, whether these aspects were utilized or not were investigated and if the participants utilized, the researcher classified them separately naïve to informed beliefs. As mentioned before, if someone's point of view is classified as "naïve", it is incompatible with current NOS understanding. A "mixed"

perspective is neither naive nor well-informed. It encompasses a variety of forms in which fragmented viewpoints coexist and may contradict one another. The final extant view type is an “informed” informed view, which indicates a desirable view that conforms to contemporary NOS understanding views accepted by science philosophers, scientists, and educators.

In following section, firstly the researcher prepared a Table 4.3 to show how many participants revealed the aspects of NOS under each category of NOS understanding.

Table 4.3. The number of participants reveal their NOS understanding in distal and proximal contexts of SSL.

	Risk Analysis in Science		Social Embeddedness of Science		Tentative Nature of Scientific Knowledge		Subjectivity of Scientific Interpretation	
	PF	GR	PF	GR	PF	GR	PF	GR
Naive View	8	1	1	1	12	1	-	-
Mixed View	9	5	9	7	4	2	2	6
Informed View	2	13	4	9	3	16	17	13
Total	19 100%	19 100%	14 74%	17 89%	19 100%	19 100%	19 100%	19 100%

When this table was examined, except the aspect of social embeddedness of science, all participants revealed the aspect of NOS in both contexts. For the aspect of social embeddedness of science, 14 participants (74%) revealed in Processed Food while 17 participants (89%) revealed in Golden Rice.

To investigate more detail, the researcher expressed participants' views related to each aspect of NOS for each scenario by supporting with quotations in the following part. Then, it discussed how these aspects had changed across the distal and proximal contexts of SSI. It was shown with pie charts demonstrating the percentage of each category for each aspect of NOS (naïve= yellow, mixed=blue, informed= green). It enables the researcher to compare these aspects of the participant utilized in distal and proximal context of SSI.

4.3.1. Risk Analysis in Science

How the participants evaluated the risk related to the issues by regarding scientific data in the text. All participants revealed the aspect of risk analysis in science in distal and proximal contexts of socio-scientific issues (SSI). For the issue in the context of Processed Food, there 8 participants showed naïve belief related to risk analysis in science. It was thought that even if these kinds of food are unhealthy for human beings, they are still obliged to use them due to being relevant to their nutrition. They did not mention any scientific evidence related to the risk of consuming salt, sugar, and oil on human health.

P17(PF): *Why should we prevent it, if the tax increases, many people will stop buying and maybe they can be healthier, but it's about people's nutrition. Why should we prevent their rights and needs? We make it harder to consume processed foods. I don't think it's necessary even if it's healthy.* (see Appendix G, Q30)

For the distal context, only 1 participant who utilized naïve belief concentrated on that any genetically modified food (GMO) can harm to human. He/ she did not evaluate the scientific information related GMOs and did not decide what Golden Rice should or should not allow to produce by evaluating scientific information about GMOs. The participant's saying related to risk analysis was given below.

P4(GR):...*So, I don't know at all. Let me think. Normally it's genetically modified, but what's their risk for people? It's not clear exactly, I couldn't think of whether it was ever produced or not.* (see Appendix G, Q31)

Secondly, in the Processed Food scenario, 9 participants who utilized mixed belief related to risk analysis in science for this scenario. They evaluated scientific knowledge and regarded the risk of the issue, but they do not believe that it is harmful. In other words, they were aware of the harm of Processed Food, but they want people living in Turkey to use it by not acknowledging scientific knowledge. It was underlined that consuming these kinds of foods is not a big deal, if it is, people can see it on television. If it is, there should be news about the effects on people, but there is not any news about that. The example of mixed belief related to risk analysis in Processed Food was presented below.

P16(PF): *Obesity and related diseases result in excessive sugar and fat. Yes, this is a possible situation, but when we consume it often, it seems like something that can actually happen. In America, people only eat such products. And sometimes they become the subject of documentary such as overweight and vascular occlusion. There are not that many cases in our country. So I'm saying that we would definitely hear it on TV. We didn't see it. That's why it's not consumed in large quantities, so I think it's not a dangerous thing in our country. Do not worry.* (see Appendix G, Q32)

For the Golden Rice scenario, 5 participants who utilized mixed belief related to risk analysis in science focused on pros and cons of the issue. It mentioned the benefits of Golden Rice on children's health. While mentioning its advantages or disadvantages, they underlined that they are not risk takers. Some did not understand why it is risky even if the probability of its risk were mentioned in the text. The quotation from the participant was given below.

P19(GR):...*it looks like something that can be very useful when you look at it. It's for children, but I think experts are needed to decide this. I can't take this risk, but I don't understand how risky it is.* (see Appendix G, Q33)

Lastly, 2 participants who utilized informed focused on scientific knowledge about Processed Food. They mentioned that these kinds of foods are unhealthy for humans and too risky for their health. After evaluating the risk of consuming these kinds of food, they thought the government should increase the price of these foods for human health. There is an example of participant' saying below.

P12(PF):...*In other words, when you look at it, obesity is shown as the cause of every disease, and we should not take this risk mentioned in every scientific article. That's why the increase in prices is right for human health.* (see Appendix G, Q34)

13 Participants who utilized informed belief focused on scientific arguments related to both advantages and disadvantages and tried to solve issue related to Golden Rice. During answering probing questions related to Golden Rice, they reread the text and underlined every scientific data. One of the examples of informed view in Golden Rice is given below.

P2(GR): *There are 4 arguments in this story. Two of them are advantages and two of them are disadvantages. One advantage can be seen as a countervailing solution to childhood blindness affecting children in Vietnam. It can be useful in the Vietnamese context. It says that it increases the absorption of vitamin A, so that it can be a solution to eye health problems. I've said this, but it's also been suggested that it could be a solution to childhood blindness. A group of scientists also mentioned that there is no evidence that there is any danger. Of course, I would like it to be produced when you evaluate it like that.* (see Appendix G, Q35)

Following classified this aspect of NOS: risk analysis in science as naïve, mixed, and informed, the variations of the category of the aspect were presented with pie charts in Figure 4.8 separately for each scenario below.

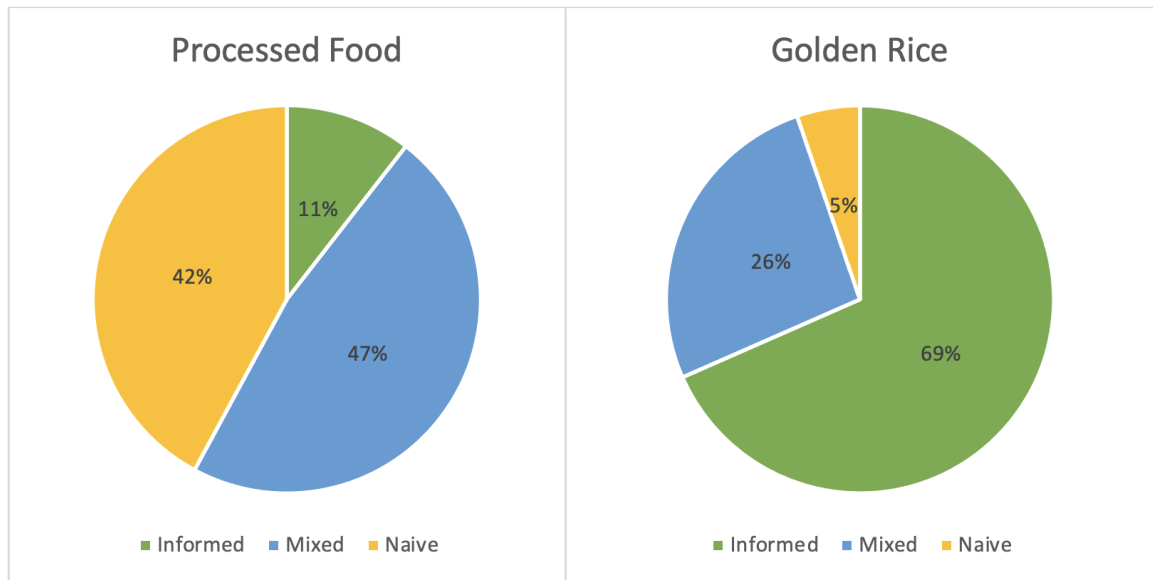


Figure 4.8. The Categorization of Revealed Aspects of Risk Analysis in Science in Distal and Proximal Context of SSI.

Once the pie charts are analyzed in Figure 4.8, in Processed Food participants (47%) utilized mixed view related to the issue most. Informed view (11%) was displayed less in Processed Food. On the contrary to Processed Food, participants (69%) displayed informed view in Golden Rice. Participants (5%) who utilized naïve view related to risk analysis in science was least. It can be asserted that participants showed more informed views about the aspects of risk analysis in science in the Golden Rice scenario than in the Processed Food scenario while mixed and naïve views related to this aspect are more than the Golden Rice scenario.

4.3.2. Social Embeddedness of Science

For this aspect of NOS, not all participants utilized the aspect of social embeddedness of science. For Golden Rice (distal one), 17 participants utilized this aspect while 14 participants utilized in resolving the issue related to Processed Food (proximal one). The categorization of this aspect that participants mentioned was represented with quotations. For instance, in Processed Food, 1 participant who utilized naïve belief related to the social embeddedness of science focused that the scientific knowledge does not affect human life while answering the third question of semi-structured interviews: *What do you think about the social effects of your decision?*

P7 (PF):...*Just as I am not sure, some people in the society are also unsure about the issue. Some draw attention to health problems. Some focus on accessibility. There will definitely be opposing opinions, but I don't know, it won't affect the society much. We will continue in the same way. What effect could it have?* (see Appendix G, Q36)

In Golden Rice, 1 participant who utilized naïve belief related to the social aspect of science. It was underlined that their decisions cannot affect the society in answer to the same question of semi-structured interviews. They pointed out that if we take this risk, it does not affect people in society. This example is given below.

P8(GR): *I think it will not have an effect because if a solution was brought to an issue that has no solution, maybe it would have an effect. For example, if I'm going to give an example from today; vaccines.. it is said that it has too many side effects, but the current greatest solution to a situation that has no solution. People preferred it. But when there is a diet created with other nutrients as a solution to vitamin A deficiency, why should it affect society by taking such risks?* (see Appendix G, Q37)

In Processed Food, 9 participants who utilized mixed belief did not ensure the effect of science on society. While trying to solve the issue, uncertain sayings related to the issue were formed. They were not aware of the mutual relationship between science and society. In addition to these, one of them said that society affected my decision related to Processed Food, but science does not have influence on society. These examples of mixed belief related to social embeddedness of science were given below.

P15(PF): *I didn't want the prices to increase, in this case it directly affects people. People are a part of this society after all. People will continue to consume this type of food. More people may turn to processed foods. This can lead to obesity and related health problems in the country. But it also means that more people will be satisfied and happy. I think scientific data has a negative effect at this point, or it doesn't seem to affect it negatively. so, no effect.* (see Appendix G, Q38)

P19(PF): *I think society has influenced my decision here. I tried to decide by considering the dynamics of the society and the people in the society. I can't talk about science effecting society, I think it's the opposite...Scientists look for what kinds of studies that needs to be done. In the end, they should not disregard the [the needs of] the society.* (see Appendix G, Q39)

In Golden Rice, 7 participants who utilized mixed belief focused on the effect of science on society, but they did not mention how it affect each other. A few did not know the structure of society in Vietnam, so they did not realize how society affect science or vice versa. One example from the participant was given below.

P9(GR): *...It is also a feature that we make this decision for a poor country. After all, not everyone can obtain every nutrient. With golden rice, it can be fully met, that is, it provides the intake of vitamin A. I didn't know what effect it would have on a distant society after all. I live in Turkey, it's easy to talk when you look at it. but it will affect every society but i am not sure how and why.* (see Appendix G, Q40)

In Processed Food, 4 participants who utilized informed belief were realized the mutual relationship between science and society. It was emphasized that we do not think that society and science are separated. Therefore, they underlined the decisions related to issue affect society itself. This example was given below.

P10(PF): *Both sides affect each other. I mean society and scientific research directly affect each other. This is how science exists. We cannot think of it as something separate.* (see Appendix G, Q41)

In Golden Rice, 9 participants who utilized informed belief focused on interconnection of science and society. Scientific knowledge and tied to link the society was placed on their sayinga while resolving the Golden Rice issue. Even if they did not know people in society, they were aware of the effect of science on society.

P17(GR): *It is a scientific study and made for society, so it has an impact on society. We don't think of it as a separate thing but how it affects. Let me think. Hmm, I mean, if there is a solution, if it helps the production of vitamin A and has an effect on the body, it will ultimately have a positive effect on public health. People will be happy; their children their loved ones will live. Or children don't have childhood blindness. In this respect, we observe that science has the power to create a positive impact on society. Definitely directly related to each other. science and society.* (see Appendix G, Q42)

Following classified this aspect of NOS as naïve, mixed, and informed, the variations of the category of the aspect: social embeddedness of science were presented separately for each scenario with pie charts in Figure 4.9 below.

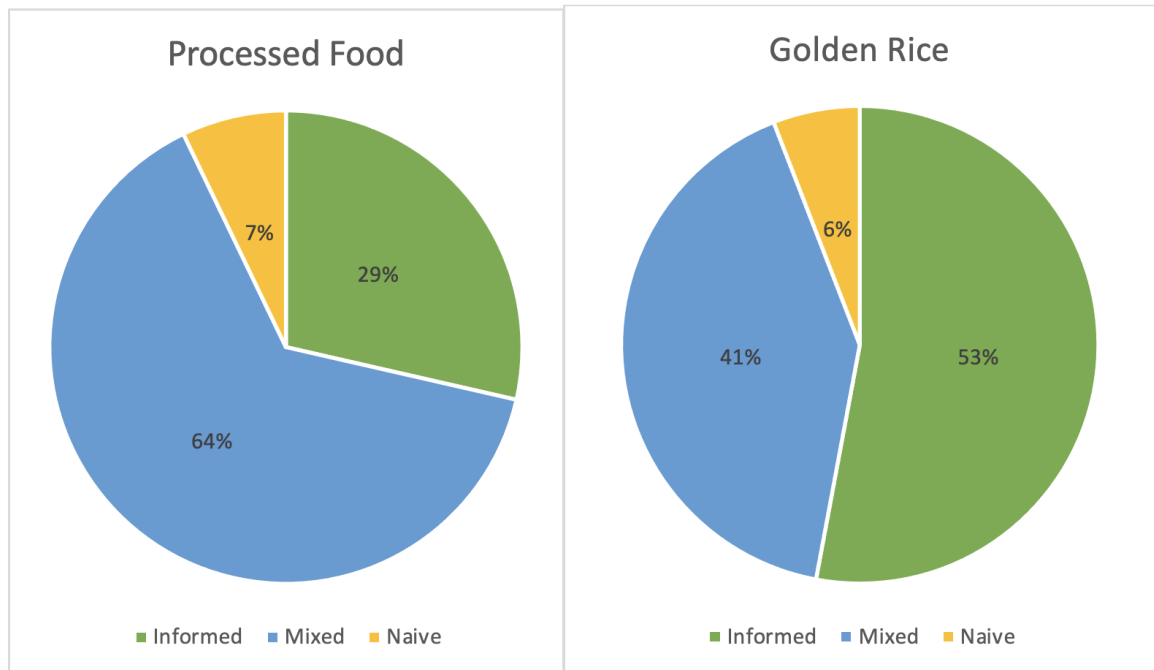


Figure 4.9. The Categorization of Revealed Aspects of Social Embeddedness of Science in Distal and Proximal Context of SSI.

As examined the pie charts in Figure 4.9, most of participants (53%) utilized informed view related to the aspect in Golden Rice while participants (64%) utilized mixed view related to this aspect in Processed Food. Moreover, the number of participants who utilized naïve view related to social embeddedness of science is almost same.

4.3.3. Tentativeness Nature of Scientific Knowledge

All participants displayed this aspect of NOS in both contexts. The variation of categorization for each scenario was represented below independently. For the Processed Food scenario, 12 participants utilized naïve belief related to tentativeness of scientific knowledge. It was thought that their decisions will not change in time because the life standards in Turkey are not good. They underlined that since most poor people cannot reach food, the government should not increase the prices of these kinds of foods. Some argued that their decisions will change if the life conditions in Turkey will be better, specifically better economic situations. Even if there is no mention about agriculture of Turkey in the written text of Processed Food scenario, few underlined that decision can be the result of the new development in agriculture in Turkey producing more cheap organic foods. However, they did not mention any new scientific study related to Processed Food. In addition to these, these 12 participants who utilized naïve belief thought that the government should not increase the prices of these foods. Some examples from the participants were represented below.

P4(PF): *If production increases in agriculture in Turkey, the amount of food for people also increases. Then, these organic foods don't need to be so expensive, which reduces the demand for processed foods. I say that people now have access to healthy food. In this case, I support the tax increase, my decision will change...* (see Appendix G, Q43)

P5(PF): *I don't think my decision will change when our economy is in such bad shape. Most poor people in this country do not have access to food. I mean, no matter how harmful these foods are, I definitely focus on their accessibility, and I don't think my decision will change.* (see Appendix G, Q44)

For Golden Rice, only 1 participant utilized naïve belief related to tentativeness of scientific knowledge. He/she focused that we as people living in Vietnam need the intake vitamin A. If the deficiency of Vitamin A is common like the deficiency of B12, I can say that we should produce and consume Golden Rice because of the need. He/she did not scientific methods, or knowledge, seen below.

P10(GR): *I don't know how common vitamin A deficiency is in the world, or how important it is, but I know that B12 deficiency is common. If vitamin A reaches that level, if very, very bad situations begin to occur in its deficiency, then perhaps we may need it much more in the whole world. Then I would like my decision to change, to be produced. But I don't think there is such a situation right now, of course, I haven't done any research, but I don't think that it will change.* (see Appendix G, Q45)

For the Processed Food scenario, 4 participants who utilized mixed belief focused that their decisions might be changed in future because of new scientific methods. However, at the same time, it was believed that they might not be changed due to unsuccessful investigations in Turkey. Even if the new studies are done, it may not be reliable because the companies will try to prevent it. The companies want people living in Turkey to buy these kinds of foods. One example from the participant was presented below.

P16(PF): *Of course, my decision will change if studies show it better, I don't know, or if it is proven that it does not actually cause obesity. but I don't believe that it is not done in Turkey. Even if it is done, there is competition between companies, they prevent something. Something has to happen, or the results of this study are applied to Turkey late or something. I don't know what decision will happen, but if it does, I'll look at the evidence and may change my decision.* (see Appendix G, Q46)

For the Golden Rice scenario, 2 participants who utilized mixed belief concentrated on the need for more scientific investigations, but they tended to think that their decisions will not change in future. In other words, they realized new researchers can affect their decision, but they did not trust that new studies would be done due to the need more time to observe the possible effect of Golden Rice on the human body or environment. One of two participants' ideas related to the tentative nature of scientific knowledge was represented below.

P9(GR): *I would do a lot of research, that's for sure. I would really try to get to know that country. Is it really needed? Are there any alternatives without golden rice? Then I would do some more research on it, whether there are more studies or not that might predict the effects. But it seems more likely that it will not change. It takes a lot to change, and it seems hard right now. If something unexpected happened in this population, that would prove how correct my decision was. I would focus on research results, if there was such research.* (see Appendix G, Q47)

Lastly, for the Processed Food scenario, 3 participants utilized informed belief related to tentativeness of scientific knowledge. They pointed out that if new scientific research related to processed food improves or proves its harm to human health, their decision will change in the future. The history of the atomic model that changed in time was mentioned by one participant. There were quotations from the participants below.

P2(PF): *Of course, there is a possibility of change if there is additional evidence from the opposite side or an argument that I cannot answer. I'm not saying that this is exactly what it is. Even atomic theories are changing. If scientists present the experiments, research, and reliable sources, I will believe the findings and change my decision accordingly.* (see Appendix G, Q48)

P8(PF): *Hmm. My decision changes. New studies are conducted, people consuming processed foods are examined, and accordingly, I will examine the results, talk to experts, and change my mind, of course.* (see Appendix G, Q49)

16 participants who utilized informed belief related to tentativeness of scientific knowledge concentrated on new scientific knowledge or investigation for the Golden Rice scenario. They noticed that their decision can be changed with new investigations. They gave examples of the scientific studies related to both investigating people who used Golden Rice and investigating uncertainty of the effects of Golden Rice. One example from the participant represented below.

P16(GR): *Scientists will work to resolve the uncertainty. By examining the results of these studies, I can say that golden rice should not be produced. Or something happened in the future in someone who uses it. When they examine this thoroughly, I can look at the sources I know, that is, the reliable ones, and change my decision. There may be variability because we look at the scientific data and decide.* (see Appendix G, Q50)

Following classified this aspect of NOS as naïve, mixed, and informed, the variations of the category of the aspect: tentative nature of scientific knowledge were presented separately for each scenario with pie charts in Figure 4.10 below.

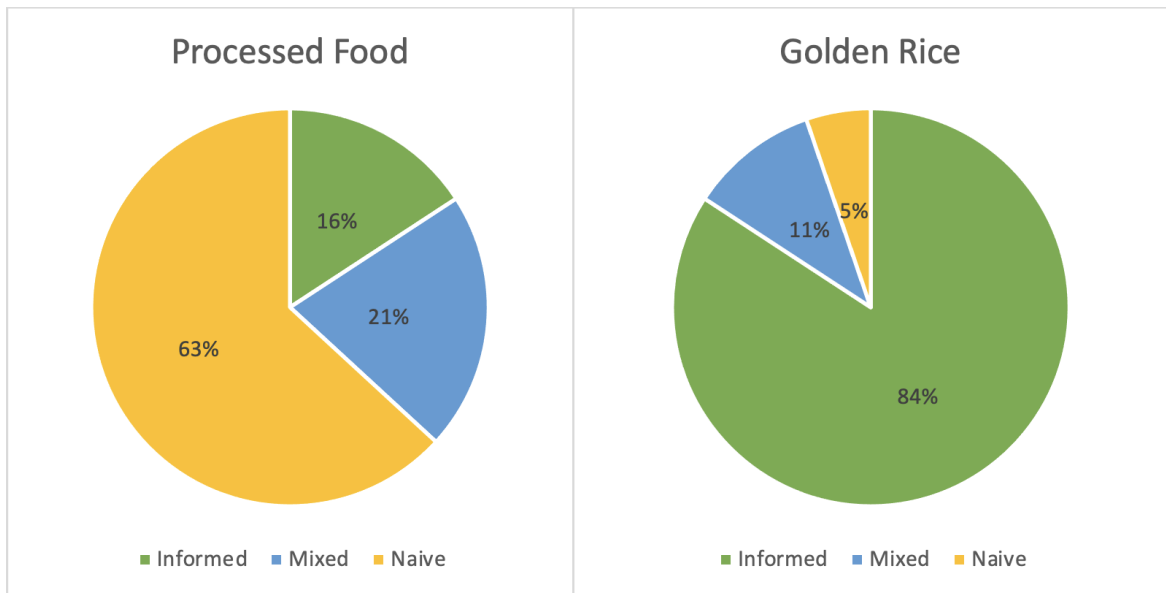


Figure 4.10. The Categorization of Revealed Aspects of Tentative Nature of Scientific Knowledge in Distal and Proximal Context of SSI.

When the pie charts in Figure 4.10 were analyzed, in the proximal context (Processed Food) of SSI, most participants (63%) showed naïve belief related to the tentative nature of scientific knowledge. They only focused on society, not scientific data. Also, the number of PSTs who utilized informed belief is least in Processed Food. However, in the distal (Golden Rice) context of SSI, almost all participants (84%) showed informed belief related to this aspect. They all focused on scientific research. Naïve belief was utilized least by the participants (5%).

4.3.4. Subjectivity of Scientific Knowledge: Scientific Interpretation

All participants utilized this aspect in both contexts. The variation of this aspect for each scenario was presented below. Moreover, all participants utilized mixed or informed belief related to subjectivity of scientific knowledge aspect while in resolving the issues in distal and proximal contexts of SSI. No one showed naïve belief in both contexts.

In Processed Food, only 2 participants who utilized mixed belief specifically focus on the companies that participants work with. Participants realized that scientists can have different perspectives by looking at the same scientific data. Moreover, one of them emphasized that this may have changed people to people because of having their own experiences. However, both argued that scientists work with companies and behave considering advantages and favors for companies. They have different perspectives because they interpret scientific data by considering the profits of the company they work with. One of them was given below.

P12(PF): Scientists manage their own research, after all, everyone has their own orientation. they interpret the data according to themselves; they want to interpret it. This is human nature; I think it's hard to look at it without prejudice. All person's observations and experiments will be different. We can summarize it as doing research using different methods. Now, when we think about processed foods, we can say that certain companies are working with scientists and apologizing with the policy of praise our product and increase sales and hire scientists. Even so, there is a difference.(see Appendix G, Q51)

In Golden Rice, 6 participants who utilized mixed belief focused that scientific interpretation is based on humans, so there might be differences among people. However, some mentioned these differences result in people's own study. Specifically, people manage and guide their own study by considering how they want or what they want to find as a result. Moreover, some of them underlined that these differences can be related to companies the scientists work with like Processed Food. This example was given below.

P15(GR): *It's about perspective. In other words, scientists focus on what they prioritize and concentrate on it. Like us, they are also human. They look at their own personalities. Sometimes we read that some companies are praising this product and directing scientists, even this point of view accepts it and publishes it. It is being redirected. In this case, different perspectives emerge.* (see Appendix G, Q52)

Other categorization, informed view for Processed Food, 17 participants who utilized informed belief related to subjectivity noticed that scientific interpretation directly linked to people' own perspectives, life, and experiences, seen below.

P6(PF): *...There are personal differences, their own lifestyles, different family structure, different environment they grew up in, different perspectives, even though they are scientists; they are also human. it's hard to find exactly the same thing by looking at the same data. So we are different people. So I think it's normal.* (see Appendix G, Q53)

After investigating the category of informed view related to scientific interpretation in Golden Rice, 13 participants who utilized informed belief of the aspect referred that people' own life and thoughts have influence on research they investigate and focus on. Even if they examined the same scientific data, they can interpret differently with the effect of different human experiences. They clearly state that science can be predicted differently from person to person.

P5(GR): *...isn't this the point of subjectivity of science? In other words, because people are different from each other, scientific processes are different. In fact, different people mean different thoughts, different perspectives on life. and these differences affect scientific processes. Some focus on health, while others focus on the environment. It seems like we can say that being human influences on science.* (see Appendix G, Q54)

Following classified this aspect of NOS as naïve, mixed, and informed, the variations of the category of the aspect: subjectivity of scientific interpretations were presented separately for each scenario with pie charts in Figure 4.11 below to analyze the differences.

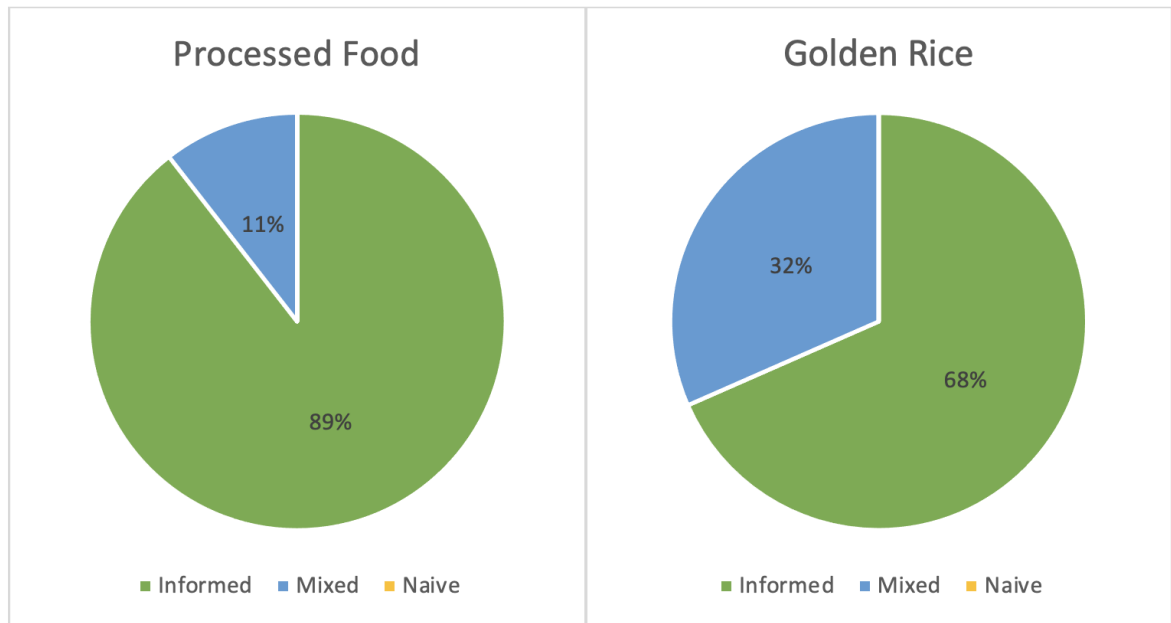


Figure 4.11. The Categorization of Revealed Aspects of Subjective Interpretation of Scientific Knowledge in Distal and Proximal Context of SSI.

When the pie charts in Figure 4.11 are examined, participants (89%) displayed more informed views related to the aspects of subjectivity in Processed Food scenario while the participants (68%) displayed more mixed views in Golden Rice. As mentioned before, for this aspect nobody in this study showed naïve view in both contexts.

5. DISCUSSION

In this section, the findings represented in previous chapter will be discussed. The design of this section was prepared to cover each research question, so this section was separated into three sub-sections: the informal reasoning and socio-scientific issues (SSI), the factors related to informal reasoning and the nature of science utilization in the contexts of SSI. In each section, the findings of each question were interpreted and their association with prior research was debated.

5.1. The Informal Reasoning and SSI

Informal reasoning has an important role in socio-scientific decision making in order to provide scientific literacy that is one of main goals of science education (Sadler & Zeidler, 2004; Zeidler & Keefer, 2003; Zeidler et al., 2009). Therefore, it is crucial and necessary to investigate the informal reasoning of individuals in the context of SSI, as it has an important role in achieving scientific literacy. In this manner, how pre-service science teachers (PSTs) negotiate and resolve the socio-scientific issues has been examined in this study. The findings of this study underlined that the importance of morality, emotive factors, personal and social considerations for socio-scientific decision making, supported by previous studies (Bell & Lederman, 2003; Sadler & Zeidler, 2005a; Zeidler et al., 2009).

Sadler and Zeidler (2005a) conceptualized “informal reasoning patterns” as a result of research investigating informal reasoning in the context of SSI. They examined college students’ informal reasoning. It was reported that they developed three informal reasoning patterns: rationalistic, emotive, and intuitive. Likewise, in this study PSTs’ informal reasoning patterns in response to Golden Rice and Processed Food were investigated and categorized according to this “informal reasoning patterns” framework. The result of this study showed that this framework was valid and applicable as well in the Turkish contexts. The studies conducted by

Topcu (2008) and Topcu et al. (2011) also demonstrated that this framework was valid to illustrate PSTs' informal reasoning in various SSI in Turkish contexts. Recently, the study supported that these patterns was also valid in Turkish context to determine elementary school students' informal reasoning (Ozden, 2020).

A noticeable trend emerging from the data of this study was the extent to which these various patterns of reasoning were integrated into participant's overall informal reasoning process. In other words, the findings of present study showed that PSTs displayed various informal reasoning patterns in response to two dilemmas. Sadler and Zeidler (2005a) claimed that an individual can show different informal reasoning patterns for specific issues. It means that one pattern can support another in resolving one issue. For that, a model included all informal reasoning patterns as well as their combinations. It revealed rationalistic, emotive, intuitive, rationalistic-emotive, rationalistic-intuitive, emotive-intuitive, and rationalistic-emotive-intuitive informal reasoning patterns.

In this study, while PSTs were trying to negotiate and resolve the issues, they displayed more than one informal reasoning pattern for the same issue. In response to two SSIs, different types of informal reasoning patterns (rationalistic, emotive, and intuitive) were together integrated into one person's overall informal reasoning. In addition to these, this study demonstrated that this overlapping model was valid for the informal reasoning patterns of PSTs in both contexts. When the different types of informal reasoning patterns revealed by the participants are examined, there is only one separate reasoning pattern (rationalistic) and some overlapping reasoning patterns (rationalistic-emotive, rationalistic-intuitive). There is overlapping reasoning consisting of all reasoning patterns (rationalistic-emotive-intuitive) in each individual case. According to the socio-scientific literature, participants may exhibit a combination of informal reasoning patterns in response to the same issue (Sadler & Zeidler, 2005; Ozden, 2020; Topcu, 2008).

Specifically, in PF, 9 participants (47%) showed two patterns: emotive and rationalistic informal reasoning while 10 participants (53%) showed all patterns together in resolving the issue. In GR, 7 participants (37%) displayed all patterns in response to the issue while 7 participants (37%) displayed two of three informal reasoning patterns: 4 participants (21%) rationalistic-intuitive; 3 participants (16%) rationalistic-emotive informal reasoning patterns. Differently, 5 participants (26%) showed only one pattern: rationalistic informal reasoning in GR. In short, participants displayed various informal reasoning patterns in both contexts. In other words, while trying to solve the same issue, participants tried to find a solution with the different way of thinking. The claim of overlapping informal reasoning patterns was approved by the previous research findings (Pedretti, 1999; Sadler & Zeidler, 2005a; Topcu, 2008, Yang & Anderson, 2003). In addition to these, studies asserted that since socio-scientific issues have different perspectives such as morality, they may provide individuals to reveal different ways of thinking in resolving the issues (Sadler, 2004; Sadler & Zeidler, 2005a; Sadler & Zeidler, 2009). In addition, since participants utilized their informal reasoning in resolving the issues, the result of this study demonstrated that SSI contexts can be used to reveal individuals' informal reasoning while pointing out the SSI like the previous studies published in literature (Bell & Lederman, 2003; Sadler & Donnelly, 2006; Topcu, 2008; Zediler et al., 2019).

When the PSTs' informal reasoning patterns were examined, all participants displayed rationalistic informal reasoning pattern at least in distal and proximal contexts. In other words, all participants used some scientific evidence while negotiating and resolving the issues. While some participants used the scientific evidence written in the scenarios, some of them tried to solve the issues by referring to the scientific studies they had previously read on the topic. Two different SSI contexts provided PSTs to show rationalistic thinking and to evaluate and use scientific evidence, which means that they advised rational solutions to issue, supported by previous studies (Sadler & Zeidler, 2004; Sadler & Zeidler, 2005a; Topcu, 2008). In this study, all participants showed instances of rationalistic informal reasoning patterns in both contexts; however, when the overall instances of

rationalistic informal reasoning pattern revealed by PSTs in the distal and proximal contexts are compared, participants showed (67%) rationalistic informal reasoning in GR while they showed (39%) rationalistic informal reasoning in PF. In other words, participants used more scientific data in the Golden Rice. They reread the scenario and evaluate scientific data on it. They made arguments with scientific data from scenarios in resolving the issue. In conclusion, in a context that was distant to participants, they tried to solve the problem by using scientific data in scenarios. It may be claimed that participants tend to focus on scenario to get general knowledge about the issue, and the society. For proximal context, it may be claimed that participants tend to trust their own knowledge and experiences about the issue because of the issue related to where they live.

In addition to rationalistic informal reasoning pattern, all participants showed (100%) emotive informal reasoning in resolving the issue related to Processed Food while 10 participants showed (53%) this pattern in the Golden Rice scenario. Various SSI contexts provide evidence to reveal PSTs' emotive thinking, similar to the studies (Sadler & Zeidler, 2005; Topcu, 2008; Ozden, 2020). When two contexts of SSI used in this study were compared, all the participants showed (100%) emotional reasoning while trying to solve a problem that affected themselves, specifically in PF. They used their feelings in response to issues and approached the issue emotionally. They were talking about how they are members of this society and felt responsible about the well-being of people living in Turkey. In conclusion, when the issue is given to them in a context that is familiar to them, they are accustomed to solving the issue in a more emotional way. It is believed that moral perspectives arise as they can observe the living conditions of people living in the country including themselves. However, in distal contexts 10 participants (53%), not all participants, revealed their emotions in response to the issue. They mentioned that it is necessary to think people' socio-economic status and living conditions, but others mentioned that they did not live in another country and know the life conditions there. Almost half of the participants did not demonstrate empathy in resolving the issue because they did not observe the consequences of the issue in their real life. It is claimed that in the issue given in

distal context, the participants were more isolated from real life by concentrating on the scenario. They were therefore more inclined to use the scientific evidence in the scenario, not their emotions such as empathy and sympathy.

Aside from rationalistic and emotive informal reasoning patterns, the participants displayed gut-level and instantaneous reactions or responses to two SSI. These reactions can be negative or positive. Sadler and Zeidler (2005a) categorized this intuitive thinking as an intuitive informal reasoning pattern in responding to SSI. In this study, 9 participants (47%) showed intuitive informal reasoning in PF while 11 participants (59%) showed this pattern response to the issue in GR. The contexts of SSI have an impact for revealing intuitive thinking in resolving complex issues (Sadler & Zeidler, 2005; Ozden, 2020; Topcu, 2008). It can be claimed that participants tend to react more spontaneously when evaluating the issues given at a distal context. Because of not being familiar with the context, they tend to think more spontaneously. In the proximal context of SSI, they gave reactions in a way that they wanted without evaluating the evidence in detail.

When all informal reasoning patterns in total across two SSIs were examined, in Processed Food, these are rationalistic informal reasoning (39%), emotive informal reasoning (50%) and intuitive informal reasoning (11%). Also, these are rationalistic informal reasoning (67%), emotive informal reasoning (14%) and intuitive informal reasoning (19%) in Golden Rice. It can be claimed that the informal reasoning patterns of the participants varied on Processed Food; however, participants tend to use their emotions, and feelings in resolving the issue that is familiar to them. On the other hand, in Golden Rice, they revealed more instances of rationalistic informal reasoning. As they were not familiar to society in Vietnam, they tend to reread the written text and use the scientific evidence in it while resolving the issue. In addition to informal reasoning patterns, the total number of these patterns displayed by the participants in Processed Food 157 while this number is 126 in Golden Rice. It can support those participants who tend to make arguments related to the issue and be more motivated to resolve the issues in the proximal context that is familiar to them. In other words, when

the decision made by them potentially have an impact on their lives, they were more interested in resolving the issue and making arguments related to the issue, consisted with the other studies supported the idea that SSI contexts can enables students to be more motivated to share their own ideas and participate discussion about the issues (Järvelä & Renninger, 2014; Sadler & Dawson, 2012).

When distribution of informal reasoning patterns in 3-D plots are examined, participants' informal reasoning patterns varied in Processed Food. In other words, the participants used different ways of thinking while solving the issue in Processed Food, so the points of the participants spread out the area, as seen in Figure in 4.5. However, most of them utilized rationalistic thinking more in resolving the issue in Golden Rice. It provided the data points of each participant to gather in a specific area in the 3-D plot. As seen in Figure 4.6., the curve of 19 points seems to be tightly packed in Golden Rice. As a summary, the finding demonstrated that the informal reasoning patterns used are related to the socio-scientific contexts. Despite the fact that two parallel scenarios included human health concerns, the prevalence of rationalistic reasoning were observed more in distal context of SSI. The emotive reasoning was observed to be used more by PSTs in proximal context.

5.2. The Factors Related to Informal Reasoning

In the socio-scientific issues literature, some studies focused on the variables that are related to informal reasoning and that have influence on informal reasoning (Albe, 2008; Bell & Lederman, 2003; Sadler & Zeidler, 2004; Topçu, 2008). In this study, the factors considered by PSTs in resolving the issues were examined and categorized into five: personal consideration, moral and ethical consideration, health consideration, economic consideration, and environmental consideration.

Specifically, Processed Food scenario was prepared to include health and economic considerations. In response to this scenario, PSTs utilized these factors in resolving the issue: economic (42%), personal (35%), moral and ethical (18%) and health (5%) considerations. In Golden Rice scenario consisting of health and environmental considerations, PSTs utilized these factors in resolving the issue: health (59%), moral and ethical (19%), environmental (16%) and economic (6%) considerations.

First factor considered by PSTs in resolving the issues was moral and ethical considerations. Since socio-scientific issues also have moral dilemmas, participants reveal their moral and ethical perspectives or concerns related to issues in decision making in the context of SSI. Therefore, some studies underlined that moral and ethical perspectives are main factor revealed while resolving the issues (e.g., Bell & Lederman, 2003; Fleming, 1986a, 1986b; Fowler et al., 2009; Sadler & Zeidler, 2004; Sadler & Donnelly, 2006; Topcu, 2008). Bell and Lederman (2003) conducted research with college professors to better realize the expected factors on their decision making on a variety of scientific societal issues, and they found that moral consideration played a significant role in participants' decision making on these issues.

In line with previous research, the current study found that moral-ethical perspectives played an important role in negotiating and resolving the issues. In the proximal context of SSI, participants (18%) used moral and ethical consideration in trying to resolve the issue while participants (19%) used moral and ethical consideration in distal context of SSI. The percentage of PSTs who considered this factor in resolving the issue was almost the same in distal and proximal contexts of SSI. It was underlined that they are people that live for other people in resolving the issues, so they were aware of these kinds of issues including human value. Based on the socio-scientific literature and the result of the current study, it is possible to assert that SSI entails moral and ethical standpoint because SSI include social dilemmas that are often the result of people's moral-ethical concerns.

Second factor considered by PSTs was environmental consideration. Most studies presented that when participants are engaged with environmental issues, they recognized environmental concerns related to issues in resolving SSI (Herman et al., 2018; Kinslow et al., 2019; Owens et al., 2019; Zeidler et al., 2005). In this study, there was environmental concern related to threat of producing Golden Rice on environment in distal context of SSI. PSTs (16%) used this concern while pointing out the issue, supported by previous studies above. On the contrary to Golden Rice, no one used environmental concerns in resolving the issue in Processed Food because of the context that did not involve environmental concern about the issue. This finding also supported the idea that engaging with SSI embedded environmental and ecological concerns provides participants to use this concern and make argument about that while resolving the issues.

Third factor related to informal reasoning was personal consideration. Some studies investigated personal experiences in resolving the SSI (Albe, 2008; Bell & Lederman, 2003; Sadler et al., 2004; Sadler & Zeidler, 2004; Topcu, 2008). According to them, personal experiences have a central role in decision making in the context of SSI because these issues about science and society are embedded with personal domains. Specifically, Bell and Lederman (2003) reported that personal experiences influenced decisions related to technological and ecology issues. Albe (2003) underlined participants' personal experiences, social and cultural rules were determinant to resolve the issues. Topcu (2008) conducted a study with PSTs and emphasized their informal reasoning affected by their personal experiences. Also, their experiences were one of peculiar factors in their informal reasoning. PSTs used personal experiences in resolving the issues six scenarios except a scenario related to cloning. It was reported that in the cloning scenario there were complicated terms, so participants cannot use their pre-knowledge and experiences related to the issue. As a result of this study, like other studies, personal experiences are one of main factors related to informal reasoning in the context of SSI.

To examine the findings of this study, in the proximal context participants (35%) used their experiences and pre-knowledge about the issues in resolving the issue while no one used their experiences in distal context of SSI. They underlined that they could not solve the issue related to Golden Rice because they did not know the country and the living conditions there. It may be claimed that since participants have no experiences about living in Vietnam as citizens, they may not use their personal issues. However, when participants were engaged with the issue related to the use of Processed Food in Turkey, they shared their pre-knowledge and experiences about consuming these kinds of food while resolving the issues. As a result, consistent with studies in literature, participants utilize their experience as consideration in pointing out the issues. However, the content and the context of SSI should be prepared accordingly. It may be claimed that a topic that participants are familiar with or related to the country in which they live can be selected and prepared as SSI scenarios. Therefore, they can present to elicit their personal experience in solving the issues.

Fourth factor was economic concern considered by PSTs in resolving the issue. This is consistent with some studies in the literature (Presley et al., 2013; Sadler et al., 2004; Topcu 2008; Wu & Tsai, 2007). As SSI have economic challenges associated with the issue, the economic interest of individuals has influence on their decision making in the context of SSI. In this study, there was economic concern related to the Processed Food scenario: accessibility for people from different socio-economic levels, so participants (42%) used economic concern while trying to solve the issue. However, in Golden Rice, participants (6%) used economic concern even if there was no mentioned economic concern in the scenario. It could have occurred because SSI are issues associated with society and economy is one of the main dimensions of the society. Therefore, they tried to consider that Vietnam is one of developing countries and there may be poor people there. This was like a guess, but in Processed Food participants as Turkish citizens can observe the prices of the products in the market, so this factor is considered by PSTs mostly in Processed Food. They may experience this in their lives because poverty affects more than 30% of Turkey's population according to the World Bank (2019). The PSTs claimed that most Turkish citizens could not afford

the organic foods because they were prohibitively expensive. It was mentioned that Processed Foods were an alternative for people who have low socio-economic status in Turkey.

Lastly, a factor considered by PSTs in resolving the issues was health consideration. In socio-scientific literature, SSI are defined as multi-dimensional dilemmas that can involve cultural, moral, health, religious, economic, scientific, and technological (Kolstø, 2001; Zeidler et al, 2002; Sadler, 2004). Moreover, there are some SSI including the concerns related to human and animal health such as GMOs, animal experiment, nuclear power plants, allergic reactions, heart disease, and obesity. When individuals are engaged with these kinds of SSI, they can reveal health concerns related to the issue (Eastwood et al., 2012; Sadler, 2011).

In the current study, one of the factors related to informal reasoning was health consideration. Both Processed Food and Golden Rice scenarios involved health concerns. In these scenarios, there was balanced scientific evidence related to human health. However, while in Golden Rice, participants (59%) used health concerns in resolving the issue, only few participants (5%) used health concerns in Processed Food. For Golden Rice scenario, participants tend to reread the written text for negotiating the issue, so they may consider and focus on these scientific evidences about human health. On the other hand, even if the scenario involved human health concerns related to obesity due to consuming Processed Foods, the number of PSTs who considered this factor in resolving the issue was quite less compared to the Golden Rice issue. It may be claimed that as PSTs were familiar to the issue, they tend to share own ideas without evaluating scientific evidences in the written text. They tend to think and consider the living conditions of people experienced by themselves in Turkey instead of health concerns related to obesity. Therefore, when the difference of the number of PSTs who consider health concerns between two contexts was examined, it may be asserted that the context of SSI, especially Processed Food, can be redesigned as distal to provide participants to evaluate and consider scientific evidence related to human health.

5.3. Utilized Nature of Science Understanding in the Context of SSI

Another aim of this study is to investigate the utilization of nature of science understanding in the distal and proximal contexts of SSI. The definition of NOS understanding is not a concern in this study; however, it is defined as beliefs about the construction and validation of scientific knowledge, as well as its social dimensions. The current study concentrated on how scientific knowledge is constructed, its nature of tentative and subjective and risk analysis in science while resolving the issues.

The semi-structured interviews in this study proposed to address some aspects in order to apprehend PSTs' NOS utilization in the contexts of SSI. These NOS aspects are risk analysis in science, social embeddedness of science, tentativeness of scientific knowledge, and subjective interpretation of scientific knowledge. Since scientifically literate students must recognize how knowledge is built and confirmed through scientific practice, these aspects align with the aims of science education.

Philosophers and researchers have been debating which NOS understanding and scientific characteristics should be incorporated into science teaching and assessment (McComas & Olson, 1998; Osborne et al., 2003; Clough, 2007;2011; Allchin, 2011; Irzik & Nola, 2011; Erduran & Dagher, 2014). Allchin's approach: case-based scenario, as previously explained, was used in this study. As cases, Golden Rice and Processed Food as well as probing questions in semi-structured interviews had been used to gather data. According to Allchin (2011), individuals should assess the validity and credibility of scientific knowledge by considering social, and cultural contexts. As a result, the relevant and authentic case provided an excellent context for assessing PSTs' utilization of NOS. The four aspects of NOS understanding will be discussed in the following paragraphs, as will the implications of case-based NOS evaluation.

The utilization of three aspects of NOS understanding: risk analysis in science, tentativeness of scientific knowledge and subjective interpretation of scientific knowledge were done by all participants (100%). Only for the aspect of social embeddedness of science not all participants utilized this aspect in resolving the issues. Specifically, 14 participants (74%) utilized it in Processed Food while 17 participants (89%) revealed it in Golden Rice. Participants utilized their NOS understanding in both contexts. This result of this study is consistent with studies (Eastwood et al., 2012; Sadler et al., 2004; Walker & Zeidler 2007; Zeidler et al., 2002). They concluded that SSI can be excellent context to assess and to reveal NOS understanding.

Individuals need to decide what is true or false and what is reliable or not while making decisions related to scientific and societal issues (Zeidler et al., 2002). As a result, individuals as citizens must become scientifically literate, figure out science-related social issues, and make informed decisions. They must gain a functional understanding of the nature of science to achieve this goal. Given these aspects, risk analysis regarding socially related scientific issues becomes critical. In this study, risk analysis in science as an aspect of NOS understanding utilization was examined in distal and proximal contexts of SSI. In Golden Rice, most participants (69%) utilized informed beliefs related to the issue. Their sayings were based on scientific evidence. They tried to evaluate scientific evidence about both advantages and disadvantages of the issue. Some of them argued the risk of consuming Golden Rice on human health while resolving the issue.

However, in Processed Food PSTs (11%) who utilized informed belief. They did not evaluate scientific evidence in text and their sayings were mostly emotional based. They showed mostly mixed (47%) and naïve (42%) beliefs. There was a significant difference between participants' beliefs in distal and proximal contexts. In other words, almost all PSTs utilized informed views in Golden Rice while they utilized naïve and mixed beliefs in Processed Food. It may be claimed that while individuals resolve the issues that are given at proximal context or familiar to them, they may not evaluate scientific data related to the issue. Instead of evaluating scientific data, they relied on their own experiences to analyze the risk of the issue. Some of them argued that there is no risk of consuming Processed Foods.

Since SSI creates dilemmas related to science and society, it may be possible to prepare the context of SSI to reveal the understanding of the relationship between science and society. The studies in the literature supported how science involves social and cultural values can be represented and served in the context of SSI (Eastwood et al., 2012; Sadler et al., 2016; Sadler, 2004; Zeidler et al., 2013). Their results showed that NOS understanding can be revealed and developed with the use of SSI contexts. In this study, most of the participants' views related to social embeddedness of science were revealed in both contexts. Specifically, 14 participants (74%) revealed this aspect in Processed Food while 17 participants (89%) utilized this in Golden Rice. In comparison of this aspect revealed by participants in both contexts of SSI, some participants (53%) utilized informed views in Golden Rice. Even if they did not know the social structure of Vietnam, they underlined the interconnections of science and society. They realized that their decisions and solutions to the issue have influenced people in the society. For this scenario, some (41%) utilized mixed and some (6%) utilized a naïve view. However, in the Processed Food scenario, most of them (64%) utilized mixed views. They realized the effect of science on society; but, it does not influence people living in Turkey. In this scenario, participants (29%) utilized informed view, and others (7%) naïve view. It may be claimed that PSTs as members of society have biases about other people living there. PSTs did not think that other people trust scientific data even if PSTs considered the connection between science and society. As

a result, individuals tend to display informed views when resolving the issues given to them in a distal context.

The aspect of NOS understanding related tentative nature of science can be revealed and assessed in decision making process in the the context of SSI, supported by some studies (Allchin, 2014; Sadler & Zeidler, 2009; Sadler & Barab, 2007; Walker & Zeidler, 2007). In accordance with these studies, all participants revealed their belief related to tentativeness of scientific knowledge in both contexts. In Golden Rice, almost all PSTs (84%) utilized informed beliefs related to the tentative nature of scientific knowledge. They realized and underlined that the new methods or evidence provide different results, which enables their decisions to change in future. A few participants (11%) showed mixed belief in Golden Rice while one participant (5%) showed naïve belief. However, in Processed Food PSTs (63%) utilized naïve beliefs related to this aspect. They did not mention any scientific process or evidence; they focused on the society such as economy, income of the people and agricultural developments. It can be said that social and cultural values overtake scientific truths in resolving the issue related to the use of Processed Food. Also, a few participants (16%) utilized informed and some (21%) utilized mixed views. As a result, individuals do not focus on scientific processes and new methods. The societal details can be underlined by individuals in the process of resolving the complex issue in the proximal contexts instead of underlining the effect of new methods on scientific process.

Lastly, since SSI have different perspectives to create dilemmas, individuals can interpret scientific knowledge differently because of having different perspectives. Therefore, they can realize subjective interpretations of scientific knowledge and reveal their beliefs related to this aspect in the context of SSI (Karisan & Zeidler, 2017; Sadler, 2009; Walker & Zeidler, 2007). In this study, all participants revealed this aspect of NOS understanding in both contexts. No one utilized naïve beliefs in both contexts. In addition, participants utilized informed beliefs mostly related to subjective interpretations of scientific knowledge in both contexts of SSI. They realized that the interpretation of scientific knowledge by humans can be different

because of having different experiences, thoughts, and lifestyles. Specifically, in Golden Rice participants (68%) utilized informed view while they (89%) utilized informed view in Processed Food. It may be claimed that when individuals engaged with SSI including different perspectives related to issues, they can realize that scientific data can be interpreted differently. People evaluated all scientific data such as advantages and disadvantages of the SSI and they determined their positions about those issues. There are people who have different arguments compared to them while discussing SSI, even if they are looking for the same data in the text. In short, the result of this study showed that SSI that are given in different contexts allows individuals to realize that these scientific processes are human based.

6. CONCLUSION

In this section, first of all, a summary of the findings of this study is represented in Table 6.1. Also, the implications of this study, limitations, and the suggestions for further research are explained separately in the light of the findings of this study.

Table 6.1. A summary of findings of this study.

The Proximal Context of SSI: Processed Food (in Turkey)	The Distal Context of SSI: Golden Rice (in Vietnam)
•Utilization of emotive informal reasoning	•Utilization of rationalistic informal reasoning
•Making more arguments about the issue	• Less production of arguments about the issue
•More motivated to resolve the issue	• Less motivated to resolve the issue
•Economic & Personal Consideration	•Health Consideration
•Utilization of mixed belief related to the aspect of risk analysis in science	•Utilization of informed belief related to the aspect of risk analysis in science
•Utilization of mixed belief related to the aspect of social embeddedness of science	•Utilization of informed belief related to the aspect of social embeddedness of science
•Utilization of naïve belief related to the aspect of tentative nature of scientific knowledge	•Utilization of informed belief related to the aspect of tentative nature of scientific knowledge
•Utilization of informed belief related to the aspect of subjective nature of science	•Utilization of informed belief related to the aspect of subjective nature of science

6.1. The implication of the study

The current study investigated pre-service science teachers' informal reasoning, the factors considered, and the utilization of NOS understanding in resolving the socio-scientific issues. Based on the findings of this study, it has considerable important implications for science curriculum developers, science educators, and teachers.

In many countries, the primary objective of science education is to train individuals to be scientifically literate citizens (Ryder, 2001). For developing democratic citizenship, individuals need to engage with moral decision making about the issue (Bell & Lederman, 2003; Driver et al., 2000; Kolstø, 2001). In other words, individuals are expected to graduate from the schools with the ability of evaluating scientific evidence and making informed decisions about scientific and societal issues that may confront in their lives. Socio-scientific issues, component of science curricula, are excellent tool to reach scientific literacy (Lederman & Lederman, 2012; Sadler et al., 2004). The findings of this study specifically showed the importance of working out moral and social aspects of SSIs on individuals' informal reasoning processes. It makes sense that sustained exposure to socio-scientific decision-making will give learners to explicitly explore and display their own principles, logic, emotions, and intuitions about science and its social applications. Therefore, this process provides them to comprehend their roles as citizens in democratic societies influenced by science and technology.

When the contributions of SSI into science education are considered, for curriculum developers it is significant to determine what the basic concepts of the subject are and which subject heading in the curriculum conceptually overlaps, and for which general purposes the curriculum may integrated into the teaching process after specifying a SSI topic that can potentially be handled in the classroom environment (Hancock et al., 2019; Zeidler & Kahn, 2014). Guven and Mugaloglu (2020) underlined that this integration of SSI into the teaching process can be managed using two specific approaches. The first is that SSIs are handled as the

unit's basic guiding question, and thus conceptual content, scientific skills, and attitudes are organized around the purpose of searching an answer to this question (Zeidler & Kahn, 2014). The second is that SSIs that are addressed at a particular phase of the unit provides opportunities for the students to put their knowledge and skills to work through a process that develops concepts, skills, and attitudes learned through various teaching processes throughout the unit (Güven & Mugaloglu, 2020; Topcu, 2015). Given that current science curricula are structured disciplinary rather than interdisciplinary, the first approach poses implementation challenges for teachers. It may be argued that the second approach helps students to use, make sense of, and develop their conceptual knowledge and scientific practices that they have already developed from a disciplinary perspective. As a result, SSI can be effective as a part of the unit through a learning process to enrich science classrooms in a way of promoting scientific literacy.

Furthermore, the findings of this study contribute to how SSI contexts as a part of a unit should be prepared. This study showed that the participants were more motivated to make arguments while resolving the issue that they were familiar with, in the proximal context of SSI. On the other hand, participants used rationalistic thinking more by evaluating scientific evidence in distal contexts of SSI. Therefore, it can be claimed that the issue can be designed to be placed between neither proximal or distal to students. For curriculum developers and educators, it is important to prepare such context, that is proximate enough to motivate students and engage in making arguments and is distal enough to evaluate scientific data and engage with these processes. Moreover, as two contexts can be used for different goals like increasing motivation to participate and engaging with rational thinking, curriculum developers can prepare and categorize the SSIs from proximal to distal. If teachers want to motivate students and reveal their emotion in resolving the issue, they can choose the issue categorized as proximal or close to proximal one.

Another aim of this study was to how participants utilized their understanding of the nature of science in two SSI contexts. The findings showed that well prepared SSI contexts provide individuals to reveal NOS understanding utilization. Without asking any questions like what is science? or what is the relationship between science and society? SSI narratives enabled participants to utilize their NOS understanding in resolving the issues. Otherwise, even if there were balanced scientific evidence in distal and proximal contexts of SSI, participants were engaged more with evaluating and analyzing scientific evidence in written text in distal context. In other words, individuals focused on scientific evidence about the issue that they are not familiar with. As NOS understanding is crucial for reaching scientific literacy, curriculum developers may consider the designing of SSI contexts including problem solving processes that do not affect learners' life.

Last educational implication is about the integration of SSI into science classrooms. Teachers are required to provide a classroom environment for their students to express their feelings, and emotion in engaging with SSIs. Rationalistic thinking is traditionally in science classrooms, and teachers usually aim to ensure the development of rationalistic thinking skills of their students (Sadler, 2004). However, the findings of this study showed that rationalistic thinking is not the only way of thinking to resolve the dilemmas, and there are other ways of thinking: emotional and intuitive thinking, supported by previous studies (Sadler & Zeidler, 2005a; Ozden, 2020; Topcu, 2008; Yilmaz-Tuzun & Topcu, 2011). Therefore, a discourse environment where students are free to express themselves can be created in a science classroom for not isolating students who think in an emotional way. As a result, it is crucial to provide an appropriate environment for students to express personal ideas and emotions. Students need to feel that what they are saying about the issues are valuable in this environment while resolving the socio-scientific dilemmas.

6.2. Limitations

Even though this study fills a gap in the literature by investigating informal reasoning in different contexts of SSI, it also has some limitations that should be addressed in future studies. Firstly, the selection of SSI might be seen as a limitation of this study. For this study, there were two SSI (Processed Food and Golden Rice). Different issues can be selected and redesigned to be parallel to each other to examine informal reasoning patterns. Another limitation is related to the time conducting study. In Turkey, the prices of food products have recently increased. The PSTs may have been influenced by this situation in resolving the issue related to Processed Food.

6.3. Suggestions for Future Research

Upon that basis of the current study and previous studies, the following suggestions for future research studies can be manufactured. In this study, pre-service science teachers revealed their informal reasoning and NOS understanding utilization in distal and proximal contexts of SSI. How people of all ages engage with dialogue about SSIs and resolve these issues are needed to investigate. As the trends about informal reasoning in socio-scientific issues have been accelerated, future research may focus on replicating with different samples such as in-service teachers. In addition, by considering the significance of SSI in science curricula for middle and high school students, future studies may be conducted with high and middle school students.

Furthermore, in this study the topics of Processed Food and Golden Rice were used as SSI. Different SSI may be selected, prepared, and given to participants at distal and proximal contexts in future research studies by regarding where potential participants live. For instance, by noticing the country in which future studies will be conducted, an issue related to the country and an issue in another country can be selected to examine the informal reasoning of the participants. It provides an opportunity to investigate the effects of the content or the context of SSI on informal reasoning.

The findings of this study showed that PSTs were more motivated to make arguments and share their ideas in the proximal context. Also, they scientific evidence in written text and showed mostly rationalistic informal reasoning in resolving the issue in the distal context. In addition to rationalistic informal reasoning, in distal context participants utilized more informed views related to NOS understanding aspects. For further research, the context of SSI may be designed and framed for students to engage them with evaluating scientific processes and motivate them, too. Therefore, SSI design may enrich science classrooms in terms of students' motivation and the way of thinking.

Lastly, the current study investigated the informal reasoning patterns in distal and proximal context of SSI. It did not investigate informal reasoning quality, which is another element of informal reasoning. Future studies may focus on the quality of informal reasoning in the proximal and distal context of SSI.

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APPENDIX A: PROCESSED FOOD

Most human beings have busy lives and live far from their food sources. People need to buy foods that can be stored on the shelf, prepared easily, and consumed anytime. Therefore, the production and sales of processed foods have increased all over the world. Labeling something as a processed food means that it is changed before consumption. This can range from a simple process such as washing and packaging to a complex process such as adding flavors enhancers and preservatives to meatball patties before freezing.

One group of scientists argues that food processing helps us to consume a broader range of foods, which enables people to have a balanced diet. We can transport foods from anywhere to our homes, so people reach what they need as food. We are not limited to what is produced locally or by season. This significantly increases food supply and accessibility for most people who live in cities.

However, another group of scientists claims that consuming processed food can be unhealthy for the human body. Some processed foods include extra salt, sugar, fat and sometimes preservatives to enhance their taste, contribute to the structure of the food and keep them safe. Consuming these kinds of food leads to intake of more than the recommended amounts of nutrients and food preservatives. Hence, they may cause obesity and a variety of health problems.

On the other hand, it is argued that processed foods are financially accessible to a wider population. Usually processed foods are cheaper than unprocessed foods due to large scale production. They also help to reduce food waste because usually processed foods have a longer shelf life than fresh foods. People do not need to consume them immediately. Hence, safe storage reduces food waste due to spoilage and making them financially appropriate choice.

Furthermore, the studies highlighted that people are more likely get dependent to processed foods because of their enhanced taste. Research shows that consuming processed foods trigger parts of the brain that lead to craving for such foods and consuming them more and regularly. Hence, such dependence may lead people to develop unhealthy eating habits and associated health problems.

1. Do you think that Turkish government should increase the taxes on the Processed Food in Turkey? Explain and justify your decision.
2. Considering the evidence presented in the scenario and your own knowledge, how would you persuade someone who thinks differently from you?
3. What do you think about the social effects of your decision?
4. How would you think about someone in your family using Processed Foods?
5. Do you think that your decision about increase the taxes on Processed Food might change in the future? Explain and justify your decision.
6. Scientists have different perspectives on Processed Foods, even though they look at the same data. How would you evaluate this situation?

APPENDIX B: GENETICALLY MODIFIED FOOD: GOLDEN RICE

Scientists have developed a new genetically modified strain of rice by adding the genes of a bacterium in the soil that can produce beta-carotene through photosynthesis. Beta-carotene is found in plants such as pumpkin, apricot, carrot and gives them their yellow-orange color and is used in the production of vitamin A in the human body. The aim of producing genetically modified rice is to deal with Vitamin A deficiency.

One group of scientists argues that eating genetically modified rice can help prevent blindness by improving vitamin A intake during digestion. As a result, this could reduce childhood blindness, which affects 500,000 children worldwide each year, especially in developing countries in Asia, like Vietnam. This group argues that no studies have indicated any dangers associated with genetically modified food.

Another group of scientists argues that how eating genetically modified rice can affect organisms is not known. When new genes are passed on to organisms, it will be difficult to identify how organism has changed as a whole. Since there is no biochemical analysis or studies of the golden rice to identify how this crop has changed as a whole, people should not consume it.

It is argued that golden rice could be helpful for people with weakened immune system. People die from diseases that would normally survive due to a weakened immune system, which may partly be attributed to vitamin A deficiency due to a poor, single-source diet. Production of golden rice can deal with the issue of Vitamin A deficiency, which may be essential in countries like Vietnam where rice is a major food source.

The new genetically modified rice is grown in the same regions as other rice so there might be crossing over (contamination). This would change the genetic material

of traditionally grown rice. Such a contamination may affect the rice production in an unknown way. It is argued that a healthy balanced diet would be a better solution than the golden rice to deal with the Vitamin A deficiency.

1. Do you think Vietnamese government should allow production and marketing Golden Rice? Explain and justify your decision.
2. Considering the evidence presented in the scenario and your own knowledge, how would you persuade someone who thinks differently from you?
3. What do you think about the social effects of your decision?
4. How would you think about someone in your family using Golden Rice if you live in Vietnam?
5. Do you think that your decision about Golden Rice might change in the future? Please explain why.
6. Scientists have different perspectives on Processed Foods, even though they look at the same data. How would you evaluate this situation?

APPENDIX C: İŞLENMİŞ GIDALAR

Çoğu insan, yoğun bir hayata sahiptir ve besin kaynaklarından uzakta yaşar. İnsanlar, rafta saklanabilen, kolayca hazırlanabilen ve her an tüketilebilen gıdaları satın almayı tercih ederler. Bu tercih, tüm dünyada işlenmiş gıdaların üretiminin ve tüketiminin artmasına sebep olmuştur. Bir yiyeceğin işlenmiş gıda olarak tanımlanması, tüketilmeden önce herhangi bir işlemde geçtiği anlamına gelir. Bu, yıkama ve paketlenme gibi basit bir işlem olabileceği gibi, köfteye lezzet arttırıcılar ve koruyucular ekledikten sonra dondurmaya gibi karmaşık işlemler de olabilir.

Bir grup bilim insanı tarafından, işlenmiş gıdaların, insanların dengeli beslenmesini sağlayacak daha geniş bir gıda yelpazesine erişmesine yardımcı olacağı savunulmaktadır. Yerel ve mevsimlik üretilen gıdalarla sınırlı kalınmadığından, insanlar tercih ettiği gıdalara kolayca ulaşabilmektedir. Bu da şehirlerde yaşayan çoğu insan için gıda teminini ve erişilebilirliğini önemli ölçüde arttırmaktadır.

Ancak başka bir grup bilim insanı tarafından, işlenmiş gıda tüketiminin insan vücudu için sağlıksız olabileceği iddia edilmektedir. Bazı işlenmiş gıdalarda, lezzetlerini arttırmak, gıdanın kıvamına katkıda bulunmak ve onları güvenli bir şekilde saklayabilmek için ekstra tuz, şeker, yağ ve bazen koruyucu maddeler bulunmaktadır. Bu tür gıdaları tüketmek, önerilen miktarlardan daha fazla tuz, şeker, yağ gibi besinler ve gıda koruyucusu alımına yol açabilir. Bu nedenle, işlenmiş gıdaların obeziteye ve çeşitli sağlık sorunlarına sebep olabileceği iddia edilmektedir.

İşlenmiş gıdaların daha geniş bir nüfus için ekonomik olarak erişilebilir olduğu da öne sürülmektedir. Genellikle işlenmiş gıdalar, fabrikalarda büyük ölçekte ve düşük maliyette üretilmeleri nedeniyle, işlenmemiş gıdalardan daha ucuz olabilmektedir. Ayrıca işlenmiş gıdalar gıda israfını azaltmaya da yardımcı olurlar çünkü genellikle taze gıdalardan daha uzun raf ömrüne sahiptirler. İşlenmiş gıdalar, bozulmadan saklanabilmeleri sebebiyle gıda israfını azaltırlar ve bu da işlenmiş

gıdaları tercih edilebilir bir seçim haline getirir.

Öte yandan, arařtırmalar, insanların lezzetleri nedeniyle işlenmiş gıda tüketmeye daha fazla eğilimli olduklarını göstermektedir. İşlenmiş gıdaların tüketilmesindeki bu artış, bu tür gıdaların daha fazla ve düzenli olarak tüketilmesinde bir sebep olarak gözükmemektedir. Bu nedenle, işlenmiş gıdaların tüketimindeki bu eğilim, insanları sağlıksız beslenme alışkanlıklarına sahip olmalarına ve buna bağlı olarak sağlık sorunlarıyla karşılaşmalarına yol açabileceği iddia edilmektedir.

1. Türkiye devleti işlenmiş gıdalar üzerindeki vergiyi arttırmayı planlamaktadır. Siz bu plana katılır mısınız katılmaz mısınız? Kararınızı gerekçeleri ile açıklayın.
2. Metinde sunulan delilleri ve kendi bilgilerinizi göz önünde bulundurduğunuzda sizden farklı düşünen birini nasıl ikna edersiniz?
3. Bu kararınızın toplumsal etkileri hakkında ne düşünürsünüz?
4. Ailenizden birinin işlenmiş gıdaları tüketmesi hakkında ne düşünürdünüz?
5. İşlenmiş gıdalardan alınan vergilerin artırılması konusundaki kararınızın gelecekte değişebilir mi? Kararınızı açıklayın ve gerekçelendirin.
6. Bilim insanları işlenmiş gıdalar hakkında aynı verilere bakmalarına rağmen farklı bakış açılarına sahiptir. Bu durumu nasıl değerlendirirsiniz?

APPENDIX D: GENETİĞİ DEĞİŞTİRİLMİŞ GIDA: ALTIN PİRİNÇ

Bilim insanları, beta-karoten üretebilen bir bakterinin genlerini pirince ekleyerek, genetiği değiştirilmiş yeni bir pirinç türü geliştirdiler. Beta-karoten; kabak, kayısı, havuç gibi bitkilerde bulunan ve onlara sarı-turuncu rengini veren bir maddedir. İçerdiği beta-karoten sayesinde hafif turuncumsu renge sahip olan genetiği değiştirilmiş bu pirince, altın pirinç denilmektedir. Beta-karoten, insan vücudunda A vitamini üretiminde kullanıldığı için altın pirinç üretiminin amacı, ağırlıklı olarak pirinç ile beslenen ve genellikle fakir ülkelerde yaşayan insanlarda gelişen A vitamini eksikliği ve bu eksikliğin yol açtığı sağlık problemlerine çözüm olarak sunulmasıdır.

Bir grup bilim insanı, genetiği değiştirilmiş pirinç tüketmenin, sindirim sırasında A vitamini emilimini artırarak, A vitamini eksiliğine dayalı olarak gelişen göz sağlığı problemlerini önlemeye yardımcı olabileceğini savunmaktadır. Örneğin, altın pirincin, özellikle Vietnam gibi Asya'daki gelişmekte olan ülkelerde yaşayan çocukları etkileyen ve sıklıkla rastlanan çocukluk çağı körlüğüne çözüm olabileceği öne sürülmektedir. Bu bilim insanları, genetiği değiştirilmiş gıdalarla ilgili herhangi bir tehlikenin olduğuna dair bir araştırmanın olmadığını ve bu sebeple altın pirincin üretilmesini ve tüketilmesini önermektedir.

Başka bir grup bilim insanı tarafından ise, organizmalara yeni genler aktarıldığında, organizmanın bir bütün olarak nasıl değiştiğinin tam anlamıyla belirlenmesinin mümkün olmadığı öne sürülmektedir. Spesifik olarak pirinç üzerinde yapılan bu genetik değişiklik hakkında yeterli biyokimyasal analizler veya araştırmalar olmaması sebebiyle altın pirincin bütünsel genetik yapısındaki değişiklik bilinmemektedir. Ayrıca, pirinci tüketen organizmaların nasıl etkilendiği de bilinmediğinden, insanların altın pirinci tüketmemesi gerektiği iddia edilmektedir.

Öte yandan, altın pirincin zayıflamış bağışıklık sistemi olan insanlar için faydalı

olabileceği de öne sürülmektedir. İnsanlar, dengeli olmayan bir beslenme düzeni nedeniyle kısmen A vitamini eksikliğinden zayıflamış bir bağışıklık sistemine sahip olabilmektedir. Bu sebeple normalde güçlü bağışıklık sistemi ile korunabilecekleri hastalıklara karşı savunmasız kalmaktadırlar ve birçok sağlık problemi yaşamaktadırlar. Altın pirinç tüketimiyle insanlar, Vietnam gibi pirincin ağırlıklı bir besin kaynağı olduğu ülkelerde A Vitamini eksikliğinin sebep olduğu bağışıklık sisteminden kaynaklı sorunlarla başa çıkabilirler.

Genetiği değiştirilmiş altın pirinç, diğer pirinçlerle aynı bölgelerde yetiştirilebileceğinden pirinçler arasında gen aktarımı (kontaminasyon) olabilir. Bu durum, geleneksel olarak yetiştirilen pirincin genetik materyalinin değişmesine hatta kaybolmasına sebep olabilir. Böyle bir gen aktarımının, pirinç üretimini nasıl etkileyeceği bilinmemektedir. Bu sebeple A vitamini eksikliğini gidermek için altın pirinç üretimi yerine, sağlıklı ve dengeli beslenmenin altın pirinçten daha iyi bir çözüm olacağı öne sürülmektedir.

1. Vietnam hükümeti altın pirinç üretimi ve tüketimine izin vermeyi planlamaktadır. Siz bu plana katılır mısınız? Kararınızı gerekçeleri ile açıklayın.
2. Metinde sunulan delilleri ve kendi bilgilerinizi göz önünde bulundurduğunuzda sizden farklı düşünen birini nasıl ikna edersiniz?
3. Bu kararınızın toplumsal etkileri hakkında ne düşünüyorsunuz?
4. Siz o bölgede yaşayan biri olsaydınız ailenizden birinin altın pirinç tüketmesi hakkında ne düşünürdünüz?
5. Altın pirinç hakkındaki kararınızın gelecekte değişebileceğini düşünüyor musunuz? Lütfen nedenini açıklayın.
6. Bilim insanları altın pirinç hakkında aynı verilere bakmalarına rağmen farklı bakış açılarına sahiptir. Bu durumu nasıl değerlendirirsiniz?

APPENDIX E: CONSENT LETTER

T.C.

BOĞAZIÇI ÜNİVERSİTESİ

FEN BİLİMLERİ VE MÜHENDİSLİK ALANLARI İNSAN ARAŞTIRMALARI
ETİK KURULU KATILIMCI BİLGİ ve ONAM FORMU

Araştırmayı destekleyen kurum:Boğaziçi Üniversitesi

Araştırmanın adı:Fen Öğretmen Adaylarının Sosyobilimsel Konularda Karar Verme Süreçlerinin İncelenmesi

Proje Yürütücüsü/Araştırmacının adı:Özlem Özdemir

Adresi: İstanbul

E-posta adresi: ozleozdemir0103@gmail.com

Proje Konusu: Sosyobilimsel konularda değerlendirme ve karar verme sürecinde fen öğretmen adayları arasındaki bireysel farklılıkların etkisi bulunmaktadır. Fen öğretmen adaylarının sosyobilimsel konularda karar verme süreçlerini, bu bireysel farklılıklara göre incelemek önemlidir. Bu araştırmada, iki sosyobilimsel konu hakkında karar verme süreciniz incelenecektir. Bu çalışma, Boğaziçi Üniversitesi Fen Bilimleri ve Mühendislik Alanları İnsan Araştırmaları Etik kurulu onayı ile yapılmaktadır.

Onam: Bu çalışma kapsamında, fen öğretmen adaylarına sunulan sosyobilimsel konularda karar verme sürecini incelemeyi umuyoruz. Araştırmaya katılmayı kabul ettiğiniz takdirde toplamda 30 dk sürecek olan iki senaryoyu değerlendirmenizi istenecektir. Senaryoları okuduktan sonra araştırmacı ile yapılandırılmış röportaj yapmanız istenecektir. Röportaj boyunca konuşulanlar ses kayıt cihazı kayıt altına alınacaktır. Bu formda sizden istediğimiz bilgiler ve araştırma kapsamında sağladığınız veriler sadece araştırmacının erişiminde bulunacak olup, sadece araştırma

amaçlı kullanılacaktır. Araştırma sonunda oluşacak olan bilimsel tez ve/veya yayında kişileri belirtebilecek herhangi bir bilgi bulunmayacaktır. Araştırma tamamlandıktan 1 yıl sonra fiziksel ve dijital veriler imha edilecektir. Çalışmaya katılmanız tamamen isteğe bağlıdır. Sizden ücret talep etmiyoruz ve size herhangi bir ödeme yapmayacağız. İstedığınız zaman çalışmaya katılmaktan vazgeçebilirsiniz. Bu durumda sizden almış olduğumuz veriler imha edilecektir.

Yapmak istediğimiz araştırmanın size risk getirmesi beklenmemektedir. Öğretmen adaylarının sosyobilimsel konularla ilgili karar verme ve geliştirme süreçlerine dahil olmalarının hiçbir zararı yoktur. Aksine sosyobilimsel konular Millî Eğitim Bakanlığı Fen Bilimleri Dersi Öğretim Programında sosyal ve vatandaşlıkla ilgili yetkinliklere sahip, bireysel karar verebilen, düşüncelerini farklı gerekçelerle destekleyebilen öğrencilerin yetiştirilmesi gerekçesi ile dahil edilmiştir. Bundan dolayı öğretmen adaylarının sosyobilimsel konularla ilgili bir çalışmaya katılması, kendini geliştirmesi ve bu konuyu özümsemesi bakımından pozitif katkı yapacaktır. Bu nedenle, yapılan bu çalışma fen bilimleri eğitiminin amacı ve hedefleri ile paralellik göstermekte ve öğrenmeyi desteklemektedir.

Bu formu imzalamadan önce, çalışmayla ilgili sorularınız varsa lütfen sorunuz. Daha sonra sorunuz olursa, Özlem Özdemir Telefon: 0 554 338 27 93, sorabilirsiniz. Araştırmayla ilgili haklarınız konusunda Boğaziçi Üniversitesi Fen Bilimleri ve Mühendislik Alanları İnsan Araştırmaları Etik Kurulu'na (fminarek@boun.edu.tr) danışabilirsiniz.

Bana anlatılanları ve yukarıda yazılanları anladım. Bu formun bir kopyasını aldım. Çalışmaya katılmayı kabul ediyorum.

Katılımcı Adı-Soyadı:.....

İmzası:

Tarih (gün/ay/yıl):/...../.....

APPENDIX F: EXPERT VIEWS

	Processed Food		Golden Rice		If not, what are your reasons? What are your suggestions for improvement
	Appropriate	Not Appropriate	Appropriate	Not Appropriate	
Advantages and disadvantages are clearly stated in the presented text.					
The presented text is balanced in terms of advantages and disadvantages.					
The sub-dimensions of health, economy and environment in the text are presented in a balanced way compared to each other.					
The advantages and disadvantages of the issues in the text are given impartially, without giving any direction.					
The text provides sufficient content for the participants to form arguments from different positions.					
The text content allows participants to be involved in the decision-making process.					
It has been appropriately addressed as a socioscientific issue.					
The two scenarios are prepared to be structurally parallel to each other.					
The questions in the two scenarios are suitable for measuring potentially emerging understandings of the nature of science.					
Want to add					

APPENDIX G: TRANSLATED QUOTATIONS

<p>P11(PF): Metinde de bahsettiği gibi işlenmiş gıdaların pratikliği de ortada. Paketi aç ve tüket çoğunu hemen. Fırına attıktan sonra oluyor örneğin. Bence herkesin hayatında konuştuğum kişi de dahil kullandığı bir şey. Hem ucuzluk hem de kısa sürede hazırlama pratikliği olsun insanlar kullanıyor. Onun dışında fiyatı da makuller herkese göre.</p>	<p>P11(PF): As mentioned in the text, the practicality of processed foods is obvious. Open the package and consume most of them immediately. For example, after put it in the oven, you can eat. I think it's something that everyone uses in their life, including the person I talked to. It's both cheap and practical to prepare in a short time, so people use it. Also, the price is reasonable for everybody.</p>
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Q1

<p>P8(PF): organik gıda birçok insan için çok pahalı, bundan dolayı erişimi de zor. Bilim insanlarının bu tarz besinlere yaptığı değişiklikler herkesin ulaşabileceği, köyde yaşayamayan bir insanın bile ulaşabileceği bir gıda. Ondandır bilimin bu yönde kullanmaya olumlu bakıyorum ben.</p>	<p>P8(PF): organic food is very expensive for a lot of people, so accessing to these foods are difficult. The changes that the scientists made to these foods made the foods accessible to everyone, even for a person who cannot live in a village. That's why I see this usage of science as beneficial.</p>
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Q2

<p>P5(GR): Çünkü a vit eksikliği olan kişiler için bu bir opsiyon iyileşmek için bir çözüm yolu olarak görülüyor. Hani diyor ki çocukluk çağı körlüğüne çözüm olarak sunulabilir diyor. ya da doğuştan ya da sonradan oluşabilecek bu vitaminin eksikliğinden kaynaklı bir bağışıklık sistemi sorunu olursa bunu da çözebileceği ön görülüyor. Eğer altın pirinç üretilmezse bu insanların tıbbi tedavileri daha uzun süren pahalı olabilecek tedavileri süreçleri içerebilir sonuçta. hani bu pirinç çözüm sunacaksa, sağlıklı gıdalar kadar etkili olup çözüm.</p>	<p>P5(GR): Because for people with vitamin A deficiency, this is seen as an option, a solution for healing. You know, scenario says, it can be offered as a solution to childhood blindness or if there is an immune system problem caused by a congenital or subsequent deficiency of this vitamin, it is predicted that it will be able to solve it. If gold rice were not produced, these people's medical treatments might last longer and might be more expensive. If this rice is going to offer a solution, it is as effective solution as healthy food.</p>
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Q3

<p>P15(GR): Tabii ki toplumu olumlu etkileyecektir çünkü sonuçta toplumun çoğunda fakirlikten dolayı yani yeterli beslenemeden dolayı oluşmuş sağlık sorunları var. Buna çözüm olacak bilimsel olarak üretilmiş bir besinden bahsediyoruz. Çocukların sahip olduğu körlüğe de çözüm olabilmemiş bundan dolayı hani bence toplumu olumlu etkileyecek bir gelişme bu.</p>	<p>P15(GR): Of course, it will have a positive effect on society, because most of the people in society have health problems due to poverty, that is, due to insufficient nutrition. We are talking about a scientifically produced food that will be the solution to this. It could also be a solution to the blindness of children, so I think this is a development that will positively affect the society.</p>
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Q4

<p>P18(PF): Türkiye'de yaşamın nasıl olduğu belli. İnsanlar aç ve biz bunu düşünmeliyiz. Yani ben aç değilim çok şükür ve bu insanları görüyoruz, empati kurmak gerekiyor ne kadar sağlıksız olsa da bu tarz besinleri tüketenleri düşünelim. Bence herkes ister taze organik gıda ama görüyoruz ki çok zor.</p>	<p>P18(PF): It is obvious how life is in Turkey. People are hungry and we must think about it. So, I'm not hungry, thank goodness, and we see these poor people, we need to empathize, let's think about those who consume this type of food, no matter how unhealthy it is. I think everyone wants fresh organic food, but we see that it is very difficult in Turkey.</p>
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Q5

<p>P17(PF): Bilemiyorum ya açlık sınırimız yükselmiş durumda. Marketteki fiyatlar ile herkesin istediği ihtiyacı gibi beslenebilmesi mümkün değil. Çoğu insan aç oldukları ve yeterli şekilde beslenemediği için bu tarz ürünleri alıyorlar. Bunların vergilerini arttırsak nasıl olur karınları doyabilir. Bence vergiyi arttırmak acımasız bir eylem olur. Bu durum insanlar üzmele kalmaz bir de açlıktan ölmelerine sebep bile olabilir. Ben bundan dolayı desteklemek istemiyorum, aksi durumda insanların duygusal halini ve fiziksel durumlarını düşünmek istemiyorum.</p>	<p>P17(PF): I don't know, our starvation line has increased. With the prices in the market, it is not possible for everyone to eat as they want and need. Many people buy these products because they are hungry and do not have enough nutrition. If we increase their taxes, how can they be fed. I think raising the tax would be a cruel act. This situation not only upsets people but can even cause them to die of hunger. That's why I don't want to support it, otherwise I don't want to think about people's, emotional state, and physical conditions.</p>
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Q6

<p>P8(GR): Bilim insanların bu tarz besinlere yaptığı değişiklikler herkesin ulaşabileceği bir besin. Bu pirinç fakir olan insanlar için bir çözüm gibi düşünebiliriz. Bu insanların iyi olmasını düşünmeli ve umut etmeliyiz. Ondan dolayı bilimin bu yönde kullanmaya olumlu bakıyorum ben.</p>	<p>P8(GR): The changes that the scientists made to these foods made the foods accessible to everyone. This rice is like solution for poor people.. We should think and wish those people's well being That's why I see this usage of science as beneficial.</p>
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Q7

<p>P15(GR): Üstelik Vietnam gibi ülkelerde hep pirinç üretiliyor çünkü iklimi uygun. Pirinç üretimini kendi yaptığı için maliyeti de düşük olacaktır. Bu durumda halkın her kesiminden kişilere ulaşacak bir ürün yani. Zengin de fakir insanlar da tüketebilecek. İnsanları düşünmek zorundayız. İşlenmiş gıdalar gibi.</p>	<p>P15(GR): Moreover, rice is always produced in countries like Vietnam because the climate is suitable. Since it produces rice by itself, its cost will be low. In this case, it is a product that will reach people from all socio-economic status. Rich and poor people alike can consume it. We have to think about people. Like processed foods.</p>
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Q8

<p>P6(PF): Daha geçen gün markete gittim ve abur cubur alacaktım. Fiyatları çok fazla idi. Tabii yurttta kaldığım için sağlıksız besleniyorum. Hiç hoşuma gitmedi bu durum. bu fiyat artışı hoşuma gitmemişti o yüzden kesinlikle koyulmamalı bence.</p>	<p>P6(PF): I just went to the market the other day and I was going to buy some snacks. Their prices were so high. Of course, I eat unhealthily because I am living in dorm. I don't like this situation. I do not like this increased price, so I definitely think that tax should not be imposed.</p>
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Q9

<p>P3(PF): Sen almıyorsun bu gıdaları seni etkileyen bir şey yok derim ne diyeyim.</p>	<p>P3(PF): You don't buy these foods, what can I say, there is nothing that affects you.</p>
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Q10

<p>P3(GR): üretilmesine izin vermediğimiz için toplumun ortalama ömrü uzar heralde. iyi olurdu heralde. Faydası olur heralde. Ne desem de bilemedim.</p>	<p>P3(GR): I guess the average lifespan of the society will increase because we do not allow it to be produced. it would have been good. It'd be helpful, I guess. I don't know what to say.</p>
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Q11

P7(GR): Hala normal pirinç var farkında mısın al onu tüket yani işe yaramadığı görülürse bunun yerine normal pirinç tüketilebilirsin belki de derdim.	P7(GR): Do you realize that there is still normal rice, take it, so if it is seen that it does not work, I would say that maybe normal rice should be consumed instead.
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Q12

P1 (GR): A vitamini eksikliği içinde havuç alıp yemelisin derim heralde.	P1(GR): In case of vitamin A deficiency, I guess, I say that you should take and eat carrots.
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Q13

P8 (PF): ben annemle yaşıyorum, kışın bezelye pişiyorsa ve ben farklı bir tat alıyorsam, anneme soruyorum, bu konserve mi? çünkü hemen anlıyorum ve sevmiyorum açıkçası. Annem de diyor ki mesela, bugün bu yemek yemeği pişirmek istedim bu yüzden kullandım. diyorum kadın istiyor ne isterse onu pişirsin kullansın tabii ki. Anladın mı? Bazen bu konserveler kurtarıcı oluyor.	P8 (PF): I live with my mother, if she cooks peas in winter and I get a different taste, I ask my mom, is this canned? Because I immediately recognize it and frankly, I don't like it. My mother answers, for example, I wanted to cook this dish today, so I had to use it. I say, of course, the woman should use something whatever she wants. Did you understand? Sometimes cans can be savers.
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Q14

P14 (PF): ben öğrenciyim çok fena yani. Markete girmek insanı biraz sinir bile ediyor. Kendim için en basitinden bu zamların olmasını istemem. Tüketiyorum ya ve öğrenci olarak bundan vazgeçmem zor gibi.	P14 (PF): I am a student. that's so bad. Going to the market is even a little nerve-wracking. I simply do not want increasing prices for myself. I'm consuming it, and as a student, it's hard for me to give up on it.
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Q15

P2 (PF): Bunu seçmek bizim elimizde. Neden bu vergi artırımını ile alakalı olsun ki? bu seçimi insanlar yapabilir. Sen başka insanlar adına seçemezsin. Erişebilir olarak daha fazla insan hitap ediyor sonuçta. erişebilirlik olsun insanlar kendi yolunu kullanmak konusunda kendi yolunu çizsin.	P2 (PF): it's up to us to choose it. why would this be about tax increases? People can make this choice. You cannot choose for other people. It's accessible so more people can reach these foods, after all. There should be accessibility for everybody and everybody should decide on whether to consume them.
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Q16

P10 (PF): Örnekleri az da olsa bu obezitenin gerçek oluşunun kanıtını sunarım diye düşünüyorum ama çok da ikna olmazlar gibi geliyor. ama yani türkiyede yaşayan insanları düşünmek gerekiyor bir yerde, halden anlamak lazım. yazık derdim.	P10 (PF): I think that I can present the proof that this obesity is real, even if there are few examples, but it seems that they are not very convinced. but one has to think about the people living in Turkey, one must understand the situation. I'd say sorry.
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Q17

P13 (GR): Sen tüketmiyorsan bile çözüm arayan insanlar için bu riski almaya değer derdim çünkü kurtulabilecek insanlar var. bilime güven biraz derdim. ayrıca ilaçlara geri döneceğim ama ilaçların etkileri okay ama yan etkileri de var. bunun da yan etkisi böyle olabilir diye düşünüyorum.	P13 (GR): Even if you don't consume it, I would say it's worth taking the risk for people looking for solutions because there are people who can recover with it. I would say you should trust in science. I will also go back to the drugs but the effects of the drugs are okay but there are also side effects. I think this could be a side effect as well.
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Q18

P17 (GR): Direkt çocukları ya da toplumda yaşayan insanları kurtarmaya odaklandım. Daha beteri olacaksa bile günü kurtarmaları için kesinlikle olması gereken bir yenilik gibi geldi bana bu riski almaya değer kurtarabileceğiniz insanları düşününce	P17 (GR): I focused directly on saving children or people living in the community. Even if it's worse, it seems like a must-have innovation to save the day, considering the people you can save, it's worth taking the risk.
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Q19

P1 (PF): Aslında bir yandan iyi olur çünkü işlenmiş gıdalar sağlıklı ve belki bu besinleri almazlar ve insanlar sağlıklı yemek yapmaya daha çok eğilimli olurlar. Bu anlamda sağlıklarını korumak açısından anlamlı bir eylem olabilir.	P1 (PF): It's actually good on the one hand, because processed foods are unhealthy and they may not buy this food, and people tend to cook and eat healthy foods. In this sense, it can be a meaningful action in terms of protecting their health.
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Q20

P17 (PF): etkisi olması açısından vergi artırımını olmalı diyorum. Yani insanlar daha az tüketebilir belki. Çünkü gerçekten çok zararlı bir şey. Bazı makalelerde sigara kadar zararlı olduğu yazıyor. Fazla yağ ve şekerin. Öyle bakıldığı zaman gerçekten tüketmemek gerekiyor. Devletin bu tarz ürünlerde vergi artırımına gitmesi çok normal. İnsanların sağlığından daha önemli değil sonuçta.	P17 (PF): I say there should be a tax increase in order to have an effect. So maybe people would consume less. Because it's really harmful. Some articles say it is as harmful as cigarettes. Too much fat and sugar. When you look at it like that, you really shouldn't consume it. It is very normal for the government to increase taxes on such products. After all, it is not more important than people's health.
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Q21

P2 (GR): Çok fazla bilinmeyen şey var. Daha kötü de olabilir bu insanlar. Sağlıkları daha kötü de etkilebilir demek istiyorum. bu kadar risk gerek olmadığını düşünüyorum.	P2 (GR): There are so many unknowns. These people could become worse. I mean their health could be affected even worse. I don't think it's necessary to take such a risk.
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Q22

P 10 (GR): A vitamini eksikliği sağlık açısından kötü aynı zamanda insanların bağışıklık sisteminin zayıf olması da fakat bunu giderebileceğimiz başka yöntemler varken sağlıklı beslenmek ya da bağışıklık sistemimizi geliştirmek gibi farklı yöntemler varken bunları yapmak için, direkt böyle pirincin yapısını değiştirip nasıl diyim sonucunu bilmediğimiz seylere bizi götürecek olan bir maddeyi üretmek ve kullanmak yerine bildiğimiz çözümlerden yola çıkıp hem sonucunu biliyoruz bu bize yararlı dengeli beslenmek bizim için daha doğru daha sağlıklı.	P 10 (GR): Vitamin A deficiency is bad for health, it causes people to have a weak immune system, but while there are other methods for repairing this, such as eating healthy or improving our immune system, producing a substance by changing the structure of rice would lead us to things that we do not know. Instead, we should use the solutions we know, it would be more healthy and the result would not be unknown or dangerous.
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Q23

P17(PF): Ben zam olmasın dedim çünkü olursa herkes sinirlenir ilk başta. Fakat bu normal. Türkiye ekonomisi gerçekten kötü durumda. Biz Türkiye'de yaşayan insanlar ve ülkenin durumunu düşünmeliyiz.	P17(PF): I said that there should be no raise, because if there is, everyone would get angry at first. But this is normal. The economy of turkey is really bad now. We should think of people living in turkey and situation of the country.
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Q24

<p>P19 (PF): bu duruma sevinecek birçok insan olacak diye düşünüyorum. Bilimsel olarak ne kadar sağlıksız olduğunu söyleseler de insanlar sürekli ürünlerin fiyatlarının artışına odaklanıyor. Ondan dolayı bilimsel verilerdense kendi durumlarına odaklanıp sevineceklerdir. Psikolojik olarak rahatlama diyelim. toplumun huzuru için bu zammı desteklemiyorum aslında.</p>	<p>P19 (PF): I think there will be many people who will be happy about this situation. Even though they say how unhealthy it is scientifically, people are constantly focusing on the increase in the prices of products. Therefore, they will focus on their own situation rather than scientific data and rejoice. Let's call it psychological relief. In fact, I do not support increasing prices for the sake of the peace of the society.</p>
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Q25

<p>P9 (PF): pizza yemek lüks oldu ülkede. eğer fiyatlar artarsa toplumun belirli bir kesimini yok sayarak yapmış oluyoruz. halihazırda artıp duran bir enflasyon var. ekonomik sıkıntı mevcut. Ekonomik düzeyi iyi olmayan aileleri düşünmek zorundayım. Toplum önemli bir kriter benim için.</p>	<p>P9 (PF): Eating pizza has become a luxury, If the prices are increased, it would mean ignoring a specific part of the society. There is already increasing inflation in Turkey. There is an economic problem. I have to think about families whose economic level is not good. I mean, society is an important criterion for me.</p>
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Q26

<p>P2 (GR): Vietnam sonuçta fakir bir ülke bence oradaki fakir insanları düşünmemiz lazım. Devlette düşünmeli. Eğer besin alamıyorlarsa buna durumları yok demektir. bu ürünü üretip ucuz bir şekilde onlara sunulabilir diye düşünüyorum. Bir nevi işlenmiş gıdalar gibi.</p>	<p>P2 (GR): Vietnam is a poor country after all, I think we have to think about the poor people there. Government should think. If they can't get food, it means they don't have it. I think that this product can be produced and offered to them in a cheap way. Kind of like processed foods.</p>
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Q27

<p>P2(GR): Gen aktarımı sayesinde gen yapısını da bozulabileceğini öne sürmüş metinde de. Düşünsenize gen aktarımı oldu ve normal ve çoğu insanın kullandığı beyaz pirincin de yapısını bozuyoruz. Toplumun belirli bir kesimi sağlıklı yapmayı hedefliyoruz ama bir anda herkesi etkileyecek bir duruma dönüştü. Gen aktarımı çevre açısından da insan sağlığı açısından da faydalı bulmadım doğrusu.</p>	<p>P2(GR): It is also claimed in the text that the gene structure can be deteriorated thanks to gene transfer. Think about it, there has been a gene transfer and we are destroying the structure of normal white rice that most people use. We aim to make a certain part of the society healthy, but it has suddenly turned into a situation that will affect everyone. In fact, I did not find gene transfer beneficial for the environment or for human health.</p>
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Q28

<p>P13(GR): Çevremiz için zararlı olabilir. metinde de söylemiş kontaminasyon olabilir. Ben genelde de çok risk taker birisi değilimdir ondan dolayı bilinmezliğe doğru adım atmak çok da mantıklı gelmedi bana. Aynı ekosistem sonuçta. Eğer üretilmesi durumunda eğer olumsuz sonuçlar çıkacaksa bu diğer ülkedeki insanları etkileyebilir. Hayvanlar arılar hatta hava ile taşınabilir bu diğer alanlardaki yerel pirinçleri de bozabilir.</p>	<p>P13(GR): It may be harmful to our environment. There may be contamination mentioned in the text. I'm not usually a risk taker, so it didn't make much sense to me to step into the unknown. It's the same ecosystem after all. If it is produced, if there will be negative consequences, it may affect people in the other country. Animals, bees, even airborne, can also spoil local rice in other areas.</p>
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Q29

P7 (PF): Neden engelleyelim vergi artarsa birçok insan almaktan vazgeçer ve belki daha sağlıklı olabilirler ama insanların beslenmesi ile ilgili. Onların haklarından, ihtiyaçlarını neden engelleyelim? İşlenmiş gıdaların tüketilmesini zorlaştırıyoruz. Sağlıklı bile olsa buna gerek yok bence.	P7 (PF): Why should we prevent it, if the tax increases, many people will stop buying and maybe they can be healthier, but it's about people's nutrition. Why should we prevent their rights and needs? We make it harder to consume processed foods. I don't think it's necessary even if it's healthy.
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Q30

P4 (GR): Yani hiç de bilemiyorum ki. Düşünüyüm. Normalde genetiği değiştirilmiş ama yani onların insanlar için riski de ne olabilir ki. Tam da belli değil ya, hiç üretilip üretilmemesini düşünemedim.	P4 (GR): So, I don't know at all. Let me think. Normally it's genetically modified, but what's their risk for people? It's not clear exactly, I couldn't think of whether it was ever produced or not.
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Q31

P 16 (PF): Obezite ve ona bağlı fazla şeker ve yağdan dolayı oluşacak hastalıklar. Evet bu da olası bir durum ama sık sık tükettiğimiz zaman aslında olabilecek bir şey gibi geliyor. Amerika'da insanlar sadece bu tarz ürünlerden yiyorlar. Ve bazen belgesel konusu oluyorlar fazla kilolar ve damar tıkanıklığı gibi. Bizim ülkemizde o kadar çok vaka yok. Yani televizyonda kesin duyardık diye söylüyorum. Görmedik. O yüzden çok fazla sayıda tüketilmiyor gibi bundan dolayı bence hiç tehlikeli bir şey değil ülkemizde. Merak etmeyin.	P 16 (PF): Obesity and related diseases result in excessing sugar and fat. Yes, this is a possible situation, but when we consume it often, it seems like something that can happen. In America, people only eat such products. And sometimes they become the subject of documentary such as overweight and vascular occlusion. There are not that many cases in our country. So, I'm saying that we would hear it on TV. We didn't see it. That's why it's not consumed in large quantities, so I think it's not a dangerous thing in our country. Do not worry.
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Q32

P19 (GR): yani bakınca çok faydalı olabilecek bir şey gibi. Çocuklar için ama bu da karar vermek uzmanlara gerek var bence. Bu riski alamam ben neresi riskli çok da anlamadım ama.	P19 (GR): it looks like something that can be very useful when you look at it. It's for children, but I think experts are needed to decide this. I can't take this risk, but I don't understand how risky it is.
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Q33

P12 (PF): yani baktığımız zaman obezite her hastalığın sebebi olarak gösteriliyor her bilimsel makalede ve bu riski almamalıyız. Fiyatlarının artması insan sağlığı için doğru o yüzden.	P12 (PF): In other words, when you look at it, obesity is shown as the cause of every disease, and we should not take this risk mentioned in every scientific article. That's why the increase in prices is right for human health.
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Q34

<p>P 12 (GR): Bu hikâyede 4 tane argüman var. İki tanesi avantaj iki tanesi dezavantaj sıralıyor. Bir avantaj ise Vietnam'da çocukları etkileyen çocukluk çağında rastlanan körlüğe mücadele edebilir çözüm olarak görülebilir. Vietnam bağlamında faydalı olabilir. a vitamini emilimini arttırdığını söylüyor böylece göz sağlığı problemlerine çözüm olabileceğini söylüyor. Bunu söylemişim ama ayrıca çocukluk çağı körlüğüne çözüm olabileceği öne sürülüyor. Bir grup bilim insanı da zaten tehlike olabileceğine dair bir kanıt olmadığından bahsetmiş. Böyle değerlendirince üretilmesini isterdim tabii ki.</p>	<p>P 12 (GR): There are 4 arguments in this story. Two of them are advantages and two of them are disadvantages. One advantage can be seen as a countervailing solution to childhood blindness affecting children in Vietnam. It can be useful in the Vietnamese context. It says that it increases the absorption of vitamin A, so that it can be a solution to eye health problems. I've said this, but it's also been suggested that it could be a solution to childhood blindness. A group of scientists also mentioned that there is no evidence that there is any danger. Of course, I would like it to be produced when you evaluate it like that.</p>
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Q35

<p>P7(PF): Benim emin olmadığım gibi toplumdaki bazı kişilerde de konu hakkında emin olamayanlar olur. Bazıları sağlık problemlerine dikkat çeker. Bazıları ise erişebilirlik. Karşıt düşünceler kesinlikle olacaktır ama bilmiyorum çok etkilemez ya kararım toplumu aynı şekilde devam ederiz. Ne etkisi olabilir ki.</p>	<p>P7 (PF): Just as I am not sure, some people in the society are also unsure about the issue. Some draw attention to health problems. Some focus on accessibility. There will be opposing opinions, but I don't know, it won't affect the society much. We will continue in the same way. What effect could it have?</p>
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Q36

<p>P2 (GR): Bence bir etkisi olmayacaktır çünkü çözümü olmayan bir duruma çözüm getirilmiş olsa belki etkisi olurdu. Örneğin günümüzden örnek vereceksem; aşular. Çok fazla yan etkisi var diye konuşuluyor. Ama çözümü olmayan bir duruma şu anki getirilen en büyük çözüm. İnsanlar tercih bunu ettiler. Ama a vitamini eksikliğine çözüm olarak başka besinler ile oluşturulmuş diyet varken bu denli riskler ararak çözmeye çalışmak neden etkilesin ki toplumu?</p>	<p>P2 (GR): I think it will not have effect because if a solution was brought to an issue that has no solution, maybe it would have an effect. For example, if I'm going to give an example from today, vaccines. it is said that it has too many side effects, but the current greatest solution to a situation that has no solution. People preferred it. But when there is a diet created with other nutrients as a solution to vitamin A deficiency, why should it affect society by taking such risks?</p>
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Q37

<p>P15 (PF): fiyatları artmasın istedim bu durumda direkt insanları etkiler. İnsanlarda bu toplumun bir parçası sonuçta. İnsanlar bu tarz gıdaları tüketmeye devam edecek. Daha çok insan işlenmiş gıdalara yönelebilir. Bu da ülkede obezite ve ona bağlı sağlık sorunlarına yol açabilir. Ama daha çok insanın karnı doycak ve mutlu olacaklardır demektir aynı zamanda. Bilimsel veriler bu noktada olumsuz etkiliyor bence ya da olumsuz değil de etkilemiyor gibi. Etkisi yok yani.</p>	<p>P15 (PF): I didn't want the prices to increase, in this case it directly affects people. People are a part of this society after all. People will continue to consume this type of food. More people may turn to processed foods. This can lead to obesity and related health problems in the country. But it also means that more people will be satisfied and happy. I think scientific data has a negative effect at this point, or it doesn't seem to affect it negatively. so, no effect.</p>
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Q38

<p>P19 (PF): Bence burada toplum benim kararımı etkiledi. Toplumun dinamliğini, toplumdaki insanların düşünerek karar vermeye çalıştım. Bilimsel bir etkiden bahsedemem toplum üzerinde, bence tam tersi. Yani toplum etkiliyor bilimsel verileri.</p>	<p>P19 (PF): I think society has influenced my decision here. I tried to decide by considering the dynamics of the society and the people in the society. I can't talk about a scientific effect on society, I think it's the opposite. that is, society affects scientific data.</p>
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Q39

P 9 (GR): Fakir bir ülke için bu kararı vermemiz de bir özellik aslında. Sonuçta herkes her besini elde edemiyor. Altın pirinç ile bunun ful karşılanabilme durumu var yani a vitaminin alımını sağlıyor. Ay bilemedim ki sonuçta uzak bir toplum nasıl bir etkisi olur. Türkiye de yaşıyorum konuşması kolay baktığımız zaman. Ama illaki her toplumu etkiler bu ama nasıl ve neden etkiler emin değilim	P 9 (GR): It is also a feature that we make this decision for a poor country. After all, not everyone can obtain every nutrient. With golden rice, it can be fully met, that is, it provides the intake of vitamin A. I didn't know what effect it would have on a distant society after all. I live in Turkey, it's easy to talk when you look at it. but it will affect every society, but I am not sure how and why
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Q40

P 10 (PF): İki taraflı birbirini etkiler. Demek istediğim toplum ve bilimsel araştırmalar birbirini doğrudan etkiler. Bilim hani böyle var oluyor. Aynı bir şey olarak düşünemeyiz.	P 10 (PF): Both sides affect each other. I mean society and scientific research directly affect each other. This is how science exists. We cannot think of it as something separate.
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Q41

P17 (GR): Bilimsel bir çalışma ve toplum için yapılmış topluma etkisi olur bu yüzden. Aynı bir şey gibi düşünmeyiz ama nasıl etkiler. Hmm yani şöyle eğer çözüm olursa a vitamini üretimine yardımcı olup vücuda etkisi görülürse sonuçta toplum sağlığı açısından olumlu etkiler. İnsanlarda mutlu olur çocukları sevdikleri yaşamış oluyor. Ya da çocukluk çağı körlüğüne sahip olmuyorlar. Bu yönden bilimin toplum üzerindeki olumlu etkiyi yaratacak gücü olduğunu da gözlemlemiş oluyoruz. Kesinlikle birbiri ile doğrudan ilişkili. Bilim ve toplum yani	P17 (GR): It is a scientific study and made for society, so it has an impact on society. We don't think of it as a separate thing but how it affects. Let me think. Hmm, I mean, if there is a solution, if it helps the production of vitamin A and influences the body, it will ultimately have a positive effect on public health. People will be happy; their children their loved ones will live. Or children don't have childhood blindness. In this respect, we observe that science has the power to create a positive impact on society. Definitely directly related to each other. science and society.
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Q42

P4 (PF): Türkiye de tarımda üretim artarsa insanlara yetebilecek gıda sayısı da artar. Bu organik gıdaların bu kadar pahalı olmasına gerek yok o zaman. Böylece işlenmiş gıdalara olan talep azalır. Ben de derim ki insanlar artık sağlıklı yiyeceklere ulaşabiliyorlar. Bu durumda vergi artsın diye desteklerim, kararım değişir.	P4 (PF): If production increases in agriculture in Turkey, the amount of food for people also increases. Then, these organic foods don't need to be so expensive, which reduces the demand for processed foods. I say that people now have access to healthy food. In this case, I support the tax increase, my decision will change.
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Q43

P 5 (PF): ekonomimiz böyle kötü durumda iken sanmıyorum kararım değişmez. Bu ülkede çoğu fakir insan besinlere ulaşamıyor. Yani bu besinler ne kadar zararlı olursa olsun kesinlikle ulaşılabilirliğine odaklanıyorum ve kararımın değişmeyeceğini düşünüyorum.	P 5 (PF): I don't think my decision will change when our economy is in such bad shape. Most poor people in this country do not have access to food. I mean, no matter how harmful these foods are, I focus on their accessibility, and I don't think my decision will change.
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Q44

<p>P 10 (GR): A vitamini eksikliği dünya üzerinde şu an ne kadar yaygın ya da ne kadar önemli bir eksiklik bilmiyorum ama mesela B12 eksikliği yaygın biliyorum. Eğer A vitamini de o boyuta gelirse, eksikliğinde çok çok kötü durumlar ortaya çıkmaya başlarsa tüm dünyada o zaman belki buna çok daha ihtiyacımız olabilir. O zaman kararım değişsin, üretilsin isterim. Ama şu an öyle bir durum olduğunu düşünmüyorum tabii araştırma yapmadım ama düşünmüyorum ki değişsin.</p>	<p>P 10 (GR): I don't know how common vitamin A deficiency is in the world, or how important it is, but I know that B12 deficiency is common. If vitamin A reaches that level, if very, very bad situations begin to occur in its deficiency, then perhaps we may need it much more in the whole world. Then I would like my decision to change, to be produced. But I don't think there is such a situation right now, of course, I haven't done any research, but I don't think that it will change.</p>
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Q45

<p>P16 (PF): Çalışmalar olur ne bileyim daha iyi şekilde sunarlarsa ya da obeziteye aslında sebep olmadığını kanıtlanırsa, tabii ki kararım değişir. Ama ben hiç inanmıyorum Türkiye'de yapılmaz yani yapılsa da şirketler arasında rekabet var bir şeylere engel olurlar falan. İlla bir şey olur ya da Türkiye ye bu çalışma sonuçları geç uygulanır. Ne karar gerçekleşir bilmiyorum ama gerçekleşirse kanıtlara bakar kararımı değiştirebilirim.</p>	<p>P16 (PF): Of course, my decision will change if studies show it better, I don't know, or if it is proven that it does not actually cause obesity. but I don't believe that it is not done in Turkey. Even if it is done, there is competition between companies, they prevent something. Something must happen, or the results of this study are applied to Turkey late or something. I don't know what decision will happen, but if it does, I'll look at the evidence and may change my decision.</p>
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Q46

<p>P9 (GR): Çok araştırma yapardım orası kesin. O ülkeyi gerçekten tanımaya çalışırdım. Gerçekten ihtiyaç var mı? altın pirinç olmadan da alternatifleri var mıdır? sonra daha fazla çalışma var mı yok mu etkilerini öngörebilecek bunun üzerinde bir araştırma daha yapardım. Ama değişmeme ihtimali daha fazla gibi geliyor. Değişmesi için çok şey lazım o da zor gibi şu an. Bu popülasyonda beklenmedik bir durum olmuş olursa bu da benim kararım ne kadar doğru olduğunu kanıtlamış olur. Araştırma sonuçlarına odaklanırdım eğer öyle bir araştırma olursa.</p>	<p>P9 (GR): I would do a lot of research, that's for sure. I would really try to get to know that country. Is it really needed? Are there any alternatives without golden rice? Then I would do some more research on it, whether there are more studies or not that might predict the effects. But it seems more likely that it will not change. It takes a lot to change, and it seems hard right now. If something unexpected happened in this population, that would prove how correct my decision was. I would focus on research results if there was such research.</p>
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Q47

<p>P2 (PF): Ek bir karşı taraftan bir kanıt ya da benim cevap veremeyeceğim argüman olursa tabii ki değişme ihtimali var. bu kesin bu budur demem yani. Atomik teorileri bile değişiyor. Bilim insanları deneyleri, araştırmaları ve güvenilir kaynaklarla ile sunarlarsa, bulgulara inanır ona göre kararımı değiştiririm.</p>	<p>P2 (PF): Of course, there is a possibility of change if there is additional evidence from the opposite side or an argument that I cannot answer. I'm not saying that this is exactly what it is. Even atomic theories are changing. If scientists present the experiments, research, and reliable sources, I will believe the findings and change my decision accordingly.</p>
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Q48

<p>P8 (PF): kararım değişir. Yeni çalışmalar yapılır işlenmiş gıdalar üzerinde tüketen insanlar incelenir ona göre ben de sonuçlarını inceler uzmanlar ile konuşur ve kararımı değiştiririm tabii ki.</p>	<p>P8 (PF): my decision changes. New studies are conducted, people consuming processed foods are examined, and accordingly, I will examine the results, talk to experts, and change my mind, of course.</p>
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Q49

<p>P16 (GR): Belirsizliği çözmek için bilim insanları çalışmalar yapacaktır. Bu çalışmaların sonuçlarını inceleyip altın pirinç üretilmesin diyebilirim. Ya da kullanan birinde ilerde bir şey oldu. Bunu da iyice inceledikleri zaman bildiğim kaynaklara yani güvenilir olanlara bakıp, kararımı değiştirebilirim. Değişkenlik olabilir. Bilimsel verilere bakıp karar veriyoruz çünkü.</p>	<p>P16 (GR): Scientists will work to resolve the uncertainty. By examining the results of these studies, I can say that golden rice should not be produced. Or something happened in the future in someone who uses it. When they examine this thoroughly, I can look at the sources I know, that is, the reliable ones, and change my decision. There may be variability because we look at the scientific data and decide.</p>
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Q50

<p>P12 (PF): Bilim insanları kendi araştırmalarını yönetiyorlar sonuçta herkesin kendi yönelimi var. Kendilerine göre verileri yorumluyorlar yorumlamak istiyorlar. İnsanın doğası bu bence biraz yani önyargısız bakmak zor. Her insanın yaptığı gözlemler deneyler de farklı çıkacaktır. Farklı metotlar kullanarak araştırma yapmak diye özetleyebiliriz. Şimdi işlenmiş gıdaları düşününce kesin firmalar bilim insanları ile çalışıp bizim ürünü öv şunu yap satışlar artсын politikası ile özür dileyerek bilim insanlarını alıyorlar tutuyorlar diyebiliriz. En basitinden bundan dolayı bile farklılık oluşuyor.</p>	<p>P12 (PF): Scientists manage their own research, after all, everyone has their own orientation. they interpret the data according to themselves; they want to interpret it. This is human nature; I think it's hard to look at it without prejudice. All person's observations and experiments will be different. We can summarize it as doing research using different methods. Now, when we think about processed foods, we can say that certain companies are working with scientists and apologizing with the policy of praise our product and increase sales and hire scientists. Even so, there is a difference.</p>
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Q51

<p>P 15 (GR): Bakış açısı ile alakalı. Yani öncelik verdiği şey ne ise ona odaklanıp ona yoğunlaşıyor bilim insanları. Bizim gibi aslında onlar da insan. Kendi kişilikleri ile alakalı aslında bakarsınız. Bazen okuyoruz bazı firmalar bu ürünü öv diyerek bilim insanları yönlendiriyorlar bu bile bakış açısı aslında onu kabul edip yayınıyorlar. Yönlendiriliyor. Bu durumda farklı bakış açıları da ortaya çıkıyor.</p>	<p>P 15 (GR): It's about perspective. In other words, scientists focus on what they prioritize and concentrate on it. Like us, they are also human. They look at their own personalities. Sometimes we read that some companies are praising this product and directing scientists, even this point of view accepts it and publishes it. It is being redirected. In this case, different perspectives emerge.</p>
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Q52

<p>P 6 (PF): Kişisel farklılıkları, yaşam tarzları, aile yapısı, büyüdüğü ortam, çevre farklı perspektifler var onlar bilim insanları olsa da onlar da insan. Aynı veriye bakarak exactly the same şeyi sonucu bulması zor. Farklı insanlarız yani. O yüzden normal bence.</p>	<p>P 6 (PF): There are personal differences, their own lifestyles, different family structure, different environment they grew up in, different perspectives, even though they are scientists; they are also human. it's hard to find the same thing by looking at the same data. So, we are different people. So, I think it's normal.</p>
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Q53

<p>P5 (GR): bu bilimin öznel noktası değil mi? Yani insanlar birbirinden farklı oldukları için bilimsel süreçlerde farklı oluyor. Farklı insanlar farklı düşünceler farklı hayatlar bakış açıları demek aslında. Ve bu farklılıklarda bilimsel süreçlere etki ediyor. Bazısı sağlığa odaklanırken bazısı çevreye odaklanıyor. İnsan olmanın bilime etkisi diyebiliriz gibi geldi.</p>	<p>P5: Isn't this the point of subjectivity of science? In other words, because people are different from each other, scientific processes are different. In fact, different people mean different thoughts, different perspectives on life. and these differences affect scientific processes. Some focus on health, while others focus on the environment. It seems like we can say that being human influences on science.</p>
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Q54

APPENDIX H: ETHICS COMMITTEE APPROVAL

Evrak Tarih ve Sayısı: 07.10.2021-32549



T.C.
BOĞAZIÇI ÜNİVERSİTESİ REKTÖRLÜĞÜ
Fen Bilimleri ve Mühendislik Alanları İnsan Araştırmaları Etik Kurulu
(FMİNAREK)

Sayı : E-84391427-050.01.04-32549
Konu : 2021/18 Kayıt numaralı başvurunuz
hakkında

07.10.2021

Sayın Dr. Öğr. Üyesi Devrim GÜVEN
Matematik ve Fen Bilimleri Eğitimi Bölüm Başkanlığı - Öğretim Üyesi

"Fen Öğretmen Adaylarının Kendilerine Yakın ve Uzak Sosyobilimsel Konularda Karar Verme Süreçlerinin İncelenmesi" başlıklı projeniz ile Boğaziçi Üniversitesi Fen Bilimleri ve Mühendislik Alanları İnsan Araştırmaları Etik Kurulu (FMİNAREK)'e yaptığımız 2021/18 kayıt numaralı başvuru 04.10.2021 tarihli ve 2021/08 No.lu kurul toplantısında incelenerek etik onay verilmesi uygun bulunmuştur.

Bu karar tüm üyelerin toplantıya on-line olarak katılımıyla ve oybirliği ile alınmıştır. COVID-19 önlemleri nedeniyle üyelerden ıslak imza alınmadığından bu onam mektubu tüm üyeler adına Komisyon Başkanı tarafından e-imzalanmıştır.

Saygılarımızla bilginize sunarız.

Prof. Dr. Tınaz EKİM AŞICI
Başkan

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Doğrulama Kodu :BSN3863782 Pin Kodu :15312

34342 Bebek-İstanbul

Telefon No:0212 287 17 53 Faks No:0212 265 70 06

İnternet Adresi:www.boun.edu.tr

KeP Adresi:bogaziciuniversitesi@hs01.kep.tr

Belge Takip Adresi : <https://turkiye.gov.tr/ebd?eK=4787&eD=BSN3863782&eS=32549>

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