INVESTIGATION OF PRESERVICE SCIENCE TEACHERS' NATURE OF SCIENCE UNDERSTANDING AND DECISION MAKING ON SOCIOSCIENTIFIC ISSUE THROUGH THE FRACTAL MODEL

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ELİF ECE ADAL

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Prof. Dr. Yaşar KONDAKÇI
Director

I certify that this thesis satisfies all the requirements as a thesis for the degree of Doctor of Philosophy.

Assoc. Prof. Dr. Elvan ŞAHİN
Head of Department

This is to certify that we have read this thesis and in our opinion it is fully adequate, in scope and quality, as a thesis for the degree of Doctor of Philosophy.

Prof. Dr. Jale ÇAKIROĞLU
Supervisor

Examining Committee Members

Prof. Dr. Ceren ÖZTEKİN	(METU, MSE)	_______
Prof. Dr. Jale ÇAKIROĞLU	(METU, MSE)	_______
Prof. Dr. Nihal DOĞAN	(Bolu Abant İzzet Baysal Uni., MFE)	_______
Assoc. Prof. Dr. Elvan ŞAHİN	(METU, MSE)	_______
Assist. Prof. Dr. Güliz Karaarslan SEMİZ	(Ağrı İbrahim Çeçen Uni., MFE)	_______

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Name, Last name: Elif Ece ADAL

Signature :

ABSTRACT

INVESTIGATION OF PRESERVICE SCIENCE TEACHERS' NATURE OF SCIENCE UNDERSTANDING AND DECISION MAKING ON SOCIOSCIENTIFIC ISSUE THROUGH THE FRACTAL MODEL

ADAL, Elif Ece
Ph.D., Department of Elementary Education
Supervisor: Prof. Dr. Jale ÇAKIROGLU

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This is a qualitative grounded theory study to reveal how decision making (DM) processes on socioscientific issue (SSI) in a referendum case are operated by unsophisticated (Group U) and sophisticated (Group S) ones in terms of nature of science (NOS) understandings. Firstly, pre-study was conducted with focus group interviews with pre-service science teachers. With the findings, semi-structured in-depth interviews of main study for DM on SSI- the artificial meat was developed.

In main study, 12 participants' responses were analyzed and new DM model named the Fractal Model of DM which reflects real life situation DM process especially referendum case was constructed. In DM, NOS lens usages of five NOS aspects about creativity and imagination, observation and inference, empirical-basis, subjectivity, and social and cultural embeddedness, and, 23 other lens usages such as animal rights (morality), economic, risk factor etc. were detected and explained through the Fractal Model.

It was understood that, with multiple lens usage, each participant had multi-perspective considerations in DM. While Group S used NOS lenses mainly parallel with their NOS understandings, in same case Group U used NOS lenses in a more complicated way. Generally, Group U with rational ritualism and Group S with go-for-it approach ended the referendum simulation with YES for sale of the artificial meat in Turkish markets. Three participants with mixed-scanning voted NO and they were only participants who used sophisticatedly NOS lens about empirical-basis in their decision.

Keywords: Science Education, Nature of Science, Decision Making, Sociocientific Issue, the Fractal Model of Decision Making

ÖZ

FEN BİLGİSİ ÖĞRETMEN ADAYLARININ SOSYOBİLİMSEL KONUYA İLİŞKİN BİLİMİN DOĞASI ANLAYIŞLARININ VE KARAR VERMELERİNİN FRAKTAL MODEL ÜZERİNDEN ARAŞTIRILMASI

ADAL, Elif Ece
Doktora, İlköğretim Bölümü
Tez Yöneticisi: Dr. Jale ÇAKIROGLU

Ekim 2019, 318 sayfa

Bu nitel bir gömülü kuram çalışmasıdır ve bilimin doğasına dair gelişmiş (Grup S) ve gelişmemiş (Grup U) anlayışları olanların sosyobilimsel konuya ilişkin karar verme süreçlerini nasıl işlettiğini ortaya koyma amacı taşır. İlk olarak fen bilgisi öğretmen adaylarıyla odak grup görüşmeleri üzerinden ön çalışma yapılmıştır. Elde edilen bulgular ile sosyobilimsel konuda- yapay et karar vermeyi içeren ana çalışmanın yarı yapılandırılmış derinlemesine görüşmeleri geliştirilmiştir.

Ana çalışmada, 12 katılımcının açıklamaları analiz edilmiş ve özellikle referandum durumu gibi gerçek yaşam durumlarındaki karar verme sürecini yansıtan, Karar Vermenin Fraktal Modeli adı verilen yeni bir karar verme modeli oluşturulmuştur. Karar vermede, bilimin doğasının beş boyutuna (yaratıcılık ve hayal gücü, gözlem ve çıkarım, deneysel temellilik, öznellik ve toplumsal ve kültürel bağlılık ile ilgili) ait merceklerin ve örneğin hayvan hakları (ahlak), ekonomik, risk etkeni gibi 23 diğer merceğin varlığı Fraktal Model üzerinden tespit edilmiş ve açıklanmıştır.

Karar verirken, her katılımcılın çoklu mercek kullanımı ile birden fazla perspektif ile değerlendirme yaptığı anlaşılmıştır. Grup S ağırlıklı olarak kendi gelişmiş bilimin doğası anlayışlarıyla aynı doğrultuda bilimin doğası mercekleri kullanımı yaparken, Grup U bazı durumlarda daha karmaşık bir şekilde bilimin doğası mercekleri kullanımı yapmıştır. Genel olarak, referandum simülasyonunu rasyonel ritüalizm ile Grup U, tam gaz ileri yaklaşımı ile Grup S, yapay etin Türkiye marketlerinde satılması için EVET ile bitirmiştir. Karma-tarama yapan katılımcılar HAYIR oyu vermiştir ve sadece bu 3 katılımcı kararlarında deneysel-temellilik ile ilgili bilimin doğası merceğini iyi bir şekilde kullanmıştır.

Anahtar Sözcükler: Fen Eğitimi, Bilimin Doğası, Karar Verme, Sosyobilimsel Konu, Karar Vermenin Fraktal Modeli

To the Tulpars

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LIST OF ABBREVIATIONS

SSI	Socioscientific issue
DM	Decision making
NOS	Nature of science
NOS1	The Tentative Nature of Scientific Knowledge
NOS2	The Creative and Imaginative Nature of Scientific Knowledge
NOS3	Observation and Inference in Science
NOS4	The Empirical Nature of Scientific Knowledge
NOS5	The Theory-Laden Nature (subjectivity) of Scientific Knowledge
NOS6	The Social and Cultural Embeddedness of Scientific Knowledge
uNOS	Unsophisticated understanding about NOS
sNOS	Sophisticated understanding about NOS
u-sNOS	Mixed understanding about NOS
GM food	Genetically modified food

CHAPTER 1

INTRODUCTION

> *Scientific knowledge enables us to do all kinds of things and to make all kinds of things. Of course if we make good things, it is not only to the credit of science; it is also to the credit of the moral choice which led us to good work. Scientific knowledge is an enabling power to do either good or bad - but it does not carry instructions on how to use it.*
>
> ***Richard Feynman***

The very famous physicist Feynman's quotation above highlights the importance of scientific knowledge and morality in the decisions about doing something. Moreover, with this quotation, he mentioned that there is no handbook which explains in which way, whether it is good or bad, scientific knowledge will be used. However, the researcher of the present study is one of those people including teachers, educators, researchers who believe that to understand nature of science can illuminate the pathways of the usage of scientific knowledge. More specifically, it is believed that as our understanding about the interaction between nature of science and decision making improves, at least the citizens will be close to being more responsible in their decisions, which affects their lives, and they will be close to making decisions which reflect their true choices, which is vital for all people as decisions affect our lives. Thus, it can be said that while scientific knowledge is the constitutive component of the decision, nature of science is the critical component of scientific knowledge; therefore, nature of science understandings have the potential to affect the usage of scientific knowledge in decision making.

The 1990 UNESCO World Conference on Education for All maintains that science education should aim at forming a world community which consists of scientifically and technologically literate citizens (UNESCO, 1999; see also Donnelly, Jenkins & Layton, 1994). Moreover, in 2005, an extensive science curriculum reform was made in Turkey in Turkish 2005 Elementary Science and Technology curriculum, where the idea of scientifically and technologically literate citizens was frequently emphasized as the vision, goal and one of the main principles (MNE, 2006). Later in 2013, a new science curriculum, which was introduced as a very short version of the previous one, was made generally in the light of 2005 reform. Similarly, the vision of 2013 Turkish Science curriculum is “educating all students as scientifically literate people” (MNE, 2013). Moreover, “educating all students as scientifically literate people” is the general goal of the 2018 Turkish Science curriculum (MNE, 2018), which is the current science curriculum in Turkish education system from 3rd to 8th grade levels.

Because understanding NOS is seen as a critical component of scientific literacy (NSTA, 1982), in the literature, there are a lot of studies which focus on the improvement of the understandings about NOS (e.g., Lederman & Druger, 1985; Zeidler & Lederman, 1989; Abd-El-Khalick & Lederman, 2000; Moss, 2001; Dhingra, 2003). Despite the ongoing discussions, with its most basic and simplest definition, nature of science (NOS) can be referred to as the epistemology of science (Lederman, 2006). After investigating 50 years of research related with NOS, Lederman (2006) presented the general state of the evolution of those research studies. This evolution is summarized in the following paragraph.

After it was clearly understood that K-12 students and teachers did not typically possess “adequate” conceptions of NOS, research generally focused on the improvement of NOS understandings. Then, it was generally argued that explicit approaches were more effective than implicit ones in order to improve NOS understandings. From then on, however, two very worrying problems about the issue have become evident. First, having adequate NOS understandings for teachers is not necessarily translated into classroom implementation mainly because teachers do not regard NOS as an instructional outcome of equal status with that of "traditional" subject matter outcomes. Second, sufficient classroom implementation does not necessarily improve students' NOS understandings. This final, relatively chaotic, position has made some researchers go back to the initial suggestions about the impact of NOS in order to highlight more the importance of NOS understanding by focusing on the possible reasons why we teach NOS and why adequate understanding NOS is necessary.

One of the most extensive explanation, on which many recent research studies are based, came from Driver, Leach, Millar, and Scott (1996) and with Lederman's (2006, p.831-832) summary, they explained why understanding NOS is important through five arguments:

1. Utilitarian: Understanding NOS is necessary to make sense of science and manage the technological objects and processes in everyday life.
2. Democratic: Understanding NOS is necessary for informed decision-making on socioscientific issues.
3. Cultural: Understanding NOS is necessary to appreciate the value of science as a part of contemporary culture.
4. Moral: Understanding NOS helps develop an understanding of the norms of the scientific community that embody moral commitments that are of general value to society.
5. Science learning: Understanding NOS facilitates the learning of science subject matter.

Although each of these five arguments is directly related with and sheds light on many important points in modern human life, the second argument of Driver et al. (1996), 'democratic argument,' has a special characteristic as it is about decision making. Individuals have to make decisions continuously in every part of their lives, generally in order to solve the problems varying from the very simple one to the very complicated one which might be affected by many factors (Rue & Byers, 2003). A decision can simply be defined as selecting one of the alternatives; however, the decision itself is not a big part of the decision making – it is just a bit of it (Daft, 2003, p.272). In other words, decision making is a process in order to identify the problems and reach the conclusion. Decision making needs an effort not only before the decision but also after the decision. Therefore, decision making is also a process which includes regulation, problem solving and use of resources.

In addition to these, decision making is such an important issue that educators classified it as a life skill and they have tried to take it into consideration more and more in time. For example, in 2013 and in 2018 Turkish Science curriculum, the "life skills" is a part of skills in the learning area and explained as follows:

"b. Life Skills: This area covers basic life skills such as analytical thinking, decision making, creativity, entrepreneurship, communication and team work in order to reach scientific knowledge and to use it." (MNE, 2013, p.V and MNE, 2018 p.9)

Furthermore, the second argument of Driver et al. (1996), 'democratic argument,' has also a special characteristic as it is about socioscientific issues. Socioscientific issues are the controversial issues, which contain scientific and social aspects, and include moral or ethical reasoning (Sadler, 2004a, 2004b; Zeidler, Sadler, Simmons & Howes, 2005; Zeidler & Sadler, 2008). In fact, socioscientific issues have come to agenda since socialization of science with World War II because in World War II, usage of the technology was life-or-death issue and this irrevocably bounded science and technology to the society; however, the adoptions of socioscientific issues by curricula were relatively new and only after the science-technology-society movement in education in the 1980s (Yager, 1996). Today, it is argued that, in a democratic society, the citizens should take responsibility and make decisions about socioscientific issues as the results affect all of us (Zoller, 1982; Roth & Lee, 2004; Deober, 2011; Hofstein et al., 2011). In addition to this, many educators have advocated that decision making about socioscientific issues should be an integral component of scientific literacy (e.g., Bodmer, 1986; Bingle & Gaskell, 1994; Kolstø, 2001b; Zeidler & Keefer, 2003; Sadler, 2004a). With the acceptance of these point of views, SSI became a part of science curricula worldwide (e.g., KMK, 2005; DFE, 2014; MNE, 2018). In 2018 Turkish Science curriculum, it is stated that developing reasoning abilities, scientific thinking habits and decision making skills by using socioscientific issues is one of the basic aims of the curriculum.

In conclusion, decision making (DM), socioscientific issue (SSI), and nature of science (NOS) are naturally bounded to each other. SSI is complex and controversial issue and needs DM because argumentations about SSI will be wasted if DM does not follow them. Moreover, in order to have a proper solution, beside other epistemologies or lenses such as morality and economic, DM about SSI needs to be proceeded through NOS lenses. Therefore, in the widest sense, this study is an attempt to reveal why we teach NOS by focusing on its most vital function, if any, in DM about SSI. In addition to this, referendums are real life situations in which citizens take responsibility at least with their votes. Therefore, related with SSIs, referendum reflects one of the best cases to understand why we try to teach NOS to "all students" as science teachers. For the referendum situation, the present study used a new model, the Fractal Model of DM, in which there are thinking regions which are *'goals', 'criteria', 'alternatives'* and *'decision'* which reflect the ordinary people's thinking systematic.

As a result, with the present study, it is hoped that teaching NOS to all students will gain deeper meanings which help to educate more responsible citizens in SSIs with adequate lens usages including NOS lens in DM.

1.1 Purpose of the Study

The aim of this study is to determine the impact of nature of science (NOS) understandings on decision making (DM) about a socioscientific issue (SSI). In order to achieve this aim, the decision making patterns of two groups, (i) Group U which consists of the members who had unsophisticated NOS understandings and (ii) Group S which consists of the members who had sophisticated NOS understandings were compared through the Fractal Model of DM[1] and in the light of the following main research question and sub-questions of it:

[1] In the present study, the four thinking regions of the Fractal Model of DM: (1) Thinking region about 'goals' shows the thoughts about the question for which reason is the artificial meat produced/ why will we use the artificial meat/ what will artificial meat cause?, (2) Thinking region about 'criteria' shows the thoughts about the question what should/must the qualification of the

How are DM processes about an SSI operated by Group U and Group S participants in a referendum case?

1. How are the initial responses of Group U and Group S participants after they have just met a new SSI?
    1.1. How are the perceptions of Group U and Group S participants about the new SSI?
    1.2. How are the approaches of Group U and Group S participants to being informed of the new SSI?
    1.3. How are the initial decision making strategies of Group U and Group S participants before being informed about the SSI?
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3. How do lenses of Group U and Group S participants become activated in the DM process about an SSI in a referendum case?
    3.1. How do NOS lenses of Group U and Group S participants become activated in the DM process about an SSI in a referendum case?
    3.2. How do other lenses of Group U and Group S participants become activated in the DM process about an SSI in a referendum case?

artificial meat be?, (3) Thinking region about 'alternatives' shows the thoughts about the question what can be compared with artificial meat?, and (4) Thinking region about decision' can exist through the interactions of 'goals', 'criteria' and 'alternatives'.

4. How do Group U and Group S participants use their decision making strategies in the DM process about an SSI in a referendum case?
5. How are the preferences of Group U and Group S between ‘Referendum’ and ‘Committee’ as the decision making authority about an SSI?

Within the framework of the research questions above, interactions between NOS and DM about SSI were analyzed.

1.2 Significance of the Study

The aim of this study is to determine the impact of nature of science understandings on decision making about a socioscientific issue. In fact, all three issues DM, SSI and NOS are each very important for educational reasons. DM is such an important issue in education that it has been classified as a life skill for students in science curricula (e.g., MNE, 2018) and DM literature is based on studies of more than a century. Science curricula have covered SSIs as the SSIs are science related societal issues, the decisions about the SSIs affect all society (Zoller, 1982) and SSI literature is based on the studies over many decades. NOS is a component of scientific literacy (NSTA, 1982) which is ultimate goal of many science curricula, and NOS literature is based on the studies of more than a half century. Moreover, the intersection of these three literatures which is the literature of DM about SSI through NOS altogether is relatively very new and very limited. Although many researchers have emphasized the importance of DM with adequate NOS understanding especially in SSIs (e.g., Bodmer, 1986; Hoolbrook & Ranikmae, 2009; Zoller, 2009), only a few studies focused directly on revealing the relationships between NOS understanding and DM. In fact, there are six studies focused directly on NOS effect on DM about SSI as follows: (1) Bell (1999); Bell and Lederman, (2003), (2) Zeidler et al. (2002), (3) Walker and Zeidler (2003), (4) Sadler, et al (2004), (5) Liu et al. (2010), and (6) Khishfe (2012). All the previous attempts shed light on the NOS effect on DM about SSI, but their findings were sometimes controversial. Moreover, the present study is separated from all these six studies mainly because of using a DM model, considering participants’ true interests in the selection of SSI, assessing NOS directly through the selected SSI, and examining verbal responses. In fact, the research design of the present study was constructed to respond to some main criticisms below related with the all six previous studies. Therefore, it is hoped that the present study brings important methodological improvements to NOS effect on DM about SSI literature.

Firstly, none of the six previous studies stated above were constructed on a decision making process model; therefore, the researchers strictly focused on the *'decision'* itself and they did not adequately cover 'decision making' as a process. However, the definition of decision making is well established as a process and explained through its steps in normative models (e.g., Raiffa, 1968; von Winterfeldt & Edwards, 1986; Janis & Mann, 1977; Carroll & Johnson, 1990; Ratcliffe, 1997; Robbins & Coulter, 2012). Moreover, the present study proposes a new DM model which was constructed directly through the participants' responses. Therefore, in the present study, DM was considered as a process and the interaction between NOS and DM was examined through this process. Furthermore, since the present study was conducted with pre-service teachers, it focused on the ordinary citizen's DM process in case of a referendum related with an SSI as referendum reflects one of the best cases to understand why we try to teach NOS to "all students" as science teachers. Therefore, this research study also covered the necessity of the construction of a specific DM model for a referendum situation, which arose from the gap in the related literature. Furthermore, the DM model constructed in the present study is the first model in DM literature which includes fractal geometry. The fractal geometry is the continuation of the theory of chaos and it is used to explain the situation where the inputs become outputs just like in DM. In DM, a problem is a kind of a solution and the decision creates the problem (Adair, 2000); therefore, the problem and decision act as both input and output of a DM. Thus, the fractal geometry of the DM model of the present study allows the ontological changes and replaces the steps of DM in line with what DM literature mentions.

Secondly, in none of the six previous studies stated above, the participants' true interest level and prior knowledge about used SSI were considered through a focus group. Therefore, the previous studies missed to consider personal relevance to selected SSI. In fact, in the literature, students' personal interests in a particular SSI were seldom reported and issues about how to select an appropriate SSI were in dark (Fang, 2019). However, in the DM literature, it is emphasized that DM process is affected by the people's readiness to make a decision, priorities among the existing problems, and ways of collecting information (Bettman et al., 1991; Svenson, 1996). Moreover, for a proper analysis, beside selected SSI being clearly understandable, interesting and familiar, the participants' prior knowledge should also be similar in that SSI (Fraenkel & Wallen, 2006). Therefore, in the present study, firstly a Focus Group interviews were conducted with two groups of potential participants of the main study (NOS effect on DM about SSI). The reason is that with the focus group interviews, the researcher can concentrate on the group's conscious or unconscious behaviors and the psychological and sociocultural characteristics and in this way, can reach detailed information about the participants' world views, life styles, interests, experiences, tendencies, opinions, perceptions, emotions, attitudes and habits (Yıldırım & Şimşek, 2005; Baş & Akturan, 2008). With the analysis of these Focus Group interviews, the selected SSI was the artificial meat. As the scientists are still working on it, the artificial meat consists of unstructured problems in uncertainty conditions. In addition to this, the artificial meat is a controversial issue including moral and ethical aspects most potentially in the societies having taboos about meat products. Moreover, the artificial meat is strictly connected to the two interest areas (food technologies and nourishment, and healthiness) that the focus group liked to discuss most and thus is familiar with. Furthermore, the artificial meat has come to agenda in the last decade, which is the focus group's interested time period for SSIs. Besides, with the total analysis on the focus group interviews, it was concluded that for the focus group, the probability to know deeper information about the artificial meat was quite low and this situation helped to minimize subject characteristics threat.

Thirdly, in all the six previous studies stated above, NOS was mainly assessed through the issues different from their own SSI. In fact, Khishfe (2012) used the same SSI in her study to assess the understandings about NOS, but it was only for one aspect of NOS, the tentativeness of scientific knowledge. Therefore, it seems that the previous studies ignored the possibility of NOS differences in different scientific disciplines. However, Lederman (2006) mentioned that different scientific disciplines may have different definitions of NOS. In the present study, NOS understandings of the participants were analyzed specifically through the selected SSI, which is the artificial meat. Therefore, the possible risk of the misunderstanding in the interaction between NOS and DM about an SSI due to the possibility of different NOS understandings in different disciplines was eliminated.

Finally, in all the six previous studies, data analyses were conducted mainly based on the written responses of the participants. Actually, some interviews were carried out in some of the previous studies (e.g., Bell & Lederman, 2003; Khishfe, 2012), but only after the questionnaires for clarification purposes. Although questionnaires are generally preferred by the researchers due to their advantages they provide in terms of time and effort spent on data analysis, one-to-one interviews, especially in-depth interviews, are much more efficient in collecting detailed information, and they serve many more advantages mainly with regards to the validity and quality of the study (Boyce & Neale, 2006). Therefore, in the present study, in-depth interviews, which can help the researcher reach much more sophisticated data to analyze, was selected as a qualitative research technique to conduct the study.

In addition to this, the present study examined NOS by focusing on its most vital function, if any, in DM about SSI through pre-service science teachers. The effect of SSIs on the society increases with the increase in number of SSIs, and NOS is necessary for informed DM about SSI. Moreover, science teachers are not only ordinary citizens who have responsibility in SSIs but also the educators who lead students to take responsibility in SSIs. Therefore, it is hoped that to understand how pre-service science teachers, who are the future science teachers, approach DM about SSI through NOS, will help educators to improve the course programs related with NOS, DM, and SSI in the universities, and enlighten the selection of the procedure and material used in the DM on SSI science classroom activities because in the future these activities will be conducted by today’s pre-service science teachers.

Furthermore, as the present study is the first attempt to reveal the impact of NOS on DM about SSI by using a DM model, it is hoped that the findings of this study will point out how NOS aspects diffuse the steps of DM. In this way, the findings will encourage the researchers to construct functional models about the issue used in science education, pre-service science teacher education and in-service education too.

Most importantly, when the current discussions and trends about science education are considered, it is hoped that the findings of this study will provide effective information for curriculum developers and teachers in order to re-organize science education and teaching approaches in much more favor of society by guiding our students to become informed decision makers on socioscientific issues by taking the responsibility.

1.3 Definitions of Terms

Decision making

Decision making is a process of making reasoned choices among alternatives based upon judgments consistent with the values of the decision maker (Heath, White, Berlin & Park, 1987). Considering the professional decision makers, decision making is explained by linear normative models which generally started with the step of identifying the problem and ended with the step of evaluating the decision and *'decision'* itself is only a part of this process (Daft, 2003).

Decision

Decision is a choice (Cambridge, 2019) and it is a part of a DM where one of the alternatives is selected (Daft, 2003).

Normative model

Normative models are the models which explain the steps of decision making and possible relationships among those steps. In general, normative models were developed by philosophers and economists, and then, they were adopted by psychologists (Edwards, 1954).

Thinking regions

Thinking regions are *'goals', 'criteria', 'alternatives'* and *'decision'* and they show ordinary people's thinking systematic when they decide about an SSI in a referendum situation. As there is no normative model which reflects the decision making in a referendum situation, in the present study, with the help of the analysis of participants' responses, the linear steps of decision making were replaced with these thinking regions which include a non-linear double way interaction among steps in a fractal construction.

Lenses in decision making

Lenses in decision making are the epistemological factors that can affect the decision making such as NOS, religious and economic. Although there are several usages to define the factors in DM, in the present study, the term 'lenses' was found more suitable as these epistemologies or subgroup of some epistemologies act just like 'lenses' on the eyes which make the issues clearer according to their related perspectives. Moreover, in the present study, the term 'other lenses' were used to mention the lenses other than NOS.

Decision making strategy

Decision making strategy is a way to make a decision about something. There are five main approaches for DM which are rationalistic (to focus on comprehensive information enough to know 'almost everything'), incrementalism (to focus on a very specific piece of information), go-for-it approach (to tend to try everything new), rational ritualism (after realizing that there is not enough comprehensive information, to act as if there was) and mixed scanning (to start to focus on the piece of information which is top priority by also considering the effect of this on the entire construction in order to make a temporary decision) (Etzioni, 1989).

Nature of science

Nature of science (NOS) is the epistemology of science (Lederman, 2006).

Socioscientific issue

Socioscientific issues are the controversial issues which contain both social and scientific aspects (Sadler, 2004a).

Referendum

Referendum is a vote in which all people in a country or an area decide on an important question (Cambridge Dictionary, 2019)

Committee

Committee is a small group of people chosen to represent a larger organization and either make a decision or collect information for it (Cambridge Dictionary, 2019).

CHAPTER 2

LITERATURE REVIEW

This chapter includes the literature review of both the underlying theory which constitutes a base for the study, and the methods and results of the previous studies.

2.1 Decision Making

In the literature there are very clear and very close explanations for decision making even if they are presented in different disciplines such as economy, psychology, and education. According to economists Raiffa (1968) and von Winterfeldt and Edwards (1986), decision making is the process of making choices among competing courses of actions. Moreover, psychologists Janis and Mann (1977) regard the human as "a reluctant decision maker — beset by conflict, doubts, and worry, struggling with incongruous longings, antipathies, and loyalties, and seeking relief by procrastinating, rationalizing, or denying responsibility for his own choices" (p. 15). They argue that the decision maker's choice among alternatives is the result of the consideration of a sequence of questions which deal with perceived risks of the status quo and of change, perceived ability to find a better solution, and time limitations.

Among the educational researchers, Heath, White, Berlin and Park (1987) defined decision making as the process of making 'reasoned choices among alternatives based upon judgments consistent with the values of the decision maker'. Moreover, Cassidy and Kurfman (1977) had a more extended definition of decision making since they categorized the decisional situations as personal and public. They stated that decision making is the making of reasoned choices, which require judgments connected with one's values, from among alternative courses of action regarding a personal or public issue. Furthermore, in order to directly reflect the classroom situation, Kortland (1996) specified his definition by students and stated that decision making is a process which occurs when students present an argued point of view in a situation of choice between alternatives.

In addition to these, more recently, management researchers Robbins and Coulter (2012) add the initial and final steps of the decision making to the definition by mentioning that decision making is not just a simple act of choosing among alternatives, but it is a process that begins with identifying a problem and ends with evaluating the outcome of the decision, in order to highlight much more that decision making is a process.

2.1.1 Normative model of decision making

In order to explain the steps of decision making and possible relationships among those steps, normative models are used. At first, normative models were developed through decision making (DM) theories by philosophers and economists, and then, they were adopted by psychologists (Edwards, 1954; Coombs et al., 1970). More specifically, economy theorists have been concerned with DM since the days of Jeremy Bentham (1748-1832), who was a British philosopher, jurist, and social reformer. Moreover, related with the issue, in the literature there is still an obvious dominance of economists among other theorists.

DM theories have come into existence from two approaches: structural approach or process approach. Structural (or input-output) approach considers DM as a result of a process (Bettman et al., 1991; Svenson, 1992). One of the earliest structural approaches proposed was 'Economic man' which is counted in Theory of Riskless Choices and it assumes that a decision maker is completely informed, infinitely sensitive, and rational (Edwards, 1954). However, in process approach, researchers have studied ongoing process of DM and the theories have covered pre and post decision processes of DM (Bettman et al., 1991; Svenson, 1992). Although one of the earliest studies with process approach was in 1956 by Brhem (1956) as it focused on post-decision changes in the desirability of alternatives, the systematic involvement of both pre and post decision processes occurred in 1964 with Conflict, Decision and Dissonance Theory of Festinger (1964). After that, Janis and Mann (1977) focused on the process in pre and post decision and proposed Conflict, Choice and Commitment Theory. Moreover, they described a five-stage process for proper DM. These stages were: (1) appraising the challenge; (2) surveying alternatives; (3) weighing alternatives; (4) deliberating about commitment; and (5) adhering despite negative feedback. Moreover, in general, according to most general earlier normative models, in order to behave in a rational way while making a decision, a person should:

(a) list relevant action alternatives,

(b) identify possible consequences of those actions,

(c) assess the probability of each consequence occurring (if each action was undertaken),

(d) establish the relative importance (value or utility) of each consequence,

(e) integrate these values and probabilities to identify the most attractive course of action, following a defensible decision rule. (Beyth-Marom et al., 1991, p.21)

Moreover, by looking at the related literature it can be understood that although the normative models have been very close to each other, in time, the steps in normative models have been improved; for example, Beyth-Marom et al. (1991) proposed a nine-step DM model for the decision making curriculum as follows:

1. Distinguishing between decision calling for different decision-making models (e.g. decisions under certainty, risk and uncertainty)

2. Identifying and defining a decision-making situation

3. Listing action alternatives

4. Identifying criteria for comparing the alternatives and the possible consequences of each alternative

5. Assessing the probability of possible consequences (when necessary)

6. Assessing the utilities of possible consequences (when necessary)

7. Evaluating each alternative in terms of its attractiveness and probability

8. Assessing the value of collecting additional information

9. Evaluating the decision-making process (p.26)

Moreover, in time, the steps in normative models have been able to be diversified by the subject studied. For example, psychologists Carroll and Johnson (1990) offered a normative model, which is stated in Figure 2.1, for their research areas. By looking at Carroll and Johnson's model, it is clearly understood that after identifying the problem, developing criteria and generating alternatives occur simultaneously. This situation is completely different from Janis and Mann's (1977) strict one-by-one order for DM. Moreover, instead of 'adhering despite negative feedback' step of Janis and Mann's (1977) normative model, in DM process, Carrol and Johnson (1990) placed monitoring side by side with acting.

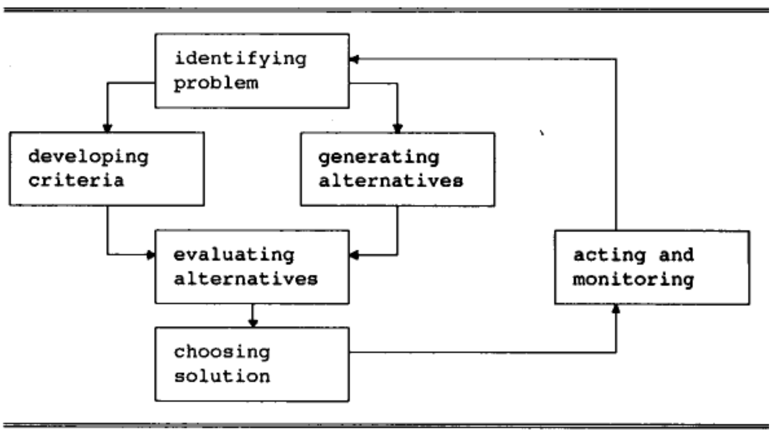

Figure 2.1 A normative model for the decision making process offered by Carroll and Johnson (Carroll & Johnson, 1990; cited in Kortland, 2006, p. 675).

Although Carroll and Johnson's DM model had a better attempt to involve post decision activity than the previous DM models as monitoring provides feedback and it can restart all DM process if the feedback is negative, in DM literature the share of attention of the post decision activity was received after Svenson's (1992) Differentiation and Consolidation Theory (Talanker, 2016). With her Differentiation and Consolidation Theory, Svenson (1992) offers a three phased process for DM. In the first phase, recognizing the problem and identifying the alternatives occur respectively. Then, the second phase is the differentiation of available options with holistic differentiation based on intuition, or previous experiences, or process differentiation in which weighing the pros and cons of alternatives happens. Moreover, the second phase covers structural differentiation, or reinterpreting the ambiguous information, identifying the new alternatives, and regulating the decision rules and criteria. The second phase ends with remaining only a single satisfactory alternative among all other alternatives. Finally, the third phase, which is called as post decision consolidation, is about the people's continuing differentiation in order to be more sure about the appropriateness of the chosen option (the decision).

In addition to this, another phase model was proposed by the psychologists Betsch and Haberstroh (2005) and according to this phase model (in Figure 2.2), DM process is respectively composed of (i) preselectional phase which covers DM steps: identification of the problem, behavior generation, and information search, (ii) selectional phase which covers DM step: appraisal and choice, and (iii) postselectional phase which covers DM steps: behavior implementation and feedback. Moreover, each phase involved in Betsch and Haberstroh's (2005) phase model shows some similarities with Janis and Mann's (1977) a five-stage process because of its linear structure of DM steps, with Carrol and Johnson's (1990) model because of the involvement of the step for feedback and with Svenson's (1992) three-phased model because of the consideration of both pre and post decision process in DM. However, the phase model of Betsch and Haberstroh (2005) reflects also memory process inputs to each step.

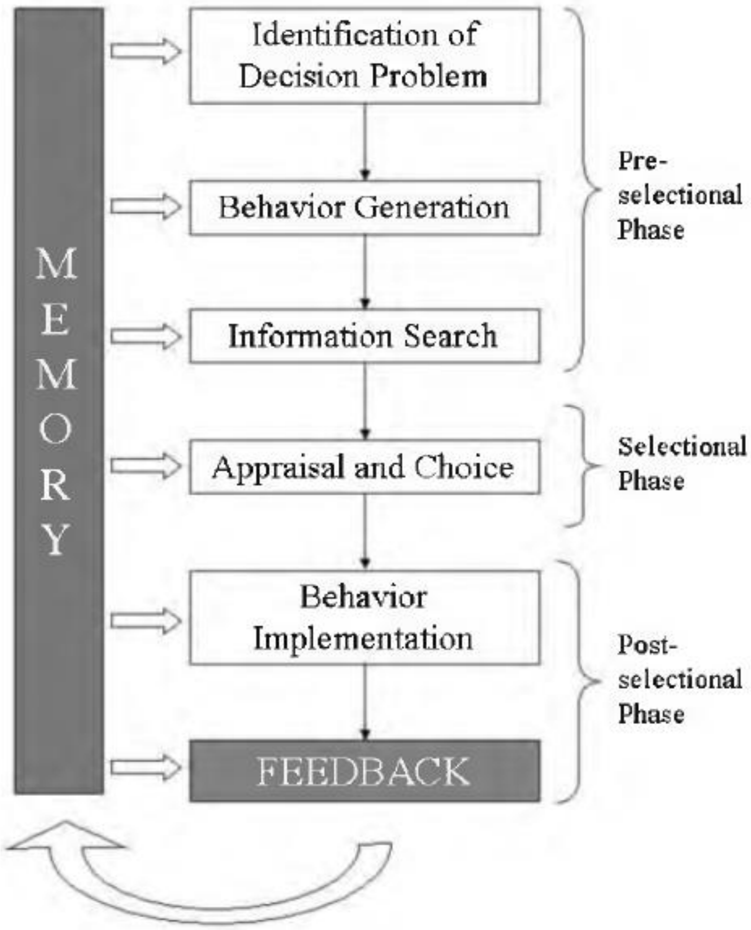

Figure 2.2 Phase model of the process of decision-making (Betsch & Haberstroh 2005, p. 362).

Furthermore, although in the process approaches, the bases of the DM models are generally similar, different disciplines express different DM models. For example, Robbins and Coulter (2012) introduced a recent DM model for economic management (in Figure 2.3). Different from phase model of Betsch and Haberstroh (2005), this model do not reflect the involvement of the memory in DM. In addition to this, different from Carroll and Johnson’s model, the recent normative model (Robbins & Coulter, 2012) of decision making for managerial purposes does not include simultaneous steps; there is a strict one-by-one order among the steps. Moreover, it seems that managerial purposes need an additional criteria step, which is allocating the weights to the criteria.

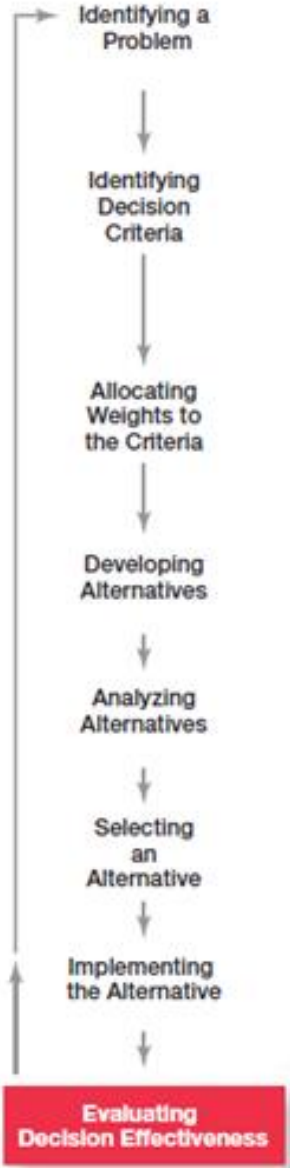

Figure 2.3 A recent example for normative model of decision making used in economic management (Robbins & Coulter, 2012, p.179).

To give another example, in medical decisions and medical care plans, Domino Model of DM (in Figure 2.4), which has emerged from the studies about medical reasoning, decision making, planning and other tasks, is revealed (Glasspool & Fox, 2005). In the Domino Model, each step was identified directly through a specific medical purpose. The numbers in the Domino Model represent the steps of DM as follows:

[1] to establish a clinical goal to diagnose the cause of the problem

[2] to set the possible explanations of the problem for diagnosis decision

[3] to formulate a set of arguments for and against the competing explanations

[4] to assess the arguments to arrive at a specific diagnosis decision

[5] to assess the arguments' overall "force" to arrive at the choice of an appropriate therapy plan

[6] to schedule the actions of the plan to meet various constraints on time, data, and other resources

[7] to manage unexpected side effects or failures to achieve original goals

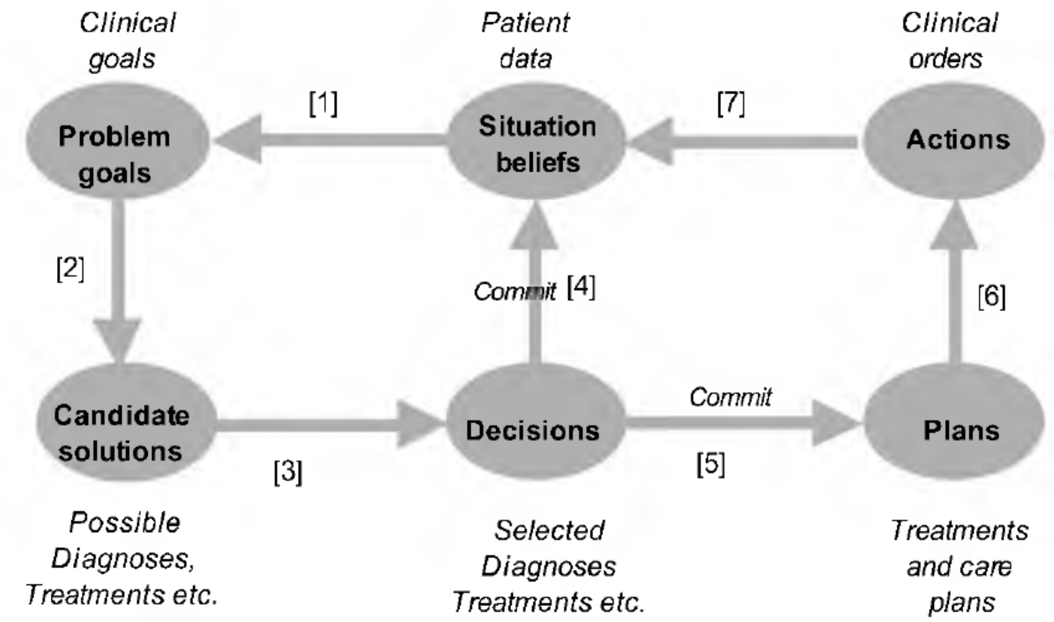

Figure 2.4 The domino model of decision making in cognition (Fox & Das, 2000; cited in Glasspool & Fox, 2005, p.348).

2.1.2 Normative model of decision making presented in science education research

Among other disciplines, appearance of normative models of decision making in education is relatively new. Moreover, when the related literature was investigated, it was revealed that in general, in science education research areas, there is a shift from adoption of a normative model from a different discipline to reformulation of the steps of different normative models for the specific use of science research. For example, Kortland (1996), in his article "An STS Case Study about Students' Decision Making on the Waste Issue", brings Carroll and Johnson's normative model (shown in Figure 2.1) into the forefront in order to discuss the Dutch junior secondary education students' existing and developing decision making ability. The sample included 8 middle ability students (four male and four female) from 8^{th} grade level physical science course and a structured interview was used to reveal the students' decision making ability. With the findings of the study of Kortland (1996) about students' decision making on the waste issue, it is understood that students firstly stated a decision, and then, they made argumentation about the decision. Moreover, although most students used one or more criteria to evaluate the alternatives, the range of the criteria used was limited and weighting of conflicting criteria was lacking. Furthermore, although, in most cases, the validity of criteria mentioned by the students seemed to be acceptable, the clarity of the criteria was problematic in some cases.

However, in order to stimulate quality group discussions, Ratcliffe (1997) did not adopt a normative DM model from other disciplines, but rather she developed a new decision making structure by selecting and improving related steps of normative models of Janis and Mann (1977), Hirokawa and Scheerhorn (1986), and Beyth-Marom et al. (1991). For example, Ratcliffe did not include the initial step "identifying the problem" of decision making in her study by explaining even if encouraging pupils to identify a problem could be important, the nature of the science course did not allow it. Thus, Ratcliffe focused on 6 steps in decision making as follows:

1. *Options:* List or identify the possible alternative courses of action in considering the problem or issue.

2. *Criteria:* Develop or identify suitable criteria for comparing these alternative courses of action. The nature of these criteria is left open to discussion.

3. *Information:* Clarify the information known about possible alternatives, with particular reference to the criteria identified and to any scientific knowledge or evidence.

4. *Survey:* Evaluate the advantages and disadvantages of each alternative against the criteria identified.

5. *Choice:* Choose an alternative based on the analysis undertaken.

6. *Review:* Evaluate the decision-making process undertaken, identifying any possible improvements. (p.169)

The aim of the study of Ratcliffe (1997) was to explore 15-year-old pupils' skills, knowledge and values used in DM about SSIs. The sample consisted of 93 male students from four classes of General Certificate of Secondary Education (GCSE) in a school at the United Kingdom. Ratcliffe (1997) collected data through written works from 93 students in order to understand (i) use of the decision making structure; (ii) information identified and used, particularly that from science lessons and (iii) nature of criteria used in making the decision (p.170). Moreover, in order to understand the processes of decision making, she audio-taped two discussion groups in each class and interviewed 37 students. Related with the findings of the study, Ratcliffe (1997) stated that the steps of the decision making model are not necessarily express the natural order of the students' problem consideration, and the students had some problems with the process about information vigilance and systematic use of identified criteria. On the other hand, the findings showed that awareness of reasons for procedures helps the students' decision making. Moreover, recognition and use of scientific concepts allowed pupils to draw on scientific evidence to support their reasoning. In addition to this, the students' motivation about discussion and decision making on SSIs was high enough to engage this kind of activity in classroom context.

Beside Ratcliffe's (1997) quality-focused DM structure, value-focused DM framework, which is offered by McDaniels et al. (1999) and Acar et al. (2010), was applied frequently in learning and teaching socioscientific DM (Fang et al., 2019). This value-focused DM framework includes five steps as: (1) to characterize what matters to stakeholders, (2) to create alternatives, (3) to employ information to identify the impacts of the alternatives, (4) to identify the tradeoffs, and (5) to summarize the agreements, disagreements and underlying reasons for different perspectives.

In addition to this, Lee and Grace (2012) aimed to understand students' reasoning and decision making about an SSI and for their study, they constructed an eight-step DM framework (in Figure 2.5) through the three phases in Svenson's (1992) Differentiation and Consolidation Theory. Lee and Grace (2012) used this DM framework in the classroom activity about DM on protection from avian flu and they collected data from 88 13-14 years old Chinese students in two different contextual settings (40 students from Hong Kong and 48 students from Guangzhou). Whole classroom activity took three lesson hours and these lessons were spread into two weeks. Within eight-step DM framework, step 1 and 2 were proceeded in the first lesson, steps from 3 to 7 were proceeded in the second lesson and step 8 took place in the third lesson. Lee and Grace (2012) used pretest posttest approach in order to identify the change in the decision of the student. Therefore, data was composed of the students' records (at the beginning of the activity, only after the small introduction) by video typed presentation during the activity and a focus group interview after the activity. After data analysis, Lee and Grace (2012) identified six types of justification perspectives, which are science/health, economic, sociocultural, consumer choice, practicality and environmental hygiene. Moreover, the findings showed that the students were capable of reasoning from multiple perspectives even before the research activity. Furthermore, Lee and Grace (2012) concluded that decision making is affected by several contextual factors. According to Lee and Grace (2012), when students from different settings share something with each other, it is likely to result in wider perspectives and metacognitive reflection on their own point of views, personal and societal values, and embedded sociocultural influences.

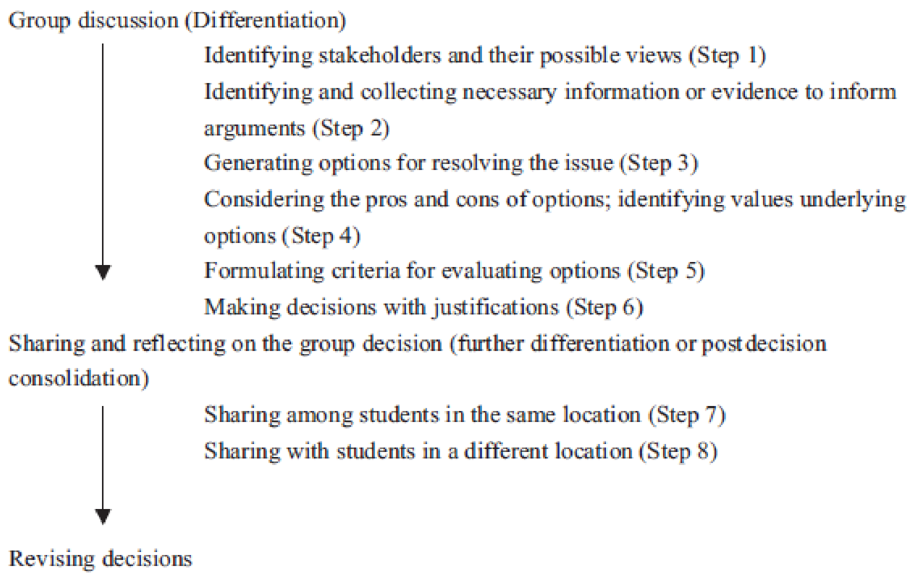

Figure 2.5 Decision-making framework used in Lee and Grace's study, encouraging outcome-relevant involvement (Lee & Grace, 2012, p.791).

Recently, Fang, Hsu, and Lin (2019) have proposed a socioscientific decision making framework under the light of process approach in DM expressed mainly by Svenson (1992), Ratcliffe (1997), and Betsch and Haberstroh (2005). This framework covers performing informal reasoning in formulating the decision space and using a decision-making strategy just as in Papadouris's study (2012). Furthermore, compatible with Böttcher and Meisert (2013) and Gresch and Bögeholz (2013), using metacognition to reflect on DM is considered in the socioscientific decision making framework used by Fang et al. (2019). This framework reflects three phases of decision making. In phase 1, formulation of the decision making space occurs. In phase 2, a suitable decision making strategy is posited. Phase 3 is the post-selectional phase where metacognition plays role and reflecting on the decision-making process occurs. With this decision making framework, Fang et al. (2019) analyzed 24 articles (from 1995 to 2015) which directly focus on socioscientific decision making and which have a clear definition of decision making. In the study of Fang et al. (2019), the articles were separated into two groups according to their research designs. While the first group was composed of 11 articles in which the relationships between students' cognitive conditions and decision making performances were covered, the second group was composed 13 articles in which the effects of task conditions on students' decision making were examined. A summary of the analyses of Fang et al. (2019) is shown in Figure 2.6 which respectively includes the socioscientific DM framework proposed by Fang et al., the same framework with the results of the second group studies, and the same framework with the results of the first group studies. According Fang et al. (2019), in both groups, most of the studies examined phase 1 through informal reasoning, evidence-based reasoning, and social interactions; moreover, eight studies focused on phase 2 and only in three studies phase 3 was examined. Moreover, the findings showed that the students had difficulty in phase 1 and phase 2; for example, when prioritizing criteria and when using an appropriate decision making strategy. In addition to this, it was understood that the effects of scientific knowledge and scientific epistemological beliefs on evidence-based reasoning were more direct than that of informal reasoning.

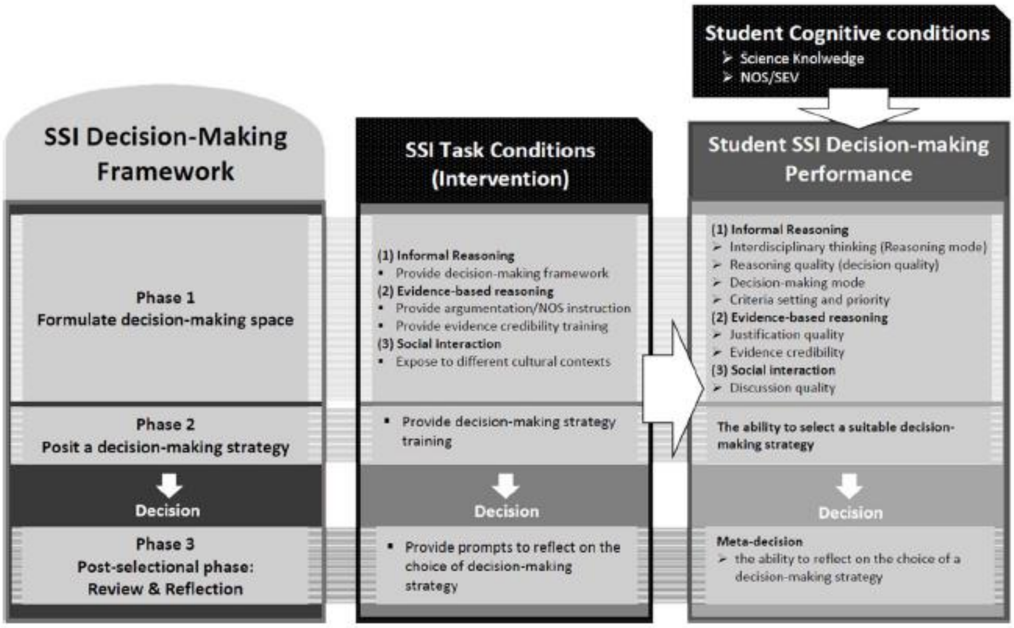

Figure 2.6 A summary of Fang et al.'s (2019) study through the socioscientific decision-making framework (Fang et al., 2019, p.436).

At that point, there is something that should be emphasized more clearly. Whichever normative model is considered, in the literature, it is obvious that decision itself and decision making are different concepts. A decision can be simply defined as selecting one of the alternatives; however, the decision itself is not the big part of the decision making – it is just a bit of it (Daft, 2003, p.272). In other words, decision making is a process in order to identify the problems and reach the conclusion. Decision making needs an effort not only before the decision but also after the decision. Therefore, decision making is also a process which includes regulation, problem solving and use of resources (Yönetim ve Liderlik Prensip Emri 23-6:1, cited in Sağır, 2006).

However, it was understood that the studies (from Bell, 1999; to Khishfe 2012) focused directly on NOS effect on DM about an SSI did not use any DM model and therefore, they mainly examined the decision itself instead of decision making. Moreover, although DM models have been widely used in learning and teaching SSIs (Fang et al., 2019), the DM models in SSI studies (e.g., Kortland, 1996; Ratcliffe, 1997) were fundamentally based on other disciplines than education. DM models used in SSI studies did not evolve by data collection from students' or teachers' decision process on an SSI. In other words, these studies did not explore the DM steps in the context of an SSI, they proceeded an existing one – a DM model of different discipline or a DM model adopted from different discipline - for an SSI generally in order to provide a framework for the related discussion. Furthermore, these adopted DM models were found to be inappropriate for concrete tasks and too difficult for complex, real world situations just like SSIs (Aikenhead, 1989; Ratcliffe 1997; Kolstø 2006).

2.1.3 Significance of decision making in science education

The importance of decision making for citizens' life and the relationship between scientific literacy and decision making were firstly highlighted by the report of Royal Society (1985) whose author is W. F. Bodmer. After that, other organizations related with education such as American Association for the Advancement of Science [AAAS] (1989), National Research Council [NRC] (1996) and Organisation for Economic Cooperation and Development [OECD] (1999) emphasized that one component of being a scientifically literate person is making knowledge-based decisions. Moreover, in 2013 and 2018 Turkish Science Curriculum, Ministry of National Education [MNE] counted decision making as one of the life skills.

In addition to this, many researchers have put emphasis on the need to develop students' 'scientific literacy' regarding everyday life problems and socioscientific decisions (e.g., Aikenhead, 1985; Fleming, 1986a; Millar & Osborne, 1998). Moreover, they have drawn attention to the argument that decision-making as a particular attribute should be encouraged in education for scientific literacy as well (e.g., Bodmer, 1986; Hoolbrook & Ranikmae, 2009; Zoller, 2009). For example, Bodmer (1986) expressed the need for science education frequently through decision-making. According to Bodmer, national industry and national prosperity depend on science not only because devices are created by science and technology but also because many personal and public decisions in fact involve a scientific aspect. In democratic societies, public opinion has a major effect on the decision-making process and an uninformed public is very vulnerable to misleading ideas; therefore, it is essential that in addition to decision makers, individual citizens recognize and understand the scientific aspects of public issues. In this way, the greater the familiarity with the nature and findings of science is, the more resistant to pseudo-scientific information the individual will be. This better understanding of science will result in better decisions not because the decisions are 'right' but because these decisions are made in the light of an adequate understanding of the issues when compared with the ones made in the absence of such understanding.

A step further, Zoller (1982) proposed to reconstruct the ‘science curriculum’ through decision making abilities. According to Zoller (1978, 1990), the decision making capability is vital in human life and it can be improved through instruction. Moreover, Zoller (1982) criticized the weakness of the traditional curricula in equipping students with sufficient experiences needed to make them capable decision makers. Furthermore, by premeditating the ‘first-hand experience’ he offered a decision-making oriented science and technology curriculum in which students are exposed to open-ended problems within their natural setting, students are provided with real decision making situations and students have opportunities to get involved in scientific-technological action.

Even one more step further, Holbrook and Rannikmae (2009) proposed to redefine the relationship between ‘science’ and ‘education’ by emphasizing the importance of citizens’ participations in decision making for the goodness of society. According to Holbrook and Rannikmae, there is a trend in which less attention is given to scientific literacy as the possession of conceptual understanding of abstract science ideas and more emphasis is put on the ability to make decisions regarding the technological applications of scientific ideas or socioscientific issues that society faces. In line with this trend, Holbrook and Rannikmae brought to the forefront NOS influence on decision making in societal issues among different NOS approaches and offered a shift in teaching approaches from ‘science through education’ to ‘education through science’ as indicated in Table 1.

Table 2.1

A comparison of similarities and differences in emphases between 'Science through Education' and the alternative 'Education through Science' (Holbrook & Rannikmae, 2007, cited in Holbrook & Rannikmae, 2009, p.283)

Science through Education	Education through Science
Learn fundamental science knowledge, concepts, theories and laws.	Learn the science knowledge and concepts important for understanding and handling socio-scientific issues within society.
Undertake the processes of science through inquiry learning as part of the development of learning to be a scientist.	Undertake investigatory scientific problem solving to better understand the science background related to socio-scientific issues within society.
Gain an appreciation of the nature of science from a scientist's point of view.	Gain an appreciation of the nature of science from a societal point of view.
Undertake practical work and appreciate the work of scientists.	Develop personal skills related to creativity, initiative, safe working, etc.
Develop positive attitudes towards science and scientists.	Develop positive attitudes towards science as a major factor in the development of society and scientific endeavours.
Acquire communicative skills related to oral, written and symbolic/tabular/ graphical formats as part of systematic science learning.	Acquire communicative skills related to oral, written and symbolic/tabular/ graphical formats to better express scientific ideas in a social context.
	Undertake socio-scientific decision making related to issues arising from the society.
Apply the uses of science to society and appreciate ethical issues faced by scientists.	Develop social values related to becoming a responsible citizen and undertaking science-related careers.

2.2 Research on Decision Making about Socioscientific Issues

Socioscientific issues (SSIs) are the controversial, open-ended issues containing both social and scientific aspects with moral or ethical reasoning and they have no definite answers (Sadler, 2004a, 2004b; Zeidler, Sadler, Simmons & Howes, 2005; Zeidler & Sadler, 2008). There are two social contexts of science as external and internal. With science's external social context, the interactions between the constituents of society - such as technology, economics, politics, laws and ethics - and science occurs. With its internal social context, the historical and social dynamics mediate the production of knowledge (Ziman, 1984; Rosenthall, 1989). Therefore, although SSIs are the product of knowledge and technology, they do not rely on only scientific consideration. SSIs include many perspectives such as political and economical; furthermore, the public discussions and criticisms occur for SSIs because their controversial nature with moral/ethical linkage make them debatable about whether they are suitable or not in society (Sadler & Zeidler, 2004a; Sadler & Zeidler, 2005; Eggert et al., 2013; Siribunnam et al., 2014). Thus, an issue cannot be an SSI if it is not mutually influenced by science and society and any issue of modern science can be an SSI if it raises ethical questions (Sadler & Zeidler, 2005; Fang, Hsu & Lin, 2019). Many SSIs are related with health issues and environmental problems; moreover, all modern science issues with ethical questions such as those related with biotechnology and those related with genetic engineering are counted as SSIs (Eggert & Bögeholz, 2009). In addition to this, building a new nuclear power plant, genetically modified food, recycling, water quality and quantity, water fluoridation, global warming, gene therapy, cloning, stem cell research, fetal tissue implantation, the relationship between diet and cancer, the relationship between cigarette smoking and cancer, the effectiveness of battle against exotic species M. micrantha, the protective role of central slaughtering of chickens related with the spread of avian flu, acid rain, food additive use, waste management, and world hunger are some specific examples of SSIs which were studied in the research area of science education and/or which were integrated in school curriculum for science-technology-society (STS) education (e.g., Fleming, 1986a, 1986b; Rubba &Harkness, 1993; Kortland, 1996; Bell, 1999; Walker & Zeidler, 2003; Sadler & Zeidler, 2004a; Sadler et al., 2004; Sadler & Zeidler, 2005; Halverson et al., 2009; Liu et al., 2010; Molinatti et al., 2010; Lee & Grace, 2012; Khishfe, 2012; Cebesoy & Öztekin, 2018).

SSIs have been realized or have came to agenda after socialization of science with World War II (Aikenhead, 1994). On the other hand, the adoptions of SSIs by curricula were relatively new. In fact, in the 1980s, firstly the science, technology and society (STS) movements aimed to educate the students about the interdependency among science-technology-society (Yager, 1996). However, according to Pedretti and Hodson (1995), STS education became diffuse because of its approaches which are different from each other; for example, in STS education a disarrange among the isolated courses focused on particular STS issues, pedagogical strategies, and the order of science textbooks can occur. Therefore, the SSI movement has risen with its aims which focus on the science-based social issues relevant to students' both current and future world (Driver et al., 2000; Kolstø, 2001b).

In a democratic society, even if they are not the experts in science or technology ordinary citizens should take responsibility and make decisions about SSI because the results affect all of us (Zoller, 1982; Roth & Lee, 2004; Deober, 2011; Hofstein et Al., 2011). However, the SSIs are complex issues because they can have multiple perspectives and multiple solutions generally because of their open-ended and ill-structured problems and none of these perspectives and solutions can be absolutely true because of the diversity in the balances between advantages and disadvantages of these perspectives and solutions (Zohar & Nemet, 2002; Sadler & Zeidler, 2004b; Sadler, 2009). Thus, different from many decisions in everyday life, sophisticated DM strategies are needed for SSIs (Seethaler & Linn, 2004; Eggert & Bögeholz, 2009) and SSIs require critical thinking abilities and establishing interconnection between science and society (Kuhn, 2005; Kolstø, 2006). Moreover, in order to prepare the students to decide better and find sustainable solutions which are alternative to the existing ones, the students need to gain the abilities to consider complex facts, to integrate multiple opinions and connected arguments (Sadler & Donelly, 2006). Furthermore, with the findings of research which focused on implementation of SSIs in the classrooms, it was understood that SSIs themselves help to improve the students' higher order skills such as critical thinking and argumentation (e.g., Zohar & Nemet, 2002; Grace, 2009; Sadler, 2009).

In addition to this, in order to adapt to the developments in science and technology, becoming a scientifically literate person is the ultimate goal of many science curricula and many educators argued that SSIs can be used to develop scientific literacy (e.g., Zeidler, 1984; AAAS, 1989; Driver et al., 2000; Kolstø, 2001b; Ratcliffe & Grace, 2003; Zeidler, et al., 2005; Sadler, et al., 2007; Hofstein, et al., 2011; Lee et al., 2012) and decision making about SSIs should be an integral component of scientific literacy (e.g., Bodmer, 1986; Bingle & Gaskell, 1994; Kolstø, 2001b; Zeidler & Keefer, 2003; Sadler, 2004a). With the acceptance of these point of views, SSI became a part of science curricula worldwide (e.g., KMK, 2005; DFE, 2014). In Turkey, SSI were integrated into the science curriculum in 2005 (MNE, 2005). Today, developing reasoning abilities, scientific thinking habits and decision making skills by using socioscientific issues is one of the basic aims of the curriculum (MNE, 2018, p.9).

When the literature is examined, it is understood that there are two main tendencies in the studies related with decision making on socioscientific issues: one considers the ways of DM on SSI (e.g., Fleming, 1986a, 1986b; Korpan et al., 1997; Hogan, 2002; Sadler & Zeidler, 2005), while the other considers the epistemologies affecting DM on SSI (e.g., Sadler & Zeidler, 2004a; Halverson et al., 2009; Lee & Grace, 2012; Cebesoy, 2014). Moreover, although there are several studies in first tendency, as they generally have different research perspectives and different focuses (e.g., Tytler et al., 2001; Kolstø, 2001a), it is hard to combine their findings. For example, Fleming (1986a, 1986b) used two knowledge categories for students, one of which was knowledge of social world including individuals' ideas about themselves, morality, and society and the other one was knowledge of physical world such as scientific content knowledge. He conducted semi-structured interviews with 38 high schol students in Canada who had successfully completed both high school chemistry and biology through two scenarios, which were about nuclear plants and genetic engineering. After the analysis of the data collected from those students, he concluded that while discussing socioscientific issues, students tended to use their knowledge of the social world more than that of physical world. He stated that students' knowledge of physical world was very limited and students had a chance to use it only in analyzing and discussing SSIs. Moreover, Tytler, Duggan and Gott (2001) aimed to understand how individuals who are not professional scientists construct, interpret and apply evidence in a discussion and decision making about a socioscientific issue. In order to achieve this aim, they conducted a case study about a community's struggle over a local environmental issue in United Kingdom. They collected data from all accessible documents about the socioscientific issue such as newspaper editorials, reports of public meetings and government reports; in addition to this, they interviewed three community members who had different perspectives about the issue. After the analysis of data, Tytler et al. (2001) formulated that the public relied mainly on three types of evidence which are (i) formal scientific evidence based on the data; (ii) informal evidence (e.g. common sense, personal experience) and (iii) wider issues which impinge on the evidence (e.g. environmental or legal concerns). According to Tytler et al. (2001), in SSI debate, the importance of the scientific evidence was recognized by the public; however, they did not rely on scientific evidence very often in the formulation and support of positions related with that SSI. On the other hand, the public decisions about SSI were dominated by informal evidence. They concluded that informal evidence acted as a bridge between scientific or technical assertions and the people's personal, political, and practical understandings. Moreover, they stated that in the public discussion and decision making about SSI, there were wider issues- personal values about the environment, the economy, and moral commitments - which affected the processing of the scientific and informal evidence by people. Furthermore, in his qualitative research, Kolstø (2001a) investigated 16-year-old Norwegian pupils' ways of evaluating information and knowledge claims for decision making in an SSI. There were 22 participants in the study and they were interviewed with semi-structured protocols after they read the reports about power lines and cancer. Kolstø (2001a) determined that there were two bases for the students' judgements about the SSI: (i) the informational statements themselves and (ii) the authorities who provided the information. According to him, there were also two modes for judgement in which students accepted or evaluated the information or the source of information. Therefore, with the analysis of data collected from the interviews, he identified four 'resolution strategies' in students' decision making about the selected SSI which are (1) Acceptance of knowledge claim, (2) Evaluation of statements using 'reliability indicators' and through explicitly 'thinking for themselves', (3) Acceptance of researchers or other sources of information as authoritative, (4) Evaluation of sources of information in terms of 'interests', 'neutrality' or 'competence'. He found that in decision making about an SSI, some pupils used all these strategies, while others used only one or two. He stated that even though most of the students operated evaluative strategies in order to assess the given information about SSI, the students' analyses were superficial and generally the students reached shortsighted or inaccurate conclusions. In addition to this, in United States, Sadler and Zeidler (2005) conducted semi-structured interviews with 30 college students on the topic of human genetic engineering in order to explore how individuals negotiate and resolve genetic engineering dilemmas. They identified three patterns of informal reasoning in decision making which are (a) rationalistic informal reasoning which consists of reason-based considerations without the influence of emotions (b) emotive informal reasoning which consists of care-based consideration, and (c) intuitive informal reasoning which consists of considerations based on immediate reactions to the context. They found that participants generally used combinations of these reasoning patterns when they resolve the socioscientific issue.

On the other hand, as the studies in second tendency considering the epistemologies or sub-group of these epistemologies had generally similar perspectives about the issue, their findings are comparable with each other and also there is a coherence among the findings. However, there are two critical points about these studies focusing on the usages of the epistemologies in decision making about socioscientific issues. Firstly, although there are several studies (e.g., Sadler & Zeidler, 2004a; Cebesoy, 2014) that focused on the usages of the epistemologies or sub-group of these epistemologies in decision making about socioscientific issues, only few of them (e.g., Bell, 1999; Khishfe, 2012) include NOS, all of which are summarized in the following section. Secondly, in the literature there is no single title used to mention those epistemologies; some call them perspectives, while some others call them lenses or factors etc. For example, Lee and Grace (2012) worked on students' reasoning and decision making about a socioscientific issue with 88 13-14 years old students in two different schools. The selected socioscientific issue was about the protective role of central slaughtering of chickens related with the spread of avian flu and they identified six types of justification perspectives, which are science/health, economic, sociocultural, consumer choice, practicality and environmental hygiene. In the literature it is stated that not only students at this age but also college students have limited multi-perspective reasoning ability (Hogan, 2002; Kortland, 1996; Liu et al., 2010), the findings of Lee and Grace's study showed that students were capable of reasoning from multiple perspectives even before the research activity. Moreover, they concluded that decision making is affected by several contextual factors and that when students from different settings share something with each other, it is likely to result in wider perspectives and metacognitive reflection on their own point of views, personal and societal values, embedded sociocultural influences. Another example was the study of Halverson et al. (2009), in which they chose stem cell research as a socioscientific issue for decision making. They conducted qualitative research on 132 undergraduate college students' papers in order to identify the factors influencing decision making about a controversial socioscientific issue. The findings showed that the students used eight different perspectives as lenses to form their decisions about stem cell research, which are medical application, ethical, rights, economic, religious, personal anecdotes, political and scientific. In addition to this, they found that while the most common perspective was medical application, scientific perspective was not as common as it was expected. Moreover, Halverson et al. (2009) stated that most students used multiple perspectives when making decisions. However, they highlighted that the perspectives were not equally valued when students had multiple perspectives; in fact, students generally relied more on ethical perspectives. Moreover, Sadler and Zeidler (2004a) and Cebesoy (2014) focused on the factors which influenced decision making and they mentioned 15 different categories for each study and named them as 'DM Influences'. Sadler and Zeidler (2004a) conducted interviews with 20 college students and they collected the ideas, reactions and feelings of the students regarding the issues of gene therapy and cloning. The qualitative analysis that Sadler and Zeidler made showed that moral considerations significantly influenced decision making. They identified ten patterns for moral reasoning of the students related with the selected socioscientific issues, which were health improvements, diversity, social stratification, slippery slope, societal betterment, overpopulation, taking human life, means to an end, disturbing natural order, and parental rights. In addition to these moral considerations, they found a series of other factors which were religion, personal experiences, family biases, need for more information, popular culture that emerged as important dimensions of socioscientific decision making. Similarly, with Sadler and Zeidler (2004a), Cebesoy (2014) tried to explore the factors which affect the science teachers' decision making process and she found that moral considerations were the emergent factor that influenced science teachers' decisions. Cebesoy (2014) conducted semi-structured interviews with 18 science teachers about gene therapy and its applications. The analysis showed that personal experiences, socio-cultural considerations, emotive considerations, religious considerations, economic considerations, technological considerations, moral considerations, value considerations, socio-psychological considerations, political considerations, legal considerations, family bias, pop culture, support of science, and miscellaneous factors affected science teachers' decisions about gene therapy. She also mentioned that although multiple factors played a collective role in science teachers' decisions, the morality considerations were the most active factor.

2.3 Research on Nature of Science Understandings' Effect on Decision Making about Socioscientific Issues

In the present study, the aim is to determine the impact of nature of science (NOS) understandings on decision making about a socioscientific issue. NOS covers the philosophy, sociology, psychology and history of science and science educators use the term NOS in order to describe the intersection of issues among these disciplines which have the potential to affect science teaching and learning (McComas, Clough & Almazroa, 1998). Essentially, NOS is the epistemology of science, science as a way of knowing, or the values and beliefs inherent to scientific knowledge and its development (Lederman, 1992). Moreover, although there are some disagreements among philosophers, historians, and science educators, a general agreement was established in seven aspects of NOS which are (1) the tentative nature of scientific knowledge, (2) the empirical nature of scientific knowledge, (3) the subjective nature of scientific knowledge, (4) the involvement of creativity and imagination to scientific knowledge, (5) the social and cultural embeddedness of scientific knowledge, (6) the distinction between observations and inferences, and (7) the functions of and relationships between scientific theories (Lederman, 2006).

NOS studies extend over a period of more than a half century and there are a lot of well-known research studies related with it. For example, at first, Anderson (1950) focused on assessing the teachers' conceptions with 56 teachers from biology and chemistry discipline through eight questions about scientific method, and therefore, it was understood that both biology and chemistry teachers had serious misconceptions. Moreover, Klopfer and Cooley (1961) developed the Test on Understanding Science (TOUS) which became the most widely used paper-and-pencil test to assess the conceptions of students (Lederman, 2006) and after several survey with TOUS, they stated that high school students' understandings about science and scientists were not realistic (Klopfer & Cooley, 1963). One of the most often cited studies related with NOS conceptions was Miller's (1963) comparison of TOUS scores of 735 7^{th}-12^{th} grades students and 51 biology teachers. According to the findings of the study, from 11% to 68% of 9-12 grades students had a better score than 25% of the science teachers. Therefore, Miller concluded that not only students but also many science teachers do not understand science, and teachers' understandings about science are not good enough to teach science effectively. Furthermore, there were many attempts to develop a NOS instrument mainly in order to raise the validity and reliability of assessment of NOS understandings such as Welch' (1967) Science Process Inventory (SPI), Billeh and Hasan's (1975) Nature of Science Test (NOST), Ruba's (1976) Nature of Scientific Knowledge Scale (NSKS) and Cotham and Smith's (1981) Conceptions of Scientific Theories Test (COST). However, Views on Science-Technology-Society (VOSTS) instrument which was developed by Aikenhead, Fleming, and Ryan (1987) is different from many other previous instruments because rather than a numerical score calculated through limited response to certain items, it provides a series of alternative student position statements from open-ended students' paragraphs about an issue or a topic of science-technology-society. Moreover, by using VOSTS, Aikenhead et al. (1987) conducted a six-year study with Canadian high school students who were in their graduating grade level, and that study was different from many other previous studies because of the bigness of its sample size, which included 10.800 students. Related with this six-year study, four articles which are about I. methods and issues in monitoring student views Aikenhead et al. (1987),

II. views about the interaction among science, technology and society Fleming (1987), III. views about characteristics and limitations of scientific knowledge Aikenhead (1987), and IV. views about the characteristics of scientists Ryan (1987) were published. However, the findings of this study were very similar with the main findings of the previous studies (e.g., Mead & Metraux, 1957; Rubba & Andersen, 1978; Bady, 1979): the students had naïve NOS conceptions. There are 114 multiple choice items in VOSTS inventory and in order to assess both students' and teachers' understandings about NOS, for years, items of VOSTS or modified items from VOSTS have been used by researchers worldwide (e.g., Bradford et al., 1995; Abd-El-Khalick & BouJaoude, 1997; Lieu, 1998; Tairab, 2001; Miranda & de Freitas, 2008). In Turkey, one of the largest sampled and one of the most cited studies with the items of VOSTS was conducted by Doğan and Abd-El-Khalick (2008). They collected data from 2020 10^{th} grade level students and 362 science teachers and they concluded that in general teachers' and students' NOS understandings were similar and naïve. Although VOSTS was developed through a student-centered process (Lederman et al., 2002) and although the validity of it is high degree (Ryan & Aikenhead, 1992), it is a standardized and convergent paper-pencil instrument; therefore, it collects responses which are limited with the given statements in the questionnaire (Lederman et al., 2002). Thus, in order to assess the NOS views, alternative approaches such as interviews, open-ended questionnaires, concept maps and performance-based assessments (Lederman et al., 1998; Edmondson, 2005; Audrey et al., 2005) have come to agenda. One of the early attempts in alternative approaches to assess NOS view came from Lederman and O'Malley (1990) by Views of Nature of Science, Form A (VNOS-A). VNOS-A is open-ended survey consisting of seven items, each of which focuses on different aspects of NOS, and it was designed to be used for follow-up interviews. After that, VNOS-B, VNOS-C, VNOS-D and VNOS-E were developed in order to improve and/or variate VNOS-A (Lederman, 2006) and they have been widely used by many researchers from all around the world (e.g., Kattoula, 2008; Quigley et al., 2011; Leblebicioğlu et al., 2012; Yoon et al., 2014; Shi & Wang, 2017).

When NOS literature is examined, it is understood that this literature is dominated by the studies focusing on the issues: (i) developing NOS instruments in order to assess NOS understandings, (ii) the students' and teachers' understandings about NOS and (iii) the ways to teach or learn NOS. Lederman (2006) generalized the findings of these studies as follows: K-12 students and teachers generally do not have adequate conceptions about NOS (e.g., Mackay, 1971; Lederman, 1986; Doğan Bora, 2005; Çakıroğlu & Köksal, 2010), explicit, reflective instruction is more effective in learning NOS than the implicit one (learning through experiences by simply "doing" science) (e.g., Carey & Stauss, 1968; Akindehin, 1988; Khishfe, 2008; Cansız et al., 2016), teachers' conceptions of NOS are not necessarily transferred to classroom practice and this does not happen automatically (e.g., Lederman & Zeidler, 1987; Bell et al.; 2000; Akerson et al., 2000) and teachers do not give as much importance to NOS outcomes as they give to the outcomes of traditional subject matter knowledge (e.g., Duschl & Wright, 1989; Lederman,1999).

On the other hand, although there are a lot of NOS studies, when the related literature was investigated, it was clearly understood that there are only six studies by (i) Zeidler, Walker, Ackett and Simmons (2002), (ii) Bell and Lederman (2003), (iii) Walker and Zeidler (2003), (iv) Sadler, Chambers and Zeidler (2004), (v) Liu, Lin and Tsai (2010) and (vi) Khishfe (2012), which directly focused on the exploration of the relationship between NOS and DM about an SSI. All of them used different SSIs but similar NOS aspects based on the seven most accepted NOS aspects mentioned in the previous section. Moreover, the evidence from these studies is limited and offers mixed results. The following part provides a summary of these studies with their methodological details.

Zeidler, Walker, Ackett and Simmons (2002) investigated the relationships between students' conceptions of the nature of science and their reactions to the evidence that challenged their beliefs about socioscientific issues. 41 pairs of students (82 participants, 65% consisted of high school students and 34% represented college students) were selected purposefully in order to reflect maximum variation sampling through questionnaires and interviews about their views of NOS and their beliefs about a socioscientific issue addressing animal rights. With more detail, the study by Zeidler et al. consisted of 3 phases, and at the beginning of the study, there were 248 participants (147 from high school physics and biology classes and 101 from university pre-service elementary scientific methods classes). In the first and second phases Zeidler et al. evaluated all 248 participants' NOS conceptions and collected their beliefs about animal rights. Then, for the third phase, they purposefully selected 82 participants in order to obtain pairs with different levels of variation (low and high) based on an ordinal scale for their belief convictions.

In the first phase, Zeidler et al. assessed the students' NOS conceptions about four areas: (1) the tentativeness of scientific claims and why those claims may change; (2) the role of empirical evidence in the activity of science; (3) the role of theoretical commitments, social and cultural factors in generating scientific knowledge; (4) the extent to which human creativity, imagination, and sociocultural-embedded factors influence formulation of scientific knowledge, through written responses from the open-ended questionnaire, which were previously used to assess students' beliefs in NOS by Lederman, O'Malley (1990), Abd-El-Khalick et al., (1998) and Bell et al. (2000).

In the second phase (approximately 1 week after the application of the NOS questionnaire to the students), Zeidler et al. presented to the students a socioscientific scenario which was modified from Brinckerhoff and Zeidler (1992). This scenario was about animal rights and with this scenario, the students need to make decisions according to their moral reasoning and ethical beliefs. Moreover, Zeidler et al. stated that this particular scenario was pedagogically appropriate for their sample, which includes the students from 9th graders to college undergraduates, as the scenario did not necessarily require technical knowledge in order to comprehend and analyze the issue, and the use of specific content knowledge. After the scenario, Zeidler et al. collected the students' written responses again through the open-ended questionnaire.

In third phase, Zeidler et al. conducted a qualitative study with semi-structured interviews with 41 pairs of students who were selected through their initial responses to the scenario and nature of science questionnaire. The paired students were probed with five questions (modeled from Kuhn, 1991, 1992). After these interviews, in order to control the effects of varied arguments with differing logical constructions, the researchers gave the students one of two reports which have “exactly same content” but with a different title (‘Report Supports Animal Testing for Medical Research’ or ‘Report Supports Computer Modelling for Medical Research’), and then, they collected the students’ confidence level about the authors’ findings.

Zeidler et al. used discourse analysis for the data collected by questionnaires and they identified three broad ethical orientations, which were scientific considerations, religious considerations and social considerations in the students’ responses. On the other hand, they found only a few connections between students’ NOS view and their socioscientific reasoning patterns. The findings showed that a few students considered only two NOS aspects in socioscientific decision making. These NOS aspects were (i) the social and cultural factors in generating scientific knowledge and (ii) the importance of empirical evidence in the activity of science. With more detail, Zeidler et al. found that the relationship between NOS and DM was manifested at three levels: (a) some students noted that the social and cultural perspectives affect how they view the scientific enterprise, (b) some students acknowledged the role of empirical evidence (However, the authors noted that students’ views of empirical evidence were narrow and one-sided when applied to their position about animal rights issue.), (c) some students compartmentalized scientific knowledge and personal knowledge.

In their study, Bell and Lederman (2003) attempted to explicate the role of the nature of science in decision making on science and technology based issues and to identify the factors and reasoning associated with these types of decisions. They focused on well-educated adults not only because finding diversity from low and high NOS understandings in well-educated adults is easier than K-12 students, but also because in daily life, adults have more positions to make substantial personal and public decisions on science and technology based issues. Bell and Lederman selected 21 volunteer participants purposively from the faculty of geographically diverse universities. Firstly, an open-ended questionnaire and follow-up interview were designed to assess their decision making on science and technology based issues was conducted with all participants. Secondly, a second open-ended questionnaire and follow-up interview were conducted with all the participants in order to assess their views of NOS. After that, 18 participants were selected and placed in one of the two groups (Group A for the participants who were most consistent with current conceptions of NOS and Group B the participants who were inconsistent with current conceptions of NOS) based upon their divergent views of the nature of science. Then, profiles of each group's decision making were constructed, based on participants' previous responses to the decision making questionnaire and follow-up interviews. Finally, the two groups' decisions, decision influencing factors, and decision making strategies were compared. In order to avoid some misunderstandings about the design of this research, here it is important to mention that this grouping approach was just for data analysis; no additional questionnaire was conducted by Bell and Lederman after grouping.

In their study firstly, Bell and Lederman provided all participants with four scenarios and accompanying questions for the Decision Making Questionnaire (DMQ), developed by Bell and checked for content validity by a panel of experts, in order to understand the participants' decision patterns. These scenarios were related to real-world issues on a variety of science and technology topics upon which a citizen might be expected to vote or make personal decisions. Bell and Lederman listed the scenarios that they used as scenario I: fetal tissue implantation, scenario II: global warming, scenario III: the relationship between diet and cancer, and scenario IV: the relationship between cigarette smoking and cancer. Each scenario was followed by three to five questions which aimed at eliciting both "yes" or "no" decisions and encouraging participants to explain the factors and reasoning patterns affecting their decisions. After this questionnaire, the participants were interviewed to give them a chance to clarify and elaborate on their responses to the DMQ.

After the written responses to the DMQ and clarifications for these responses, Bell and Lederman gave the participants The Views of Nature of Science (VNOS) Questionnaire consisting of six open-ended items for written responses adapted from Lederman and O'Malley (1990) and Abd-El-Khalick et al. (1998). With the analysis of the data collected from VNOS and follow-up interviews, Bell and Lederman constructed the profiles of views of the nature of science for each participant. These profiles were used for the separation of the participants into Group A or Group B according to their understandings of the nature of science.

Related with the findings of their study, Bell and Lederman identified 11 factors in decision making, which were nature of science, economics, moderation, moral/ethical issues, personal issues/values, personal philosophy, pragmatism, social/political issues, support of science, values and miscellaneous, and they explored 5 different decision making strategies which were considering the evidence, conservatism, risk analysis, cost/benefit analysis and values-based. They stated that there were no differences between the decisions of the two groups. Moreover, in both groups the participants mostly considered personal values, morals/ethics, and social concerns in their decisions. In addition to this, all participants considered scientific evidence in their decision and interestingly, although many of the participants held absolute conceptions of the nature of science, most of them did not require absolute proof. However, Bell and Lederman stated that the participants' views of nature of science did not prominently affect their decisions. Therefore, they highlighted that these findings which contrast with basic assumptions of current science education reform efforts and the goals of nature of science instruction should be re-examined.

Walker and Zeidler (2003) had three items in their study agendas: (1) to explore the effectiveness of web-based learning environment for students' learning about socioscientific issues, (2) to explore the effect of web-based learning environment on students' nature of science understandings and (3) to identify the relationship between students' nature of science understandings and their decisions on a socioscientific issue if it existed. The selected socioscientific issue was genetically modified foods after assessing 50 students' concern levels about three controversial issues which were global warming, water fluoridation and genetically modified foods. After that, they purposefully selected 36 students from 9^{th} grade to 12^{th} grade at a suburban vocational education school as all of them had covered the basic genetic concepts in 8^{th} grade level. These students were separated into two groups: the first one was for pilot study and it included 20 participants and the second one was for the actual study and it included 16 participants. They administered Nature of Scientific Knowledge Scale (NSKS) to all students and each group had introductory discussions about nature of science with a semi-structured interview under the light of the Views on the Nature of Science Questionnaire (VNOS), which was developed by Lederman et al. (2001). Then, they watched a video about the controversy of genetically modified foods. After that, Walker and Zeidler provided the students with a series of online activities related with the issue and follow-up interviews. With more detail, they constructed five internet-based activities for the students. The titles of them were Genetically Modified Foods in Perspectives, What is a Genetically Engineered Plant?, Multiple Perspectives of the Genetically Modified (GM) Controversy, To Label or Not to Label, and Plan for the Debate. Each activity had its own special objectives and activity steps. For example, with the activity named Genetically Modified Foods (GMF) in Perspectives, it was aimed to introduce GMF and to explore the students' understandings about how controversies in science are possible.

These internet based activities took five days and the sixth day was for the classroom debate. In classroom debate, Walker and Zeidler separated the students into three groups according to their positions about genetically modified foods. Each group had three minutes to defend their positions and then each student had also the opportunity to express their final position regardless of their group position. Therefore, Walker and Zeidler used five sources of data: (i) descriptive field observations, (ii) students' responses to NSKS, (iii) students' written answers in chat room discussions within the web-based activities, (iv) students' work (collecting supporting evidence about genetically modified foods and organizing it) on the classroom debate activity and (v) students' responses to semi-structured interviews through VNOS.

With the analysis on the students' responses to VNOS and to online questions, four aspects of NOS which were tentative, creative, subjective and social aspects were found to be consistent with the desired learning outcomes in the national standards for the majority of the students. Moreover, it was understood that the majority of the comments of the students were about the government's role in the safety testing and the government's controls over the products of science and these comments covered the relationship between science and society. On the other hand, after the transcription of the debate was analyzed, it was understood that the students did not state explicit reference to NOS aspects even to the social aspect which was the aspect appeared in students' comments during the online unit. The analysis showed that the social aspects were implicitly addressed by the students during debate. In order to explain any possible relationship between students' NOS understandings and decision making, Walker and Zeidler made further analysis with the data from three students who contributed to the majority of the dialogue. These three students had close answers to the NOS online and interview questions and their NOS understandings also were close to each other. However, it was understood that NOS did not appear as a contributing factor in the students' decision making about genetically modified food. Therefore, Walker and Zeidler concluded that in order to reflect NOS understandings to the decisions about controversial socioscientific issues, the students need to be directed by explicit discussions.

Sadler, Chambers and Zeidler (2004) aimed to explore student conceptualizations of NOS and students' interpretations and evaluations of conflicting evidences of a socioscientific issue. 84 high school students participated in this study by reading contradictory reports about the status of global warming and responding to questions in an open-ended NOS questionnaire. After that, in order to triangulate data from the written responses, 30 of 84 students were interviewed. More specifically, in their research Sadler et al. focused primarily on three aspects of NOS: its empirical basis, cultural embeddedness, and tentativeness. In the research design, Sadler et al. forwarded their study on the global warming issue. They emphasized that this particular issue was identified and selected by consensus of the researchers because it included information consistent with NOS aspects, there was no need for technical knowledge in order to comprehend this issue, it did not prohibit the use of specific content knowledge, it was pedagogically appropriate for the students who were the sample of the study and it was in line with the various patterns in prior studies.

In their study, Sadler et al. provided each student with a fictitious 'Science Brief' which included two opposing statements on global warming issue. One is entitled 'Global Warming: An Impending Environmental Crisis', and it reported that humans cause the global warming and it is a very real threat to the environment. The other is entitled 'Global Warming Myth: Evidence Against Environmental Crisis', and mentioned the evidence which showed that the current warming trend is a real threat to the environment as it is a natural event. Moreover, in order to minimize any possible ordering effects, one-half of the students firstly read the report 'Global Warming' while the other half read the 'Global Warming Myth' first. After reading the articles, in order to reach the data about the student conceptualizations of pertinent NOS issues and factors that influence socioscientific decision-making, Sadler et al. collected the students' written responses through a five-item open-ended questionnaire, which was constructed for their study. Approximately 1 week after the questionnaire administration, they selected purposefully 30 students among the ones responded to the questionnaire according to their diversity in critical thinking abilities in order to supplement the data analysis of questionnaire responses by interviewing them. In these individual interviews, students had the chance to reread the 'Science Brief', and then, the researcher asked the 'same questions' in the questionnaire in order to make clarification to the students' written ideas by encouraging them to express those ideas verbally.

Analysis showed that although a direct effect of NOS on DM could not be found in the light of the findings, it can be possible to say that students' interpretations and evaluations of conflicting evidence were influenced by various factors related to NOS. These factors were data interpretation and social interactions including individuals' own articulation of personal beliefs and scientific knowledge. With more detail, as this study focused only on three NOS aspects, the empirical nature of science, the social embeddedness of science and the tentative nature of science, the results were linked to them. The findings showed that over 80% of the students had some basis about the empirical nature of science as those students were able to identify the data in two controversial articles given to them. On the other hand, Sadler et al. concluded that only 53% of the students seemed to use conceptual aspects related to empirical nature of science properly. Moreover, it was understood that the economic influences were frequently cited by the students in their comments about global warming. Besides economy, the students also mentioned personal perspectives, societal causes and societal effects. With the analysis on students' comments about inconsistencies between global warming statements in the two articles, Sadler et al. identified five categories for students' explanations which were myth confusion, different data, different data analysis, beliefs and opinions and different foci. Moreover, it was revealed that the reason for finding one article more meritorious than other article was related with personal relevance of the students, i.e. finding one article to have better data and information and finding the other article to have better explanation. In addition to this, some students mentioned that both articles had the same amount of scientific merit. Furthermore, Sadler et al. identified three categories in the students' assessment of persuasiveness of the articles which were personal relevance, information quality and previous personal beliefs. With the analysis, it was understood that in the consideration of socioscientific issues, a large portion of the students did not consider scientific merit to be a convincing factor. According to Sadler et al., these results showed that the students tended to use their personal opinion rather than scientific knowledge in the consideration of socioscientific issues.

Liu, Lin and Tsai (2010) used a mixed methodology by combining quantitative and qualitative approaches which is similar to the previous studies related with the relationships between NOS and DM on SSI and they aimed to explore the interaction between scientific epistemological views (SEVs) and the reasoning process in socioscientific decision making, if it exists. They collected data from 177 college students (60% science and 40% non-science majors) in three public universities with SEV instrument and five weeks later with a DM questionnaire. SEV instrument was developed by Tsai and Liu (2005) in order to assess beliefs about NOS related with cultural and social embeddedness of science, the invented and creative nature of science, the theory-laden nature of science and the tentativeness of scientific knowledge. Moreover, for the study, DM instrument was designed through the socioscientific issue about the effectiveness of battle against exotic species *Mikania micrantha* which has caused economic and ecological problems. This DM instrument contained an informative text with different perspectives about the socioscientific issue *M. micrantha* and a set of open-ended questions, an example of which is *"Do you think that efforts to control this weed should be continued and expanded or be suspended?".* Liu, Lin and Tsai (2010) called the aspects of information or evidence the participants used to make their arguments on the issue as the reason modes and with the data analysis of DM instrument, they identified four reasoning modes, which were ecological, ethical aesthetic, scientific-technological and social economic. According to the findings, while science students mostly used scientific-technological reasoning, non-science students used mostly ecological reasoning. However, more than half of the students were not able to make reasoning with multiple perspectives, which means that most of the college students were far from interdisciplinary thinking about the SSI. Moreover, it was understood that non-science students or students who had tentative beliefs about scientific knowledge tended to have multi-perspective thinking, realized the complexity of the SSI and questioned the information given in the text about SSI more than the other students who participated in the study. Furthermore, the findings of the study showed that students with adequate understandings about the involvement of creativity and imagination to science used reasoning modes other than ecological reasoning in decision making about an environmental issue. On the other hand, Liu, Lin and Tsai did not find any clue from the students' responses to show the impact of NOS aspects other than tentativeness of scientific knowledge and creative and imaginative nature of science.

In her study, Khishfe (2012) mainly asked whether the NOS understandings of high school students would influence their decision making after explicit NOS instruction. In order to reach this aim, she focused on five aspects of NOS (Abd-El-Khalick et al., 1998) in which nature of scientific knowledge is (a) tentative, (b) empirical, (c) inferential, (d) creative and imaginative, and (e) subjective. Moreover, she studied on two issues: (1) change in students' NOS understandings after explicit NOS instruction in the context of a socioscientific issue and (2) the effect of explicit NOS instruction on students' decisions and DM factors. Khishfe designed her study as a quasi-experimental research and 90 students participated in this study among 9th grade students in a public school. She formed 4 groups (two for treatment-one regular and one honor students, and two for comparison-one regular and one honor students). All groups received a four-week unit which consisted of instruction and activities about genetic engineering and how to formulate arguments and make decisions related to this controversial issue. Only the treatment groups additionally received an explicit instruction about application of NOS aspects in formulating arguments and in making decisions. At the beginning of the treatment, Khishfe conducted firstly NOS questionnaire, and then, the scenario about genetically modified food to all groups in order to collect the participant's written response. After 4 weeks, at the end of the treatment, she conducted the same questionnaires in the same order with all participants for the same reason. Moreover, in order to establish the validity of the questionnaire and the scenario, she randomly selected 5 individuals from all groups after each application and gave them an opportunity to clarify their responses verbally with an interview.

After analysis by comparing pre and post application, Khishfe (2012) found that the understandings about the creative and imaginative nature of science of the treatment group and the comparison group were similar. However, related with other aspects of NOS, Khishfe stated that explicit NOS teaching improved the students' NOS understandings. On the other hand, the results with Chi-square analyses showed that there were no differences between the decisions (in terms of yes or no) of two groups although the treatment group had an explicit instruction about both NOS and the application of NOS aspects in making decision about a socioscientific issue. In addition to this, with the analysis it was revealed that decision of the students was dominated by other factors except for NOS. These factors were moral/ethical, health, choice, economic, religious, and some miscellaneous factors. These results were mainly parallel with the findings of the previous studies such as Bell and Lederman (2003). However, the results also showed that after explicit instruction about NOS and application NOS to DM, more students (about 37% of the participants) in the treatment group reflected their NOS understandings related with (1) tentative nature of science (2) empirical nature of science and (3) subjective nature of science to their decisions about the socioscientific issue. With more detail, while only 3 of 42 participants from comparison group referred to NOS aspects, 17 of 41 participants from the treatment group referred to at least one of the three NOS aspects when they made a decision about genetically modified food in the post-instruction. These findings were new in the findings of the previous studies and according to Khishfe, they indicated a relationship between NOS understandings and DM. Khishfe explained the reason for identifying NOS effect on DM about SSI in her study by underlining the importance of the explicit instruction about application of NOS to DM, which the students in the treatment group received.

2.4 Conclusion of Literature Review

In conclusion, with the literature review it was understood that DM literature is connected to many disciplines and it covers the studies in more than a century. Moreover, for many decades, the subjects about SSI have been studies by educational researchers and NOS literature spread to more than a half of a century with a great number of research. Thus, all the literatures of DM, SSI and NOS are so comprehensive, they have become more and more popular in time and the findings in these three literatures have magnificently enlightened the educational issues. In addition to this, DM, SSI and NOS are naturally bounded to each other because SSI is complex and controversial issue and in order to move from endless argumentations to real action, SSI needs a process of DM and in order to have a proper solution DM about SSI needs to be proceeded through epistemologies including NOS. However, the number of studies focused directly on NOS effect on DM on SSI is very limited and they serve mixed result for some cases. Their findings can be summarized as although epistemology involvement to DM was detected (generally with multi-perspective reasoning), no, or indirect, or very limited NOS effect on DM about SSI was reported.

In the literature, the first direct attempt to understand NOS effect on DM about SSI was raised with Bell and Lederman’s works (Bell, 1999; Bell & Lederman, 2003) and this attempt has opened a new pathway in educational research. The other studies mainly followed this pathway by making some methodological adjustments and by considering different SSIs, and all of them served valuable information to the literature. However, from Bell (1999) to Khishfe (2012), the studies focusing directly on NOS effect on DM about SSI have continued to carry exactly same four weaknesses in their methodologies. These four weaknesses are (i) using no DM model, (ii) selecting SSI without focus group interviews in order to understand the participants’ true interest level and prior knowledge about SSI, (iii) assessing NOS through the issues different from their own SSI, and (iv) collecting mainly written responses.

CHAPTER 3

METHODOLOGY OF THE STUDY

The aim of this study was to determine the effect of nature of science understandings (NOS) on decision making (DM) about a socioscientific issue (SSI). In order to reach the aim of the study, the method that was used throughout the research will be explained in this section in detail.

3.1 Research Design

This study is a qualitative research grounded theory study. As there were only a few studies (e.g., Bell, 1999; Khishfe, 2012) investigating the effect of NOS understandings on DM about an SSI, this phenomenon was still left to be much unexplored with its dynamics as none of the previous studies considered DM as a process. Moreover, this study was the first which was interested in a referendum situation about an SSI, and in the literature there were no defined structures in order to explain the way of thinking about an SSI of the ordinary referendum participants. Thus, the main research question of this study is a "HOW" question and it is needed to gather sophisticated data directly from the participants in order to develop an understanding about the issue. Therefore, grounded theory was needed to be conducted because it is the research strategy in order to enable systematic discovery of theory from the data (Glaser & Strauss, 1967) and its main emphasis is on the knowledge gained during the investigation (Hunter et al., 2005). Thus, the researchers –just like the researcher of the present study– who thought that "theory could and should be stimulated through and 'grounded' by – empirical research" (Dey, 2004, p.80) conducted grounded theory when they needed. Although the definition of grounded theory is very clear according to the researchers, there are some different point of views and disagrements in the application of ground theory even between the Glaser and Strauss, who were the first two researchers in the construction of the grounded theory itself (Baş & Akturan, 2008). Therefore, in the following part, a brief explanation about how grounded theory was conducted in the present study is provided in order to enlighten the researcher perspective. For example, parallel with Cutcliffe's (2000) point of view, a literature review was made before data gathering and analyzing, and in this way, it was hoped to complete lack of information in the research area and to have a more rational perspective. Moreover, with the suggestion of Baş and Akturan (2008), the researcher of the present study avoided making random sampling and directed to make purposeful sampling and then, directly involved in conducting all data gathering process (Nakip, 2003). In addition to this, in order to have better results in terms of representatives of the real situation, more than one data gathering techniques were used (Backman & Kyngas, 1999). At first, focus group interviews were conducted in order to understand potential participants' basic social process, basic social psychological process and main concerns related with the studied issue (Galser, 1978; Charmaz, 2006). The sample of the focus group interviews was constructed through the potential participants of the main study and it reflected the theoretical sample which occurs in grounded theory study (Cutcliffe, 2000). The findings of the focus group interviews were used to develop the data gathering tool for the in-depth interviews in the main study. Appropriate with the spirit of the grounded theory study, both the focus group and the in-depth interview questions were semi-structured and even after the pilot studies they evolved from one application to another application (Hancock et al., 2009). In grounded theory, the analysis begins as soon as the first bit of data is collected (Corbin & Strauss, 1990, p.6). In fact, in the present study, the constant comparative method (Glaser & Strauss, 1967) was conducted with the comparison of data with data, data with codes and codes with codes during not only data collection but also after all data collected. Furthermore, all three codings of grounded theory which are open coding, axial coding and selective coding represented by Corbin and Strauss (1990) were made through the collected data. In the present study, with open coding/initial coding (Thornberg & Charmaz, 2012), for example, it was reached the code 'for which reason is the artificial meat produced' related with participants' DM process about the selling of the artificial meat and it was labelled as the concept *'goals'*, and then the code 'what should/must the qualification of the artificial meat be?' was labelled as the concept *'criteria'* and the code 'what can be compared with artificial meat?' was labelled as the concept *'alternatives'*. Moreover, with axial coding it was understood that *'goals', 'criteria'* and *'alternatives'* were the category 'the thinking regions' in DM process and by the double way interactions among them, a fourth thinking region which was labelled as *'decision'* was fed continuously. Then, with the selective coding, *'decision'* was put on the core and the questions: 'what happens?' and 'how does it happen?' were established through this such as identifying the effectiveness of goals in decision or the effectiveness of NOS lenses in decision and so on. In addition to this, as it can be understood above, key points coding (Baş & Akturan, 2008) was also conducted in the present study, and in this way, codes constructed concepts, and then, the concepts formed categories.

As a result, as the present study is grounded theory, the real research design was very complex in terms of structure mostly because data collection processes and the analysis processes were interrelated. For example, in the present study, in the line with the intimation of Thornberg and Charmaz (2012) memo writings were made from the first data collection to the end of the all analysis. Although the thoughts and questions in the memo writings were used and reused in the steps of grounded theory when it was needed, memo writing was not shown in the research design model in Figure 3.1 because memo writings were not the ruling steps of this study. Therefore, in order to simplify this complicated structure in research design model, it was only focused on the ruling steps of the research in each related duration. Moreover, in Figure 3.1 expert opinions were directly shown in the research design just because they were the rulling steps in their duration. These expert opinions were vitally important in the present study and they directly shaped the process of the grounded theory in each time. More specifically, in the present study, the discussions with experts (mainly with three professors on science education at a university) helped the researcher develop new insights and increased theoretical sensitivity for the sake of grounded theory just like Corbin and Strauss (1990) emphasized.

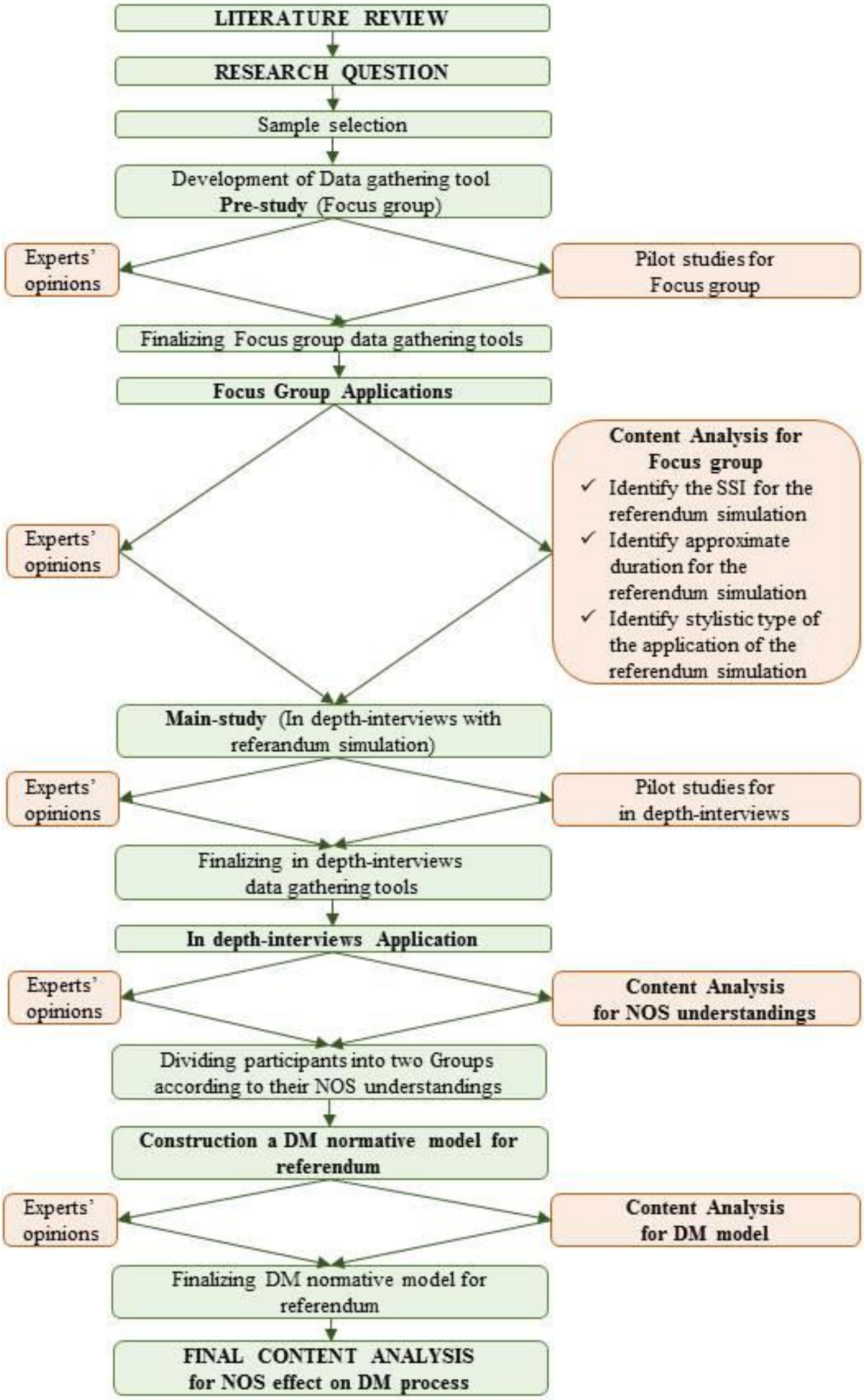

Figure 3.1 The research design model of the study.

Moreover, the research design of the present study was constructed to respond to 4 main criticisms about previous studies which were stated by the researcher:

1. Previous studies did not conduct Focus Group interviews *and therefore, they did not identify research specifications and the type of problem in SSI through the perceptions of the participants*

The type of the problem of the SSI in the present study is unstructured problem in uncertainty conditions and it was defined through the perceptions of the participants by conducting Focus Group interviews. Although some previous studies (e.g., Bell & Lederman, 2003) provided the definitions of the type of problem in the selected SSI, these definitions were not constructed by considering the participants' real perceptions about the selected SSI for that study. However, in the DM literature, it is clearly emphasized that DM process is affected by people's readiness to make a decision, priorities among the existing problems, and ways of collecting information etc. Therefore, it was concluded that in order to make a proper analysis to understand the NOS effect on DM, the selected SSI should be (1) interesting (2) familiar to be discussed (3) clearly understandable for the participants of the study. On the other hand, in order to avoid subject matter knowledge effect, (4) participants' prior knowledge about the selected SSI should be similar (Fraenkel & Wallen, 2006). These necessities affected the research design and required to conduct Focus Group interviews in order to select an SSI which consists of an unstructured problem in uncertainty conditions according to the potential participants as a way to minimize subject matter knowledge effect on DM and also in order to identify the approximate duration of the in-depth interviews and the way of informing during the referendum simulation.

The focus group interview is a qualitative technique which aimed to collect data about the conscious or unconscious behaviors and the psychological and sociocultural characteristics of the group or subgroup of people in order to understand the baseline reasons related with those behaviors of them (Yıldırım & Şimşek, 2005). With the focus group interviews, it is possible to gain detailed information about the participants' world views, life styles, interests, experiences, tendencies, opinions, perceptions, emotions, attitudes and habits (Baş & Akturan, 2008). In the focus group interviews, it is very important to provide the participants with a comfortable medium to express their opinions freely. Therefore, the main advantage of the focus group interviews is to reach the new and different ideas with the help of the group dynamic as the interactions among the focus group members stimulate the participants' emotions and ideas (Stewart & Shamdasani, 1990; Kitzinger, 1994, 1995; Krueger, 1994; Gibbs, 1997; Bowling, 2002, cited in Çokluk et al., 2011). Today, focus group interviews are mostly used to collect data about the consumers' habits mainly because with this method it is easy to gain very detailed information about the participants' interests and tendencies in one session. All these characteristics and advantages of the focus group interview led the researcher to use this method to identify the SSI for the main study through the related properties of this study's focus group which covers the third year of Elementary Science Education Department students at one of the large sized universities in Ankara.

In this study, data collected from the Focus Group was firstly used to select an SSI for referendum simulation. More specifically, in this study, it was decided that one way to minimize subject matter knowledge effect is to select an SSI about which the participants have almost no prior knowledge. In this way, no additional information apart from the one prepared for the research related with that SSI paralyzes the data. Therefore, it was concluded that the selected SSI should include unstructured problems. In fact, there are four levels of decision and only level 4 decisions include a new or unfamiliar problem and covers problem solving (Svenson, 1992). In addition to this, level 4 decisions engaged with unstructured problems that are new or unusual and for which information is ambiguous or incomplete (Robbins & Coulter, 2012). As a result, with the connection with the DM literature, it was understood that it would be more efficient to select an SSI which includes an unstructured problem for this study. Moreover, uncertainty conditions are the conditions in which the person is not certain about the outcomes and cannot even make reasonable probability estimates (Robbins & Coulter, 2012). In addition to these, uncertainty is a basic element of many decisions. There is a common tendency among adults to underestimate the uncertainty in situations and failure to realize how complex its reflections are (Fischhoff, Slovic & Lichtenstein, 1977; Lichtenstein, Fischhoff, & Phillips, 1982). Moreover, because children have simplistic views about many things, their thinking should be characterized by unwarranted certainty (Sieber, Clark, Smith & Sanders, 1978). As a result, according to Beyth-Marom et al. (1991), uncertainty should be one of the main concepts in curricula; therefore, by focusing on uncertainty conditions in the present study, it was hoped that findings would provide valuable information for future curriculum.

Moreover, in this study, data collected from the Focus Group were also used to construct a data gathering tool for referendum simulation which is not boring and easy to understand according to the potential participants.

2. In previous studies, the data were collected mainly through written responses which are limited to provide detailed information when compared with in-depth interview.

In the previous studies (e.g., Sadler, Chambers & Zeidler, 2004), some interviews were conducted only after the questionnaires in order to clarify some participants' responses. Although clarification of the data is important for the validity of the results, conducting those interviews with some participants only after the questionnaire is not seen as the best way to construct validity with the explanations given above. Moreover, in these studies, it was obvious that data analyses were mainly based on written responses. Thus, it can be concluded that in fact, researchers were likely to miss out useful detailed data in their analyses.

The questionnaires are preferred by researchers generally because of their advantages in terms of time and effort spent on data analysis[2]. On the other hand, one-to-one interviews, especially in-depth interviews, are much more efficient to collect detailed information (Boyce & Neale, 2006) and serve much more

[2] psychology.ucdavis.edu/faculty_sites/sommerb/sommerdemo/interview/ques_int.htm

advantages generally related with the validity and quality of the study. Fundamentally, one-to-one interviews are favorable because:

(1) respondent literacy is not necessary,
(2) questions and responses can be clarified,
(3) probing for additional information is allowed,
(4) complex and open-ended questions are possible,
(5) answering of questionnaire by intended person is assured,
(6) there are fewer “blanks”,
(7) participation potentially is increased by personal contact (WHO, 2008).

Moreover, in-depth interviews are more likely to provide a relaxed atmosphere in data collection as people may feel more comfortable while having a conversation with the researcher (Boyce & Neale, 2006). Moreover, in a sucsessful in-depth interview the participants will be alone, and therefore, he/she will not be affected by the other’s opinion (Berent, 1966); therefore, the participants will find a suitable medium to express their own feelings, perceptions and opinions. With the help of qualitative research method accompanied with in-depth interviews, the researcher can understand people’s experiences and focus on the parts that need to be elaborated. Rubin and Rubin (2005) put this idea in this way: “If what you need to find out cannot be answered simply or briefly, if you anticipate that you may need to ask people to explain their answers or give examples or describe their experiences, then you rely on in-depth interviews” (p. 2). Moreover, in in-depth interviews, the aim of the researcher is to explore the emotions, the viewpoints and the perspectives of the interviewees (Baş & Akturan, 2008).

For a more detailed discussion of the issue, the difference between speech and writing is of great importance. Oral expression provides space for pluralism and communion although the possibility of mistakes in terms of grammar and syntax is higher. On the other hand, written expression is more likely to be confusing, misleading and obscure. The reason for this is the lack of communicative tools such as eye contact, gesture, tone of voice and emphasis, which are used in oral language to make the meaning clear, and heavy reliance on grammar, punctuation and word choice (Wood, 2011). Another important point about the difference between speech and writing is that speech is the result of the natural mechanism of the larynx, while writing is the learned mechanism of fingers, wrist and arm. In other words, when speaking, people use their larynx, which spends little energy -even smaller than the energy spent when typing a text. As a result, spoken language is more productive as a medium for expressing ideas when compared with the written one (Horowitz & Berkowitz, 1964). In other words, people tend to keep their written expression short and this situation reduces the possibility of reaching important details.

Therefore, in this research, in-depth interview which can help the researcher reach much more sophisticated data for the analysis was selected as a qualitative research technique to conduct the study.

3. The previous studies ignored the possibility of NOS differences in different scientific disciplines.

In order to define the NOS understandings of the participants, the previous studies used mainly The Views of Nature of Science (VNOS) Questionnaire consisting of six open-ended items for written responses adapted from Lederman and O'Malley (1990) and Abd-El-Khalick, Bell, and Lederman (1998) or the questionnaire based on VNOS with following interviews for clarification of the responses. Moreover, it is known that these questionnaires include the items from different scientific disciplines such as physics, chemistry and biology. Although there is a huge agreement about the efficiency of VNOS, even Lederman (2006) himself mentioned the possibility of different definitions of NOS among different scientific disciplines in one of his mile stone articles titled '*Nature of Science: Past, Present, and Future'*. As a result, after both *'Decision Making'* and *'Science Education'* literature were reviewed, it was concluded that whether this possibility can be low or high, the possible consequences of risks taken can be very dangerous in terms of separating the participants into two different groups according to their level of NOS understandings (the Group U for unsophisticated and the Group S for sophisticated).

Therefore, this study was designed to identify the NOS understanding of the participants through the selected SSI. In other words, the data gathering tool used in in-depth interviews for referendum simulation was developed to collect also NOS understandings of the participants specifically about the selected SSI, which is the artificial meat.

4. None of the previous studies were constructed on a decision making process model.

As it was mentioned in the section about decision making, decision and decision making are different concepts. According to Daft (2003), a decision can be simply defined as selecting one of the alternatives; however, the decision itself is a very small part of the decision making. Moreover, in the literature it is well stated that decision making is a process explained by normative models which show the steps of this process mainly starting with 'identifying problem' and generally finishing with 'evaluating the decisions'.

However, when the decision making questionnaires of the studies were investigated, it was understood that the items of those questionnaires failed to reflect the steps of decision making but 'evaluating the decision'. Mainly, the questionnaires started with the items which aimed at obtaining "the decision (as yes or no)" and continued with the items for "other decisions" and/or for justification of the *'decision'*. By revealing this obvious pattern, it can be concluded that although researchers used the term 'decision making' in their studies, in fact they covered a very small part of this process. In other words, these researchers strictly focused on the *'decision'* itself and missed out the 'decision making' process toward the *'decision'*.

Moreover, the present study was conducted with pre-service teachers, and it focused on the ordinary citizen's DM process in case of a referendum related with an SSI as it reflects one of the best cases to understand why we try to teach NOS to "all students" as science teachers. Moreover, it was understood that the referendum case includes a very different kind of DM process from what the normative models in the literature present especially related with three reasons (i) time flow in thinking,

(ii) 'yes' or 'no' ending and (iii) the participants' lack of special education or experiences about DM process. Firstly, time flow in thinking was different from that of other normative DM models as the referendum offered a ready solution because of its nature. In other words, the artificial meat was the already selected solution for this referendum simulation and the participants tried to figure out the possible goals, criteria and alternatives about it. Secondly, with referendum simulation, it was understood that as a referendum ends with voting 'YES' or 'NO' to a solution, participants feel no need to 'develop' real alternatives to a particular problem. Finally, in this referendum simulation, being ordinary citizens, the participants had no special education about DM process and they even did not have enough experiences about DM process just like the businessmen or politicians. Therefore, this research covered the necessity of the construction of a specific DM normative model for a referendum situation, which arised from the gap of the related literature.

3.2 General Profile of the Interviewer

In a qualitative research, the interaction between interviewer and interviewees is an important factor. Therefore, it is necessary to draw a general profile of the interviewer. In this study, the interviewer was the researcher herself. The researcher has been an elementary science teacher for 15 years. The researcher started her work life in a publishing house as a coordinator of a country wide examination system and worked there for approximately two years. Moreover, in her career the researcher found the chance to work as an elementary teacher in a classroom of a village public school for 5 months. After that, the researcher mainly has focused on giving one-to-one science lessons in order to continue her academic career in science education.

In her academic career, the researcher has been mainly interested in elementary science curriculum. Furthermore, she is interested in student motivation, science teachers' qualifications especially about students' scientific misconceptions, alternative assessments techniques, philosophy of science education, nature of science, gender equity in the classroom, development of science lessons educational materials by always making connections with elementary science curriculum.

In the present study, the interviewer role that the researcher preferred to take on was the composition of the miner and the traveler, which was suggested by Kvale (1996). In brief, in the miner role, the interviewer thinks that the knowledge is hidden inside the subject under study and it is waiting to be uncovered by the researcher. In the traveler role, the interviewer is closer to the postmodern understanding of knowledge and the researcher takes on a very interactive position in his/her study while he/she is communicating with the subjects of the study. Moreover, Kvale suggests bringing together the advantages of these two metaphoric understandings of the interviewer and centers a "semi-structured life world interview," in which conversation is a research tool. The main points in such kind of conversation are that the interlocutors do not exchange views only spontaneously and the interlocutors do not have equal positions because the interviewer designs and controls the situation and supports his/her questioning with follow-up questions according to the answers that the interviewee provides.

3.3 General Profile of the Interviewees

In this study, purposive and convenience sampling strategies were used and interviews were made with the pre-service science teachers. The sampling was purposive because it was based on the need for mainly elimination of subject characteristics threat by selecting people who:

i. have similar educational background in terms of DM process and the SSI used in this study,

ii. are at similar ages,

iii. have similar social and scientific interests,

iv. are feasible to separate into two groups in terms of their NOS understandings as unsophisticated and sophisticated according to Lederman’s expressions about NOS.

Therefore, it was decided that *(1)* pre-service science teachers *(2)* at third year *(3)* in the same university are fit for this study. Firstly, restrictive conditions led the researcher to focus on pre-service science teachers, who are responsible for attending at least a one-semester course, methods of teaching science 1, in which NOS understandings may significantly improve because related with the pre-service science teachers this course covered the aims developing NOS, scientific inquiry and scientific literacy understandings, performing activities related to the science concepts, nature of science and science process skills, clarifying and refining own views of science, and appreciating the role of NOS and history of science in science education.

Secondly, being a third year student was also important to find sophisticated people in terms of NOS understandings as they have taken NOS related lessons at that level. Finally, they would be in the same university in order to find the people who have a more similar social profile. In this study, it was thought that having participants with a similar social profile is also important to minimize extraneous variables and to identify better the proper communication style for the referendum simulation.

In addition to this, convenience sampling was used for the researcher’s availability, and therefore, it focused on the pre-service science teachers at the university in the city where the researcher has lived. In this way, it was thought that it would be easy to contact and to schedule the interviews with the participants.

The descriptive information about the participants of the main study (in-depth interviews in referendum simulation) is listed in Table 3.1. In order to respect the confidentiality of private life, the real names of the participants were hidden in the table. Instead of their names, the code numbers were used according to their NOS understandings. In addition to this, in fact, there were 16 participants for in-depth interviews. However, after content analysis was done for their NOS understandings, 12 of 16 were found to be suitable to be placed into two groups and the NOS profiles of these 12 participants are widely explained in the related section. In this study, all of the participants were female, which was not surprising because teaching is very favorable occupation in Turkey for women. It is hoped that this situation would also help to equalize their personal experiences which can be also counted as a variable in DM process.

Table 3.1

The descriptive information about the participants of the main study (in-depth interviews in referendum simulation)

	No.	**Gender**	**Age**	**Year**	**Interview recorded duration**
GROUP U	U1	Female	21	3	135 minutes
	U2	Female		3	147 minutes
	U3	Female	24	3	173 minutes
	U4	Female		3	117 minutes
	U5	Female	24	3	136 minutes
	U6	Female		3	132 minutes
GROUP S	S1	Female	22	3	128 minutes
	S2	Female	23	3	120 minutes
	S3	Female	22	3	177 minutes
	S4	Female	22	3	129 minutes
	S5	Female	22	3	140 minutes
	S6	Female	24	3	197 minutes (from pilot study)

U: Participants who have unsophisticated NOS understandings
S: Participants who have sophisticated NOS understandings

At this point it is important to mention that, in this study, before the main study, a pre-study was conducted with focus group interviews in order to develop the data gathering tool for the main study. In the following section, this pre-study conducted with focus group interviews is explained, and there is detailed information to understand the general characteristics of the pre-service science teachers which enlightens the general characteristics of the participants in the main study.

3.4 Data Gathering Method

In this study, firstly, a pre-study was conducted with focus group interviews in order to construct data gathering tool for the main study, which was in-depth interview method conducted through referendum simulation about a selected SSI. In the following sections detailed information about both the pre-study and main study is explained.

3.4.1 The pre-study conducted with Focus Group interviews in order to develop the data gathering tool for the main study

The general aim of the pre-study was to develop a data gathering tool for the main study which is suitable for the related chracteristics of the subjects studied on. When the DM literature was investigated, it was understood that the readiness of a person such as making a decision about an issue, his/her priorities among the issues and his/her sources of information about an issue can highly affect the DM process (Bettman et al., 1991; Svenson, 1996). Moreover, as it was stated before, it was concluded that in order to make a proper analysis to understand the NOS effect on DM, selected SSI should be (1) interesting (2) familiar to be discussed (3) clearly understandable, and (4) participants' prior knowledge about the selected SSI should be similar (Fraenkel & Wallen, 2006). In order to achieve these aims, focus group interviews were constructed, and then, conducted with second year pre-service science teachers as they would be the subjects of the main study in the following year.

3.4.1.1 Purpose of the pre-study

The focus group interview in the pre-study was developed through the following research questions:

1. In general, at which level are the pre-service science teachers interested in socioscientific issues?
2. How do the pre-service science teachers collect information about socioscientific issues?
3. What kind of socioscientific issues are the pre-service science teachers interested in most?

4. How do the pre-service science teachers like to discuss socioscientific issues?
    4.1. How should the duration of the interviews be arranged for pre-service science teachers to discuss socioscientific issues?
    4.2. How should the environment of the interviews be arranged for pre-service science teachers to discuss socioscientific issues?
    4.3. Which kind of communication style do the pre-service science teachers prefer while discussing socioscientific issues?

Within the framework of the research questions above, the characteristics and the readiness of the pre-service science teachers were analyzed.

3.4.1.2 Sample Selection for Focus Group

For the focus group interviews purposive sampling was used and it focused on second year pre-service science teachers who would be able to start their third year in which NOS related course exists. The verbal announcement about the general aim and the technique of the study was made to the pre-service science teachers. Then, the contact information of volunteers was collected. The number of volunteers was high enough to make interviews in two sessions by separating the participants into two groups in order to increase the validity of the focus group interviews. Moreover, in order to collect more detailed data from the focus group by keeping group dynamics high, the volunteers were asked to form two groups by themselves. After all the schedules were finished for the focus group interviews, two groups, one with 6 members and the other one with 7, were formed by the volunteers and interviews were made with each group in different sessions. As it is seen in Table 3.2, the real names of the participants were hidden in order to respect the confidentiality of private life. Instead of the names, code names were used to show their groups by end letters of the names, 'a' for Group I and 'e' for Group II. At this point it is very important to mention that 7 of these total 13 participants participated in the main study too.

Table 3.2

The descriptive information about the participants of the pre-study (focus group interviews)

Group I				Group II			
Code	**Gender**	**Age**	**Year**	**Code**	**Gender**	**Age**	**Year**
Ayla	Female	22	2	Afife	Female	23	2
Belma	Female	23	2	Bilge	Female	21	2
Ceyda	Female	21	2	Cemre	Female	21	2
Derya	Female	23	2	Defne	Female	21	2
Esra	Female	23	2	Ege	Female	21	2
Fatma	Female	23	2	Feride	Female	22	2
				Gökçe	Female	21	2

3.4.1.3 Development of the data gathering tool for Focus Group

Firstly, in order to understand the readiness of the focus group to make a decision about an SSI, semi-structured focus group interview questions were prepared. Then, a pilot study was conducted with a group of four friends to focus. Therefore, some adjustments were made in order to clarify the focus group interview questions. Lastly, the interview questions were checked by the experts from science education department, and then, the data gathering tool for the focus group interviews, which is stated in Appendix D, took its final version.

3.4.1.4 The Analysis of Focus Group

The data gathered through focus group interviews were analyzed using content analysis to understand what kind of data gathering tool could be constructed for the main study. This analysis is explained in the following sections.

3.4.1.4.1 The general atmosphere of the Focus Group interviews

Analyzing the general atmosphere of the focus group interviews is important in order to understand the communicational dynamics of the focus group. Moreover, in this study, analysis through direct observations was used to construct the communicational circumstances of the main study, which was in-depth interviews in the referendum simulation.

For the focus group interviews, a familiar cafe in the focus group's university campus was selected in order to make the volunteers feel comfortable to be involved in the discussions. This place was also suitable for such kind of applications as it already had a special section for business meetings with a boardroom table. The application times for both of the interviews were arranged with the participants by also considering the appropriateness in terms of crowdedness of the place. In this way, a friendly medium was established for the participants to express their thoughts and feelings easily.

In the interviews, the voice recording device was used with the permissions of the participants and it remained on during the whole interviews, which took approximately 2 hours each, including a 10-minute break and a 15-minute free discussion time for the participants without the researcher.

At that point, it is important to mention that all participants of the focus group interviews were motivated to be involved in the study and at the end of the interviews, they generally seemed to be happy, too. In fact, some of the participants directly stated that they were glad to be there.

Moreover, it was observed that apart from one participant from each interview group who talked more frequently than others, in general, all participants were involved in the discussions equally. Furthermore, because they expressed themselves very well in discussions, and because they wondered to understand other participants' thoughts, it was concluded that the members of the focus group generally internalized the modern discussion culture.

In addition to this, it was understood that the friendship among the members of the focus group was based on the faculty interactions. It was also observed that they treated the other members of the focus group gently and they listened to the others' opinions very carefully.

3.4.1.4.2 The Focus Group's level of interest in SSIs

In the interviews, it was observed that although the participants easily gave many examples from SSIs, not all of them paid equal attention to each SSI. Fatma's quotation below is very representative:

> *Fatma: Hocam, there is one more thing. For example, a person cannot search every topic. Let's say, for example, I like music, so I am interested in news about music. But, for example, let's say, we had talked about abortion. I may not search that. But, for example, news about fashion might attract the attention of another one of our friends, so he/she might be interested in that. I mean it is not always necessary to do research about these topics I think. I mean it is about the person's own area of interest.*

Ceyda also stated this situation as below:

> *Ceyda: People talk about a lot of things. We hear about a lot of new things in the news. There are new things on the Internet, social media. We would read them all then. We skip most of them. This is something that partly stems from intention…*

Furthermore, the speech among Feride, Cemre and Ege regarding the interview question "Do you follow the news about SSIs" is also very good to show the focus group's general interest level about SSIs.

> *Feride: No. I usually look at the headlines [of the news], so you know, I've never had the thing to go into and explore the news.*
>
> *Cemre: If it really attracts my attention, then I open and read it.*
>
> *Ege: Me too.*
>
> *Cemre: For example, they have produced artificial bone or muscle or something. I don't remember clearly now. You know, that really attracted my attention. I mean they produced it. I looked at it, I mean I examined it, I looked it up on the Internet.*

Moreover, it was understood that in general, participants were not interested in the SSIs passionately and they found this situation natural. On the other hand, it was also understood that if an SSI comes to agenda of the country, they become motivated to investigate it. For example, the following speech between Ceyda and Esra about Akkuyu Nuclear Plant is a good example to show the focus group dynamic about this issue:

> *Ceyda: After Akkuyu nuclear power emerged, I felt the need to read about it on the Internet because I realized that I didn't have much information. But, as I mentioned before, how correct or wrong it is, I got informed that way.*
>
> *Esra: Yes, these issues were dominating at that time, I read about it at that time.*

Here it is also important to mention that the participants explained that the main reason for their lack of interest in SSIs was their course intensity in their university education. Moreover, it seemed that for the focus group, their university education formed the center of their lives. For example, Derya explained her situation as follows:

> *Derya: I, for example, was reading the books in biology class last semester. The instructor was not lecturing and I was reading by myself. I saw it there. I mean the thing of some institutite. You know, when you go online, they say you can find fingerprints, data or similar stuff there. I really wanted to look it up, but my priority there was to finish the topics as soon as possible and to study for the exam for example. I have no time because we have one exam after another one.*

In addition to this, it was understood that the focus group needed some encouragement to go over the SSIs which they are interested in. For example, they felt a need to do more detailed research about an SSI almost only when they had to prepare a presentation for their lessons. Collective response of the Group I participants below is also representative about how much interested they are in the SSIs.

> *Esra: I am not much familiar with this issue [nuclear power stations]. I don't have a good grasp of it.*
>
> *Ceyda: I mean we don't have much information about it, but at least there is something, you know, it's been he topic.*
>
> *Fatma: I mean we've heard about it here and there.*
>
> *Belma: I had written an essay on nuclear energy for 102 course. I had searched about it a lot.*
>
> *Others: Wow, you know the topic.*

Moreover, Cemre also provided a representative example to show in what circumstances the focus group felt the need to do more detailed research about an SSI.

> *Cemre: Because I have never forced myself that way [to make a clear decision]. I speculate like this and when I feel confused, I feel indecisive. Let's leave this. Frankly, I have never made such an in-depth investigation… But there is something: as I said before, I have never done research and I think spontaneously. I put a plus here and then I put a plus there too, and then I feel confused. I can't choose one. Both sides make sense… I say this one has this, OK, but that one has that, and then I feel puzzled. But just as you did, if they told me that there had to be a voting in the end, then I would sit and search about it seriously.*

As a result, the analyses showed that there are 9 common discourses, which are listed in Table 3.3, in order to identify the focus group's general interest level in the SSIs.

Table 3.3

The characteristics of the Focus Group's interest about SSI

Collective discourses
We are not interested in all kinds of SSIs.
Our attention to the SSIs is drawn only when we are informed about them by news or lessons.
We generally look at only the headline of the news about SSIs on the internet and only if the news gets our attention, we are interested in the content of the news story.
If an SSI gets our attention, we only investigate it on the internet.
We cannot have enough time to consider and to investigate the SSI deeper because of our lessons schedule.
We need encouragement to be interested in the SSIs more.
For us, the most effective encouragement to draw our attention to an SSI is an obligation.
Our departmental lessons make us interested in the SSIs more.

3.4.1.4.3 The Focus Group's information sources about SSIs

As it was stated before, the focus group is affected by the general agenda of the country. The following quotation of Belma was very representative:

> *Belma: We get interested in whatever the recent news is about. We talk about it with friends. We say "look, this happened today", like that, and then we discuss it.*

Moreover, it was observed that the participants from both interviews make internet surf over and over again when they have a discussion about an SSI. Therefore, it was understood that the focus group lives very close to the internet based social media and they mainly feed on news on the internet about SSIs. The following speech flow of the first interview's participants after the interview question "Do you follow the science and technology related news?" was a good example to identify the focus group information source about the SSI.

> *Ayla: I mean when it is on the news. News on the Internet, news in the newspapers.*
>
> *Belma: Whenever I see it on the Internet, I click on it. But I don't spend a special effort.*
>
> *Esra: There are a lot of them on the news, on the Internet.*
>
> *Fatma: Hocam, I now download even newspaper applications and I check it out there.*

Furthermore, as it can be seen in the following quotations of Gökçe and Cemre, the focus group generally investigated the internet based news about an SSI superficially.

> *Gökçe: [Instead of reading the written news] I like watching videos more. For me, when I follow them through these kinds of things [videos], to be honest, I don't think they may be so wrong. Therefore, I don't dwell on it much, I don't search for it somewhere. I feel content with the information there if I am not much curious about it. And I don't really feel curious about it much most of the time. That remains, I feel that's enough, I get it, and that's it. You look at it as if [the information there] is correct.*
>
> *Cemre: What's more, in those kinds of news, the people talking there are usually the people conducting that study. Say professor doctors, or somebody else. I didn't check whether it is correct or not. It already attracted my attention and I opened it to get more information. I guess I trust them, so I never questioned whether the news is fake or not.*

The speech flow of second interview's participants also summarized the focus group's general tendency about the information source about the SSIs.

> *Bilge: I have seen a movie about cloning. Is cloning OK?*
>
> *Ege: I really don't know whether cloning is OK or not. I mean there is such a rumour in scientific circles.*
>
> *Gökçe: I don't know much about it.*
>
> *Feride: We need to check this out on the Internet.*
>
> *Gökçe: Have you ever?*
>
> *Bilge: We've watched a movie, what else is needed? (chuckling)*
>
> *Ege: We discussed this in class… years ago.*
>
> *Feride: I had a debate on it.*

When all related speech was analyzed, 3 main discourses were identified about the focus group's information source about the SSIs, which are listed in Table 3.4.

Table 3.4

The characteristics of the Focus Group's source of news about SSI

Collective discourses
Our primary source of news about the SSIs is based on the internet and we also get informed from other media and the lessons.
We investigate the news about the SSIs superficially.
We are affected by the agenda of the media related with the SSIs.

3.4.1.4.4 The Focus Group's interest areas about SSIs

When the data from the focus group interviews were analyzed as a whole, it was seen that the participants mentioned 42 different SSIs. Moreover, it was understood that each participant was able to give an example from more than one SSI during the interviews. In Table 3.5, 12 different interest areas are listed for the focus group by categorizing all 42 SSIs, which were mentioned by the members of two groups from different sessions.

Table 3.5

Focus group's interest areas about the SSIs

Interest areas about the SSIs	**Involvement in the discussions**
Food technologies and nourishment (Genetically modified food, additive agents, seed statute etc.)	both groups full involvement
Healthiness and technologies about health (abortion, organ donation, influenza vaccine, cosmetic surgery, cloning, tissue culture etc.)	both groups full involvement
Energy technologies (nuclear power, solar power, hydroelectric plants etc.)	both groups full involvement
War technologies (mass destruction weapons)	both groups full involvement
Robotics (artificial intelligences etc.)	one group full involvement
Communication technology (smart phones, virtual world, internet based social media etc.)	one group full involvement
Use of natural sources (water, petrol etc.)	one group full involvement
Intelligence technologies and security of the private life (recording the personal information etc.)	one group full involvement
Animal rights (animal testing, animal husbandry etc.)	both groups partial involvement
Climate change (global warming)	one group partial involvement
Industrialization and development based problems (conurbation, rural-urban migration, economic inequalities etc.)	one group partial involvement
Perception management (mind control research)	one group partial involvement

In addition to this, with the analysis of participation densities of the interviewees in the discussions in both interviews, it was understood that the SSIs related with *(i)* food technologies and nourishment, *(ii)* healthiness and technologies about health, *(iii)* energy technologies, and *(iv)* war technologies were the only four interest areas that all interviewees tended to discuss together as a group. Therefore, these four areas were identified as the focus group's interest areas about SSIs. In the following excerpt, there is an example from the first interview for how easily the focus of the discussion changed to the food technologies even when they were talking about completely different issues. This example also shows how volubly the speeches flow when the issue comes to the food technology related subjects.

> *Fatma: For example, they have produced a new telephone line and distributed free to all people, the whole country. There is free talk, sms, and a lot of other things. Everybody inserts it to their phones, and then, through that telephone line, just by pushing a button, an electromagnetic wave does something and that gives harm to*

some cells in people's brains. People beat each other to death. What was the name of that movie? I forgot it. For example, the world is struggling with hunger and therefore, they gathered all rich people together in a certain place and the rest is killing each other. It was the year 2100 or something.

The researcher: Did you find this movie persuasive? Have you dwelled on it?

Fatma: Yes, I did hocam. This might sound a bit unrealistic but can you imagine what we could do if we were too tested by hunger? Imagine you are hungry. I mean there is nothing. Crops don't grow.

Derya: There is a series which consists of three episodes. It is called Black Mirror. This offers nice criticism on these issues.

Fatma: In fact, I think we are misinformed about GMO. Hocam, I think hunger is the unavoidable end. I mean even now, day by day, we are not able to produce as much wheat as in the past. Because the structure of the soil is changing, temperature is changing, conditions are changing. For example, in Ankara, it is just getting warm in some places, but assume that it gets warm earlier. Therefore…

Derya: Yes, for example, the wheat rotted because of heavy rains.

Fatma: Yes, for example, I watched it on the news a few days ago, strawberries are now this size [very big] but without hormones. Now that hunger is the unavoidable end, I think scientists are trying to do such things.

Esra: But did we start GM products because we were hungry?

Others: To boost productivity.

Ceyda: While trying to boost its productivity, they are decreasing something else.

…

Ceyda: What you eat won't be corn any more.

Others: Yes, exactly.

A second example can be given from the second interview which was during when the researcher gave them time to discuss the issues with each other alone. This example is also very representative to show how quickly the subject of the discussion changes from war technologies to food technologies.

Afife: Wars spread everywhere, almost everywhere.

Bilge: And there are also some subtle wars, not the overt ones only.

Ege: Yes.

Bilge: The man produces a product and then, I don't know, but adds something to it.

Ege: And makes you an addict.

Bilge: And makes you an addict, yes.

Cemre: Yes.

Ege: Harms the health of the whole society

Feride: Blocks our thinking.

Gökçe: For example, GDO is too, you know.

Afife: Yes.

Bilge: Yes, in fact it is close to that.

Defne: This affects the next generations.

Feride: Affects us too

Gökçe: Us too.

Moreover, all the mentioned socioscientific events in the interviews that came to the country's and world's agendas are listed in Table 3.6. With this table, it is clearly understood that the participants could easily remember and so were interested in the socioscientific events of the last decade. In addition to this, the participants were informed about the atomic bombs dropped by America to Hiroshima and Nagasaki in 1945 and Chernobyl nuclear accident in 1986. It is known that these two events have continued to come to the agendas frequently whenever such kind of issues are discussed in the media.

Table 3.6

All the mentioned socioscientific events in the interviews

Events	Location of the events	Date of the events
Country wide electricity interruption	Turkey	2015
Akkuyu Nuclear Plant	Turkey	2015
Ebola epidemic	West Africa	2013
Abortion law	Turkey	2012
Fukushima nuclear accident	Japan	2011
Genetically modified food law	Turkey	2010
Safety issues about influenza vaccine	World wide	2009
H1N1 influenza epidemic	Turkey	2007
Crimean-congo hemorrhagic fever	Turkey	2007
Seed statute	Turkey	2006
Avian flu epidemic	Turkey	2005
Chernobyl nuclear accident	USSR	1986
Atomic bombs dropped by America to Hiroshima and Nagasaki	Japan	1945

When all the analyses were brought together in this section, it is understood that the focus group was generally interested in five kinds of SSIs, which are listed in Table 3.7.

Table 3.7

The kinds of SSIs that the focus group was interested in

The SSIs related with:
food technologies and scarcity based problems
healthiness
energy technologies
war technologies
the events in last 10 years

3.4.1.4.5 The Focus Group's communication choices to discuss SSIs

Both focus group interviews took approximately 2 hours. Moreover, at the end of the interviews, the participants still seemed motivated to talk about the SSIs. It was concluded that the focus group felt ready to discuss the SSIs longer. It was also observed that being in a friendly and familiar place helped the participants feel even more comfortable to express their ideas. In addition to this, when the participants' choices about source of news were taken into consideration, it was concluded that the data gathering tool prepared for the referendum simulation should include generally short information supported by some visuals like the ones popular web pages have.

3.4.2 Data gathering tool for the main study

Under the light of the focus group interviews, it was decided to connect a referendum simulation with in-depth interviews through the SSI -the artificial meat. The artificial meat issue consists of unstructured problems in uncertainty conditions as the scientists are still working on it. Moreover, the artificial meat is directly related with the food technologies and nourishment and also can be easily connected to healthiness, which were the two interest areas that the focus group liked to discuss most and thus is familiar with. In addition to this, the artificial meat has come to agenda in the last decade, which is the focus group's interested time period for SSIs. Furthermore, with the total analysis on the focus group interviews, it was concluded that for the focus group, the probability to know deeper information about the artificial meat was quite low and this situation helped to minimize subject characteristics threat. In addition to this, Turkish cuisine is very rich in meat dishes and it is known that Turkish people like to consume those meat dishes a lot. However, there are also some taboos about the consumption of meat products in Turkey, mainly because of the reflections of the dominant religion. Therefore, the artificial meat is a controversial issue from the perspective of Turkish people and the people with similar interests and concerns about meat products.

Beside all the process of pre-study conducted with focus group interviews, the development of data gathering tool for the main study took 6 months, including its own pilot studies. After the selection of the artificial meat as the SSI in order to make a decision in the referendum simulation, a wide research was done about it on the internet as the basic information source of the focus group was that. Then, the information collected from the internet was classified, simplified and rearranged according to the focus group's general characteristics. After that, the in-depth interview questions were prepared to conduct the referendum simulation and the first draft of the data gathering tool was presented to the experts. Under the light of expert opinions who are professors on science education at a university in Turkey, some adjustments were made to the in-depth interview questions and the data gathering tool became ready for the pilot study.

The pilot study was implemented to two volunteers of the focus group members and the interviews took more than 3 hours. With the analysis of the data of this pilot study, it was decided to make some changes in some questions and figures of the data gathering tool for the second draft of it. Then, the second draft of the data gathering tool was presented to the same experts who are professors on science education in order to give it the final shape.

The final shape of the data gathering tool for the main study (see Appendix C) which was used to conduct in-depth interviews for the referendum simulation consisted of five categories of information and the semi-structured questions related with them including the questions which mainly focus on the participants' NOS understandings. These five categories of information about the artificial meat are "News about the Artificial Meat", "The Production Procedure of the Artificial Meat", "Opinions of the Scientists Who Work on the Artificial Meat", "Opinions from Worldwide about the Artificial Meat" and "Opinions of Turkish People about the Artificial Meat" and all of them are briefly explained in the following section.

3.4.2.1 News about the artificial meat

'News about the Artificial Meat' in Figure 3.2 was prepared to collect the initial responses of the participants by rearranging the various internet based news about the artificial meat in 2011, 2012 and 2013[3]. It is related with just the publicity of the artificial meat and includes very little information which covers only some opinions about its taste and form besides the general information about the scientists who work on it and the approximate cost of the study[4]. This was the start of the referendum simulation.

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[3] The information, captures and photographes in Figure 3.2 were used from: BBC NEWS (2013, August 5). World's first lab-grown burger is eaten in London. Last Retrieved September 20, 2019 from https://www.bbc.com/news/science-environment-23576143; Parry, David (2013). Cultured beef [Photograpy]. PA Wire. cited in Culturedbeef Org.. Last Retrieved September 20, 2019 from https://culturedbeef.org/media-resources/14044; Sözcü Gazetesi (2013, August 7). Yapay et 'görücüye' çıktı. Last Retrieved September 21, 2019 from http://sozcuhaber.blogspot.com/2013/08/yapay-et-gorucuye-ckt.html

[4] From 2013 to 2019, there have been some improvements in the production of the artificial meat and therefore the average cost of a kilogram of the artificial meat/cultured meat reduced from 250.000 euros to 100 euros. For more information see also: González, A., & Koltrowitz, S. (2019, July 11). The $280,000 lab-grown burger could be a more palatable $10 in two years. Last Retrieved September 18, 2019 from https://www.thejakartapost.com/life/2019/07/10/the-280000-lab-grown-burger-could-be-a-more-palatable-10-in-two-years.html


Bilim insanları çiftlikte yetişmemiş, laboratuvarda üretilmiş etten yapılan hamburgeri dün tanıttı, pişirdi ve yedi (06.08.2013-gazeteler)

Hollandalı bilim insanları çiftlikte yetişmemiş, laboratuvarda üretilmiş etten yapılan hamburgeri dün tanıttı, pişirdi ve Batı Londra sanat ve televizyon stüdyosunda yedi.

The Wall Street Journal gazetesinin haberine göre, 'laboratuvar hamburgeri' çiğ dana kıymasına benziyordu ama pembe rengi kırmızı pancar şerbeti ve safran kullanılarak verilmişti. Ekmek kırıntıları ve eti bir arada tutması için bağlayıcı madde de içeren hamburger köftesi ayçiçek yağında kızartıldı ve yaklaşık 200 katılımcının bulunduğu basın toplantısında, araştırmada yer almayan bir yemek yazarı ve yemek bilimci tarafından test edildi.

İlk tespit: sığır etinin genelde sahip olduğu yoğun çeşniye sahip olmasa da benzer bir dokuda.

Tadına bakanlar laboratuvarda üretilen köftenin, sığır etinin genelde sahip olduğu yoğun çeşniye sahip olmasa da benzer bir doku ve sulu yapıda olduğunu belirtti. Bu kişiler etin çeşnilendirilmesi gerektiğini belirttiler. Muhabirlere ise eti tatma fırsatı verilmedi, etkinliğin organizatörü herkes için yeterli et bulunmadığını açıkladı.

Birkaç yıldır devam eden çalışmanın maliyetinin 250 bin Euro'nun üzerine olduğu belirtildi.

Figure 3.2 News about the Artificial Meat.

After the participants had time to read the news by themselves, the follow-up questions were asked to them. These questions focused on collecting data about the initial responses such as how much information the participants have about artificial meat at the beginning, how much curiosity this news arouses and what kinds of advantages and disadvantages the artificial meat can have. At the end of the follow-up questions, the participants were directed to vote for the referendum about selling the artificial meat in Turkish markets.

At this point, it is better to emphasize that first votings were done only after the news with almost no information about the artificial meat, in order to collect data to understand the participants' attitudes in this kind of circumstances. In this way, it was also aimed to understand better their attitudes towards following informing parts such as the production procedure of and the scientists' opinions about the artificial meat in order to search a connection between the participants' initial responses and their final decision if exists. In addition to this, this part of the referendum simulation was also prepared to understand the participants' natural way of thinking when they meet a relatively new SSI and besides the data from other parts, the data collected from this part was used to construct a DM model for this study.

3.4.2.2 The production procedure of the artificial meat

'The Production Procedure of the Artificial Meat' informing part in Figure 3.3 consists of brief technical explanations about the laboratory work of the artificial meat[5].In this referendum simulation, the participants investigated each explanation one by one and some additional clarifications and details about the procedure were given to them when they asked, too. This part was mainly prepared to put forth the reliability level of this study by determining whether the participants' understandings about the procedure of the artificial meat are similar or not. Moreover, the follow-up semi-sutructured questions of this part were also constructed to encouraged the participants to focus on the artificial meat, and then, to reflect their way of thinking about it. Furthermore, with this part, the participants were provided with a chance to compare the artificial meat with genetically modified food.

Figure 3.3 The Production Procedure of the Artificial Meat.

[5] The information, captures and photographs in Figure 3.3 were used from: BBC NEWS (2012, February 20). Synthetic meat grown in Dutch lab. Last Retrieved September 20, 2019 from https://www.bbc.com/news/av/science-environment-17104501/lab-grown-meat-is-first-step-to-artificial-hamburger; BBC NEWS (2012, August 5). How to grow a burger in the lab. Last Retrieved September 20, 2019 from https://www.bbc.com/news/av/science-environment-23554340/how-to-grow-a-burger-in-the-lab; Ekici, Ö. K. (2011). Yapay et geleceğin hayvansal gıdası olabilir mi?. *TÜBİTAK Bilim ve Teknik Dersigi*, *Ekim*, 36-41.

3.4.2.3 Opinions of the scientists who work on the artificial meat

'Opinions of the Scientists Who Work on the Artificial Meat' informing part in Figure 3.4 was designed by considering the scientists' general discourses about the artificial meat in order for the participants to focus mainly on the ways of using the artificial meat[6]. In this part, there are 4 groups of scientists and each group has its own explanations. The follow-up semi-structured questions were prepared mainly in order to lead the participants to compare and contrast the opinions especially with the group of questions regarding the scenario in which the participants have the responsibility for managing the budget for the artificial meat research. With the help of this scenario, the participants made a priority sequence among the 4 different groups of scientists' opinions and they tended to explain their thoughts about the artificial meat in detail.

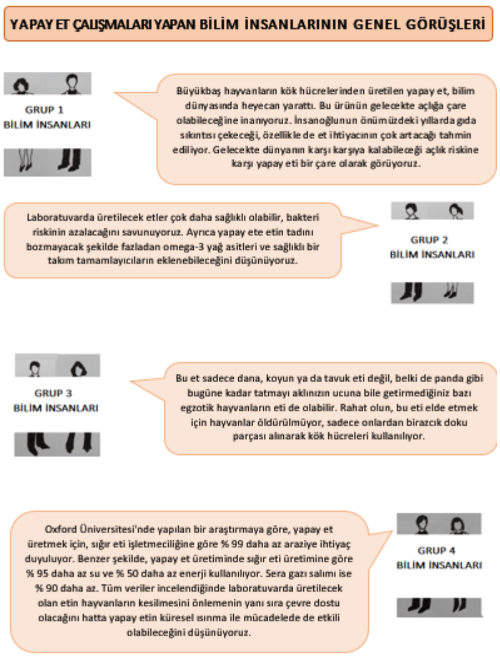


Figure 3.4 Opinions of the Scientists Who Work on the Artificial Meat.

[6] The information, captures and photographes in Figure 3.4 were used from: Hürriyet Gazetesi (2012, Febuary, 20) . Hollandalı bilim adamları sentetik et üretti. Last Retrieved September 21, 2019 from http://www.hurriyet.com.tr/gundem/hollandali-bilim-adamlari-sentetik-et-uretti-19957963; Ekici, Ö. K. (2011). Yapay et geleceğin hayvansal gıdası olabilir mi?. TÜBİTAK Bilim ve Teknik Dersigi, Ekim, 36-41.

3.4.2.4 Opinions from worldwide about the artificial meat

'Opinions from Worldwide about the Artificial Meat' informing part in Figure 3.5 was prepared directly by considering the focus group's interests in internet searches as the main source of information about the SSIs[7]. Therefore, this part consists of very brief information which reflects some opinions from worldwide that can be easily come across through an instant surfing on the internet.

Moreover, the semi-structured follow-up questions prepared for this part were used to give the participants an additional opportunity to express their own opinions better regarding the artificial meat through the opinions from worldwide. Furthermore, in this part, the participants found more chances to compare the artificial meat with the plant-based meat-like products beside the usage areas, advantages, disadvantages of it.

[7] The information, captures and photographs in Figure 3.5 were used from: Milliyet Gazetesi (2013, August 8). Vejetaryenlerin yapay et bilmecesi. Last Retrieved September 21, 2019 from http://www.milliyet.com.tr/vejetaryenlerin-yapay-et-bilmecesi/gundem/detay/1747251/default.htm; Savaş, A. (2012, June 24). Yapay et dünyayı kurtarabilir mi? Last Retrieved September 20, 2019 from https://www.sabah.com.tr/pazar/2012/06/24/yapay-et--dunyay-i-kurta-rabili-r-mi; Sözcü Gazetesi (2013, August 7). Yapay et 'görücüye' çıktı. Last Retrieved September 21, 2019 from http://sozcuhaber.blogspot.com/2013/08/yapay-et-gorucuye-ckt.html; Ekici, Ö. K. (2011). Yapay et geleceğin hayvansal gıdası olabilir mi*?. TÜBİTAK Bilim ve Teknik Dersigi, Ekim*, 36-41.; NTV (2015, October 12). Veganlık ve vejetaryenlik sağlığı nasıl etkiler? Last Retrieved September 21, 2019 from https://www.ntv.com.tr/saglik/veganlik-ve-vejetaryenlik-sagligi-nasil-etkiler,AR15oDHuLUOeiEVyEAR9Og; Hürriyet Gazetesi (2016, Febuary 24). Vejetaryen nedir? Last Retrieved September 21, 2019 from http://www.hurriyet.com.tr/kelebek/saglik/vejetaryen-nedir-40058884; Stern, J. (2013, August 5). Google co-founder: the man behind the $300K test-tube burger. Last Retrieved September 21, 2019 from https://abcnews.go.com/Technology/google-founder-sergey-brin-man-300k-test-tube/story?id=19872215; Zee News (2016, Nowember 27). NASA to work with UAE on Mars probe. Last Retrieved September 21, 2019 from https://zeenews.india.com/space/nasa-to-work-with-uae-on-mars-probe_1953956.html; animalialatina (2012, December 20). PETA logo. Last Retrieved September 21, 2019 from https://animalialatina.wordpress.com/2012/12/20/otro-ano-mas-de-exitos/peta-logo/; Sanchez, Marcio Jose (2010). Tweaking Twitter [Photography]. Associated Press. cited in Carlson, N. (2011, April 14). The real history pf Twitter isn't so short and sweet. Last Retrieved September 21, 2019 from http://www.nbcnews.com/id/42577600/ns/business-us_business/t/real-history-twitter-isnt-so-short-sweet/#.XYYKq5V7mdI with; Kelland, K. (2011, Nowember 11). Petri dish to dinner plate, in-vitro meat coming soon. . Last Retrieved September 21, 2019 from https://www.reuters.com/article/us-science-meat-f/petri-dish-to-dinner-plate-in-vitro-meat-coming-soon-idUSTRE7AA30020111111

Figure 3.5 Opinions from Worldwide about the Artificial Meat.

3.4.2.5 Opinions of Turkish People about the artificial meat

'Opinions of Turkish People about the Artificial Meat' informing part in Figure 3.6 was prepared for similar reasons with the previous informing part. This part includes the opinions of people from five different occupational areas[8].

In this study, before the participants read these opinions and expressed their response, some questions were asked to the participant in order to make a prediction about the possible general attitudes of Turkish people about the artificial meat. Besides giving the participants more chances to think about the artificial meat through the others' opinions, this final informing part was prepared in order to lead

[8] The information in Figure 3.6 were used from:

Savaş, A. (2012, June 24). Yapay et dünyayı kurtarabilir mi? Last Retrieved September 20, 2019 from https://www.sabah.com.tr/pazar/2012/06/24/yapay-et--dunyay-i-kurta-rabili-r-mi the participants to focus on the referendum situation related with Turkish markets. At the end of this part, the participants used their votes for the referendum about selling the artificial meat in Turkish markets. Moreover, with the semi-structured follow-up questions, the data which cover the detailed explanations of the participants' general thoughts about the referendum situations for SSIs and their thoughts about this referendum simulation were collected.

Figure 3.6 Opinions of Turkish People about the Artificial Meat.

3.4.3 The implementation process of data gathering tool

The interviews were operated in the places where the interviewees stated that they felt comfortable to talk such as in some places in the university campus or at home. These interviews took generally two and a half hours and there was an approximately 15-minute break in the middle of each interview. In the interviews, the voice recording device was used with the permissions of the interviewees. During the implementations, it was observed that the participants could easily adapt to the referendum simulation. Moreover, it was understood that each of the informing parts and the follow-up questions of the data gathering tool, which were explained in the previous sections, were clear enough for the participants of this study. Furthermore, the participants' motivations were high in the interviews. In addition to this, at the end of the interviews, all of them directly stated that they were happy to participate in the study.

In fact, the in-depth interviews were implemented to 16 participants including its pilots and more than 40 hours voice recordings were obtained. However, 12 of 16 participants were selected according to their NOS understandings. The detailed explanation about this issue is stated in the following section.

3.5 NOS Analysis: Separating the Participants into the Groups According to Their NOS Understandings

This study is the first study among the similar studies which focused on the effect of NOS on DM as it was designed to identify the NOS understanding of the participant directly through the selected SSI. In the interviews, between the informing parts *'The Production Procedure of the Artificial Meat'* and *'Opinions of the Scientists Who Work on the Artificial Meat'*, there was a group of questions which directly focused on collecting the participants' NOS understanding specifically through the artificial meat (see Appendix B). In this way, it was aimed that the validity of this study would remain even if there are NOS differences in different scientific disciplines.

In order to achieve this aim, in this study, six NOS aspects were focused on, which are listed in Table 3.8, stated by Lederman (2006). In the data gathering tool, there was more than one question which were constructed to specifically measure the participants' understandings about only one NOS aspect. Moreover, there were questions which focused on more than one NOS aspect. In other words, in the interviews, a chance to collect data about the NOS understandings of the participants related with each NOS aspect by multiple questions was created. In this way, the internal validity of this section was established.

Table 3.8

Focused NOS aspects for this study

Code	**NOS aspects**
NOS1	The Tentative Nature of Scientific Knowledge
NOS2	The Creative and Imaginative Nature of Scientific Knowledge
NOS3	Observation and Inference in Science
NOS4	The Empirical Nature of Scientific Knowledge
NOS5	The Theory-Laden Nature (subjectivity) of Scientific Knowledge
NOS6	The Social and Cultural Embeddedness of Scientific Knowledge

With the content analysis, 12 of 16 participants were found appropriate to be placed into the groups (six for Group U and six for Group S) according to the similarities in their NOS understandings. The summary of the participants' NOS understandings is listed in Table 3.9 for the participants who were placed into Group U and listed in Table 3.10 for the participants who were placed into Group S. With these tables, it was clearly understood that the gaps between two groups in understandings of the aspects NOS1, NOS3, NOS5 and NOS6 were large. On the other hand, the gap between two groups in understandings of the aspect NOS2 was relatively small. In addition to these, the participants' understandings were very close in NOS4.

Table 3.9

NOS understandings of the participants placed into the Group U

	Related with the artificial meat:						
Sbj	**certainty of the scientific knowledge NOS1**	**necessity of creativity and imagination NOS2**	**differences between the scientific observation and inference NOS3**	**dependency on the empirical essentialness NOS4**	**dependency on the subjectivity of the scientists NOS5**	**dependency on the social and cultural embeddedness NOS6**	**variation among the scientific knowledge with different aims NOS1-NOS2-NOS3-NOS4-NOS5-NOS6**
U1	certain	not in all steps of the scientific process	same data same inference	yes	the scientists are objective	there is no difference among the scientists from different cultures	only one procedure, same scientific knowledge
U2	certain	except from interpretation	same data same inference	yes	the scientists are objective	there are limited differences among the scientists from different cultures	only one procedure, same scientific knowledge
U3	certain	except from interpretation	the inference is not scientific knowledge	yes	the scientists are objective	there is no difference among the scientists from different cultures	different procedure, different scientific knowledge
U4	certain	except from interpretation	the inference is not scientific knowledge	yes	the scientists are objective	there is no difference among the scientists from different cultures	only one procedure, same scientific knowledge
U5	partially certain	except from interpretation	same data same inference	yes	the scientists are objective	there is no difference among the scientists from different cultures	different procedure, different scientific knowledge
U6	partially certain	very weak in interpretation	the inference is not scientific knowledge	yes	the scientists are objective	there are limited differences among the scientists from different cultures	only one procedure, same scientific knowledge

Table 3.10

NOS understandings of the participants placed into the Group S

	Related with the artificial meat:						
Sbj	**certainty of the scientific knowledge NOS1**	**necessity of creativity and imagination NOS2**	**differences between the scientific observation and inference NOS3**	**dependency on the empirical essentialness NOS4**	**dependency on the subjectivity of the scientists NOS5**	**dependency on the social and cultural embeddedness NOS6**	**variation among the scientific knowledge with different aims NOS1-NOS2-NOS3-NOS4-NOS5-NOS6**
S1	uncertain but valid	in all steps of the scientific process	they are different kinds of scientific knowledge	yes	the scientists are subjective	the scientists are affected by their culture	the scientific knowledge is totally subjective
S2	uncertain but valid	in all steps of the scientific process	they are different kinds of scientific knowledge	yes	the scientists are subjective	the scientists are affected by their culture	the scientific knowledge is totally subjective
S3	uncertain but valid	in all steps of the scientific process	they are different kinds of scientific knowledge	yes	the scientists are subjective	the scientists are affected by their culture	the scientific knowledge is totally subjective
S4	uncertain but valid	in all steps of the scientific process	they are different kinds of scientific knowledge	yes	the scientists are subjective	the scientists are affected by their culture	the scientific knowledge is totally subjective
S5	practically cannot be certain	weak in the interpretation	they are different kinds of scientific knowledge	yes	the scientists are subjective	the scientists are affected by their culture	different procedure, different scientific knowledge
S6	practically cannot be certain	weak in the interpretation	they are different kinds of scientific knowledge	yes	the scientists are subjective	the scientists are affected by their culture	different procedure, different scientific knowledge

Moreover, when these tables were examined in detail, it can be understood that there are some variations within each group. As it is seen in Figure 3.7, none of the participants who were placed into the Group U expressed totally unsophisticated NOS understandings mainly because of their sophisticated understandings about NOS4 and because of their NOS2 understandings which were very close to be sophisticated. On the other hand, the participants who were placed into the Group S generally expressed very close understandings to be totally sophisticated.

In addition to this, although U5 and U6 had less unsophisticated NOS understandings than the other participants who were placed into Group U especially because of their NOS1 understandings, they did not provide enough criteria to be included into Group S. Furthermore, although S5 and S6 had less sophisticated NOS understandings than the other participants who were placed into Group S especially because of their NOS1 understandings, they provided enough criteria to be included into Group S.

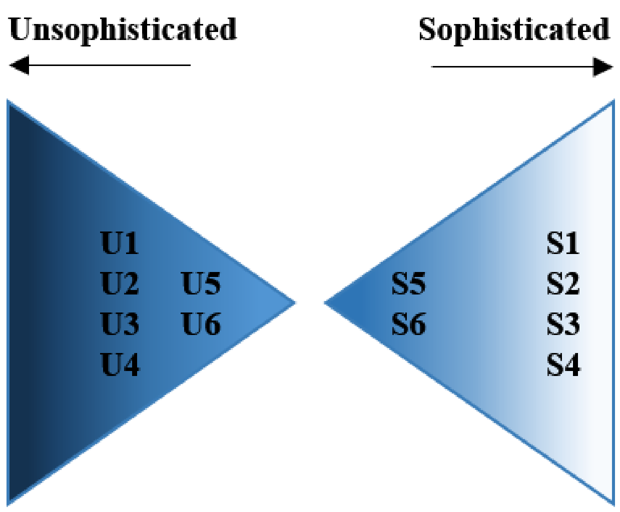


Figure 3.7 The positions of the members of Group U and Group S according to their general level of NOS understandings.

In order to explain how the participants were placed into the groups according to their NOS understandings better, in the following section some representative quotations related with each NOS aspect and related with the positions of U5, U6, S5 and S6 in their groups are provided. Moreover, in the quotations, clues can be found about the participants' understandings about the other NOS aspects because of the nature of the data gathered with in-depth interviews.

Representative quotations for the Tentative Nature of Scientific Knowledge, NOS1

In this study, the main criterion to place the participants into the NOS groups as unsophisticated (Group U) and sophisticated (Group S) was their understandings about NOS1. The participants who were placed into Group U mainly expressed scientific knowledge as absolute and certain as follows:

> *The researcher: Do you think there is certain scientific knowledge?*
>
> *U3: Yes, there is. We base everything on it already. On the ones that are certain.*
>
> *[...]*
>
> *The researcher: Do you think a piece of information which is not certain can gain certainty in time?*
>
> *U3: Yes.*

Moreover, according to two participants placed into Group U, who were U5 and U6, scientific knowledge had relatively more tentative nature than that expressed by other participants placed into Group U. Thus their NOS1 understandings were labeled as 'partially certain'.

> *The researcher: What information that the scientists have is certain about the cow meat?*
>
> *U5: For example, they must know the protein level. I think they must also know the carbohydrate level, fat level, all these levels.*
>
> *The researcher: Can we say that the measurable things then?*
>
> *U5: Yes, because they measured them.*
>
> *The researcher: What information that the scientists have is not certain about the cow meat?*

> *U5: For example, on the news they say something is very beneficial for the heart, but then, after a while, one year later, they say we think it is very harmful, so don't eat it. In my opinion, for the cow meat too, it might be beneficial for the other parts [of the body], but maybe they don't know it yet, will discover it in the future. Or eating too much meat might be harmful for another part. Now they say it is good for the heart, but that might change.*

On the other hand, the participants placed into Group S mainly thought that scientific knowledge cannot be absolute and certain as follows:

> *The researcher: What information that the scientists have is certain about the cow meat?*
>
> *S3: Nothing I guess… There are some observable features, but if certainty does not mean that it cannot change… Otherwise, I don't feel that anything has certainty.*

Moreover, according to two participants placed into Group S, who were S5 and S6, scientific knowledge is 'practically uncertain' because of the changes in, for example, technology.

> *S5: The thing that we look at and find certain is also not certain. As I said before, something changes; ratios change, technology changes in the future, then its situation might also change.*

Representative quotations for the Creative and Imaginative Nature of Scientific Knowledge, NOS2

Generally, all participants in this study had sophisticated understandings about *'The Creative and Imaginative Nature of Scientific Knowledge';* therefore, NOS2 was not a weighted criterion to place the participants into the groups. However, as it can be seen in the following quotations, the participants placed into Group U thought that although creativity and imagination are important to do science, they are not necessary in all steps of a scientific process especially in the interpretation.

> *U1: Doing this study is creativity, I mean a kind of imagination, but after you have this idea in your mind, you try to imitate that natural environment, then you create an imitation, then there is nothing about creativity there.*
>
> *U2: Yes, [creativity and imagination are important]. At the last stage of the process… The rest is obvious. In order to produce artificial meat, in is necessary to multiply the stem cells. But in the end, should it be spicier? There creativity is needed. […] However, when making an inference, yes I think it is "this way and that way," creativity might be needed at some stages of the process but the rest is obvious.*

On the other hand, the participants placed into Group S had generally much more sophisticated responses to the questions related with NOS2, as follows:

> *The researcher: Is it necessary for the scientists working on artificial meat to use their imagination and creativity while conducting these studies?*
>
> *S2: Of course, after all, it emerges with imagination in the very beginning… After imagining it, then something scientific emerges. While designing the procedure, at some certain steps they may use their imagination. In this one, embryo of the cow is used and for the other one, you said bacteria culture is used. For example, if I think what else I can use instead of this embryo… but this is not so related to imagination I guess, or it could be regarded as imagination a little. It is a kind of creativity. We can call this creativity.*
>
> *I think creativity might also be needed during data gathering. While collecting data, if it comes to his/her mind, the person may also look for something from the nature, not just the written sources. Something that seems irrelevant might turn out to be relevant, so he/she should search for them too, and form links.*
>
> *The researcher: While interpreting data?*
>
> *S2: I think again it is needed because there is a problem and the scientist has to solve it. Therefore, he/she should think creatively. Not as if he/she is solving a maths problem, but like he/she has a problem in his/her hands from real life, what can he/she do to solve it? Of course, again by using the information from the fields of maths. I think again he/she needs to use his/her creativity.*

In addition to this, S5 and S6 had relatively less sophisticated understandings than the other participants placed into Group S. For example, in the following, S6 stated that although creativity and imagination are active in all steps of the scientific process even in the collection of the data, it would be better if the scientists did not use them in the interpretation step.

> *S6: [While collecting data, imagination and creativity are at work too.] The data vary depending on how broad their perspective is. Only cow is used here but data can also be gathered through smaller living things I guess. […] In fact, [interpreting] the data should be done without using their imagination. It is more concrete. Because imagination remains more subjective but they need to reach objective conclusions based on the findings. I expect this from a scientist*

Representative quotations for Observation and Inference in Science, NOS3

Understandings about the differences in '*Observation and Inference in Science'* was one of the main criteria for the placement because the participants placed into Group U and Group S had very similar thoughts within their groups. According to the participants placed into Group U, the scientists who work on the same data will reach exactly the same inference about it. The following quotation of U2 was very representative for this issue.

> *U2: Observations, measurable things are scientific information. They are obvious, certain. Inferences are not certain; they are scientific information. But inferences may change. In general, inferences might differ but if they look at the same thing and if the ranges are the same, inferences become the same.*

Moreover, half of the participants placed into Group U had even relatively more unsophisticated understandings about NOS3 by tending to exclude the inferences to be a kind of scientific knowledge just because the inferences include subjectivity.

> *U4: [Inferences] are not [scientific information]. I mean, scientific information is subjective; in order words, scientific information, or the inference that I've made and the inference that you've made, does not have to be the same.*

However, the participants placed into Group S expressed much more sophisticated understandings about NOS3 by especially establishing an appropriate relationship between observations and inferences as related but the different kinds of scientific knowledge. For example, S4 mentioned that inference is scientific knowledge and it is based on the observations as follows:

> *S4: [Inferences] are in the scientific information, scientific process, but there is interpretation, there is imagination and creativity, so they are scientific information but in the end they are an interpretation. Since they are a result depending on the interpretation, how should I say? You know, they belong to the scientific process, but they are interpretations, so we cannot say they are definitely correct. They might be wrong, then an experiment can be designed accordingly.*

Representative quotations for the Empirical Nature of Scientific Knowledge, NOS4

With the analysis, it was understood that all the participants' understandings about '*The Empirical Nature of Scientific Knowledge*' were similar and sophisticated as it can be predicted by considering that all participants in this study were chosen from the third year of Elementary Science Education Department. Therefore, NOS4 was not used as a criterion to separate the participants into the U or S groups. Below, there are two representative speech flows from the one who was placed into Group

U and from another one who was placed into Group S in order to show how close the understandings about NOS4 of the members of both groups were:

> *The researcher: After recognizing what features of the artificial meat will scientists allow the selling of the articifical meat with contentment?*
>
> *U2: Not transmitting illness. It is important that we should not catch illness because of the embryo… The environment where it is produced can be examined, how those procedures are carried out… this procedure must be important because they gave this procedure… whether this procedure is conducted in exactly the same way. For example, is the level of protein is increased? Or what substances are added to give its taste? What substances are added to give its color? If he/she examines all these and says "ok this meets my scale," then it happens. They should pay attention to health in general.*
>
> *The researcher: How will they understand this?*
>
> *U2: Again the committee meets and examines it… checks the course of it… It is not enough to check the result only. It should be examined from time to time. And at the end, they examine the meat, the level of protein and so on; they do experiments in their own labs. It is not enough to examine the data that the others give. They themselves should examine one sample too. They should definitely have analyzed the procedure beforehand.*
>
> *The researcher: After recognizing what features of the artificial meat will scientists allow the selling of the articifical meat with contentment?*
>
> *S5: I guess they would also decide after they experiment it on something. Because things like this are not produced without testing, experimenting it on a group.*
>
> *The researcher: How will they understand this?*
>
> *S5: This requires a real procedure I guess. For example, let's say, they gave it to somewhere to be tested, they need to test it for 10 or 20 years. Maybe later, they should examine the first new generation. They should ask themselves "we fed them with this, but did anything happen to them, to their genes" so on. But just that meat, I mean, they shouldn't give the normal meat, they should give the artificial meat only, and then, they can say with contentment that nothing happens to people.*

Representative quotations for the Theory-Laden Nature (subjectivity) of Scientific Knowledge, NOS5

In this study, understandings about '*The Theory-Laden Nature (subjectivity) of Scientific Knowledge'* played an important role in placing the participants into the U or S groups, and therefore, NOS5 became an obvious criterion in the placement. Generally, the participants placed into Group U thought that although scientists can have different types of personality and background, they have similar scientific attitudes towards science or at least they should have. Moreover, these participants mainly expected that scientists should be objective in their work. For example, in the quotations below, while U1 identified a relatively strict character for the scientists and their works, U6 stated that the scientific knowledge cannot be affected by the scientists' subjectivity.

> *U1: Even if their personalities are different, he/she is a scientist and the processes that a scientist undergoes, the curiosity he/she feels are common for all of them.*

> *U6: Information is information, I mean, it is what you have. After all, it is the result of the research, not something that changes from person to person.*

However, all the participants placed into Group S had very sophisticated understandings related with the subjectivity of the scientific knowledge as it is clearly seen in the following quotation.

> *S1: Scientists' own observations by their backgrounds, opinions, I mean, even the observations they have made may change accordingly. You know, for example, a man who says that animals shouldn't be slaughtered views the issue from a more positive perspective than the other one, so he will skip some parts, won't see some other parts so on. So it might differ in terms of this I guess. Why and what he searches determines the aim. This affects scientists' research activities and their observations.*

Representative quotations for the Social and Cultural Embeddedness of Scientific Knowledge, NOS6

As the understandings of the participants about '*The Social and Cultural Embeddedness of Scientific Knowledge'* showed mainly two distinct characteristics as relatively unsophisticated ones and sophisticated ones, NOS 6 was also used as a criterion for the placement. In detail, the participants who did not mention a specific difference among the scientists with different sociocultural background, such as U5 with her representative quotation below, were placed into Group U.

> *U5: A scientist's purpose, whether Turkish or American, is to be beneficial for humanity. He/she is thinking of this. Or, as I mentioned before, even if GMO seems to be harmful, actually its purpose is to be beneficial. He/she is trying to make something beneficial. Whether he/she is Turkish or American does not make much difference.*

The participants who stated a very limited difference among the scientists with different socio-cultural background were also placed into Group U. For example, in her explanation, U2 did not state any difference in aims to produce artificial meat and she only expected a taste difference if the artificial will be produced by a scientist with different sociocultural background.

> *U2: To be honest, whether he/she is Turkish or Dutch doesn't matter; they all think about money, I won't differentiate them here. However, Turkish people like eating meat, cutting meat, understand which meat is good, then the meat they make might be better than the others because they understand the difference. […] The procedures might also differ. OK, this procedure is not likely to differ because they take the stem cell and multiply it etc. but in the last stage, I mean, adding fat and iron, for example. The stage about adding flavor to it. I think Turkish people would produce something different and more delicious, even if it is articificial.*

On the other hand, as it can be obviously seen in the representative quotation below, the participants who clearly emphasized the social and cultural embeddedness of scientific knowledge were placed into Group S.

> *S3: In which society the scientist lives affects the activities of the scientist, I think, or gives them a shape or it might have an importance in finding the question, or asking the question. It is the same in the other stages of the study. Because what we call science is something is interwoven with the nature, with society. Therefore, for me it is really normal for it to benefit from the nature it is in or to benefit from people.*

The positions of U5, U6, S5 and S6 in their groups

As it was stated before, although they were placed into Group U, in general, U5 and U6 had relatively less unsophisticated NOS understandings than the other participants placed into Group U. Moreover, in general, S5 and S6 had relatively less sophisticated NOS understandings although they were placed into Group S.

In order to explain this issue in detail, beside the examples given above, here there are additional representative quotations selected from the responses given to the question *'Do you think the pieces of scientific information about the artificial meat itself that the scientists reach differ when the scientists have different reasons for producing the artificial meat?'*. At that point, it is important to mention that this question was one of the questions which were constructed to put forth the participants' general NOS understandings. In other words, this question did not focus on a specific NOS aspect but it served as a suitable medium for the reflections of the participants' understandings about each NOS aspect.

In order to make a comparison with U5 and U6, here the response of U4 to the question above is a good example to show the reflections of general unsophisticated approaches to the NOS aspects but NOS4.

> *U4: Interpretation might make a difference in scientific information, I mean, it might be subjective, but since the results are the same, there should be a really big factor to cause a difference. For example, there is gravity and you discover it, but gravity is gone in time, then it changes. I meant this. I mean, all of them produce the same meat, but there might be a time when meat is not produced, so the other one cannot make it and has something different in his/her hands. I think when you give them all the same thing, the result must be the same.*

However, in the same question, although U5 gave a short answer, she stated more sophisticated approaches to the NOS as she put forth the differences between scientific procedures and the gained scientific knowledge from these procedures. In this way, it was concluded that in her mind, scientific knowledge is not only discovered but also produced by the scientists, and the scientists can have different attitudes towards the same subject, which may affect their work.

> *U5: I guess it differs because, let's think, one of them is trying to multiply it and the other one is trying to make it healthier. The one who is trying to make it healthier is working on protein and the other one who is trying to multiply it might be working on mitotic division. They are different fields.*

Furthermore, U6 had more sophisticated response to the same question as she also mentioned the subjectivity of the scientists. However, she finalized her speech by giving a certainty to the scientific knowledge.

> *U6: I think they differ. One group is focusing on human beings, trying to save people, and worried about their health; the other group might be worried about people too but worries about animals more. I mean they might say it's OK without meat. Those people, of course some of them are not vegetarians and still try to save animals, but most of them usually don't give much importance to meat. They might think, for example, it's OK for the artificial meat not to have a taste or vitamins. Rather than focusing on the meat, they might focus on animals. Actually, those pieces of information do not differ, but the purposes are different. Information is information, I mean, it is what you have. After all, it is the result of the research, not something that changes from person to person.*

As for the participants placed into Group S, the following response of S2 is representative and it gives the clues to show how sophisticated understandings she had in NOS aspects and it allows a comparison with the responses of S5 and S6 which are also given below.

> *S2: Yes, I think they differ because when we take a look at scientific stages, in the beginning the person must make observations. On the observations, just as we talked about a while ago, we can say that the person's personality, cultural circle, family, background information, all these have a great effect. It differs depending on what the person is studying on and what the person is looking for.*

On the other hand, S5 and S6 had less sophisticated responses to the same question than that of other participants placed into Group S. As it is seen in the following quotations, both S5 and S6 approached the issue from the same angle and gave short responses. Moreover, in their responses, they covered fewer NOS aspects, which also gave clue to understand their relatively less sophisticated NOS understandings.

> *S5: Possible because if one of them is trying to reduce the expenses, he/she will work on the expenses. He/she tries to reduce the things throughout the stages. The other one will continuously try to follow the stages exactly in the same way without changing anything.*

> *S6: They differ. As we mentioned before, the man who is trying to reduce the expenses will focus on how he can reduce the expenses by cutting down on what, and therefore, he might use different substances in different laboratory conditions so on, so he might do a lot of things in different ways. Thus, his scientific information might have differed.*

As a result, although U5 and U6 had relatively less unsophisticated understandings about NOS in some cases, the analysis showed that they were not able to provide enough criteria to be placed into Group S; therefore, they were placed into Group U. Moreover, although S5 and S6 had less sophisticated understandings about NOS, with the analysis it was understood that their general NOS understandings were sophisticated enough to be placed into Group S.

3.6 DM Model Constructed for the Present Study

In order to make a proper decision, in the literature there are some normative DM models especially according to what kind of decision is wanted to make. These normative models generally have a linear structure and define the steps of a good decision, which can be listed as for example (1) identifying a problem, (2) identifying decision criteria, (3) allocating weights to the criteria, (4) developing alternatives, (5) analyzing alternatives, and (6) selecting an alternative, (7) implementing the alternative for professional decision makers such as businessmen and politicians. On the other hand, from a wider perspective, although this study was conducted with pre-service teachers, it focused on the ordinary citizen's DM process in case of a referendum related with a socioscientific issue as it reflects one of the best cases to understand why we try to teach NOS to "all students" as science teachers. Moreover, it was understood that the referendum case included a very different kind of DM process from what the normative models in the literature present especially for three reasons (i) time flow in thinking, (ii) yes or no ending and (iii) having no special education about DM process. First, time flow in thinking in the referendum was different because the referendum had offered a ready solution and in fact an already selected alternative to its participant, in this case 'artificial meat'. Second, the referendum would end with voting 'YES' or 'NO' for a solution and its participant felt no need to 'develop' real alternatives to a particular problem. Finally, in the referendum, being ordinary citizens, the participants had no special education about DM process and they even did not have enough experiences about DM process as businessmen or politicians do. In this way, the participants did not feel any additional need to organize and check their thinking in DM process.

The analysis showed that in this referendum case the participants thought through some main questions which are:

1. For which reason is the artificial meat produced / Why will we use the artificial meat/what will artificial meat cause? - *in this study it is labeled as thinking region about 'goals'*

2. What should/must the qualification of the artificial meat be? - *in this study it is labeled as thinking region about ‘criteria’*
3. What can be compared with artificial meat? - *in this study it is labeled as thinking region about ‘alternatives’*

In addition to this, of course it was thought that there would be much more thinking regions which the participants used in the referendum such as allocating weights to the criteria. However, it was concluded that as the participants were not professional decision makers, these thinking regions were not activated as dominantly as the listed three thinking regions above and so they were not directly observed. In fact, with the analysis it was understood that those other thinking regions appeared as sub regions of the three regions: *‘goals’, ‘criteria’* and *‘alternatives’.*

Moreover, these three thinking regions: *‘goals’, ‘criteria’* and *‘alternative’* were so dominant in DM process in the referendum simulation that they were even clearly observable in the very early responses; for example, just after the participants read the news about the artificial meat while they were answering simple questions such as *“Have you heard about this news?”, “Do you have any information about this issue?”* and *“Did this news arouse curiosity in you?”.*

Related with the thinking region *‘goals’*, when Table 3.11 is considered, it is easily seen that U2 thought that the artificial meat is produced for ‘making money’, U3 thought that we can use the artificial meat in order ‘to provide necessary proteins for poor people’ and U1 thought that the artificial meat can be hope for other ‘scientific developments’ or accelerate them.

Table 3.11

Quotation examples for thinking region about 'goals' of the artificial meat just after reading the news

Sbj	Quotation
U1	The advances in science, seeing these kinds of things is really nice; I mean, it gives hope for other things.
U2	I think they all done to make money.
U3	I questioned why they had produced a meatball at 250,000 euros. Most probably, the logic behind is about not slaughtering animals.
U4	To see whether we can do this or not, to achieve scientific advancement, yes, this could be done.
U5	Whoever produces this, if it is cheap, it benefits the person. Would that benefit people, I mean, us? I don't think so. Maybe if we are poor, we might feel full.
U6	After all, not all people can directly eat meat. In this way, maybe it will be cheaper. People need protein in the end and they need to take protein somehow.
S1	I became curious about the background of this study; how did they produce it and what is their purpose? I mean, is the purpose to contribute to meat production or to protect animals?
S2	There are a lot of hungry people in the world. They can't eat meat but in this way, they may feel the taste of meat at least.
S3	One day, people really won't be able to eat meat and they will have to satisfy their hunger with this kind of products. Therefore, it is something good.
S4	I think it is for commercial purposes; I mean, the production of the artificial meat.
S5	Actually, I questioned the most why they felt the need to make something like this. [...] Like saying we can still produce things even if they have become extinct.
S6	I may think of it like they will be able to increase the nutritional value of it but now I feel like they prepared the news just to say "we made it, we achieved this, it's here!"

Related with the thinking region *"criteria,"* when Table 3.12 is considered it is easily seen that S1 thought that artificial meat should be 'hygienic'. Moreover, according to S3, artificial meat should be tested to understand the effect on human 'health'. In addition to this, in her initial response, S6 wanted to learn some qualifications of the artificial meat's 'production process', 'test results' and 'ingredients' in order to make a proper decision.

Table 3.12

Quotation examples for thinking region about 'criteria' of the artificial meat just after reading the news

Sbj	Quotation
U1	It has to be used carefully, it has to be made, developed carefully. [...] They have tried it, too.
U2	In terms of health, I think it is very harmful, it might be carcinogenic. It hasn't been examined… Here human health is not considered I think.
U3	If it is easy to produce, I mean is produced in a cheap way that everybody can eat it, it can meet some certain needs in the human metabolism, but we see that it is not cheap, either.
U4	Now there is a natural balance, why do we eat meat?.. One living thing eats another living thing, you know, the food pyramid… Here it is only meat flavored, what I understood is that protein, carbohydrate etc. does not exist in it, then, we won't be able to have met that need.
U5	Beet syrup, saffron, what is in it, what is used attracted my attention. I want to know what is in the thing I eat and how they added the flavor.
U6	Since it is artificial, after all, they have to add something to it, i.e. it is not natural, and these kinds of things somehow cause cancer for example. I mean, you know it can cause a few types of illnesses after all. It might be harmful for health.
S1	If it is produced in hygenic conditions, it might be beneficial because otherwise, we don't know how hygenic the other produced things.
S2	If it is cheap, it might benefit human beings in the short term, but in the long term, I think this will pose a danger for people in terms of health. Because I think they must have taken the necessary precautions using the available technology in order to prevent it from being dangerous in the short term.
S3	I think it should be tried out first because as far as I see here, when I look at the date, this is very recent news. I don't really know what the results or its effect on human health might be.
S4	The fact that a lot of things are artificial scares me, to be honest. I feel better when everything is natural. You know, are there any carcinogenic substances in it when it is artificial? It says there are a lot of preservatives and we see that today everything is losing their natural features.
S5	But they have done this with a budget of over €250.000. I mean, was that really necessary? I mean, when doing science, its cost should also be taken into consideration after all.
S6	In those laboratories, what procedures did it undergo, if only they were given in an order. How many times was it tested? What happened? What was the result? The nutritional values of the ingredients might have been given.

Related with the thinking region *'alternatives'*, when Table 3.13 is examined, it is understood that U4 compared the artificial meat with the animal husbandry and she thought that it could be a better solution if they used that much money on developing 'animal husbandry'. Moreover, S6 wanted to learn the cost of 'normal meat' production in order to compare it with the cost of the artificial meat.

Table 3.13

Quotation examples for thinking region about 'alternatives' of artificial meat just after reading the news

Sbj	Quotation
U1	We can eat healthy meat, we can also eat this kind of meat which is produced in laboratory conditions; we don't know the source of the meat that we eat already.
U2	I have already known that hamburgers are not so healthy and animals are abused. I would like to see what is used as a substitute for that.
U3	The logic behind is most probably about not cutting animals. Therefore, I felt that it might be produced from herbs. By using plants, they might have tried to make it similar to meat.
U4	If they spent this much money on agriculture and animal husbandry, we would overcome a lot of things in natural ways.
U5	What the scientists have produced is something that should be appreciated, I think. However, I am not for eating it because the protein that we obtain from meat definitely won't be obtained from that.
U6	You know, I don't think that it would be as healthy as normal natural meat.
S1	I immediately associated this with GMO in my mind.
S2	We already can't obtain the vitamins proteins we need even from the animals fed in real farms, and this one is produced in the laboratory. I think it is dangerous for health.
S3	For example, since we wouldn't be able to obtain that protein structure or other values that we obtain from the normal meat or since we would get something with a different organic structure, this time something in our own body might change.
S4	I've just had my climate change course a minute ago. There, for example, they are continuously talking about the fact that red meat should be consumed less. When we have something artificial, this will increase, so you know, this seems like a bad possibility although it is artificial.
S5	Usually these kinds of things, such as GMO, are produced to reduce the expenses in the end.
S6	The costs in comparison with the cost of meat should be given. We can see the cost of this study here but what is the cost of meat normally. If this comparison is given, I might talk about it more comfortably.

Moreover, the analysis showed that the participants frequently tried to make a decision about the artificial meat such as whether they would use it or not, even before it was directly asked to them. Thus, there was an additional thinking region to these three thinking regions, which was labeled as a *'decision'*. However, different from all other thinking regions, *'decision'* was the thinking region which cannot exist by itself but seems to exist through the interactions of *'goals'*, *'criteria'* and '*alternatives'*. In other words, it was understood that the interactions among three thinking regions produce a new region which is continuously fed from these three thinking regions.

As a result, a new DM model, illustrated with Figure 3.8, was constructed for this study in order to represent the DM process in a referendum case.

i. The mechanism of DM process

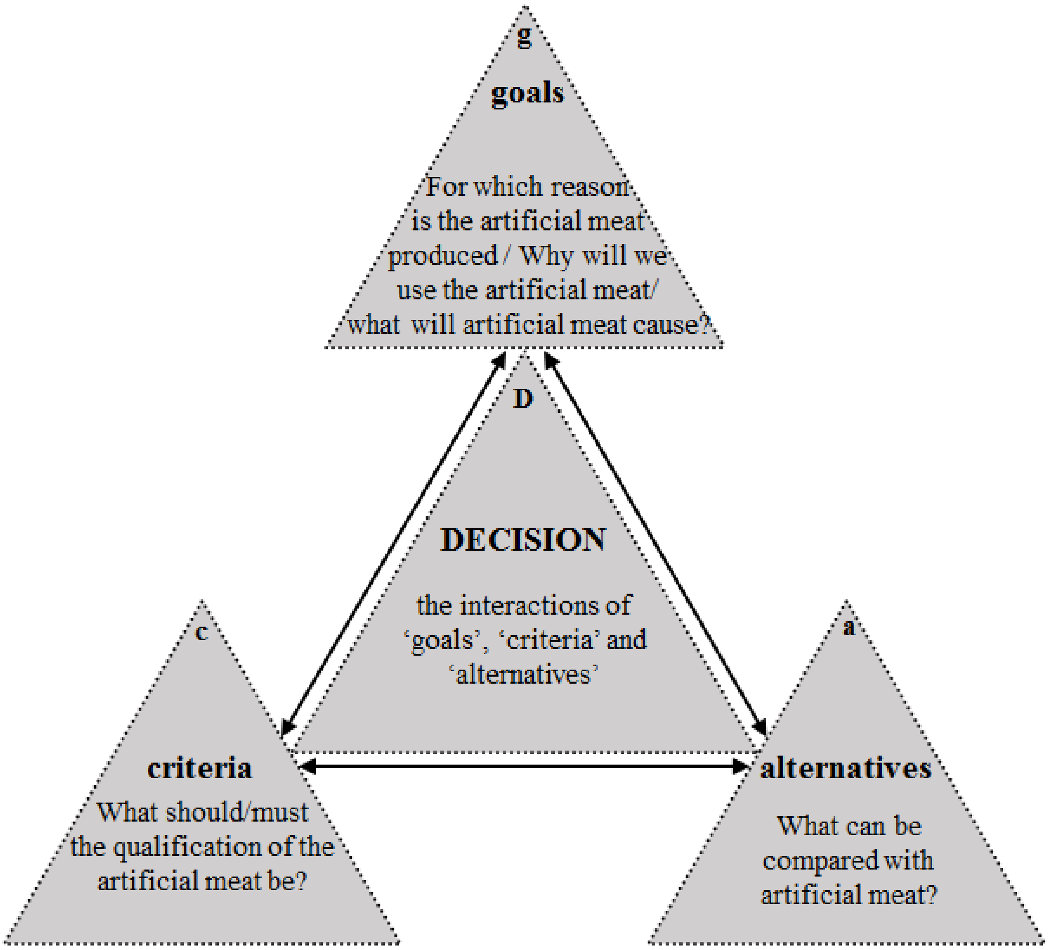


Figure 3.8 DM fractal model constructed by this study in order to show DM process in a referendum case.

ii. The final structure of the model after the decision is made

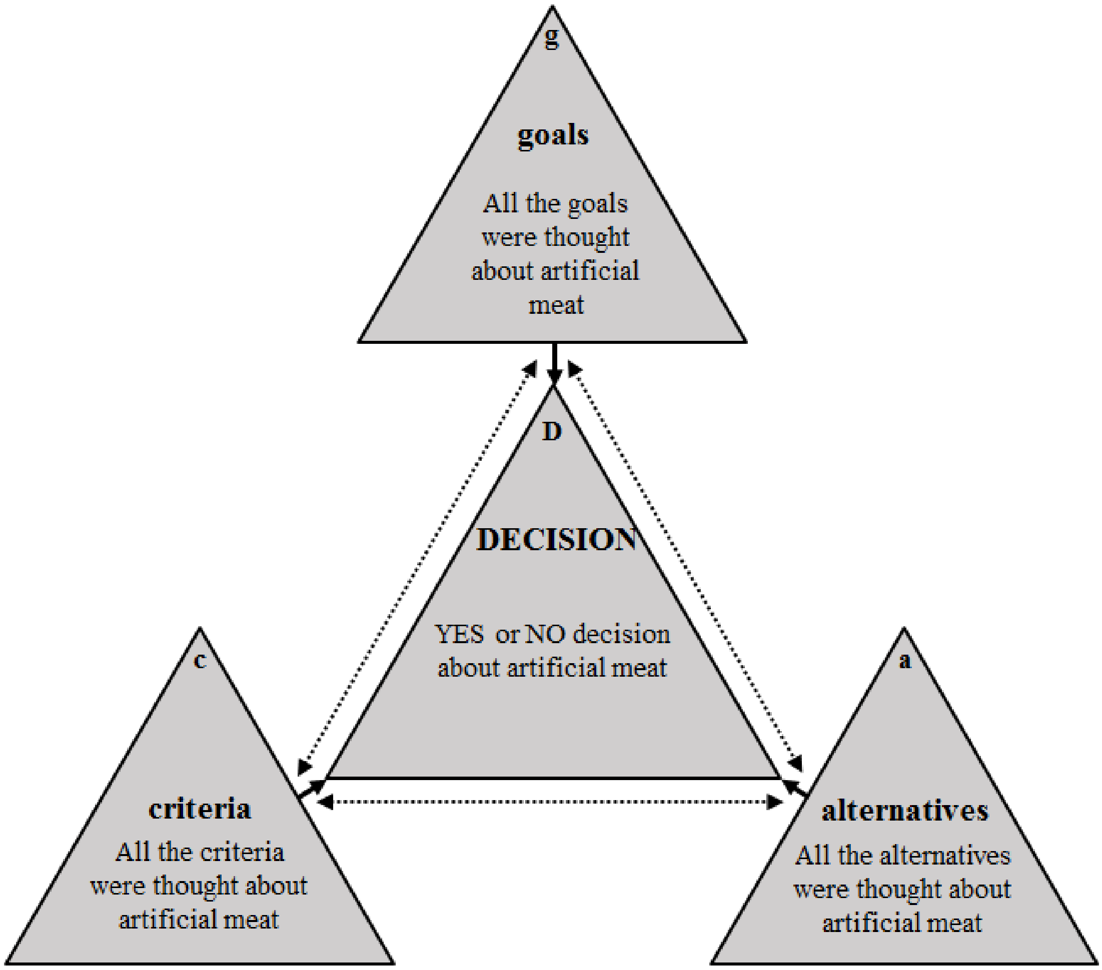


Figure 3.8 (continued)

Linear structure of the previous normative models of DM was not efficient enough to reflect a referendum case about an SSI because they were not constructed in order to reflect the real nature of DM, and they were designed to make a better decision from their own perspective according to different disciplines. Therefore, a fractal DM model was constructed by analyzing the data of this study in order to serve a reflection of a referendum case about an SSI by keeping some general approaches of the other normative models in the literature. Moreover, this fractal DM model reflects 4 main distinctive properties when it is compared with the normative models in the literature:

1. The Fractal Model of DM about referendum required thinking regions about *'goals'*, *'criteria'*, *'alternatives'* and *'decision'* which replaced the steps of the normative models in the literature. Moreover, these thinking regions appeared simultaneously in the model, which is different from the linear steps in other models which follow each other one-by-one.

The analysis showed that even in their responses to the very simple questions such as *"what attracted your attention to this news most?"* just after they read the news about artificial meat, some participants started their responses through talking about *'goals'* while some others started through talking about *'criteria'* or *'alternatives'* of the artificial meat. Moreover, they continuously made *'decisions'* about something related with the artificial meat even if it was not asked to them. In addition to this, it was frequently observed that a participant who started their response to the previous question by talking about for example *'criteria'* sometimes responded to the following question by starting to talk about *'goals'*, *'criteria'* or *'alternatives'* about the artificial meat. As a result, it was concluded that linear DM steps in the normative models in the literature were not sufficient enough to explain the nature of DM in a referendum case.

2. The Fractal Model of DM for the referendum illustrates the double way relationships among *'goals'*, *'criteria'* and *'alternatives'* and the *'decision'* determined by these relationships. In this way, it also puts forward the spirit of the natural thinking process which is described in the literature as below and therefore, it makes it possible to make interpretations which go beyond the previously formed structure where decision making steps follow each other.

- ✓ In the literature it was stated that if you want to pass across a brook running through the mountains, you hop from one stone to another or you zigzag. This passing across the brook is similar to thinking – it is mixed or disorganized but goal-oriented (Adair, 2000, p.35).

For example, the following quotation of S5 was representative to explain the double way interaction between *'criteria'* and *'alternatives'*.

S5: Here I feel that they just made it to bring about an economic advantage (goals), but there 250,000 euros surprised me though. But in the future, I mean, these tools were completed now. If it now costs this much to be made and costs less (criteria) in the future just like GM products (alternatives), then there is a cost benefit (criteria).

Moreover, when the following quotation of U1 is examined, it can be seen that there is a clear way of thinking from *'criteria'* → *'goals'* → *'decision'* → *'criteria'* → *'goals'* → *'decision'* → *'criteria'* and *'decision'* is constructed through the interactions between *'goals'* and *'criteria'*.

U1: It has to be used carefully, it has to be made, developed carefully (criteria). It is something nice but where is it going to be used? That's the question. What use does it have? Is it going to be given to people (goals)? It shouldn't I think (decision). They have tested it, too (criteria). But it shouldn't spread, people may try it, taste it but that's it (goal). It shouldn't increase, spread the world, reach us (decision). I think this way, I mean, I wouldn't like to eat this meat. This is artificial meat, we are talking about artificial meat, you wouldn't want to eat artificial meat, this is health in the end. We don't know how it is going to affect our health (criteria).

In addition to this, the following quotation of U5 is a good example to represent more complex interactions among thinking regions as it includes a way of thinking *'alternatives'* → *'criteria'* → *'goals'* → *'criteria'* → *'alternatives'* and *'decision'* is constructed by the interactions among *'goals'*, *'criteria'* and *'alternatives'*.

U6: As a result, not everybody can eat meat (alternatives) directly. In this way, maybe it will become cheaper (criteria), people need protein in the end and they need to obtain this protein in one way or other. I mean, it would be easier [to reach protein]. The body takes that protein (goals) in a way but how beneficial is that, does it give any harm (criteria)? We cannot know this. You know, it cannot be as healthy (criteria) as normal natural meat (alternatives) I think that way (decision).

3. The Fractal Model of DM about the referendum is a moving (with lines getting clear and blurred again) fractal (the whole and its pieces exhibit similar patterns). The fractal model is suitable to be used in more complex issues especially when it is necessary to make a series of decisions as it can provide an ontological change in the steps of the DM process. In other words, by using this model it is possibile to see the previous decision itself for example as a problem or criterion of a new DM process. Therefore, when a decision is made through this model, this decision can be incorporated into a new DM process easily. Moreover, with this fractal model, all process of a decision can be seen as a whole. In this way, it serves as an additional help to check for the effectiveness of the decision. Thus, this fractal

model includes the explanations in the literature given below regarding the DM process for the further studies due to its structure.

- ✓ A problem is a kind of solution or the subtle version of the solution which is embedded in the problem and each decision we made, signals a new series of actions which is different from the previous ones. The decision creates the problem (Adair, 2000). Solutions are the seeds of new problems. Therefore, in order to solve these newly-arisen problems, we need to go back to the very beginning. We need to go through a new decision making process which starts with identifying the problem and completely covers the previous one. When we administer this whole process, we will make and implement a new decision which solves the new problem, which will also cause new problems.

- ✓ "Unless a decision has degenerated into work, it is not a decision; it is at best a good intention." (Drucker, 1967). In other words, the implementation of the decision is inherent in the decision making process and in order to get good results, it has to be examined. In this case, investigating the effectiveness of the decision is also inherent in decision making process (Robbins & Coulter, 2012).

4. The Fractal Model of DM about the referendum reflects the etymological meaning of the word used in Turkish and the one in the language of this thesis, English.

The word 'karar' (decision) is transferred to Turkish from Arabic language and the word 'karar' which is derived from the root 'krr' means staying, being stable, consistency, final opinion or option. What is implied here is a general orderliness, and in our case we can interpret this as solving the problem (whether the artificial meat should be sold in markets or not) and ending the chaos.

As for the word 'decision' in English, it is seen that this word is related to the words cutting, scissors, separating in Latin. What is implied here is distinguishing between two different things and this can be considered as transitioning from a problematic or chaotic situation to orderliness in our specific case. As a result, the *'decision'* which has taken shape through the interactions among *'goal'*, *'criteria'* and *'alternative'* leaves its components and becomes an entity that can be seen on its own (and can be integrated with other problems). Moreover, *'goal'*, *'criteria'* and *'alternative'* take their final forms.

3.7 Analysis of the Data

In this study, the qualitative content analysis was used. Content analysis describes a set of analytic approaches which varies from impressionistic, intuitive, interpretive analyses to systematic, strict textual analyses (Rosengren, 1981). Researchers regard content analysis as a flexible method for analyzing text data (Cavanagh, 1997). Moreover, in content analysis any kind of qualitative data verbal, print, or electronic form obtained from narrative responses, open-ended survey questions, interviews, focus groups, observations, or print media can be analyzed (Kondracki &Wellman, 2002).

Research conducted through qualitative content analysis concentrates on the characteristics of language as communication giving attention to the content or contextual meaning of the text (Budd, Thorp & Donohew, 1967; Lindkvist, 1981; McTavish & Pirro, 1990; Tesch, 1990). Qualitative content analysis goes beyond merely counting words to work on and analyze language intensely for the purpose of classifying large amounts of text into an efficient number of categories that represent similar meanings (Weber, 1990). These categories can represent either explicit communication or inferred communication. Indeed, content analysis allows the researcher to provide knowledge and understanding of the phenomenon under study (Downe-Wamboldt, 1992, p. 314).

In order to increase the reliability of the content analysis, totally more than 40 hours of voice recordings obtained from the interviews were decoded and transcription covered 205 pages with two columns. In this study, the content analysis was used in all four steps in which the qualitative analysis was made, in order to identify the

Focus Group characteristics, in order to separate the participants into the groups according to their NOS understandings as unsophisticated and sophisticated, in order to construct a DM model for the referendum situation and finally for the main study itself.

3.8 Trustworthiness of the Study

In the present study, trustworthiness, which shows how worth paying attention to the findings is as it is related with the adequacy of the data by including realibility and validity of the findings, was considered through the postpositivist approach (Lincoln & Guba, 1985; Morrow, 2005; Elo, Kääriäinen, Kanste, Pölkki, Utriainen, Kyngäs, 2014). Therefore, in the line with Guba (1981), Lincoln and Guba (1985), and Patton (2002) trustworthiness of the study was established through providing dependability, credibility, transferability and confirmability.

3.8.1 Dependability of the study

The issue of concern in dependability/auditability is reproducibility of findings; therefore, it shows how a systematic process systematically followed by considering the way for a study to be consistent across time, researchers, and analysis techniques (Patton, 2002; Gasson, 2004). In the present study dependability was provided with intercoder reliability. For all these four steps, in which content analyses were conducted, stated above, in order to achieve intercoder reliability, more than 15 % of the data was selected randomly and with the content analysis, the themes that explained the data were established. After that, a second coder did the same thing and the analyses were compared. It was observed that there was a high level of consistency between the data analyses. Moreover, with the formula of Miles and Huberman (1994) intercoder relability was calculated as 92%. After that, the themes that were constructed differently were discussed by two coders, and an agreement was settled through them. In this way, the reliability of the study was checked and it was decided to continue the analysis with the rest of the data.

3.8.2 Credibility of the study

The credibility is related to the findings to be congruent with the reality, and therefore, it reflects authenticity of the study by ensuring the findings related to significant elements in the research context/situation (Merriam, 1998; Gasson, 2004). In the present study, the credibility was constructed through both prolonged engagement and triangulation. With the prolonged engagement sufficient time was spent in the environment of the potential participants in order to understand their culture and social settings, in fact, researcher have already shared the same environment with them in many cases. Moreover, focus group interviews were conducted with two groups in two session, and therefore, deeper understanding about the context of the potential participants was gained. In addition to this, triangulation was provided by the design of the data gathering tool which contains 7 sections, each of which focused on a specific issue about the study by covering the whole issues about the study. Therefore, although one interview was conducted per participant, it looked like 7 times data collection with 7 instruments.

3.8.3 Transferability of the study

Transferability in the qualitative research shows “how far can the findings/conclusions be transferred to other contexts and how do they help to derive useful theories?” (Gasson, 2004, p.90). For the sake of transferability, in the present study, very detailed explanations were provided especially in research design and results for the researchers in order to use them in their studies if they need.

3.8.4 Confirmability of the stduy

According to Gasson (2004), in the framework conformability, as possible as it can be, the findings should not represent the researcher's beliefs, pet theories or biases and the conclusions should depend on subjects and conditions of the study. Therefore, in brief, confirmability of the qualitative research is related with the representativeness of the findings (Gasson, 2004). In the present study, for confirmability, the relevant sections from the responses of the participants were given as direct quotations in order to make it easy to differentiate. At this point, it is important to mention that the interviews were conducted in Turkish and then translated to English, which might seem to be a handicap. However, in order to prevent the loss of meaning in translation or extra meaning added to them, two translators one of whom was native-like were assigned and worked together through the translation process of the quotations.

3.9 Ethical Issues

Before any implementations of both Focus Group interviews for pre-study and in-depth interviews for the main study, the official permission of Institutional Review Board related to ethical issue was taken, and the official permissions are presented in Appendix A and Appendix B respectively. Moreover, the possible participants were informed about aims and the implementations such as content and durations of the interviews with classroom announcements; in this way, they learned about the details of the study. In addition to this, before the implication of each Focus Group interviews and in-depth interviews, the consent form which includes the aims and concepts was read and signed by the participants. The consent froms of Focus Group interviews for pre-study and in-depth interviews for the main study were presented in Appendix E and Appendix F respectively. Furthermore, at the beginning of each interview, the participants were re-informed verbally by the researcher that the voice recording device would be used during the interviews, that they were free to have the interviews whenever they want, and all the data would beused for educational and research aims with keeping the real identities in secret. At this point it is also important to mention that all participants in the present study directly stated that they were glad to involve in the present study.

3.10 Limitation of the Study

1. This is a qualitative study, and therefore, the findings cannot be generalizable to any population.

2. Data are verbal and they were limited to participants' responses, comments, experiences, feelings and perceptions about the subjects discussed during the interviews.

3. NOS understandings of the participants reflect the aspects of NOS stated by Lederman (2006)

4. Data were limited to DM about the artificial meat in a referendum situation.

CHAPTER 4

RESULT

In this chapter, the data gathered through in-depth interviews were analyzed using content analysis in order to understand the NOS effects on the DM process in a referendum situation about an SSI.

4.1 Initial Responses

In this section, the analyses of initial responses of the participants only after they read the news about artificial meat are presented.

4.1.1 Participants' perceptions about the artificial meat: validity of the interviews

As it was mentioned before, in order to minimize the subject matter threat, the selected SSI should include *(i) unstructured problems* in *(ii) uncertainty conditions*. Moreover, in order to motivate the interviewees, the selected SSI should be *(iii) interesting*. The analyses on the first part of the interview questions showed that the participants had no prior knowledge about the artificial meat and thus, according to the participants the artificial meat consists of unstructured problems. Moreover, it was understood that according to the participants, the risks and aims of the artificial meat were uncertain. Finally, all the participants found the artificial meat interesting enough to consider. These results showed that related with the selected SSI the validity of the interviews was established. In the following section, there is detailed information about these analyses respectively.

According to the participants, the artificial meat issue contains unstructured problems

In order to minimize subject matter threat, in line with the DM literature, it was understood that it becomes more efficient to select an SSI which includes an unstructured problem for this study because unstructured problems are problems that are new or unusual and for which information is ambiguous or incomplete. In this way, the prior knowledge of the participants was equalized.

Of the participants, only S2 stated that she had heard about the artificial meat before. However, as it is clearly seen in the following quotation, she also stated that she did not have any information about it.

> *S2: I have heard of it, I remember it in the news, but I didn't get detailed information after that.*

Moreover, while 9 of 12 participants directly responded to the question 'Do you have any information about the artificial meat' by saying 'no', 3 of 12 participants explained the issue as follows:

> *U6: No, you know we hear things like GM organisms but this is not about it here I guess.*
>
> *S1: They are producing artificial things, I know that, but I haven't heard about this before.*
>
> *S6: I have already had information about the fact that they produce some nutrients with laboratory studies, but I have just learned that they also produce meat.*

According to the participants, the artificial meat contains the problems in uncertainty conditions

The analysis showed that the participants generally perceived the artificial meat as an issue with a high level of uncertainty. Moreover, both the members of Group U and Group S tried to predict the possible results of using artificial meat by mainly questioning its possible effects on health. During these questionings, they generally mentioned the empirical nature of science by requesting some experimental data about the effect of using artificial meat on human health. Furthermore, some participants questioned the possible aims of producing artificial meat in their initial responses and tried to do cost-benefit analysis about it. In the following section, there are representative quotations which clearly show that the members of Group U and Group S perceived the artificial meat as an issue with a high level of uncertainty. These quotations are also representative to understand that apart from NOS group they were in, the participants questioned the issue from very similar perspectives.

> *U1: The advances in science, seeing these kinds of things is really nice; I mean, it gives hope for other things. The advances in science is nice, but, you know, for example, we can talk about cloning. It's something good, fine but you know, testing medicine on these cloned animals is a good result but you know there are also negative sides of it. It has to be used carefully, it has to be made, developed carefully. It is something nice but where is it going to be used? That's the question. What use does it have? Is it going to be given to people? It shouldn't I think. They have tried it, too. [...] I mean we don't know how it will affect our health. I mean, they have tested its taste, ok, but how will it affect our health? How is it digested in our body? By "digestion" I mean what form does it take in our body? We really don't know this. We don't know what reaction our body will give to that.*

> *S1: I've found it interesting, but you know, I don't know whether I would eat it or not. I became curious about the background of this study; how did they produce it and what is their purpose? I mean, is the purpose to contribute to meat production or to protect animals? What attracted my attention most is the fact that this meat is artificial. Also, they didn't let the journalists test it. They said they hadn't had enough amount of meat. That's weird because you advertise something but... Also, what is the purpose of this advertising, I really didn't understand. I immediately associated this with GMO in my mind. You know we developed a reaction to such kinds of things, you know giving a reaction. I immeadiately thought about whether it is beneficial or harmful, but I don't know, I mean, is it beneficial? What would make it beneficial? Maybe the harmful side of it is about people who make a living by animal husbandry, I mean, if meat production takes place here, and if they start to do it in the factory, this can be bad for them. But now, I don't know how meat production is conducted, whether it is enough for all countries or not. If it is not, this migh be a good support. Or if it is produced in a more hygenic environment, it might be beneficial because, otherwise, we don't know how hygenic the things that are produced.*

All participants found the artificial meat interesting enough to consider

In order to understand whether the participants found the artificial meat issue interesting or not, in the interviews, the question *"Did this news arouse curiosity in you?"* was asked. It was concluded that the participants found the artificial meat interesting enough to consider.

Moreover, it was understood that while the member of Group U gave relatively short responses to the questions by generally also mentioning their other areas of interest or personal choices, as follows:

> *U5: I prefer eating healthy meat directly. But I would be curious about how they make it and check out the link. I mean, I would click on the link of the news but this wouldn't be about consuming it.*

> *U6: Me too, I would definitely check it out. I mean, I'm really into these kinds of things [scientific advances]; I also like eating, so I would check it out.*

The member of Group S generally made detailed explanations by focusing on the artificial meat itself more with a skeptical approach as follows:

> *S1: It says meatballs, what did they use to produce it? What did they themselves produce the meat from? It is not clear here in the news. They say it is not produced through farming but created in the laboratory but I wondered the details, so I would search for it. I've found it interesting, but you know, I don't know whether I would eat it or not. I became curious about the background of this study; how did they produce it and what is their purpose? I mean, is the purpose to contribute to meat production or to protect animals?*

Half of the Group S also mentioned some feelings such as repulsion and fear in their detailed explanations, just as S2 did with her following remarks:

> *S2: This news scared me a bit to be honest. Because we already can't obtain the vitamins proteins we need even from the animals fed in real farms, and this one is produced in the laboratory. I think it is dangerous for health. […] I think they used something chemical. In order to give its color, they must have used something and here yes they say they had used saffron syrup but I think they might have used something more chemical too. At least to give its taste, in order to increase its shelf life… Therefore, I think it's dangerous for health. Also, they didn't let the journalists taste it and only tasted it themselves, so they also must have some doubts about the meat that they have produced.*

4.1.2 Participants' approaches to being informed of the artificial meat: reliability of the data collected through interviews

It was important to identify whether or not the participants had similar technical understandings about 'what the artificial meat is' and 'how the artificial meat is produced' in order to put forth the reliability of the data collected through interviews. Firstly, all interviewees directly stated that they clearly understood the procedure of the artificial meat after being informed about it. Moreover, how meaningful of these declarations was understood by comparing consistencies of the participants' previous predictions about the procedure of artificial meat and their explanations after being informed about it.

It was understood that only two members from each group had close predictions about the procedure of artificial meat, and the other eight participants did not predict that in their initial responses, and their declarations are listed in Table 4.1. Furthermore, after being informed, all participants explained well whether their predictions were close or not.

Table 4.1

Declarations about the procedure of artificial meat after being informed

Declarations	**F (U)**	**F (S)**
It turned out to be different from the procedure I thought about in the beginning	4	4
It turned out to be similar to the procedure I thought about in the beginning	2	2

When these explanations were analyzed, it was understood that the close prediction owners mainly used the data 'produced in laboratory' in the news in their considerations as it can be seen in the following quotations:

> *U1: Definitely by multiplying the cells in an artificial environment, and then, and of course I don't know those stages but this is what I visualized in my mind: in an laboratory environment, taking a cell from the meat and multiplying it by mitotic division etc... This is what comes to my mind.*
>
> *U5: I thought that it is a kind of meat in a laboratory environment, I mean, meat including preservatives, when I saw the news. You know, they produced an ear, I hear about it in the news, so I thought that this one is produced in that way. I didn't search for the others at that time. But cells related to it are being researched and then they are trying to produce them accordingly.*
>
> *S1: In the laboratory but still they need to have something in their hands. They might have produced it from an already existing piece of meat. By multplying it in an environment, I don't know how, but they might have done this that way. Then, they also made something like a meatball and added some other things to it. I mean, I understood that way. I mean, there has to be somthing like a cell or something like that there.*
>
> *S6: I feel that they produced it from a piece of meat by making it bigger somehow. You know, the basic substance might be meat again, but there might also be some other things in it. I don't know now… I mean, maybe they took a cell from it or*

something else from it, I really don't know. Because, you know, they won't directly teleport it from nothing, and at the same time, it looks like meat, so I thought that way.

In addition to these, they made also realistic explanations when they compared their predictions to the real process of artificial meat as follows:

U1: [The procedure turned out to be very similar to what I had in my mind.] I thought that I couldn't describe well what was in my mind. I visualized this environment in my mind but I couldn't describe this to you, this culture medium etc… I just didn't sy stem cell. Apart from this, this exercise attracted my attention… Adding fat, iron, and some other ingredients; I couldn't predict this. However, I was able to visualize the first four stages.

U5: [It turned out to be similar but] it is not exactly the same actually. I thought that they would have add something preservative, too, but they don't exist.

S6: [the third step] is yes, exactly what we predicted… Until the last step, everything is clear to me; in terms of adding fat, iron and some other ingredients… there I'm not so sure… [in order to give its taste, adding some ingredients] increased [the sense of artificiality]. When compared with others, this part is more artificial. I mean, these are in their natural form; they are the things that are normally in it, but they needed to add them from outside. I mean it is so artificial that they gave them from outside.

S1: (She read the first step) Hah, this is exactly similar to what I predicted. (She read the second step) stem cell, ok, this also makes sense… Stem cells come together and form muscle fibers. How did they transform [into muscle fibers] now? (After all steps finish) I mean, we, you know, are formed from one cell, and then, those cells differ, this might be something like this I guess… Similar to what I had mentioned in the beginning… I thought about the first parts positively but this last step, you know, it says, some things are added, I'm confused there.

On the other hand, the other participants' predictions were not close to the real process of artificial meat. It was concluded that they mainly focused on the ingredient of the artificial meat while they predicted as it can be seen in the following representative quotations:

U4: They must have dealt with the chemistry of it for a long time… And it says it took a long time etc. So, they must have had a lot of difficulty, and it might not have worked. It said beet, saffron etc. By changing their molecular bonds, I mean, since they wanted to create something new, they might have changed their chemical bonds. They might have genetically modified them.

S2: I think they used something chemical. In order to give its color they said they had used something, hah here they say they had used saffron syrup, but I think they might have used something more chemical as well. At least in order to give its taste, to increase its shelf life […] when I read it now, they produced it from a lot of things, bread crumbs, beet, saffron; this really attracted my attention. It's very interesting.

S4: When we say 'meat' what comes to my mind is red meat, but when I heard that it is produced in the laboratory, I felt that they mixed let's say sausage, salami and then added some chicken meat, and mixed those kinds of things.

In addition to this, only U3 focused on the possible aims of the artificial meat in her prediction.

U3: The logic behind is most probably about not cutting animals. Therefore, I felt that it might be produced from herbs. By using plants, they might have tried to make it similar to meat.

Moreover, they could establish a realistic comparison between their predictions just as the close prediction owners. On the other hand, those in Group U generally received the new knowledge without making enough inquiry as follows:

U4: This turned out to be totally different from what I have thought of. I didn't think of it this way because it didn't say something like this, I mean, tissue is taken etc. It said beet, saffron, the previous news story gave information about the color. I got an idea about the ingredients here.

However, the one who made her predictions through the possible aims of the artificial meat seemed to process the new knowledge faster than the other members of Group U without attributing it certainty in order to use it in her judgements for the DM process, as follows:

U3: It turned out to be different to what I thought it was. I even liked it. I am more open up to it now, I misunderstood it when I saw the word artificial. Its production with a stem cell. Just a tissue sample is taken from the animal. It poses no other threat on the animal. In this case, it seems quite logical.

Moreover, the members of Group S generally tried to reach new judgements in order to use them in DM by processing the new knowledge very fast through their similar prior knowledge such as cloning or master cell treatments. Furthermore, while doing this they frequently referred to the empirical nature of scientific knowledge as it can be seen in the following representative quotations:

S2: When I read it now, I started to kind of have doubts about my vote 'no' actually. Because, you know, stem cells, I mean, of course stem cell treatment for human beings has just started, but still since it is produced from real tissues and real cells, I feel like it can work a bit. I don't think that it would be so harmful.

S4: It turned out to be very different from what I have thought. I thought that it is made by, you know, adding offals etc. but this looks more advanced to be honest. A few days ago, I had biology exam and I am studying these issues, cloning... You

> *know, this is advanced technology actually, but how much are they talking about stem cells in the end? Just like what I have learned in biology course, stem cell, you know, although it is not similar, I know that the first sheep Dolly was made of stem cells, but in the end, I know that the animal that is formed, or other living things, have more health problems than the normal living things.*

As a result, based on the analysis of the participants' predictions and explanations after being informed, it was understood that, whether they are a member of Group U or Group S, they perceived the production process of artificial meat similarly.

However, when a deeper analysis made on the data from this part of the interviews, an interesting difference in the explanations after being informed was realized. The members of Group U generally made no questioning for the new knowledge and they only tried to complete their deficiency in their predictions by using this new knowledge. As it was mentioned before, only U3 acted differently as she did not give certainty to the new knowledge in the DM process as much as the other members of Group U.

Moreover, interestingly attitudes of the ones in Group S, whose predictions were close to the real procedure of artificial meat, were very similar to that of Group U. They only focused on completing their deficiency in their predictions by using this new knowledge but without giving it a certainty. On the other hand, the attitude of the wrong prediction owners of Group S was very dramatic. They made an incredible effort to remove the deficiency in their predictions without giving any certainty to the new knowledge and also by questioning it by mentioning the empirical nature of scientific knowledge. It was understood that they frequently revised their judgements each time they faced a new piece of knowledge about the artificial meat in order to use them for the DM process.

4.1.3 Decision making strategies in first ballots

In the interviews, there was a ballot just after they read the news about artificial meat which contains almost no useful information to decide whether the artificial meat should be sold in Turkish markets or not. This first ballot in lack of knowledge situation was to collect data from the participants' initial responses in order to understand better their further attitudes in the DM process by comparing their initial DM strategies and final DM strategies (all DM strategies were listed in Table 4.2).

Table 4.2

Codes about the DM strategies

DM Strategy	Explanation
Rationalistic	To focus on comprehensive information enough to know 'almost everything' (especially about healthiness) in order to make a decision about the artificial meat.
Incrementalism	To focus on a very specific piece of information (especially about naturalness) in order to make a decision about the artificial meat.
Go-for-it approach	To tend to try everything new, in this case the artificial meat, without a proper analysis
Rational ritualism	After realizing that there is not enough comprehensive information to know 'almost everything' about the artificial meat, to act as if there was
Mixed scanning	To start to focus on the piece of information which is top of priority by also considering the effect of this on entire construction in order to make a temporary decision about the artificial meat.

The analysis showed that there was a difference between Group U and Group S in terms of general tendency of the DM strategies used. In addition to this, a difference was detected between the ones who voted 'yes' and the ones who voted 'no' in their initial responses.

Firstly, the members of Group U had generally a very conservative attitude towards the selling of artificial meat. 5 of 6 members of Group U voted 'no' and 1 of 6 wanted to stay abstainer. In addition to this, half of Group U used rationalistic approach by requiring comprehensive information enough to know 'almost everything' (especially about healthiness) in order to make a decision about the artificial meat, as it can be clearly seen in the following representative quotations:

> *U1: It would have been tested on animals; what kind of reactions emerge in animals or what kind of illnesses develop, results of all these would have been reached. And if it is now not much harmful, just as I mentioned before, the positive side of it might be eating meat at a very low price. In this respect, if there are no harms, if the scientists announce that yes it is not harmful etc. then I would say 'yes.' I can't say yes to something whose effects I don't know. I mean, I would like to learn the results of this. I don't think that it is right, for example, to vote with these pieces of information only. (Rationalistic → Initial response: NO shouldn't be sold)*

U3: Before voting, I would prefer to read the comments of people who know about this. Now that I am not competent at this topic, I would try to understand who puts this forth and why, why they bring this to referandum, what they say about its benefits, or its harms to society. I would try to understand what informed people say about this. (Rationalistic →Initial response: Abstainer/ wouldn't vote)

Moreover, the other half of Group U used incrementalism by focusing on a very specific piece of information (especially about naturalness-health relationships) in order to make a decision about the artificial meat as follows:

U2: I voted 'no.' I would say my health is important; let me eat the more natural one, not the artificial one. When I eat it, I would like to eat the hamburger with the natural one. I felt like this meat is unhealthy. (Incrementalism →Initial response: NO shouldn't be sold)

U5: Whatever it is, if it is artificial, I think, even when it has many advantages, there is also a disadvantage of it. Even if it is 1% of its advantages. Because it is artificial. (Incrementalism →Initial response: NO shouldn't be sold)

As for the attitudes of Group S, one of the most striking findings of this study arose as it was understood that half of Group S voted 'yes' with go-for-it approach in this lack of proper knowledge situation by tending to try everything new. Below are two representative examples of usage of go-for-it approach.

S1: I mean, I really don't know now, is this news reliable? They haven't given any details, but if I had to use my vote in this way, I would say 'yes' because I would say let it be sold and then we'll see. In the meantime, I would have time to do research, I wouldn't buy it immediately of course. Here I don't know whether other people would buy it or not. I would say 'yes' instead of saying 'no' right away, I would say 'yes' and would follow the news. If it is something good, I would buy it then. [...] people don't have to buy it just because I said 'yes.' (Go-for-it→Initial response: YES should be sold)

S5: It should be up to people's choice; it should be sold but people need to know what it is. I can say I am comfortable [with my vote]. I mean, after all it is people's choice, I am not voting to say people should eat it here, I am voting to say it should be sold. Depending on the person's choice, he/she buys it or leaves it. [...] For example, coke, everybody knows that it is bad, but whether to buy it or not is up tp people's choice. This can be like that I think. (Go-for-it→Initial response: YES should be sold)

On the other hand, other half of Group S acted just like the cumulative behavior of Group U by voting 'no' with rationalistic approach or incrementalism in their initial responses. The representative examples are below:

S6: I don't have any other piece of information… It shouldn't be allowed to be sold… Just as I mentioned before, I have no idea about how this meat is formed, what is in it, I can't see its effect on people; therefore, I don't trust it at all and I can't vote 'yes' for something I don't have any idea about. [...] If one person or, you know, a specific sample of people used it ─whether it is ok or not honestly I don't know, that's another story─ but let's assume that these people consumed it and it was found that there is no harm ─on the contrary, they said it is beneficial─ and let's say this was not given in the newspapers, but instead given in reliable and more scientific platforms, then I would choose 'yes' more. (Rationalistic →Initial response: NO shouldn't be sold)

Moreover, in Table 4.3 the difference between the attitudes of Group U and Group S, and voting 'yes' and voting 'no' are summarized.

Table 4.3

Comparison of DM strategies and the voting behaviors of Group U and Group S

Sbj	Initial responses			Sbj	Initial responses	
	DM strategy	**Vote**			**DM strategy**	**Vote**
U1	Rationalistic	NO		S1	Go-for-it	YES
U4	Rationalistic	NO		S3	Go-for-it	YES
U3	Rationalistic	Abstainer		S5	Go-for-it	YES
U5	Incrementalism	NO		S2	Incrementalism	NO
U6	Incrementalism	NO		S4	Incrementalism	NO
U2	Incrementalism	NO		S6	Rationalistic	NO

Sbj: Subject

4.2 Thinking Regions: Steps of DM in referendum situation about an SSI

As it was stated in the methodology chapter, with the analysis, it was understood that the linear steps of DM normative models in the literature were not sufficient enough to explain the DM process in referendum situation about an SSI. In fact, three thinking regions which were *'goals'*, *'criteria'*, and *'alternatives'* appeared simultaneously, and with the interactions among them the fourth thinking region which was *'decision'* was activated. In this chapter, each of these thinking regions is explained in detail by mentioning the differences between Group U and Group S in terms of how these regions were activated in the DM process.

4.2.1 Goals

The thinking region *'goals'* is related to "*For which reason is the artificial meat produced / Why will we use the artificial meat/what will the artificial meat cause?"* In the interviews, 17 *'goals'* were mentioned. The analysis showed that *'to deal with starvation and scarcity', 'to protect the animals under bad conditions in animal husbandry/to prevent the animals from being killed for food', 'to satisfy the scientific curiosity/to develop science', 'to produce healthier and more quality meat', 'to deal with global warming', 'to make profit', 'to taste and consume the meat of exotic or endangered animals' and 'to provide fresh meat for the astronauts in space'* were the common goals which were stated by all participants. The frequencies of all *'goals'* are listed in Table 4.4. In addition to this, in order to clarify how the thinking region *'goals'* became effective in the DM process, the representative quotations for each goal are listed, too. At this point it is important to state that in all quotations, there may be more than one thinking region appeared. In other words, one quotation may include only one thinking region or may include the interwoven thinking regions. This situation results from the nature of thinking as it was explained in the previous chapter in the DM normative model.

Table 4.4

The goals about producing the artificial meat

In order to	Representative Quotations	F
deal with starvation and scarcity	U4: Belki ileride kıtlık olacak bir şey olacak, paramız çok olacak ya da maliyete neden olan şeyler ucuzlayacak da hayvancılık bitecek işte o zaman buna başvurulabilir.	12
protect the animals under bad conditions in animal husbandry/ prevent the animals from being killed for food	S1: Belki hayvanların kesilmesine karşı olan bir sivil toplum kuruluşundan destek görüyor olabilir.	12
satisfy the scientific curiosity/ develop science	U6: Onlar da sırf tatmak istemeseler bile hani sırf başka hayvanlarda bu iş nasıl olacak diye denemek isterler belki. Bilimsel merak.	12
produce healthier and more quality meat	S3: Belki hani bakteri riski azabilir ama daha sağlıklı olabilir mi bu tartışılabilir ya da vücudumuzun bu tarz şeylere ihtiyacı var mı? Yani normal bir etin içinde yer alan besin değerlerinden fazlasına ihtiyacımız var mı bunların ona katılması gerekli mi değil mi?	12
deal with the global warming	U1: Ben sustainability dersi alıyorum, orada küresel ısınmanın nasıl dehşetli bir şey olduğunu öğrendim. Böyle nasıl sonuçlar doğuracak bunları falan görünce, ilerisi için bir sorun ortaya çıkacaktır ve bu yapay et o zaman bize avantaj sağlayacaktır diye düşünüyorum.	12
make profit	S4: Bence kötü bir gelişme diye düşünüyorum. Yani bunun ticari bir amaçla olduğunu düşünüyorum, yapay et üretilmesinin. Daha çok kazanmak için.	12
taste and consume the meat of exotic or endangered animals	U3: Yani herkesin sağlıklı et yiyebilmesi olabilir ya da hayvanlar işte nesli tükenirse et yine de yenilebilsin. Ama nesli tükenirse nasıl yiyeceğiz hayvanlarda biyopsi örneği alınıyor kök hücreler saklanabiliyor uzun süre gerçi. Yani böyle bir şey olabilir.	12
provide fresh meat for the astronauts in space	S6: Doğru aslında yani uygun astronotlar beslenme açısından çok sıkıntı çekiyorlar o yüzden yüksel protein içerikli vesaire yararlı olabilir onlar için.	12

Table 4.4

(continued)

In order to	Representative Quotations	F
decrease the price of meat and provide meat for poor people	S5: Şimdi ben bile Türk kafasıyla düşündüğümde bence o maliyeti düşürmek için et üretmeye çalışıyordur.	9
question the hidden aim	U5:Ben şunu anlamıyorum yani yapay et çok güvenli normal etle bire bir aynı niçin bunu üretiyorlar zaten normal et var. Amacı ne…	7
provide economic development/ open up new employment opportunities	S3: Bazıları için iş kapısı olacak bazıları para kazanacaklar bunu düşündüm. Ekonomik bir açısı var. Belki devamında bilim insanları üzerinde daha çok çalışacaklar ve daha çok geliştirecekler. […] Eninde sonunda bu ürün satılırdı gibi geliyor bana. Ekonomik getirileri yüzünden… Birilerine iş kapısı olacak alınıp satılacak…	6
provide everyone with quality, cheap and healthy meat	U1: Amacının yumuşak et yememiz olmadığını söyleyebilirim. Etin herkese ulaşması, insanların kolaylıkla ve ucuza et yiyebilmesini düşünmüştür. Aklıma başka bir şey gelmiyor.	5
meet the people's increasing meat needs with increase in population	S1: Şimdi bilmiyorum et üretimi nasıl yetiyor mu yetmiyor mu ülkelere. Yani yetmiyorsa iyi bir destek olabilir. [...] belki ülkede et sorunu var.	4
become a step of another scientific study like transplantation	S3: Bir de şunu merak ettim burada ürettiğimiz bir kas dokusunu hayvana nakil etme olanağımız var mı?	4
develop war technologies	U4: E petrol için savaşan ülkeler olduğumuzu düşündüğümüzde hani kar amaçlı bir sürü şey yapıyorlar. Ya da başkasına zarar vermek için	2
reduce nutritional value in order to deal with obesity	S6: Bu Amerika falan olsaydı şey diyebilirdim hani çok fazla et tüketimi var insanlar obez ama tabii genetiğiyle oynanmış etler tükettikleri için obezler de hani belki öyle bir politika için yapılmış olabilir diyebilirdim. Halkı zayıflatmak adına	1
vary the way of nutrition	S6: Bir de çeşitlilik sağlıyorlar belli başlı şeyleri yiyoruz biz.	1

Moreover, Table 4.5 was prepared to show the personal distribution of *‘goals’* for each member of Group U and Group S in the whole DM process. With this table, it can be figured out that the general densities to use thinking region *‘goals’* and the number of *‘goals’* were very similar in both groups. On the other hand, there were some differences in the focused *‘goals’*. Specifically, with the analysis, it was understood that Group U focused more on the *‘goals’:* ‘*to question the hidden aim’* and ‘*to provide everyone with quality, cheap and healthy meat’* than Group S did. Therefore, it can be concluded that although according to Group U scientific knowledge is absolute and certain, they did not stop questioning the usage of this knowledge. Correlatively, Group U considered the social benefit much more. In addition to this, it was understood that Group S was interested in human prosperity as they focused more on the *‘goals’: ‘to provide economic development/to open up new employment opportunities’* and *‘to meet people's increasing needs for meat with the increase in population’*.

Table 4.5

Distribution of the goals in DM process

GOALS	U1	U2	U3	U4	U5	U6	Group U	S1	S2	S3	S4	S5	S6	Group S
deal with starvation and scarcity	x	x	x	x	x	x	6	x	x	x	x	x	x	6
protect the animals under bad conditions in animal husbandry/ prevent the animals from being killed for food	x	x	x	x	x	x	6	x	x	x	x	x	x	6
satisfy the scientific curiosity/ develop science	x	x	x	x	x	x	6	x	x	x	x	x	x	6
produce healthier and more quality meat	x	x	x	x	x	x	6	x	x	x	x	x	x	6
deal with the global warming	x	x	x	x	x	x	6	x	x	x	x	x	x	6
make profit	x	x	x	x	x	x	6	x	x	x	x	x	x	6
taste and consume the meat of exotic or endangered animals	x	x	x	x	x	x	6	x	x	x	x	x	x	6
provide fresh meat for the astronauts in space	x	x	x	x	x	x	6	x	x	x	x	x	x	6
decrease the price of meat and provide meat for poor people	x		x		x	x	4	x	x		x	x	x	5
question the hidden aim	x	x	x		x	x	5	x				x		2
provide economic development/ open up new employment opportunities				x			1	x	x	x	x		x	5
provide everyone with quality, cheap and healthy meat	x	x	x		x	x	5							0
meet the people's increasing meat needs with increase in population						x	1	x		x	x			3
become a step of another scientific study like transplantation	x	x					2		x	x				2
develop war technologies				x			1		x					1
reduce nutritional value in order to deal with obesity							0						x	1
vary the way of nutrition							0						x	1
TOTAL	12	11	11	10	11	12	67	12	12	11	11	10	12	68

Furthermore, when the issue came to the *'decision'*, the analysis showed that while all members of Group U mentioned at least one of the *'goals'* in their decisions, only 4 of 6 members of Group S mentioned the *'goals'* in their decisions. Thus, it was thought that although the importance they gave looked equal in the DM process, the linkage between the *'goals'* and the *'decision'* of Group S was not as strong as that of Group U. Moreover, as it can be clearly seen in Table 4.6, two members of Group S emphasized *'to taste and consume the meat of exotic or endangered animals'* in their decisions. However, with the analysis, it was understood that this situation did not express a meaningful difference between groups in terms of *'goals-decision'* connection because one of them voted *'no'* by mentioning this goal in a positive way and the other voted *'yes'* by mentioning this goal in a negative way. Therefore, it was concluded that no meaningful difference existed related with this issue. On the other hand, two members of Group U who voted 'no' emphasized *'to make profit'* in a negative way in their *'decision'*. This means that the emphasis was on an opposition to produce artificial meat only for making profit. It was commented that this situation was consistent with the general attitude of Group U related with social benefit and there is a difference between Group U and Group S related with this issue.

Table 4.6

Distribution of the goals in 'decision'

GOALS	U1	U2	U3	U4	U5	U6	Group U	S1	S2	S3	S4	S5	S6	Group S
deal with starvation and scarcity				x	x		2	x						1
protect the animals under bad conditions in animal husbandry/ prevent the animals from being killed for food		x	x	x			3	x		x			x	3
produce healthier and more quality meat							0						x	1
deal with the global warming	x	x		x	x	x	5	x		x		x	x	4
make profit					x	x	2							0
taste and consume the meat of exotic or endangered animals							0					x	x	2
provide fresh meat for the astronauts in space			x				1						x	1
TOTAL	1	2	2	3	3	2	13	3		2		2	5	12

4.2.2 Criteria

The thinking region *'criteria'* was identified in the participants' speech contents where the participants focused on the question '*What should/must the qualification of the artificial meat be?'* In the interviews, 16 criteria were mentioned by the participants. With the analysis, it was understood that 'Healthiness,' 'Ingredients and nutritive value,' 'Flavor,' 'Effects on animals,' 'Cost,' 'Production procedure,' and 'Being experimented' were the common criteria which were mentioned by all participants. It was not surprising to see that all participants mentioned 'Healthiness,' 'Ingredients and nutritive value,' and 'Flavor' about the artificial meat if it is remembered that related with SSIs, the focus group's main areas of interest were already food technologies and healthiness. Moreover, 'Effects on animals,' 'Cost,' and 'Production procedure' were also discussed in informing parts. Furthermore, when it is considered that all participants' understandings about empirical nature of scientific knowledge were sophisticated, it was expected that all participants would mention the criterion 'Being experimented' in the DM process about the artificial meat. In addition to this, 'Price' and 'Being natural' were almost all participants' criteria about the artificial meat and they were also expected criteria because of easily established cost-price relations and because being natural is the opposition of being artificial. In order to see how the *'criteria'* were mentioned in the interviews, representative quotations were stated in Table 4.7, which also includes all of the '*criteria'* related with the artificial meat mentioned by the participants during the DM process with their total frequencies.

Table 4.7

The criteria about the artificial meat

Criteria	Representative Quotations	F
Healthiness	U1: If there are no negative effects, why would I have a negative attitude towards people's eating healthier meat and what is more, this meat, you know Omega 3 etc., such rich meat. Even if it is artificial, you know, if it is healthy, it is ok for me.	12
Ingredients and nutritive value	S6: I need to see the real meat content and the content of the meat they have produced comparatively to be convinced. These two contents should match; there shouldn't be huge differences between these values.	12
Flavor	U2: The writer: this is exactly the Turkish perspective. That's it. This wouldn't taste good at all because we know meat.	12
Effects on animals	S4: But they [vegetarians] think that even using the stem cell only gives harm to animals, but this is stem cell, you know, I don't think that this gives harm to animals.	12
Cost	S1: Animals feed but we don't eat each and every part of the animal I guess and that water and energy is used for their normal daily activities as well, but when producing the meat in the laboratory, there is a certain amount of energy needed for its growth I guess, and this is probably lower.	12
Production procedure	S2: When I read it now, I started to kind of have doubts about my vote 'no' actually. Because, you know, stem cells, I mean, of course stem cell treatment for human beings has just started, but still since it is produced from real tissues and real cells, I feel like it can work a bit. I don't think that it would be so harmful.	12
Being experimented	U6: If it completely resembles natural meat, then it's ok. I mean the content of it, the percentages etc… But now there is still a risk. Even if the percentages are the same, there might be other problems. It has to be tested.	12

Table 4.7

(continued)

Criteria	Representative Quotations	F
Price	S6: Will everybody be able to afford this [the artificial meat]? Or will the government afford it and directly give it to hungry people etc.?	11
Being natural	U3: It turned out to be different to what I thought it was. I even liked it. I am more open up to it now, I misunderstood it when I saw the word artificial. Its production with a stem cell. Just a tissue sample is taken from the animal. It poses no other threat on the animal. In this case, it seems quite logical. For me, the procedure is still artificial, but reproducting animals in farms is also artificial.	11
Texture/viscosity/color consistency	S3: If it is natural enough, what kind of fat they use is important. How these are integrated, how they are put into this muscle they produced are all important. There is one more important thing: they said its taste had a juicier form and a similar texture. This juicier form may lead me not to eat it.	8
Economic effects	S2: There might be economic consequences; this might reduce animal husbandry, so it might be more harmful in that respect.	8
Legality	U1: Of course, there is one more imperative: people need to know which one is natural meat and which one is artificial meat. I mean, selling artificial meat under the name of natural meat should be prevented as well.	8
Environmental effects	U5: I have said that. This is the most persuasive opinion, saying that it will give less harm to the environment.	8
Variation in usage area	S5: These scientists said that it is against starvation but we don't satisfy our hunger with meat only. I think this is not the only solution to starvation. Therefore, it didn't make much sense. Hunger might be satisfied with other things, with wheat for example.	6
Effects on society	S3: While sociologists evaluate this in terms of society, this one might evaluate it in terms of human psychology. For example, how to present the product so that it attracts people.	6
Religious approval	U4: In any way, it is artificial I think. Amniotic fluid is to do both with my world-view and religion. I wouldn't prefer it. I'm the sort of person who reflects my religious belief into my lifestyle. I mean, it is not prejudice, but it plays a part in my decision-making.	3

Moreover, in Table 4.8, the personal distributions of *‘criteria’* for each member of Group U and Group S in the whole DM process are listed with their frequencies. With this table, it can be understood that the general density to use thinking region *‘criteria’* was equal. However, the analysis showed that there are differences between Group U and Group S in three criteria. The biggest difference was attached to the criterion ‘Economic effects,’ which was mentioned by all members of Group S and was considered by only two members of Group U. This situation was found to be related with Group S’s general attitudes towards human prosperity which also showed itself in the previous section in Group S’s focused *‘goals’: ‘to provide economic development/to open up new employment opportunities’* and *‘to meet people's increasing needs for meat with the increase in population’*. Moreover, while 4 members of Group S thought about the artificial meat’s effects on society as a criterion, only two members of Group U stated this as a criterion. At first look, this situation seems to be inconsistent not only with the general attitude of Group S, but also with the general attitude of Group U related with this issue. However, with the analysis, it was understood that the members of Group S did not consider social benefit when they mentioned the criterion ‘Effects on society,’ but they thought how the artificial meat is voiced in society and in which way the artificial meat can be more acceptable. In addition to this, almost all members of Group U thought about the ‘Legality’ of the artificial meat while only half of Group S stated ‘Legality’ as a criterion. It was also concluded that this situation might be related with the differences between the groups about general approaches to society needs.

Table 4.8

Distribution of the criteria in DM process

CRITERIA	U1	U2	U3	U4	U5	U6	Group U	S1	S2	S3	S4	S5	S6	Group S
Healthiness	x	x	x	x	x	x	6	x	x	x	x	x	x	6
Ingredients and nutritive value	x	x	x	x	x	x	6	x	x	x	x	x	x	6
Flavor	x	x	x	x	x	x	6	x	x	x	x	x	x	6
Effects on animals	x	x	x	x	x	x	6	x	x	x	x	x	x	6
Cost	x	x	x	x	x	x	6	x	x	x	x	x	x	6
Production procedure	x	x	x	x	x	x	6	x	x	x	x	x	x	6
Being experimented	x	x	x	x	x	x	6	x	x	x	x	x	x	6
Price	x	x	x	x	x	x	6	x	x		x	x	x	5
Being natural	x	x	x		x	x	5	x	x	x	x	x	x	6
Texture/viscosity/color consistency	x	x	x		x		4	x	x	x			x	4
Economic effects				x		x	2	x	x	x	x	x	x	6
Legality	x	x	x	x		x	5		x	x		x		3
Environmental effects		x		x	x	x	4			x	x	x	x	4
Variation in usage area	x	x				x	3	x		x		x		3
Effects on society		x		x			2			x	x	x	x	4
Religious approval	x			x			2						x	1
TOTAL	13	14	11	13	11	13	75	12	12	14	12	14	14	78

The analysis showed that in the *'decision',* the members of Group U mentioned the *'criteria'* more than the members of Group S as it can be seen in Table 4.9. However, because the number of stated criteria of one member of Group U was a lot higher than that of all the other participants, this difference was not counted as meaningful enough. On the other hand, the members of Group U focused on three criteria, which were 'Healthiness,' 'Effects on animals' and 'Being experimented,' much more than the members of Group S did; therefore, it was concluded that there were differences between groups in terms of *'criteria-decision'* relation.

Firstly, while all members of Group U covered 'Healthiness' of the artificial meat as a criterion in their decision, only half of Group S mentioned this criterion. It was concluded that Group U gave much more importance to the criterion 'Healthiness' than Group S did. This situation is also explained by establishing the connections with NOS1: 'The Tentative Nature of Scientific Knowledge' and NOS4: 'The Empirical Nature of Scientific Knowledge' lens usage of the Groups in following sections.

Secondly, it was understood that more members of Group U focused on the criterion 'Effects on animals' in their *'decision'* most probably due to being unsophisticated in NOS1. They focused on informing parts of the interview more in order to gain as much information as they can.

Finally, while 4 of 6 members of Group U directly stated 'Being experimented' as a criterion for the artificial meat in their *'decision'*, only one member of Group S counted 'Being experimented' as a criterion in *'decision'*. This situation is explained with all the details and conclusions in the following section, NOS4.

Table 4.9

Distribution of the criteria in 'decision'

CRITERIA	U1	U2	U3	U4	U5	U6	Group U	S1	S2	S3	S4	S5	S6	Group S
Healthiness	x	x	x	x	x	x	6	x	x			x		3
Ingredients and nutritive value		x					1	x					x	2
Flavor		x					1						x	1
Effects on animals	x	x	x	x			4			x			x	2
Cost	x	x					2					x		1
Production procedure		x	x	x			3	x		x	x	x		4
Being experimented	x		x		x	x	4					x		1
Price		x					1							
Being natural		x			x		2			x				1
Economic effects				x			1							
Environmental effects		x		x	x		3			x		x	x	3
Effects on society				x			1							
TOTAL	4	9	4	6	4	2	29	3	1	4	1	5	4	18

4.2.3 Alternatives

The thinking region *'alternatives'* is related with the question *'What can be compared with the artificial meat?'*. The analysis showed that participants mentioned 12 *'alternatives'* in the interviews. It was understood that at the beginning of the interview, the participants thought about the *'alternatives'* in order to understand what the artificial meat is. In other words, they tried to load meanings to the artificial meat through the *'alternatives'*. However, as the DM process proceeded, they started to evaluate the effectiveness of the artificial meat by comparing it with its *'alternatives'*. 'Normal meat,' 'Genetically modified (GM) foods,' 'Plant-based meat-like product' and 'Synthetic meat' were the *'alternatives'* thought by all participants. Moreover, almost all participants focused on 'Animal husbandry' as an alternative to the artificial meat in the whole DM process. All the *'alternatives'* mentioned by the participants in the DM process are listed in Table 4.10 with their representative quotations and frequencies. In addition to this, as it is clearly seen in this table, the frequencies of the other alternatives apart from the ones mentioned above sharply decreased. However, when it is remembered that the artificial meat was selected for this study in order to minimize subject characteristic threat as it was an unfamiliar SSI for the focus group, it was expected to find some dispersed *'alternatives'*. In other words, just because the participants had no prior knowledge about artificial meat, they generally focused on the *'alternatives'* related with the informing parts.

Table 4.10

The alternatives of the artificial meat

Alternatives	Representative Quotations	F
Normal meat	U6: You know, meat is not enough for people, people want to eat it but it is not enough, the price is somehow increasing day by day etc. I don't know. On the one hand, if people want to eat it and if it doesn't cause much harm, then why not.	12
Genetically modified (GM) foods	S5: The artificial meat is better, here they directly imitated the nature but in GMO they directly change its genetics, they change something that already exists. But here they change nothing, they don't touch its DNA.	12
Plant-based meat-like product	U5: Actually, I'm thinking of something like cracked wheat. They threw something like cracked wheat into this and then they added something like glue to it. Or they might have used soy beans. I thought in this way. [...] We should eat natural. We are already a living thing who needs carbohydrates, proteins, I mean, out bodies. Each one has its own place. For example, we cannot say let's eat cracked meat instead of meat.	12
Synthetic meat	S2: The head of animal right commission thought about it emotionally, I mean extremely emotionally. Because he says that animals shouldn't be used for breeding. I mean he says no sample should be taken from animals and it should be produced completely synthetically. Well, I don't know but how are we going to eat something which is completely synthetic. What are we going to eat?	12
Animal husbandry	U4: There is a problem in the livestock sector. People want to do more qualified work, the number of people who want to work in the livestock sector is low, so I would like to work in order to solve this problem in relation to the increase in literacy rates. Now that you are not interested in animal husbandry, then multiply the stem cells in the laboratory.	11

Table 4.10

(continued)

Alternatives	Representative Quotations	F
Fast foods/ processed food	S3: I don't feel discomfort any more by it being called meat. I could be artificial meat. Other delicacies are also meat that have been processed. This one is artificial and so is the other one. This one is completely artificial, but more open.	5
Artificial tissues and organs	U1: I follow a lot of websites on Facebook that shares news stories like this. For example, I heard that they produced bones, and then, I looked into it. News stories like this attract my attention. You know, they started to print-out organs using 3-D printers and so on…	4
Supporting green housing and agriculture	U2: There is agriculture and animal husbandry in our nature. I wish we had developed through raising animals, agriculture, and wouldn't have made this much progress through industrialization, I think.	4
Dealing with the reasons for starvation and scarcity	S1: They say to me "then go and find a solution to starvation." I would get to the root of the problem. You know, what kind of a problem is there in those lands? Or if there is starvation in our country, why are all these people hungry?	2
Balancing income distribution	U3: I realized that I don't like this while reading this: you know, in order to provide food for hungry people. Saying what a nice pathway it is or saying we're trying to produce this only for that… the fact that hungry people are starving, it is not that there are so few animals and a group of people snatched them, and nothing is left for the others, you know. There is a typical chat you know, if we brought together the money of the five richest people in the world, and distribute it to the world, everybody would live in equal conditions. Distributing it to starving people, you know, a bit, is like garnishing it with words. I realized this when I read this.	2
Changing the nutritional habits	S4: I'd like to impose a life without eating red meat on people. The idea that without it we can also get the nutrients from other things, a piece of information, I don't know.	1
Environmental protection works	S6: For example, for carbon emission don't do this, don't do that… What can it be… well, forestation maybe, or a few things for cleansing rivers, seas, and so on	1

Moreover, Table 4.11 shows the distribution of the *'alternatives'* in the whole DM process to the participants. It can be clearly seen that the density of using the thinking region *'alternatives'* was very similar. With the analysis, it was understood that there is a difference between Group U and Group S in only one alternative which is 'Supporting green housing and agriculture'. While half of Group S mentioned supporting green housing and agriculture as an alternative to producing artificial meat, only one member of Group S mentioned it in the DM process. On the other hand, while none of these members of Group S focused on this alternative deeply and just stated it once in their DM process, the member of Group U directly emphasized it more than once. Therefore, it was concluded that there are no meaningful differences between groups in terms of the focus on 'Supporting green housing and agriculture' as an alternative to the artificial meat.

Table 4.11

Distribution of the alternatives in DM process

ALTERNATIVES	U1	U2	U3	U4	U5	U6	Group U	S1	S2	S3	S4	S5	S6	Group S
Normal meat	x	x	x	x	x	x	6	x	x	x	x	x	x	6
Genetically modified (GM) foods	x	x	x	x	x	x	6	x	x	x	x	x	x	6
Plant-based meat-like product	x	x	x	x	x	x	6	x	x	x	x	x	x	6
Synthetic meat	x	x	x	x	x	x	6	x	x	x	x	x	x	6
Animal husbandry	x	x	x	x	x	x	6	x	x	x		x	x	5
Fast foods/ processed food		x				x	2	x		x	x			3
Artificial tissues and organs	x					x	2	x	x					2
Supporting green housing and agriculture		x					1	x	x			x		3
Dealing with the reasons for starvation and scarcity			x				1	x						1
Balancing income distribution			x				1						x	1
Changing the nutritional habits							0				x			1
Environmental protection works							0						x	1
TOTAL	6	7	7	5	5	7	37	9	7	6	6	6	7	41

Furthermore, the analysis showed that the participants mentioned ‘Normal meat,’ ‘GM foods,’ ‘Plant-based meat-like product,’ ‘Animal husbandry,’ and ‘Fast food/processed food’ in the *‘decision’*; and these are listed with their distributions to the participants in Table 4.12. It was understood that almost all participants mentioned ‘Normal meat’ and ‘Animal husbandry’ in their decisions and all of them almost only focused on these two alternatives. Just because ‘Normal meat’ and ‘Animal husbandry’ were the naturally closest alternatives to the artificial meat, it was concluded that whether voted ‘yes’ or ‘no’, after all informing parts in the interview, the participants thought the artificial meat as a unique product.

Table 4.12

Distribution of the alternatives in 'decision'

ALTERNATIVES	**U1**	**U2**	**U3**	**U4**	**U5**	**U6**	**Group U**	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**Group S**
Normal meat	x	x	x	x	x		5	x	x	x	x	x	x	6
Genetically modified (GM) foods									x					1
Plant-based meat-like product													x	1
Animal husbandry	x	x	x	x	x	x	6	x	x		x	x	x	5
Fast foods/ processed food										x				1
TOTAL	2	2	2	2	2	1	11	2	3	2	2	2	3	14

4.2.4 Decision

In this study, the *'decision'* revolved around the question *"Should the artificial meat be sold in Turkish markets or not?"* As it was stated before, the *'decision'* was made by many connections among *'goals'*, *'criteria'* and *'alternatives'*. On the other hand, only very identical ones remained directly observable in the participants' declarations. The analysis showed that all members of Group U referred to *'goals'*, *'criteria'* and *'alternatives'*. However, it was understood that the number of direct references was limited. In addition to this, the situation generally seemed to be very similar in the declarations of the members of Group S except for the declarations of S2 and S4. S2 and S4 did not refer to any *'goals'* in their decisions. The personal demonstrations about the connections between *'goals-decision'*, *'criteria-decision'* and *'alternatives-decision'* in DM for each member of Group U and Group S are shown in Figure 4.1 and Figure 4.2 respectively. In these figures it was shown that for example, U1 had given 'YES' vote to selling the artificial meat in Turkish markets and she thought of 12 goals in DM but she mentioned only 1 goal to base her 'decision' on. In DM, U1 also thought of 13 criteria, 4 of which she connected with her decision, and she thought of 6 alternatives to the artificial meat, 2 of which she mentioned in 'decision'. Moreover, Figure 4.3 and 4.4 were prepared to show the overall group dynamics related with the connections between *'goals-decision'*, *'criteria-decision'* and *'alternatives-decision'*. As it is clearly seen with the lack of two small black arrows between *'goals-decision'* in Figure 4.4, overall *'goals-decision'* connections are weak just because of S2 and S4 as the missing arrows in the small black arrow series belong to S2 and S4 according to the order. Therefore, it was understood that the *'goals'* connections with *'decision'* was not strong in Group S as much as that of Group U.

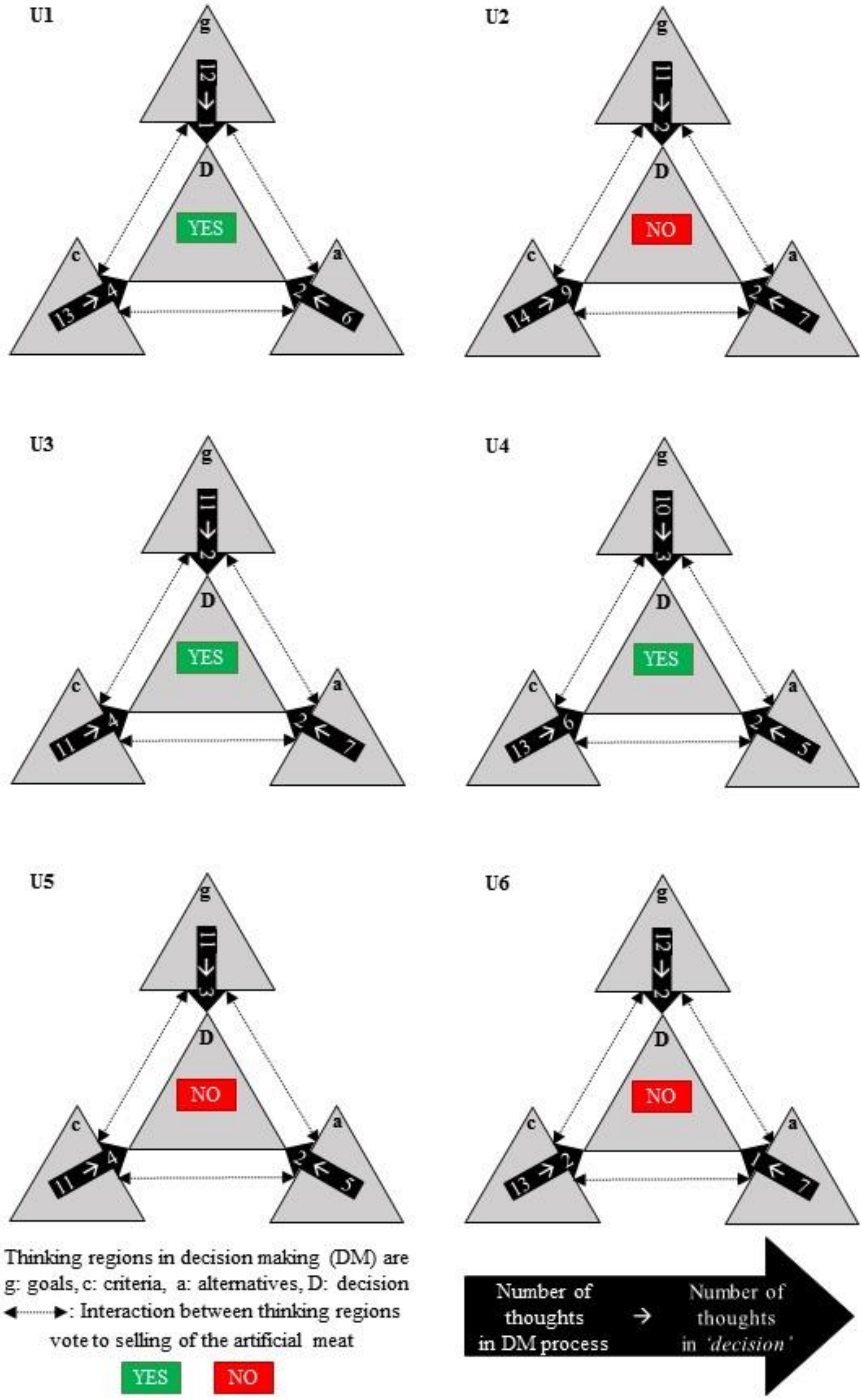


Figure 4.1 The personal demonstrations of the members of Group U for the connections between *'goals-decision,' 'criteria-decision'* and *'alternatives-decision'* in DM.

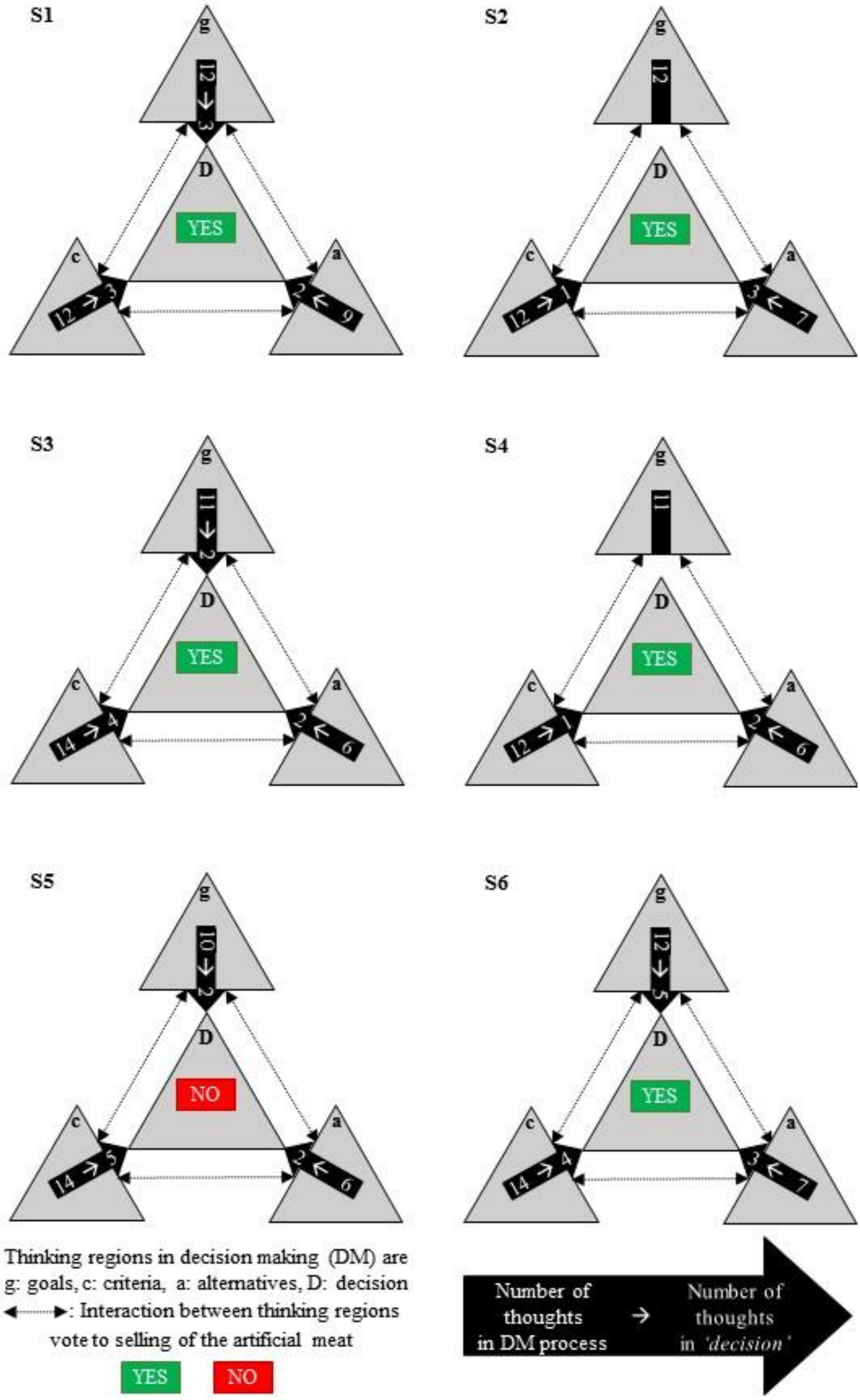


Figure 4.2 The personal demonstrations of the members of Group S for the connections between 'goals-decision,' 'criteria-decision' and 'alternatives-decision' in DM.

GROUP U

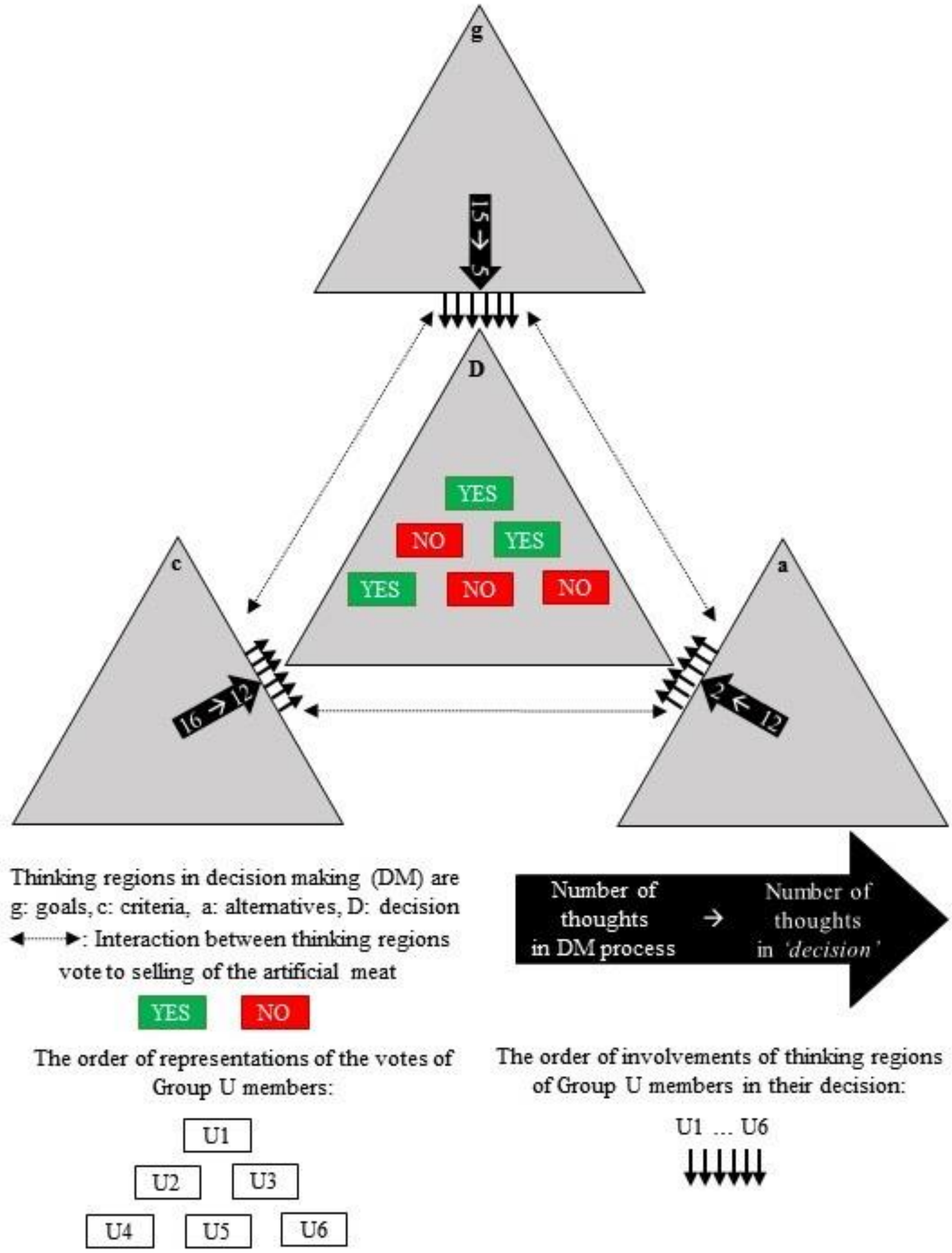


Figure 4.3 The overall demonstrations of Group U for the connections between *'goals-decision,'* *'criteria-decision'* and *'alternatives-decision'* in DM.

GROUP S

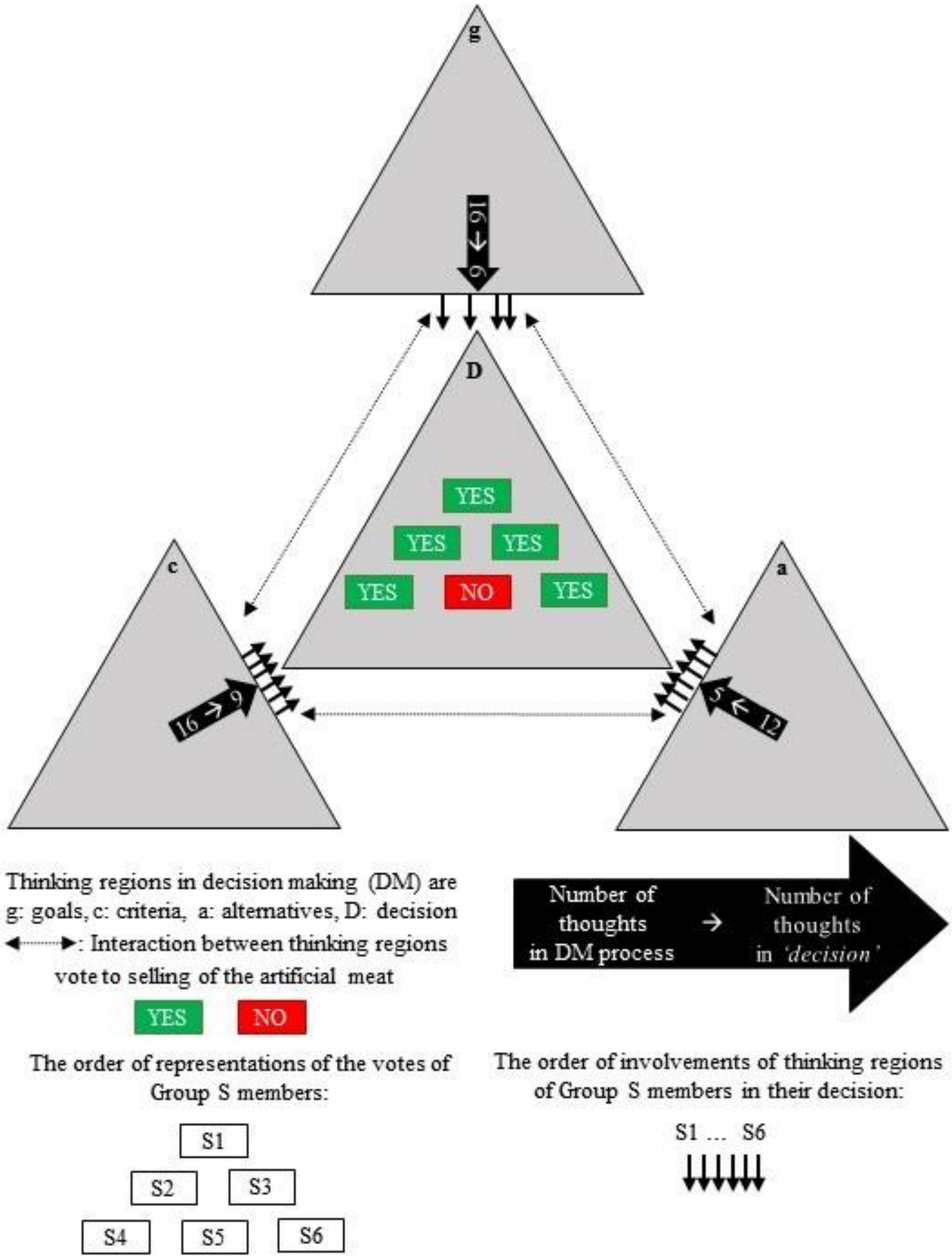


Figure 4.4 The overall demonstrations of Group S for the connections between *'goals-decision,' 'criteria-decision'* and *'alternatives-decision'* in DM.

4.3 Lens Usages in DM

In this section the participants' NOS lens usages and other lens (lenses except from NOS) usages in DM about SSI - the artificial meat - are presented through the Fractal Model of DM respectively. At the end of this section, the examples of personal lens usages are provided.

4.3.1 NOS lens usages in DM

In this section the findings from the analysis of how NOS understandings of Group U and Group S were reflected to their DM process is presented. The detailed explanation about using term 'lens' is given in the following chapter titled 'Other lenses'. With the analysis and in the light of the studies of Lederman (2006) and Khishfe (2012), codes were reached to understand the effects of NOS lens usage for five aspects and all of them are listed in Table 4.13. Moreover, Table 4.14 shows the representative quotations from NOS lens usages of each NOS aspect in the DM process which includes both sophisticated and unsophisticated usages.

At this point it is important to mention that no findings about the lens usage of the participants related with 'The Functions of and Relationships Between Scientific Theory and Law' were reached. In addition to this, no direct findings about lens usages of the participants related with 'The Tentative Nature of Scientific Knowledge' which was labeled as NOS1 in the present study were reached too, although there was a very wide gap between the understandings of Group U and Group S in terms of NOS1. On the other hand, in the following parts, there are extensive explanations about the NOS lens usages related with five NOS aspects, which are 'The Creative and Imaginative Nature of Scientific Knowledge', 'Observation and Inference in Science', 'The Empirical Nature of Scientific Knowledge', 'The Theory-Laden Nature (Subjectivity) of Scientific Knowledge and The Social' and 'Cultural Embeddedness of Scientific Knowledge' with additional representative quotations from usages of NOS lenses.

Table 4.13

NOS lens usage codes in DM process related with the artificial meat and its alternatives

NOS lens	Codes for Sophisticated NOS lens usage	Codes for Unsophisticated NOS lens usage
Creativity and imagination (NOS2)	To appreciate the scientists' creativity and imagination in doing science (sNOS2)	To find the scientists' creativity and imagination odd/ To see using creativity and imagination in science as moving away from doing science (uNOS2)
Observation and inference (NOS3)	To highlight the inferences which are strictly aligned with the data or observations/ To mean that the data have different interpretations as the observations and inferences are different kind of scientific knowledge (sNOS3)	To highlight the inferences which are not aligned with the data or observations / To mean that the data have only one interpretation as if the inferences were the sum of observations (sNOS3)
Empirical-basis (NOS4)	To tend to look for scientific knowledge, which is resulted from scientific process and inquiry (sNOS4)	To feel insufficient need to look for scientific knowledge, which is resulted from scientific process and inquiry (uNOS4)
Subjectivity (NOS5)	To consider that the scientist express different and personal perspectives because of the differences in their characters, personal qualities, experiences and working background (sNOS5)	To load a standard and strict character, personal quality and behavior on the scientists/ To expect objectivity from the scientists/ To give overcredibility to the scientists by ignoring the differences in working area (uNOS5)
Social and cultural embeddedness (NOS6)	To consider the interaction between science and the society (sNOS6)	To ignore the interaction between science and the society/ To see the scientists be isolated from the society which they are in (uNOS6)

Table 4.14

Representative quotations from NOS lens usage in DM process related with the artificial meat and its alternatives

NOS lens	Representative quotations from Sophisticated NOS lens usage	Representative quotations from Unsophisticated NOS lens usage
Creativity and imagination (NOS2)	S6: This is an expected, consistent opinion even from scientists' point of view. Scientists are open to innovation. […] Many people might not be able to think of it. Maybe, even me not accepting it is because of the fact that I cannot imagine it. That's why scientists have dreamt about it, and dwelled on what kind of an environment it could happen or worked on his/her imagination to see what form it could take.	U4: [the opinion I fall for] Group 4. [...] Well, because they don't have an opinion conflicting with me, like saying, out of the blue, we should eat pandas [...] These ones [Group 4] look into it in every aspect rather than running after craziness [like Group 3] just because they are scientists…
Observation and inference (NOS3)	S6: (While evaluating Type 2 vegetarians' inferences which are not strictly aligned with data or observation) How much should that fluid [the fluid taken from pregnant cattle] be? Would that do any harm on the offspring? They talk about it without knowing its dose. They are prejudiced about it being completely harmful.	U2: (While evaluating Type 2 vegetarians' inferences which are not strictly aligned with data or observation) For one thing, some things are obtained from animals and we do not approve the use of fluids taken from those extremely beautiful pregnant cattle [they said]. It is true that you spoil their natural pregnancy period [...] And neither do we exactly know what the content of this production is [they said]. That's what exactly I'm trying to say. We do not know what exactly everything is, and what is in it. In fact, we consume something we do not know...Well it has many things.. damages.. that's what exactly I have been trying to say right from the start.
Empirical-basis (NOS4)	S1: This [TÜBİTAK] not only reflects a scientific point of view but it also reflects the perspectives of animal rights advocates. The researcher: How did you understand that it [TÜBİTAK] justifies a scientific point of view? S1: Because some research studies have been looked into and they have gone over some data.	U1: I voted yes. It has many benefits, but I do not know how this will affect my health in the long-term. That's why this would be a bit of a question for me. [...] When I look into this process, the genetics have not been altered or so and I considered that it would not have an adverse effect on our health.

Table 4.14

(continued)

NOS lens	Representative quotations for Sophisticated usage	Representative quotations for Unsophisticated usage
Subjectivity (NOS5)	S1: A scientist might not be able to see something on his/her own. S/he might only be doing certain tests, but another scientist can come along and have a different point of view.... S/he can say let's have this and that. Let them have a look at it, you know, in this respect, it might have a drawback. You know, when the more the scientists are, the more point of views there will be. Research might also intensify as they won't all be doing research on the same things.	U6: Scientists are not of the same opinion on GMO either because they do not know its outcomes. But in general, people are against it. The case of not being of the same opinion is a result of everyone thinking differently. For one thing, it could have detriments, but it might not be harmful according to that person. If s/he doesn't have much of a scientific approach, or not objective about it, s/he might think that way. However, a scientist should be objective.
Social and cultural embeddedness (NOS6)	S5: In fact, I wondered more why they needed to do something like this. Because, you see, these things, things like GMO products, are generally produced to decrease the cost after all. But they have done this with a budget of over €250.000. I mean, was that really necessary? I mean, when doing science, its cost should also be taken into consideration after all. Because we cannot separate science financially or politically from anything, but it sounded different. Actually, some of it was spared for the research process.	U4: (The evaluation of Group 3 scientists' opinions) What do I think about now when I say this [I find producing different animals' meat unnecessary], the environment I live in affects me, my personal belief affects me, my religious belief affects me. But a scientist should have a more objective approach.

4.3.1.1 The creative and imaginative nature of scientific knowledge (NOS2)

As it was stated before, there were no so strict differences between the groups about 'The creative and imaginative nature of scientific knowledge', in this case NOS2. While the members of Group S were generally agreed that in almost all scientific process steps there is a need for creativeness and imaginativeness, the members of Group U thought that a scientist should not use creativeness and imaginativeness in some steps especially in inferring from the data. Analysis showed that NOS2 lens usages were only active in the *'goals'* step of the DM process and only in one focused issue which is considering the opinion of Group 3 scientists who suggested that the artificial meat can be used to taste any animals even if you have never thought of tasting it and even if it becomes extinct.

It was understood that while considering Group 3 scientists' opinions, Group U generally used uNOS2 lens. Under the effect of uNOS2 lens, they found the scientists' creativity and imagination odd and saw using creativity and imagination in science as moving away from doing science. For example, as it is seen below, although U4 stated that she liked the opinions of Group 3 scientists, in fact she separated them from other scientists in a sarcastic way as she thought that these scientists are crazy.

> *U4: [the opinion I fall for] Group 4. [...] Well, because they don't have an opinion conflicting with me, like saying, out of the blue, we should eat pandas [...] These ones [Group 4] look into it in every aspect rather than running after craziness [like Group 3] just because they are scientists… (uNOS2→Goal: to taste and consume the meat of exotic or endangered animals)*

In addition to this, under the effect of uNOS2 lens usage, some members of Group U even excluded Group 3 scientists from being scientist. Therefore, it was concluded that in some cases uNOS2 lens usage is together with the usage of uNOS5 lens. The quotations of U1 and U5 were very representative about this issue and are given below.

> *U1: In my opinion, no scientist starts off this kind of study by saying let me get people taste this meat. I suppose no scientist will say something like that. [...] I mean, why would we have such a need to eat everything? Why should we desire to taste all animals? [...] I find the idea that a scientist produces any kind of artificial meat and gets people to taste it, and that s/he starts doing this king of work rather*

unreasonable. (uNOS2→Goal: to taste and consume the meat of exotic or endangered animals)

U5: Well, it's not the scientists job to taste new delicacies. (uNOS2→Goal: to taste and consume the meat of exotic or endangered animals)

On the other hand, in their comments about the opinions of Group 3 scientists, almost all members of Group S used sNOS, which was very different from what Group U generally did. The following quotations clearly show that those members of Group S gave a high importance to the creativeness and imaginative of the scientist in order to produce scientific knowledge. Some members of Group S directly mentioned the scientists' creativity and imagination in their speeches as it is seen in the following quotations of S2 and S6.

S2: A very good point of view [Group 3 scientists' opinion on artificial meat] that has never occurred to me. He says, in this way, we can taste pandas, too. I'd expect this kind of an approach from scientists because, a bit ago, we have talked about imagination, creativity. (sNOS2→Goal: to taste and consume the meat of exotic or endangered animals)

S6: This is an expected, consistent opinion even from scientists' point of view. Scientists are open to innovation. […] Many people might not be able to think of it. Maybe, even me not accepting it is because of the fact that I cannot imagine it. That's why scientists have dreamt about it, and dwelled on what kind of an environment it could happen or worked on his/her imagination to see what form it could take. (sNOS2→Goal: to taste and consume the meat of exotic or endangered animals)

Moreover, the other members of Group S meant that creativeness and imagination are highly important for doing science. For example, in the following quotation, S3 talked about how scientists think of the issues that never came into her mind.

S3: I mean, a living creature, I don't know I never wonder about what panda tastes like or I never think of tasting dogs that I see around me. […] To say that we can also do this, there could be something that a scientist can put forward. I expect a scientist's desire to taste something different. They look crazy anyway. It feels like they can have all sorts of questions. (sNOS2→Goal: to taste and consume the meat of exotic or endangered animals)

In general, with the analysis on the steps of the DM process of Group U and Group S, no significant NOS2 lens usage was detected apart from the *'goals'* step as it is seen in Table 4.15. By looking at this table, it is clearly understood that while all members of Group S used sNOS2 lens in the *'goals'* step, most members of Group

U used uNOS2 lens. Therefore, it is possible to say that there is a difference in NOS2 lens usage between the members of Group U and the members of Group S.

Table 4.15

NOS2 lens usages in DM (Group U vs Group S)

Sbj	**DM steps**			
	Goal	**Criteria**	**Alternative**	**Decision**
U1	u			
U2	s			
U3	u			
U4	u			
U5	u			
U6	s			
Total	6	0	0	0
sT	2	0	0	0
uT	4	0	0	0

Sbj	**DM steps**			
	Goal	**Criteria**	**Alternative**	**Decision**
S1	s			
S2	s			
S3	s			
S4	s			
S5	s			
S6	s			
Total	6			0
sT	6	0	0	0
uT	0	0	0	0

Sbj: Subject
u: Using unsophisticated NOS lens in the steps of DM
s: Using sophisticated NOS lens in the steps of DM

On the other hand, NOS2 lens usages were not observed in any of the DM process steps except from *'goals'* with a very specific issue. Therefore, it was concluded that according to the analysis of the present study which focused on the artificial meat as a socioscientific issue, the effectiveness of NOS2 lens in ruling the DM process is very low.

4.3.1.2 Observation and inference in science (NOS3)

The understandings about "Observation and Inference in Science", in this case NOS3, were used to separate the participants into the groups. All the members in Group S thought that scientific inference and scientific observation are two different kinds of scientific knowledge. Moreover, according to the most Group U members, inference was not scientific knowledge even if it is based on scientific data or observation and some thought that even if the inference is scientific knowledge, data cannot have different interpretations; in other words, they thought that inference is the exact sum of the observations and some also thought that inference does not need to be strictly aligned with data (observations).

In general, the analysis showed that while the members of Group S used sNOS3 lens in generally every step of the DM process, half of Group U used only uNOS3 lens and the other half tended to use u-sNOS3 mixed lens in the DM process. Moreover, sNOS3 lens usage of Group U was related with considering the inferences which are strictly aligned with the data and this situation was not unexpected as Group U has such kind of heterogeneity in it as it is stated above. Furthermore, in the light of the findings, it was concluded that NOS3 lens directly and heavily affected the DM processes depending on the users' NOS3 understandings.

Under the effect of uNOS3 lens usage, according to Group U, inferences need not to be strictly aligned with the data (observations). For example, with the quotation below, it is clearly seen how excited U2 was when she considered the Second Type Vegetarians' unscientific opinions and she rapidly made inferences related with the issue by using these opinions without needing any scientific data or observations. This quotation is also representative for other members of Group U about this kind effect of uNOS3 lens usage on the *'goals'* and *'criteria'* steps of the DM process.

> *U2: (While considering Type 2 vegetarians' inferences which are not strictly aligned with data or observation) For one thing, some things are obtained from animals and we do not approve the use of fluids taken from those extremely beautiful pregnant cattle [they said]. It is true that you spoil their natural pregnancy period [...] And neither do we exactly know what the content of this production is [they said]. That's what exactly I'm trying to say. We do not know what exactly everything is, and what is in it. In fact, we consume something we do not know...Well it has many things.. damage.. that's what exactly I have been trying to say right from the start. (uNOS3 → Goal: to protect the animals under bad conditions in animal husbandry/ prevent the animals from being killed for food → Criteria: Healthiness/ Ingredients and nutritive value, Production procedure)*

With the other quotations below selected in the *'alternatives'* step, it is seen that although U2 knew that some scientific data actually exist about an inference of the healthiness of GM food, she preferred to express her personal opinion without any kind of scientific observation. This quotation is also representative for the general Group U uNOS3 lens usage with this kind of effect on the DM process when Group U focused on an alternative and a criterion attached to it.

U2: I consider GMO rather negative because why are you changing its genetics, body? Now. [...] Scientists say that people should trust them because they are carrying out cheap experiments and they are also doing them in good research environments, but I think none of these are compatible with health. (uNOS3→ Alternative: GM foods→ Criteria: Healthiness)

On the other hand, U3, U5 and U6 who wore uNOS3 lens and approached the 'new knowledge' through data have only one interpretation. Different from other members of Group U, they also wore sNOS3 lens and they generally considered the inferences which are strictly aligned with the data (observations). Therefore, these three U3, U5 and U6 were labeled with u-sNOS3 in their related steps of the DM process. For example, the following quotation is obvious to show that while with the usage of sNOS3 lens, U3 found the Group 4 scientists' opinions to be the most consistent among other groups of scientists as these opinions are inference as scientific knowledge and they are aligned with data or observation, with the usage of uNOS3 lens, U3 wanted to see a particular opposite side of these opinions as if the data used by Group 4 scientists had only one interpretation just as observation and inference were same kind of scientific knowledge. Moreover, although it was good to see U3 question the reliability of the data, it was unfortunately understood that she thought that if the data are right then the 'only' inference will be true.

U3: (The evaluation of Group 4 scientists' point of view) To begin with, he has provided viable data in his speech. For that matter, this one is the most consistent one. But he has only listed its benefits. I hope that in the proceeding paragraph, he starts with however and carries on with its adversities. If they have not seen them [its adversities] that could also be scientific, but would not be enough for me. I feel the need to do research about what the opponents say about it, the need to read. […] I am not really sure about the validity of this perspective. There are no references. It is only Oxford. How would I know? I am not really sure whether it is true or not. That would be good if it is true. (u-sNOS3 → Goal: To deal with global warming → Criteria: Environmental effects → Alternative: Animal husbandry)

Those examples above were representative to understand how the general NOS3 lens usage of the members of Group U was. It is time to consider NOS3 lens usage of them in the *'decision'* step of the DM process. The analysis showed that members of Group U also used uNOS3 lens heavily in their decision. The following quotation of U2 is representative as she could exchange the scientists' inferences, even when they were based on some scientific data, with the unscientific opinions of Second Type Vegetarians and Food Reviewer in the *'decision'* step too because she wore uNOS3 lens. It was concluded that according to her, it is not enough for inferences to be aligned with scientific data or observation to make it exempt from comparison with unscientific opinion as “inferences are not scientific knowledge.”

> *U2: When I saw the process, I said there couldn't be such kind of meat, this couldn't be meat. But later, I got confused. Scientists said that it had benefits [inference aligned with scientific data and observation]… But after that, that VEG 2 deflected me again in a nice way. [...] and the food reviewer says no it is also harmful for the environment, the electricity and the such that are used, there are also other things that are used. They are harmful too [unscientific opinion]… I got confused [by the scientists' point of view] but the ones here [the food reviewer and veg2] refuted it. (uNOS3→Decision: NO shouldn't be sold)*

On the other hand, half of Group U used u-sNOS3 mixed lens in their decisions. For example, healthiness of the artificial meat is an inference, and with her reasoning about her decision below, it was clearly seen that U6 had usage of sNOS3 lens because she requested such inference aligned with scientific data or observation that is enough to say ‘YES’ to selling the artificial meat in markets. However, she also had usage of uNOS3 lens because her request included only one research study about healthiness of the artificial meat, which means that according to her, there is only one exact interpretation of the data coming from that study as if inference and observation were the same kind of knowledge.

> *U6: You ask for opinion from this one, from that one. That doesn't work that anyway. There should be one research study on it. Well, but next time [with that research study], if it turns out to be true that it is not harmful, I will definitely vote yes. (u-sNOS3→Decision: NO shouldn't be sold)*

The analysis showed that all the members of Group S used sNOS3 lens in line with their sophisticated understanding about “Observation and Inference in Science” in all steps of the DM process. One of the most representative examples about the sNOS3 lens usage of Group S in DM process steps was the speech flow of S4 on comparing GM food with the artificial meat. Here, S4 requested more data for both GM food and the artificial meat in order to make interpretations. In this way, it was concluded that with the usage of sNOS3 lens Group S not only could approach the inferences and the observations as different kinds of scientific knowledge but also consider the dependence of the inferences on data.

The researcher: To compare [GMO and artificial meat] what do you need?

S4: I don't know. Well, this could be about doing experiments. Well, at least on humans, too, something could be done by testing both, collecting data, interpreting them. (sNOS3 →Goal: To deal with starvation and scarcity → Criteria: Healthiness, Production procedure → Alternative: GM foods)

Moreover, all members of Group S heavily searched the dependence on scientific data or observation in the opinions which they met.

S6: (While evaluating Type 2 vegetarians' inferences which are not strictly aligned with data or observation) They approach the topic from animal rights point of view again. Their point of view is expected. There could be these kind of perspectives but it should not be in a way that; for example, they are using the fluid taken from pregnant cattle. How much should that fluid be? Would that do any harm on the offspring? They talk about it without knowing its dose. They are prejudiced about it being completely harmful. (sNOS3 → Criteria: Effects to animals)

When it comes to the *'decision'* steps of the DM process, 5 of 6 continued to use only sNOS3 lens but no apparent NOS3 lens usage was detected related with S3. Moreover, the analysis showed that unlike the general attitudes of Group U, in their decision, Group S prioritized specifically the scientists' opinions who mentioned some data because of sNOS3 lens usage. The quotation of S4 is very representative about this issue and stated below respectively. These quotations are also representative to understand how good Group S were at approaching the inferences and the observations as different kinds of scientific knowledge.

S4: I will go for yes. I totally have a different opinion on that now. Because at first, I never thought that it was such a developed thing and thus, I had said I would say no. But after reading a lot, many people have make interpretations on it, NASA did it. TÜBİTAK commented on it. They have some data on it. If they say it is beneficial, I would say yes. [...] I consider the negative views on it, on the other hand, a bit more personal. It sounds like they were their own personal interpretations without knowing anything about it. However, TÜBİTAK and NASA have a lot of data. They have made observations, collected something. Because they state that it is beneficial based upon these data, I would say yes. (sNOS3 →Decision: YES should be sold)

The analysis showed that the members of Group U and the members of Group S directly reflected their understandings about "Observation and Inference in Science" to the steps of the DM process. In other words, as it is seen in Table 4.16, Group U used mainly uNOS3 lens and Group S used only sNOS3 lens in the whole DM process.

Table 4.16

NOS3 lens usages in DM (Group U vs Group S)

Sbj	DM steps				Sbj	DM steps			
	Goal	**Criteria**	**Alternative**	**Decision**		**Goal**	**Criteria**	**Alternative**	**Decision**
U1	u	u	u	u	S1	s	s	s	s
U2	u	u	u	u	S2	s	s	s	s
U3	u-s	u-s	u-s	u	S3	s	s	s	
U4	u	u		u-s	S4	s	s	s	s
U5	u-s	u-s	u-s	u-s	S5	s	s	s	s
U6	u-s	u-s	u-s	u-s	S6	s	s	s	s
Total	6	6	5	6	Total	6	6	6	5
sT	3	3	3	2	sT	6	6	6	5
uT	6	6	5	6	uT	0	0	0	0

Sbj: Subject
u: Using unsophisticated NOS lens in the steps of DM
s: Using sophisticated NOS lens in the steps of DM
u-s: Using mixed (both unsophisticated and sophisticated) NOS lens in the steps of DM

Firstly, it is better to focus on uNOS3 lens usage of Group U. There were some members of Group U who were placed in Group U as they did not count scientific inferences as scientific knowledge. These members of Group U generally ignored the search for data or observation dependency for the opinions which they met in the DM process about artificial meat because of their uNOS3 lens. Moreover, they even could not consider properly the scientific inferences based on data.

Secondly, it was concluded that the effect of sNOS3 lens usage on the DM process was highly apparent in the *'decision'* step. Besides, all members of Group S considered heavily the dependency of scientific data and observation for the opinions that they met about the artificial meat. Because of sNOS3 lens usage, Group S gave an obvious priority to the scientists' opinions which included scientific data in the *'decision'* step.

4.3.1.3 The empirical nature of scientific knowledge (NOS4)

When it is considered that all participants in this study were chosen from juniors at Elementary Science Education Department, it is not surprising to understand that they all have sophisticated understanding about ‘The Empirical Nature of Scientific Knowledge’ (NOS4). In other words, NOS4 was not used to separate participants into group S and U. Therefore, it could be predicted that there would be no difference in their usage of NOS4 lens in the DM steps between Group S and U. However, the analysis showed that the members of Group U tended to reflect some relatively more unsophisticated approaches about ‘The Empirical Nature of Scientific Knowledge’ than the member of Group S did.

Generally, Group U had u-sNOS4 mixed lens usages as they used both uNOS4 and sNOS4 lens in the DM steps. As it is seen in U3 quotation, she tried to understand and commented on the scientific process by realizing that there is a scientific process in the production of the artificial meat under the effect of sNOS4 lens.

> *U3: It turned out to be different to what I thought it was. I even liked it. I am more open up to it now, I misunderstood it when I saw the word artificial. Its production with a stem cell. Just a tissue sample is taken from the animal. It poses no other threat on the animal. In this case, it seems quite logical. This process is still artificial but so is animal production on a farm. [We can say that I'm comfortable with the process of artificial meat production in general.] (sNOS4→ Goal: To protect the animals under bad conditions in animal husbandry/ prevent the animals from being killed for food → Criteria: Production procedure, Effects to animals, Cost → Alternative: Animal husbandry)*

On the other hand, in the following quotation, this time U3 made a conclusion about GM foods, which is the alternative of the artificial meat, without requesting any scientific data by the usage of uNOS4 lens.

U3: GMO... Their genetics is manipulated and it is harmful. Just to get more production and to get it in the shortest time possible, there is a direct intervention with it and this is done in a way that it also harms people. (uNOS4→Alternative: GM foods →Goal: To deal with starvation and scarcity → Criteria: Production procedure, Healthiness)

In the *‘decision’* step, U2 was the only one who used only uNOS4 lens by prioritizing the comments with no scientific knowledge among the participants who finished the referendum simulation by voting ‘NO’. In her decision, U2 did not make any emphasis on the empirical basis about her main criterion ‘healthiness’ and this situation made it possible to conclude that her prejudice lens was so active that her NOS lenses were not that much active and she mainly made her decision under the effect of prejudice lens. Related quotation of U2 is below:

U2: I observe this around me a lot and really and people really know what natural meat is like. I do not have to provide any scientific explanation for that. Yes, people in Turkey know what natural meat tastes like. These people have also provided really logical explanations. When the cost of electricity and the like is taken into consideration yes, that's true in a sense… (uNOS4→ Decision: NO shouldn't be sold)

Moreover, U1 is representative for the usage of uNOS4 lens of Group U in the *'decision'* step by giving no significant importance to the empirical basis or being tested and being experimented for the effect of the artificial meat on the human health. In the following speech flow, although U1 regretted not giving proper importance to being tested of the artificial meat in her vote 'YES', she also gave the signals about the fact that she would still vote 'YES' for the artificial meat in a probable referendum.

U1: I voted yes. It has many benefits but I do not know how this will affect my health in the long-term. That's why this would be a bit of a question for me. [...] When I look into this process, the genetics have not been altered or so and I considered that it would not have an adverse effect on our health. (uNOS4→ Decision:YES should be sold)

The researcher: Have you come to the conclusion that this is healthy after you have seen the production process?

U1: I suppose so. (feels down, gets upset)

The researcher: Without having the need for any tests...

U1: Apparently, yes. But should be tested. [...] [Still,] It feels like yes to me after all that process. (uNOS4→ Decision: YES should be sold)

In fact, only U5 and U6 used sNOS4 lens and in this way, they voted 'NO' as they looked for scientific knowledge, which resulted from scientific process and inquiry, about healthiness of the artificial meat although they already thought personally that the artificial meat is healthy enough. In the following quotation it is clearly seen that U5 voted 'NO' in her initial response.

U5: Well, at first, I read about it and these all comforted me in fact. I said the scientists ate it. I appreciated the idea that the scientists have consumed what they have produced. This is that kind of reassurance that consumption provides. But will they consume it in the long-term? That's what should be observed. This person has consumed that once. Let him consume it for years and we observe this and after that if nothing happens to this scientist then, I will trust it and say let it be on the shelves. [...] If someone consumed it in the long-term and nothing happened to him/her. Then yes, that would be different. (sNOS4→ Initial response: NO shouldn't be sold) and she voted ‘NO’ again in *‘decision’* under the effect of sNOS4 lens.

> *U5: I do not know the outcomes of this, whether there is a pilot study of this. Have they tested them on subjects? What has happened? I don’t know. (sNOS4→ Decision: NO shouldn’t be sold)*

Moreover, U6 who wore sNOS4 lens in all previous DM steps by looking for scientific knowledge, which resulted from scientific process and inquiry, continued to wear sNOS4 lens in *‘decision’* step too, as follows:

> *U6: Well, we haven’t tested this on people yet. We have not conducted any other research. You ask for opinion from this one, from that one. That doesn't work that anyway. There should be one research study on it. (sNOS4→ Decision: NO shouldn’t be sold)*

Therefore, it can be concluded that different from U2, who mainly used prejudice lens when she voted ‘NO’, the dominant factor was the usage of sNOS4 lens in U5’s and U6’s votes ‘NO’.

When the issue comes to the NOS4 lens usage of Group S, the analysis showed that Group S frequently used sNOS4 lens in the DM steps apart from *‘decision’*. S1 is very representative to understand how the members of Group S had sNOS4 lens usage. For example, in the following speech flow, in which S1 focused only on the *‘goals’* step, a clear sNOS4 lens usage was detected as she considered the scientific data and scientific evidence:

> *S1: Naturally, TÜBİTAK approached this scientifically and it has also approached it from the point that it will be a solution to starvation, but it has also mentioned something about animals. When someone listens to this, I mean, this not only reflects a scientific point of view but it also reflects the perspectives of animal rights advocates.*
>
> *The researcher: How did you understand that it justifies a scientific point of view?*
>
> *S1: Because some research studies have been looked into and they have gone over some data. (sNOS4→ Goal: To deal with starvation and scarcity, To protect the animals under bad conditions in animal husbandry/ prevent the animals from being killed for food)*

In addition to this, like other members of Group S, in her *‘alternative-focused’* speech below, S1 simultaneously considered scientific data and evidence in her comments and realized the scientific process under the production of GMO and tried to make an interpretation about this scientific process.

S1: Foods with GMO could be a great solution to starvation, but it is more difficult to grasp it than artificial meat. I mean, it could take years. You see, they are altering a very complicated structure. Well, they do not know its effects now. If it takes a long time, it leads to mutations. They do not know them either. [...] They should dwell on articial meat, I think. The process is obvious with artificial meal. We don't know the effects of changing DNA structures. It is difficult for me anyway. There is an alteration there, too much of an alteration. I think this is too artificial. I think this is completely artificial. In GMO, they change one thing directly, but in this one, they imitate something. (sNOS4→ Alternative: GMO products → Goals: To deal with starvation and scarcity → Criteria: Production procedure, Healthiness)

In the *'decision'* step all members of Group S except S5 were labeled as u-sNOS4 mixed lens usage because although they considered empirical basis and scientific evidence for many issues about the artificial meat, they did not do the same thing for their main criterion healthiness. In other words, in their decisions, they did not give proper importance to being tested for the artificial meat and they did not look for scientific evidence for the effect of the artificial meat on the human health. Following quotation of S6 is very representative of this issue.

S6: About the content of the substance s/he feeds on, for better quality, for the environment, for animal rights. This kind of views convince me because they have justifications. This reveals that it will be good, at what percentage it will affect etc. [...] I mean, when I see so many people supporting it and this having many benefits, I even say that I wouldn't mind my own health either; thus, I'll try it. (u-sNOS3→Decision: YES should be sold)

In fact, among all members of Group S only S5, who is also the only S, who voted 'NO' for the sale of the artificial meat, had only sNOS4 lens usage in the steps of the DM process including *'decision'*. The quotations which summarize sNOS4 lens usage of S5 are below and her DM process is so full of usage of sNOS4 lens that her vote 'YES' in initial response turns into 'NO' in *'decision'* just because she frequently considered empirical basis in the new knowledge which she met about the artificial meat. Moreover, she properly considered the healthiness of the artificial meat by looking for scientific evidence about the effect of the artificial meat on human health.

S5: Now, I've changed my mind. I'd go for no. No. Because we still sort of see it through the stages we have have read about. Its effects on people is still unknown, what it is. OK. Everything is done thoroughly. The data is obvious, but I still don't know. I believe that it should be tested on certain groups. It is still something that hasn't been tested out. […] Maybe a year later, when all these tests have been conducted, I might go for yes. […] When we see its effects and consider its effects *on man, when we consider its effects on global warming, when we consider that we can enjoy the animals that will become extinct in the future, I'm all wrapped up in it. But how it will affect humans hasn't been observed yet. It's not known yet. Maybe we'll develop a genetic reaction. Something might happen. It is not certain. (sNOS3→Decision: NO shouldn't be sold)*

In Table 4.17 NOS4 lens usage of Group U and Group S is given and it is seen that "The Empirical Nature of Scientific Knowledge" lens usages were very active in all the steps of the DM process for both groups. In addition to this, with the analysis it was understood that although there was no difference in NOS4 understandings among the participants, there was a clear difference in usage of NOS4 lenses between Group U and Group S. In other words, although Group U's understandings about "The Empirical Nature of Scientific Knowledge" were as sophisticated as those of Group S, the members of Group U were not able to reflect their sophisticated understandings to their DM process and they frequently fell unsophisticated approaches about NOS4. Therefore, it was concluded that unsophisticated NOS understandings in other NOS aspects may paralyze NOS4 lens usage by making it blurred even if a person has sophisticated understandings in NOS4.

Table 4.17

NOS4 lens usages in DM (Group U vs Group S)

Sbj	DM steps				Sbj	DM steps			
	Goal	**Criteria**	**Alternative**	**Decision**		**Goal**	**Criteria**	**Alternative**	**Decision**
U1	u-s	u-s	u	u	S1	s	s	s	u-s
U2	u-s	u-s	u	u	S2	s	s	s	u-s
U3	u-s	u-s	u-s	u	S3	s	s	s	u-s
U4	u-s	u-s	u-s	u-s	S4	s	s	s	u-s
U5	u-s	u-s	u-s	s	S5	s	s	s	s
U6	s	s	s	s	S6	s	s	s	u-s
Total	6	6	6	6	Total	6	6	6	6
sT	6	6	4	3	sT	6	6	6	6
uT	3	5	5	4	uT	0	0	0	5

Sbj: Subject
u: Using unsophisticated NOS lens in the steps of DM
s: Using sophisticated NOS lens in the steps of DM
u-s: Using mixed (both unsophisticated and sophisticated) NOS lens in the steps of DM

Moreover, it was concluded that there was a connection between the usage of uNOS3 lens and uNOS4 lens. More specifically under the effect of uNOS3 lens, not seeing scientific inferences as scientific knowledge triggered usage of uNOS4 lens for the members of Group U by not considering the empirical basis in the new knowledge they met. In addition to this, it is interesting that although Group S used sNOS4 lens in other steps of the DM process, they also used uNOS4 lens in *'decision'*. It was concluded that having sophisticated understanding about tentativeness of the scientific knowledge may have caused the members of Group S to give up looking for scientific evidence for their main criterion healthiness of the artificial meat because it will never be absolute or certain.

4.3.1.4 The theory-laden nature (subjectivity) of scientific knowledge (NOS5)

In general, this analysis shows that Group U had very similar usages of NOS5 lens, which were also in line with their unsophisticated understanding about the issue. Moreover, the NOS5 lens usages of Group S were also reflection of their sophisticated understanding. In addition to this, analysis showed that although NOS5 lens seemed to be active in the *'goals,'* the *'criteria'* and the *'alternatives'* steps of decision making process, the frequencies of the usage of NOS5 lens were far lower than those of NOS3 and NOS4 for the members of the both groups and a direct usage of NOS5 lens was not observed in the step of 'decision,' either. On the other hand, through the findings from the analysis on 'Committee', which is stated later in 'Committee vs Referendum' section in detail, indirectly, it was concluded that in fact by giving over credibility to the scientist, uNOS5 lens of the members of Group U was almost always active in the decision making process.

Group U had a tendency to load a standard and strict character/ personal quality/ behavior on the scientist and had a tendency to prune or ignore the emotions of the scientists, except from the scientific curiosity as if scientists had similar characteristics and background and scientific knowledge was not affected by the scientist him/herself.

> *U1: (Group 3 evaluations carried out on the scientists' point of view) In my opinion, no scientist starts off this kind of study by saying let me get people taste this meat. I*

suppose no scientist will say that. (uNOS5→ Goals: To taste and consume the meat of exotic or endangered animals)

U5: (Evaluations carried out on Group 3 scientists' point of view) Well, it's not scientist's job to taste new delicacies. (uNOS5→ Goals: To taste and consume the meat of exotic or endangered animals)

Similar uNOS5 lens usage was also observed in the following quotation of U4 which is selected from their explanations on the Mark Post's statement: Vegetarians should stay vegetarian; this is also very good for the environment.

U4: S/he said don't eat it if you don't want it. It's none of your business. You have nothing to do with this. This is not a suitable outburst for a scientist to say. This is none of his/her business. He is right. I would have said the same thing, but Mark Post is not me. He should not say things like this. (uNOS5→ uNOS5→ Goals: To taste and consume the meat of exotic or endangered animals →Criteria: Effects to animals)

Moreover, under the effect of uNOS5, members of Group U generally appreciated the objectivity of the scientists. In other words, they had a tendency to judge the different remarks of the scientists by ignoring the subjectivity of them. Following quotation of U6 is representative.

U6: Scientists are not of the same opinion on GMO either because they do not know its outcomes. But in general, people are against it. The case of not being of the same opinion is a result of everyone thinking differently. For one thing, it could have detriments, but it might not be harmful according to that person. If s/he doesn't have much of a scientific approach, or not objective about it, s/he might think that way. However, a scientist should be objective. (uNOS5 → Alternative: GMO foods→ Criteria: Healthiness)

With the analysis it was understood that just as Group U did, Group S generally had NOS5 lens usages in line with their understandings about 'The Theory-Laden Nature (subjectivity) of Scientific Knowledge'. By using sNOS5 lens Group S considered properly the scientists' different and subjective perspectives because of the differences in their characters, personal qualities, experiences and working background. For example, S1's quotation below is representative for the usage of sNOS5 lens in *'criteria'* step.

S1: A scientist might not be able to see something on his/her own. S/he might only be doing certain tests, but another scientist can come along and have a different point of view... S/he can say let's have this and that. Let them have a look at it, you know, in this respect, it might have a drawback. You know, when the more the scientists are, the more point of views there will be. Research might also intensify as

> *they won't all be doing research on the same things. (sNOS5 →Criteria: Healthiness)*

Moreover, the following quotation of S3 which includes her response to the question "Why do some scientists study on GM foods instead of the artificial meat" is representative for how sNOS5 lens can be active in *'goals'*, *'criteria'* and *'alternatives'* steps together.

> *S3: The ones who consider human rights; for example, want to protect them but the opponents; for example, the ones in favour of GMO, are not of the opinion to protect them. They want us to produce more. Dude, if they are conducting different studies, they come up with different questions. Their questions are different. For example, a common purpose but different questions or different reasons. Maybe they have different opportunities. They might not have the budget for that or might work on this more comfortably. Or more knowledgeable about it. Or have a different creativity. It feels like; for example, planning it, designing it requires a different point of view... (sNOS5 →Goal: Variety of Goals → Criteria: Effects to animals, Production precedure→ Alternative: GM foods)*

In addition to this, it was realized that besides the curiosity, some members of Group S loaded the scientist different emotions and this situation was labeled as sNOS5 lens usage as it highlighted different and subjective perspectives for the scientist. For example, S5 talked about Group 3 scientists as they are animal lovers and she expressed their opinions in this line as follows:

> *S5: (The evaluation on Group 3 the scientists' point of view) To be able to taste the meat of endangered animals later in time... And animals are not dying, this is also, for example, something that could be expected from animal lover scientists. Now, for example, there are too many animal lovers getting killed, there are ones that do not eat meat. In this one, for example, animals are not killed. Samples are directly taken from their tissues. Well, this is something that could be expected from animal lover scientists. (sNOS5→ Goal: To deal with global warming → Criteria: Environmental effects → Alternative: Animal husbandry)*

When Table 4.18 is examined, it was understood that NOS5 lens usages in the DM process properly reflected participants' understandings about 'The Theory-Laden Nature (subjectivity) of Scientific Knowledge.' On the other hand, NOS5 lens usages were not as active as usages of NOS3 and NOS4 lenses. Moreover, apparent usage of NOS5 lens in *'decision'* step was not detected.

Table 4.18

NOS5 lens usages in DM (Group U vs Group S)

Sbj	DM steps			
	Goal	**Criteria**	**Alternative**	**Decision**
U1	u			
U2	u	u	u	
U3	u	u	u	
U4	u	u		
U5	u	u	u	
U6	u	u	u	
Total	6	4	4	0
sT	0	0	0	0
uT	6	5	4	0

Sbj	DM steps			
	Goal	**Criteria**	**Alternative**	**Decision**
S1	s	s		
S2	s	s	s	
S3	s	s	s	
S4	s	s		
S5	s	s	s	
S6	s	s		
Total	6	6	3	0
sT	6	6	3	0
uT	0	0	0	0

Sbj: Subject
u: Using unsophisticated NOS lens in the steps of DM
s: Using sophisticated NOS lens in the steps of DM

However, it was concluded that NOS5 lens behaves as a contact lens instead of lenses used in eyeglasses, and therefore, NOS5 lenses were on all participants' eyes in all DM process. It was thought that this situation makes it difficult to detect the usage of NOS5 lens.

Let's look at how this conclusion was reached. Firstly, it is known that the healthiness of the artificial meat was the main criterion for the participants. Moreover, in 'Committee' selection part, the members of Group U did not mention enough about the doctors or other sanitarians. With the analysis, it was understood that Group U gave overcredibility to the scientists who work on the artificial meat and they thought that these scientists can decide the healthiness of the artificial meat like a doctor can. Related with this issue detailed explanations are stated in 'Committee vs Referendum' section. Moreover, there are some representative examples here which also give a clue about how uNOS5 lenses were on eyes of the members of Group U during the whole DM process.

For example, with the following quotations of U2 and U4, it is understood that in the whole DM process, they thought that the scientists who try to produce the artificial meat such as Mark Post, NASA, Group 1 and Group 2 scientists are competent enough to decide whether the artificial meat is healthy or not, just like the doctors or the experts in medical field can do. Especially the quotation of U2 below is very representative about this issue.

> *The researcher: Despite emphasizing health so much, you added doctors too late. What could be the reason for that?*
>
> *U2: I thought that scientists have great knowledge on health anyway.*

Similarly, with the following quotation of U4, it can be clearly seen that in the whole DM process, uNOS5 lens, which made her give overcredibility to the scientists who produce the artificial meat, was on her eyes.

> *The researcher: Despite the fact being healthy is so important, you neither asked for a doctor's opinion nor did you appointed a doctor on the committee.*
>
> *U4: I think that these scientists have enough knowledge. Because the people we call doctors look for its causes or something when someone gets ill, but it is actually you, I mean, the ones who tell doctors that this can cause the illness when you are educating them at medicine faculties, academicians of this profession, their professors. Their views are of importance in a study like this. I think that they are also involved in these interperetations here.*

It was understood that uNOS5 lens make people give over credibility to the scientists, and then it limits the scientists' diversity. Therefore, while in a DM process related with a socioscientific issue, usage of uNOS5 lens because of unsophisticated understanding about 'The Theory-Laden Nature (subjectivity) of Scientific Knowledge' make people feel comfortable with less extensive data or knowledge than actually they need and make people consider the collected information less than actually they should do.

4.3.1.5 The social and cultural embeddedness of scientific knowledge (NOS6)

With the analysis, it was understood that members of Group U represented sophisticated attitudes about 'The Social and Cultural Embeddedness of Scientific Knowledge', NOS6, in *'goals'*, *'criteria'* and *'alternatives'* steps of the DM process about the artificial meat although they had unsophisticated understandings about NOS6. Group U members generally were able to consider the interaction between science and society by wearing sNOS6 lens and they gave proper place to the conditions of Turkey in their DM process which already include directly Turkish context with the main question of the referendum as it was related about the sale of the artificial meat in Turkish markets. In addition to this, almost all members of Group U made considerations through Turkish food culture and also they approached the criterion flavor through a cultural emphasis. For example, U3's following quotation selected from her response to the question "what can be the disadvantages of the artificial meat?", which was asked at the beginning of the interview only after she read the news about the artificial meat, is representative for how the members of Group U put forth the criterion flavor by talking about this criterion through a cultural basis.

> *U3: It might be the taste, it's something cultural in the end, and eating that kind of stuff might affect the taste. We start taking pills in cartoons, you see, and we feel satisfied with it. In fact, taste is also an important sense for humans. This could affect it. There is nothing else I can think of. (sNOS6→ Criteria: Flavor)*

Moreover, as it can be seen in the following quotation, under the effect of sNOS6 lens, Group U generally not only considered the criterion flavor in a cultural context but also wanted the scientists to consider the issue through cultural context.

> *U2: (Evaluation on a TÜBİTAK expert's point of view) Spoke just like TÜBİTAK, exactly like a scientist. He justifies what he has done, says "Yes, I'm doing it and it provides many benefits for you. I make observations on it, make my inferences, create my hypothesis and complete all my stuff, and produce artificial meat for you in a proper way." He also says things like he can see a decrease in the green house effect; however, mentions nothing about its disadvantages. Say something about its disadvantages, taste it, get down to civilians. See, it is really difficult in Turkey, in a sense, Turks know about meat. How much of it could you do with this scientific process... I mean, I'm so opposed to artificial meat but when they say animals should not be slaughtered... You see, this is important for me, but we have the tradition of eid al-adha. I think people will not be affected by this much. You see, he ignored this cultural structure when he was speaking here. (sNOS6→ Goal: To deal with global warming→ Criteria: Flavorc Alternative: Normal meat)*

In fact, among all members of Group U only U4 ignored the interaction between science and society and she also wanted to isolate the scientists from the society by the usage of uNOS6 lens as follows:

> *U4: (The evaluation on Group 3 scientists' point of view) What do I think about now when I say this [I find producing different animals' meat unnecessary], the environment I live in affects me, my personal belief affects me, my religious belief*

affects me. But a scientist should have a more objective approach (uNOS6→ Goal: To taste and consume the meat of exotic or endangered animals)

On the other hand, different from the general attitude of Group U related with this issue, the members of Group S made appropriate lens usage with their understandings about 'The Social and Cultural Embeddedness of Scientific Knowledge' in *'goals'*, *'criteria'* and *'alternatives'* steps of the DM process. In other words, Group S properly considered the interaction between science and society by the usage of sNOS6 lens in line with their sophisticated understandings. For example, with the following quotation of S1 selected from her response to the question "Which studies do the scientist who criticize the artificial meat conduct?" it is understood that she considered the issue through the comparison of the conditions of Turkey and other countries by the usage of sNOS6 lens.

S1: Do they mean that we should consume things like vegetables? I don't know. Do they mean we should produce fruit and vegetables and reproduce them? How can they send them to Africa? There will be a transportation issue. Rather than sending them something we grow, we should grow some things there. You should not only grow something there, but also provide employment for the people there so that you find an exact solution. If you keep growing things here and sending to them, it will not be the solution to starvation ... They'll be hungry again once they run out of this. Besides, there are unemployed people there, not working, we sould find an exact solution to this. Or if there are hungry people in our country, why are they hungry? I mean, is it because there is no meat, or is it because of other reasons? More precisely, this thing, well; for example, even if there is hunger in our country, this is because of financial problems not because of famine, I think. I mean, they can buy this, but they can't because they cannot afford it. (sNOS6 → Goal: deal with starvation and scarcity → Criteria: Production procedure, Economic effects → Alternative: Plant-based meat-like product, Supporting green housing and agriculture, Balancing income distribution)

Similarly, with the following quotation, under the effect of sNOS6 lens usage, S4 considered the countries' different conditions while she considered *'goals'* of the artificial meat.

S4: (The evaluation on Group 3 scientists' point of view) Scientists might be of the same opinion on this [production of artificial meat and meat from other animals] but the implementors change from society to society. (uNOS6→ Goal: To taste and consume the meat of exotic or endangered animals)

Thus, as it is seen in Table 4.19, with the analysis it was understood that usage of NOS6 lens was very similar in Group U and Group S although their understandings about 'The Social and Cultural Embeddedness of Scientific Knowledge' were different from each other. When it was thought that Group S had sophisticated understandings about NOS6, it was concluded that they directly reflected their understandings to the DM process. On the other hand, although Group U had unsophisticated understandings about NOS6, they used sNOS6 lens in their DM process about the artificial meat just as Group S did.

Table 4.19

NOS6 lens usages in DM (Group U vs Group S)

Sbj	DM steps				Sbj	DM steps			
	Goal	**Criteria**	**Alternative**	**Decision**		**Goal**	**Criteria**	**Alternative**	**Decision**
U1	s	s	s		S1	s	s	s	
U2	s	s	s		S2	s	s	s	
U3	s	s			S3	s			
U4	u				S4	s	s	s	
U5	s	s	s		S5	s	s	s	
U6	s	s	s		S6	s	s	s	
Total	6	5	4	0	Total	6	5	5	0
sT	5	5	4	0	sT	6	5	5	0
uT	1	0	0	0	uT	0	0	0	0

Sbj: Subject
u: Using unsophisticated NOS lens in the steps of DM
s: Using sophisticated NOS lens in the steps of DM

Thus, it was concluded that as the artificial meat issue was highly socioscientific, it made the participants, even the members of Group U, consider the interaction between the science behind the artificial meat and the society in which the artificial meat is used. In other words, nature of referendum issue, a socioscientific issue-artificial meat, affected the usage of NOS6 lens in the DM process. The nature of the referendum issue triggered them to make connections about social context with sNOS6 lens usage as the selected issue already included a social context. Moreover, not only Group S but also Group U had usage of sNOS6 lens. In general, the following quotation of S5 which is selected from her consideration about the news of the artificial meat is very representative for the usage of sNOS6 lens of the participants whether they are in Group U or Group S.

> *S5: In fact, I wondered more why they needed to do something like this. Because, you see, these things, things like GMO products, are generally produced to decrease the cost after all. But they have done this with a budget of over €250.000. I mean,*

was that really necessary? I mean, when doing science, its cost should also be taken into consideration after all. Because we cannot separate science financially or politically from anything, but it sounded different. Actually, some of it was spared for the research process. (sNOS6→Goal: To decrease the price of meat and provide meat for poor people → Criteria: Production procedure, Cost→ Alternative: GM foods)

4.3.1.6 Summary of NOS lens usages in DM

The personal demonstrations for the distributions of NOS lens usages to the DM steps are stated in Figure 4.5 for Group U members and in Figure 4.6 for Group S members. By looking at Figure 4.6, for example, it is understood that S1 used sNOS2, sNOS3, sNOS4, sNOS5 and sNOS6 lenses in *'goals'* step of DM as all the colors of the spheres inside the triangular area representing thinking region *'goals'* are white, which shows sophisticatedness and the numbers (2: creativity and imagination, 3: observation and inference, 4: empirical-basis, 5: subjectiviy, and 6: social and cultural embeddessnes) inside the spheres show the aspects of NOS. In the same way, Figure 4.6 shows that S1 expressed only two NOS aspects in her *'decision'*, which are NOS3 with sophisticated understanding (white sphere number 3) and NOS4 with mixed understanding (light blue sphere number 4). Moreover, the overall group demonstrations of usages of NOS lenses in DM are stated in Figure 4.7 for Group U and Figure 4.8 for Group S. These figures include some small triangles representing the aspects of NOS inside four big triangles representing the thinking regions in DM which are *'goals', 'criteria', 'alternatives'* and *'decision'*. Small spheres inside the small triangles are used to show lens usage in the related NOS aspect. By looking at the order of the spheres, it can be understood which member of that group used the related NOS lens and how the lens was used can be understood by the color of it –white for sophisticated, light blue for mixed or and dark blue for unsophisticated understandings. For example, in Figure 4.7, there is no small triangle representing NOS2 in the step *'alternatives'* of DM because no members of Group U used the NOS uderstandings about creativity and imagination while considering the alternatives of the artificial meat. In addition to this, it is understood that four members of Group U who are U2, U3, U5 and U6 used unsophisticated NOS5 (NOS aspect related with subjectivity) understandings while considering the alternatives of the artificial meat because four dark blue colored spheres inside the small triangle labeled with NOS5 are located in the area representing the step *'alternatives'* of DM process.

When thought in general, what comes first to the mind is that while Group U reflects its NOS understandings directly to the decision making process steps which are *'goals'*, *'criteria'*, *'alternatives'* and *'decision'* by using uNOS lenses, Group S uses only sNOS lenses consistent with its sophisticated NOS understandings in those steps. Moreover, Group S mainly had very close NOS lens usages to their sophisticated NOS understandings in the DM process most probably because of their very sophisticated understandings about NOS aspects. However, when Figure 4.5 and Figure 4.6, which show the individual NOS lens usage for the members of each group, and when Figure 4.7 and 4.8, which show the overall demonstrations of the groups for the usage of NOS lenses in the DM process, are comparatively considered, it can be easily understood that in some steps of the decision making process and for some NOS properties, the members of the groups (i) had inconsistent NOS lenses according to their understandings and (ii) lacked NOS lens usage. The analysis which was done in this study provided four main reasons related with the sources of these kinds of situations. The first is the fact that in the present study, nobody in Group U were 'Perfect U' (having totally unsophisticated understandings) and some of the members of Group S were not 'Perfect S' (having totally sophisticated understandings). The second one is that unsophisticated NOS understandings in other NOS aspects can paralyze NOS lens usage for the NOS aspect with sophisticated understandings. The third reason is that some NOS lenses had an unexpected interaction with each other in the DM process. The last one is that the nature of the issue which was considered to make a decision made the interviewees use a different lens from their NOS understandings in some cases.

When the usage of NOS lenses with their related NOS aspects is analyzed, firstly it should be mentioned that only NOS3 and NOS4 lenses were active in *'decision'* step. Moreover, there were no observable usage of NOS1 'The Tentative Nature of Scientific Knowledge' lens for any groups in the DM process. In addition to this, although NOS2 lens usages were generally consistent with NOS2 understandings, it was observed in only *'goals'* step with a very specific issue. Therefore, it was concluded that NOS1 does not directly affect the DM process, and the effectiveness of NOS2 lens to rule the DM process is very low. Furthermore, the biggest difference was detected in NOS3. It was understood that while Group U ignored the dependency on the data for the opinions about the artificial meat with the usage of uNOS3 lens, Group S used sNOS3 lens and in this way they considered heavily the dependency of scientific data and observation for the opinions and they gave an obvious priority to the scientists' opinions which included scientific data in *'decision'* step.

Group U had sophisticated understandings about NOS4. However, they frequently fell unsophisticated approaches about NOS4. Therefore, it was concluded that unsophisticated NOS understandings in other NOS aspects can paralyze the usage of NOS4 lens. Interestingly, Group S also reflected unsophisticated attitudes about NOS4 and they generally used u-sNOS lens in *'decision'* step. It was thought that having sophisticated understanding about tentativeness of the scientific knowledge may have caused Group S to give up looking for scientific evidence for their main criterion healthiness because it will never be absolute or certain. It is necessary here to draw attention to the fact that although all the interviewees had sophisticated understandings about 'The Empirical Nature of Scientific Knowledge', whether they were in Group U or Groups S, only 3 of 4 interviewees (U5, U6 and S5) who finished the referendum simulation about the sale of artificial meat in the Turkish markets with the vote of 'NO' used directly sNOS4 lens in the *'decision'* step.

In addition to these, it was understood that usage of uNOS5 lens caused Group U to give overcredibility to the scientists and reduced the diversity of the scientists in their perceptions. Therefore, it was concluded that while in a DM process related with a socioscientific issue, usage of uNOS5 lens make people feel comfortable with less extensive data or knowledge than actually they need and make them consider the collected information less than actually they should do as they think that the scientists have very similar abilities and they are credible enough to decide on any issue.

Moreover, not only Group S but also Group U had usage of sNOS6 lens although they had unsophisticated understandings about NOS6. Therefore, it was concluded that the nature of the referendum issue triggered them to make connections about social context, and thus, usage of sNOS6 lens because the selected issue already included a social context.

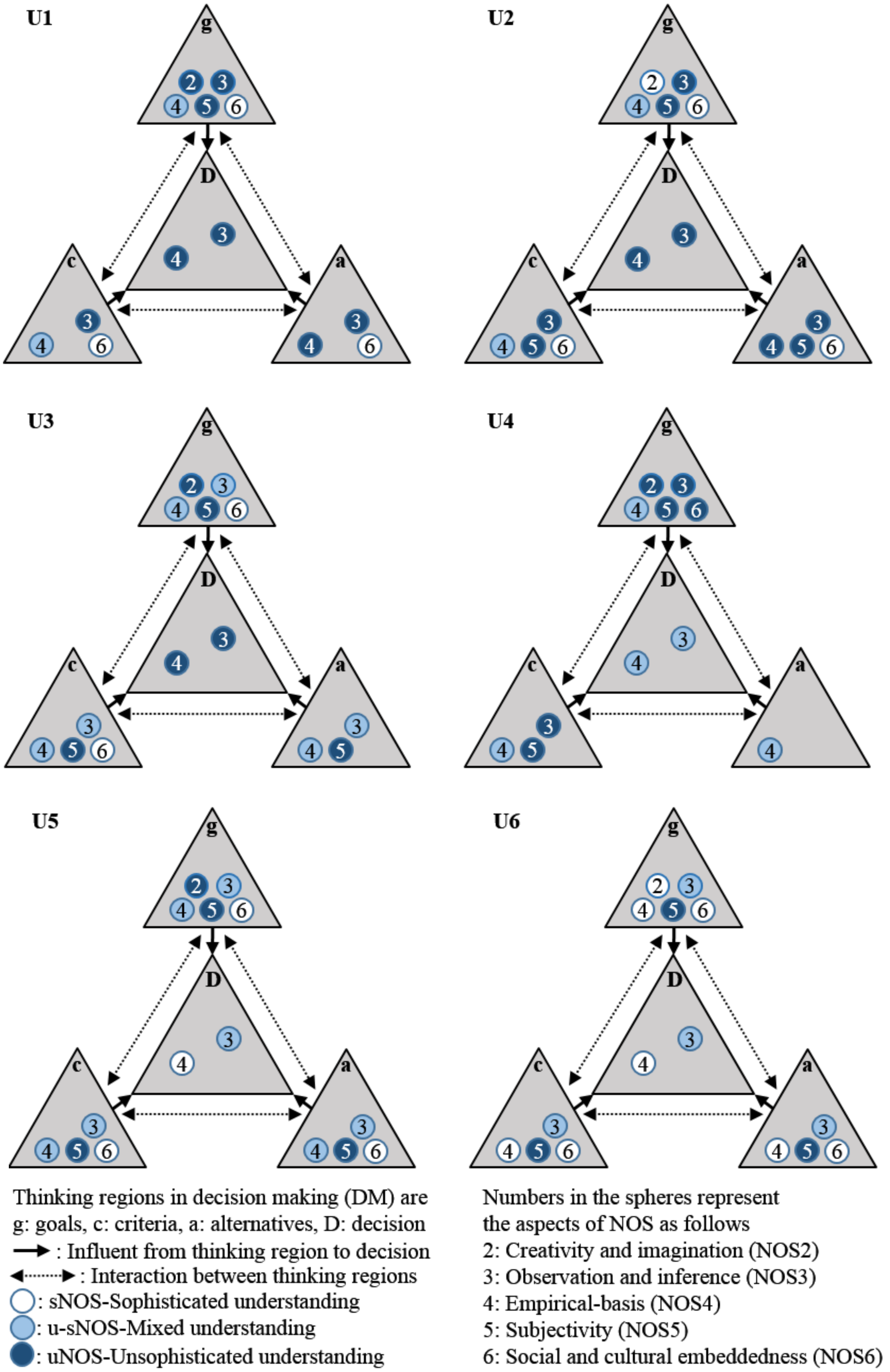


Figure 4.5 The personal demonstrations of the members of Group U for the distributions of NOS lens usages to the thinking regions in DM.

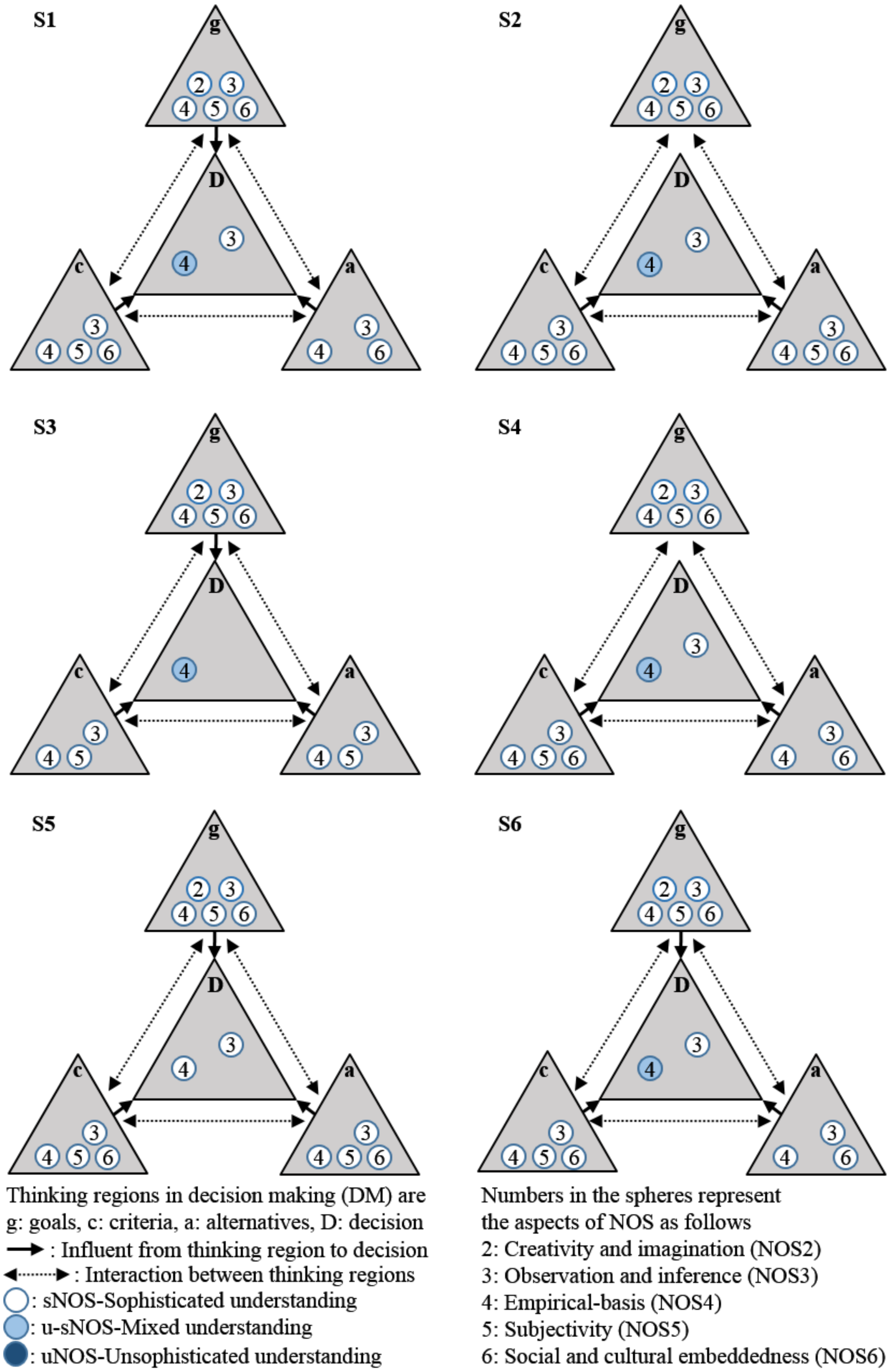


Figure 4.6 The personal demonstrations of the members of Group S for the distributions of NOS lens usages to the thinking regions in DM.

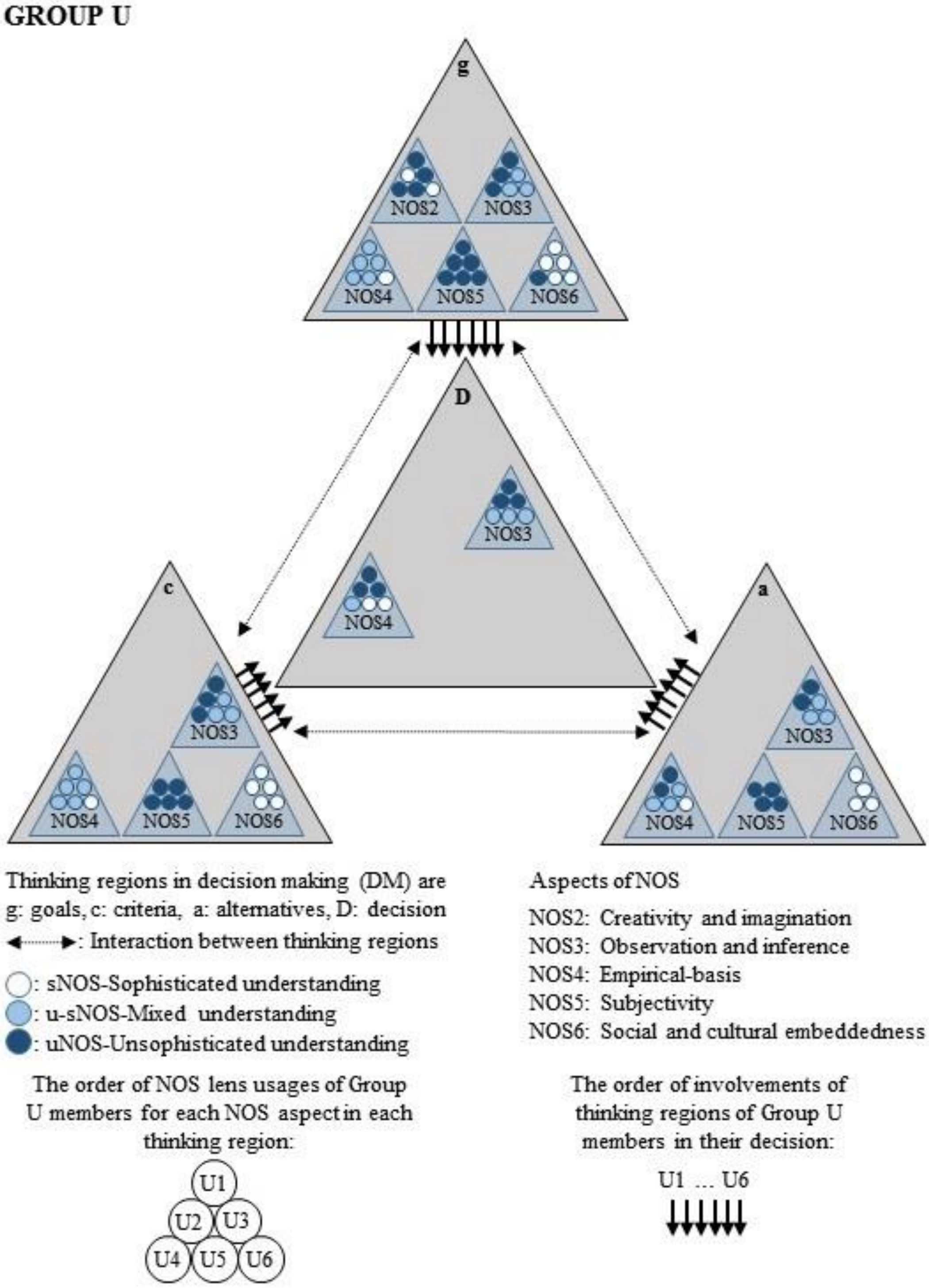


Figure 4.7 The overall demonstrations of Group U for the usage of NOS lenses in DM.

GROUP S

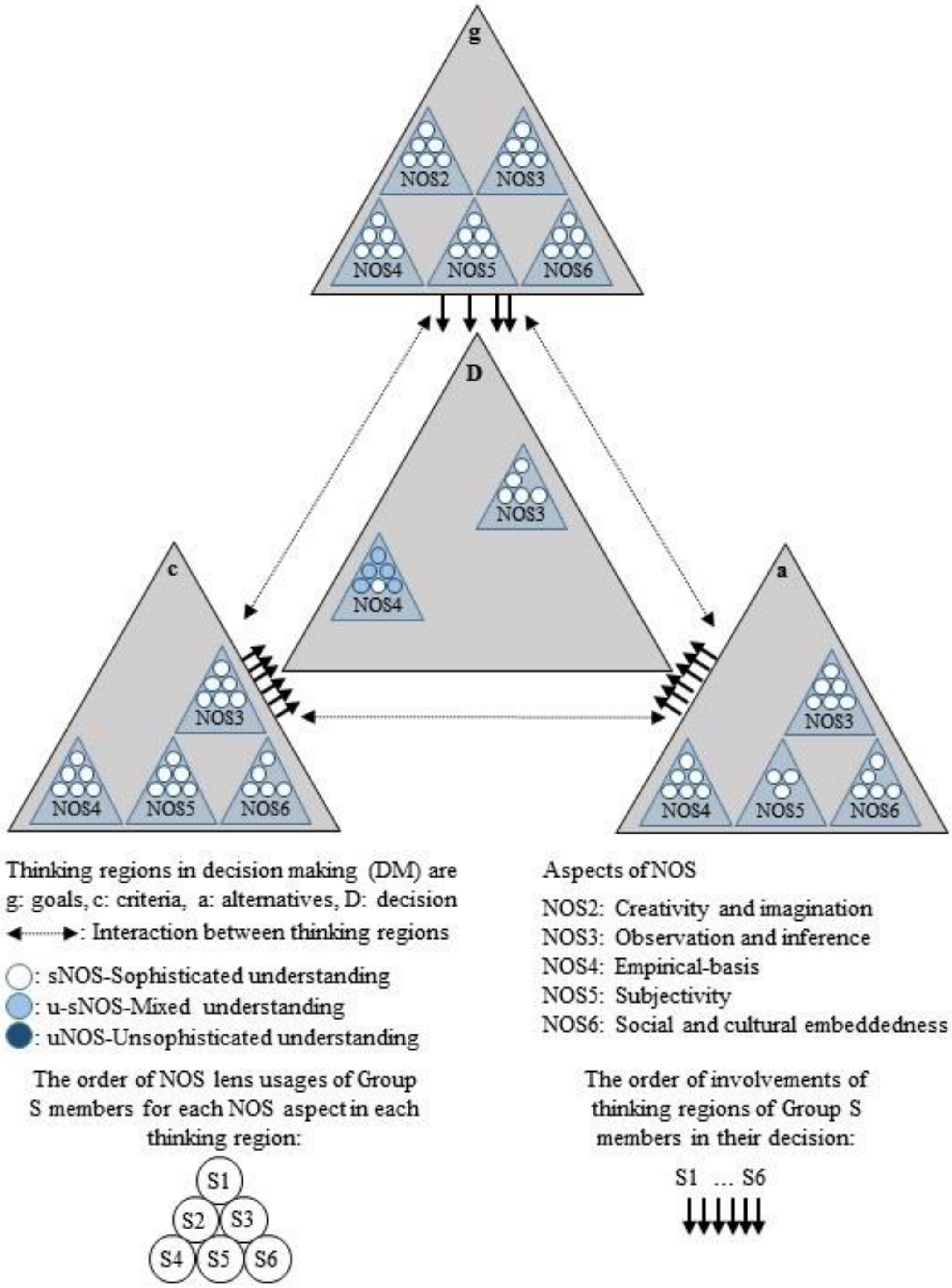


Figure 4.8 The overall demonstrations of Group S for the usage of NOS lenses in DM.

4.3.2 Other lenses

Previous studies mentioned that except from NOS, there are some other epistemologies or subgroups of some epistemologies such as religious or personal experience which affect DM. On the other hand, in the literature there is no single title used to mention them. For example, Bell and Lederman (2003) in their study found 10 of them and named them as ‘Factors’ affecting DM while Lee and Grace (2012) found 8 of them and named them as ‘Justification Perspective’. Moreover, Sadler and Zeidler (2004a) and Cebesoy (2014) focused on morality as an epistemology and mentioned 15 different categories for each study and named them as ‘DM Influences’. Furthermore, Halverson et al. (2009) in their study mentioned 8 of the perspectives which influence DM and named them as ‘lenses’.

In the present study, the term ‘lenses’ was found more suitable as these epistemologies or subgroup of some epistemologies act just as ‘lenses’ on the eyes which make the issues clearer according to their related perspectives. In addition to this, both under the light of the previous studies and with the analysis, 23 lenses which affect the DM process except from NOS were detected. In Table 4.20 the codes for these 23 lenses are listed and in Table 4.21 representative quotations are listed for each lens.

Table 4.20

Codes for other lens usages in the DM process related with the artificial meat and its alternatives

Lenses	**Codes**
Animal Rights (Moral)	Evaluations through the consideration of whether animals will be hurt or not
Environmental Rights (Moral)	Evaluations through environment protection
Humanity (Moral)	Evaluations considering people’s health and benefit for people through a large scale "humanity"
Information Rights (Moral)	Emphasis made in terms of informing consumers correctly
Natural order (Moral)	Evaluations specifically through the alteration that ecologic or natural order can be exposed to

Table 4.20

(continued)

Lenses	Codes
Curiosity	Evaluations by making emphasise on personal interest areas and curiosity
Prejudice	Judgements formed without basing on enough knowledge and hasty generalizations e.g. artificial meat has been tested, artificial meat is unhealthy, etc.
Priority	Evaluations through personal preference and priority related terms such as artificiality, naturalness, taste and luxury
Personal experience	Evaluations made by providing examples from family, relatives, friends and personal experiences
P. experience-lesson	Evaluations by making references to what has been learnt in class
Technology	Technological considerations with evaluations through the validity of production method/process (whether it is applicable in certain aspects or whether it is suitable in certain aspects)
Malicious use	Evaluations by considering the probability of misuse
Risk Factor	Evaluations through the consideration of whether it poses a threat on human health in the short-term and/or in the long-term, in terms of production method, nutritional value, content and being tested
Credibility	Evaluations through highlighting the competence of people or institutions on the related topic
Socio-cultural	Evaluations by drawing attention to Turkish culture, traditions, family and the structure of the society, and local diversities in Turkish culture
Socio-economic	Evaluations through purchasing power such as wealth/poverty or expensiveness/cheapness
Societal benefit	Evaluations based on needs and/or the quality of people's life at a large scale
Religious	Evaluations by highlighting religious belief
Economic	Evaluations through cost, profit-loss, financial development and the emphasis on sectors
Support science	Evaluations through the importance of scientific curiosity, the necessity of scientific development and the feasibility of scientific development in other fields
Pop culture	Evaluations by giving examples from widely known films, cartoons and alike
Legal issues	Evaluations by putting forth the necessity of a state control, legality and permit
Need for more information	Evaluations by making an emphasis on the requirement for more information

Table 4.21

Representative quotations for other lens usages in the DM process related with the artificial meat and its alternatives

Lenses	Representative Quotations
Animal Rights (Moral)	U4: If it does not harm the animal, we can use the amniotic fluid**.**
Environmental Rights (Moral)	S6: [Mark Post] It might be trying to lessen the carbon emission; I mean the green house effect. For example, how much more carbon does a cattle emit on its own than how many people? That's why it causes the atmosphere to heat up. Could have produced that [artificial meat] because of this.
Humanity (Moral)	U6: [Fortunately, they have asked for TÜBİTAK expert's opinion] because he is a scientist, I mean, the others do not have a scientific explanation. This writer, for example, mentioned social issues. A restaurant owner would only mention taste. No idea. The corportion only focuses on the animal. But this one is a scientist and can look into all aspects of it only for humanity, I mean. I believe that a scientist should have all this authority.
Information Rights (Moral)	S3: The content of these kinds of things should be made public. They should not consume anything they are not aware of.
Natural order (Moral)	U1: People who cannot afford i, might be able to eat cheap meat. Maybe, the number of stockers might increase in this way, but I don't know if it's a good thing…
Curiosity	S3: Strictly speaking, I'm not curious about the taste of an animal I have never eaten. I have no such interest.
Prejudice	U6: To be honest, at first, I was prejudiced about it, but later, when I saw the research, and when noticed that the taste and the sanitation would not change that much, we should not be too prejudiced, I think.
Priority	U5: Well, naturality is very important for me. When I think something that is unnatural, at such an extent, I can feel psychologically ill.
Personal experience	S1: [Food reviewer] He was right actually. I think like that too. I missed out on it earlier. I had a different perspective, but from this point of view, he is right. People give too much importance to organic this and that. They have actually started creating their own vineyards and orchards, which they paid no attention before. They try to produce everything themselves.
Personal experience (lesson)	U1: I'm taking a sustainability course. I have learnt what a devastating thing global warming is there. When I noticed what kind of resuls it could produce and so I think that there will be a problem in the future and this artificial meat will be beneficial for us then.

Table 4.21

(continued)

Lenses	**Representative Quotations**
Technology	S6: The meat that will be produced in the laboratory might be much heathier. I think this might reduce the risk of bacteria; they [Group 2 scientists] say some healthy complementary substances might be added to it. This is also possible. When I look at the procedure, if they really want, healthy substances can be added into it.
Malicious use	U3: I myself, I mean, within the family, we'll be able to eat panda. How wonderful, but explaining it to the public in that way, as a scientist, this rhetoric... I felt that it should not be told the public in that manner... Don't worry; for example, a crocodile, a snake... We already eat snakes anyway, but it means that we can even eat human meat. That makes the whole thing a different story.
Risk Factor	S2: Now, if the fetus is infected, and when this spreads to the meat first, and then to the animal that eats it and after that, to the person who eats it. Because when it spreads to humans, it can turn into an enormous pandemic. It can become highly contageous, and the world could face another epidemic again. Of course, we really do not know but even the things that are produced with those bacteria... I'm not sure how it will work out...
Credibility	U5: I think it is more logical for experts to test it. But I prefer the experts to be more thrustworthy.
Socio-cultural	U2: We are directly interested in agriculture and stock breeding; I really wish it could carry on like this. [With artificial meat] I've noticed that they are even trying to cut down on this**.**
Socio-economic	S5: This is something necessary. We know the price of meat. Many people cannot afford it, consume it. It would be wonderful to find a solution to this.
Societal benefit	S6: Carried out his/her research on things that could affect the society, has a direct stand point such as eliminating hunger, producing the nourishment important for the society...
Religious	U4: Amniotic fluid is to do both with my world-view and religion. I wouldn't prefer it. I'm the sort of person who reflects my religious belief into my lifestyle. I mean, it is not prejudice, but It plays a part in my decision-making.
Economic	S1: If this [artificial meat] can contribute to economy, it might get support from the government. [...] I would like to find out who funds it, how they will benefit from this. So what? Will that bring in a lot of money?
Support science	U1: I'm against GMO. I stated at the beginning that, well, it is good that science improves and these kinds of things are heard of, but I don't like us reaching it, us being exposed to GMO products. I mean, there must be different fields that this kind of developments can be used.
Pop culture	U3: For example, we start taking tablets in cartoons, and we feel satisfied with it. In fact, taste is also and important sense for humans.

Table 4.21

(continued)

Lenses	**Representative Quotations**
Legal issues	S2: I believe that the state definitely supports it because, I think, it is necessary to get permission for these. It is necessary to get permission to start this kind of production. Ttat's why there must be a state support.
Need for more information	S5: Now, I've changed my mind. I'd go for no. Because we still sort of see it through the stages we have read about. Its effects on people is still unknown, what it is. OK. Everything is done thoroughly, but I still don't know. I believe that it should be tested on certain groups because it is still something that hasn't been tested out.

Personal lens usage for members of Group U and Group S are listed in Table 4.22 and Table 4.23 respectively. Moreover, in Table 4.24 the total group usages of lenses in each steps of the DM process are listed with group frequencies. With the analysis, it was understood that the densities of the usages of other lenses were different in different DM steps. With these tables, it was clearly seen that the density of usages of other lenses sharply increased in *'decision'*.

Furthermore, the members of Group U made more usages of lenses than the members of Group S in *'goals'*. In addition to this, the analysis showed Group U used 16 different other lenses while Group S used 9 different other lenses in *'decision'*. At this point it is important to remember that the connection between the *'goals'* and *'decision'* was not as strong in Group S as it was in Group U. Therefore, it was seen that these findings have the qualities which support each other.

In addition to this, when Table 4.24 is examined in detail, it can be recognized that while the usages of six lenses which are Prejudice, Personal experience, Malicious use, Religious, Economic and Need for more info are higher for Group U, only usages of three lenses which are Natural order, Priority and Credibility are higher for Group S.

Table 4.22

Personal distributions of usage of other lenses in DM process for Group U

	Goals							Criteria							Alternatives							Decision						
Lenses	**U1**	**U2**	**U3**	**U4**	**U5**	**U6**	**T**	**U1**	**U2**	**U3**	**U4**	**U5**	**U6**	**T**	**U1**	**U2**	**U3**	**U4**	**U5**	**U6**	**T**	**U1**	**U2**	**U3**	**U4**	**U5**	**U6**	**T**
Animal Rights	x	x	x	x	x	x	6	x	x	x	x	x	x	6	x	x	x	x	x	x	6	x	x	x	x			4
Environmental Rights	x	x	x	x	x	x	6	x	x	x	x	x	x	6	x	x			x	x	4	x	x		x	x		4
Humanity		x		x	x	x	4		x		x			2		x					1							0
Information Rights	x						1	x	x					2	x	x					2							0
Natural order	x				x		2				x			1	x			x	x		3				x			1
Curiosity			x			x	2							0	x						1							0
Prejudice		x	x		x		3	x	x	x		x	x	5	x	x	x		x	x	5	x	x	x	x			4
Priority	x	x			x	x	4	x	x			x		3		x			x		2	x	x					2
Personal experience			x	x	x	x	4			x	x	x	x	4			x	x			2	x	x	x				3
P. experience (lesson)	x					x	2				x		x	2	x			x		x	3			x				1
Technology		x	x	x	x	x	5		x	x	x	x	x	5		x	x	x	x	x	5		x	x				2
Malicious use	x	x	x	x	x	x	6			x	x			2			x	x			2							0
Risk Factor	x	x	x		x	x	5	x	x	x	x	x	x	6		x	x	x	x	x	5	x	x	x		x	x	5
Credibility	x	x	x	x	x	x	6	x	x	x	x	x	x	6	x	x	x	x	x		5	x			x			2
Socio-cultural		x	x	x	x		4		x	x		x		3		x			x		2		x					1
Socio-economic	x	x	x		x	x	5		x	x		x	x	4		x	x		x	x	4		x					1
Societal benefit	x	x	x	x	x	x	6	x	x		x	x	x	5	x	x		x		x	4		x		x	x		3
Religious	x	x	x	x			4				x			1							0							0
Economic	x	x	x	x	x	x	6	x	x	x	x	x	x	6	x	x	x	x	x	x	6		x		x			2
Support science	x		x	x	x	x	5				x			1	x			x			2			x				1
Pop culture							0			x				1							0							0
Legal issues		x					1	x	x				x	3	x						1							0
Need more info		x	x	x	x		4	x	x	x	x	x	x	6		x	x	x	x	x	5					x	x	2
Total	14	16	16	13	17	15	91	11	15	13	15	13	13	80	12	14	10	12	12	11	70	7	11	7	7	4	2	38

Vote 'YES'

Vote 'NO'

Table 4.23

Personal distributions of usage of other lenses in DM process for Group S

	Goals							Criteria							Alternatives							Decision						
Lenses	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**T**	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**T**	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**T**	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**T**
Animal Rights	x		x	x	x	x	5	x	x	x	x	x	x	6	x	x	x	x	x	x	6	x		x			x	3
Environmental Rights	x	x	x	x	x	x	6	x	x	x		x	x	5	x		x	x	x	x	5	x		x		x	x	4
Humanity	x			x	x		3	x				x		2														0
Information Rights							0			x		x		2					x		1							0
Natural order	x		x	x		x	4			x				1	x		x				2							0
Curiosity			x		x		2			x				1							0							0
Prejudice		x		x			2	x	x	x	x	x	x	6	x	x	x	x	x	x	6		x					1
Priority	x	x	x	x		x	5	x	x	x	x	x	x	6	x	x		x	x	x	5			x				1
Personal experience							0	x		x	x		x	4			x	x		x	3							0
P. experience (lesson)			x	x			2			x	x			2			x	x			2							0
Technology	x		x	x	x	x	5	x	x	x	x	x	x	6	x		x		x	x	4	x			x	x		3
Malicious use		x					1							0							0							0
Risk Factor	x	x	x	x	x	x	6	x	x	x	x	x	x	6	x	x	x	x	x	x	6	x	x			x		3
Credibility	x	x		x	x	x	5	x	x	x	x	x	x	6	x	x	x	x	x	x	6	x	x		x		x	4
Socio-cultural	x			x	x		3	x			x	x		3	x				x		2							0
Socio-economic		x		x	x	x	4		x	x	x	x	x	5		x		x	x	x	4							0
Societal benefit	x	x	x	x	x	x	6	x	x			x	x	4	x	x	x		x	x	5	x				x	x	3
Religious							0	x						1							0							0
Economic	x	x	x	x	x	x	6	x	x		x	x	x	5	x	x		x	x	x	5							0
Support science	x		x	x	x		4			x		x		2			x		x		2							0
Pop culture							0							0							0							0
Legal issues							0		x			x		2		x					1							0
Need more info	x		x				2	x	x	x	x	x	x	6		x	x	x		x	4					x		1
Total	13	9	12	15	12	10	71	14	12	15	12	16	12	81	11	10	12	11	13	12	69	6	3	3	2	5	4	23

Vote 'YES'
Vote 'NO'

Table 4.24

Other lens usages in the DM process with frequencies for Group U and Group S respectively

Lenses	Goals U(f)	Goals S(f)	Criteria U(f)	Criteria S(f)	Alternatives U(f)	Alternatives S(f)	Decision U(f)	Decision S(f)
Animal Rights (Moral)	6	5	6	6	6	6	4	3
Environmental Rights (Moral)	6	6	6	5	4	5	4	4
Humanity (Moral)	4	3	2	2	1	0	0	0
Information Rights (Moral)	1	0	2	2	2	1	0	0
Natural order (Moral)	2	4	1	1	3	2	1	0
Curiosity	2	2	0	1	1	0	0	0
Prejudice	3	2	5	6	5	6	4	1
Priority	4	5	3	6	2	5	2	1
Personal experience	4	0	4	4	2	3	3	0
Personal experience (lesson)	2	2	2	2	3	2	1	0
Technology	5	5	5	6	5	4	2	3
Malicious use	6	1	2	0	2	0	0	0
Risk Factor	5	6	6	6	5	6	5	3
Credibility	6	5	6	6	5	6	2	4
Socio-cultural	4	3	3	3	2	2	1	0
Socio-economic	5	4	4	5	4	4	1	0
Societal benefit	6	6	5	4	4	5	3	3
Religious	4	0	1	1	0	0	0	0
Economic	6	6	6	5	6	5	2	0
Support science	5	4	1	2	2	2	1	0
Pop culture	0	0	1	0	0	0	0	0
Legal issues	1	0	3	2	1	1	0	0
Need for more info	4	2	6	6	5	4	2	1
Total	**91**	**71**	**80**	**81**	**70**	**69**	**38**	**23**

Lens usage with more than one point difference in terms of frequency for Group U
Lens usage with more than one point difference in terms of frequency for Group S

Group U used Malicious use and Religious lenses frequently in *'goals'* and then they took off these two lenses in *'decision'*. The reason why Malicious use lens did not remain in *'decision'* was that Group U tended to focus more on the good aims for producing and selling the artificial meat although in the DM process, they considered some malicious use about it. The following quotation of U is representative for this issue.

> *U5: Well, it might enable us to do the things that we can't do now. It improves our opportunities. Technology can both be used in a good way or a bad way, but this is the good way, I think... (Malicious use→ Goals: To question the hidden aim)*

Moreover, with the following quotations of U1, it is understood that she considers her own religious beliefs in her personal choices and DM process about artificial meat. However, when the issue came to the *'decision'* related with the sale of artificial meat, she gave the signals to vote 'YES' for the artificial meat by her respectful attitude towards other people's beliefs and general benefit of the society.

> *U1: Well, I wouldn't like to eat panda. It's about my belief [...] In Islam, it is suitable to consume animals that regurgitate, I mean the ones mentioned in the Koran. That's why I wouldn't like the idea that sort of meat to be produced and serviced to us. Of course, I wouldn't support that. [...] If any kind of production based on health is required yes, why not? It should be produced then... It should be produced for the ones that would like to taste it, but it should not be fed to us out of our knowledge. It's not nice. I mean I wouldn't like it. (Religious→ Goals: Goals: To taste and consume the meat of exotic or endangered animals)*

As for Group S, they did not used Natural order and Priority lenses in *'decision'*, although they used these two lenses in the DM process more than Group U did. With the analysis, it was understood that although the members of Group S had some questionings about the Natural order, these questionings were not strong enough to affect their *'decision'* as follows:

> *S3: I'd like to see someone who is interested in the environment here. Because, now, we won't slaughter animals, but I would wonder about what kind of a balance or unbalance does not slaughtering or not consuming them contribute in ecology? (Natural order→Goals: To protect the animals under bad conditions in animal husbandry/ prevent the animals from being killed for food, Criteria: Environmental effects, Alternative: Normal meat)*

Furthermore, it was concluded that the reason why Group S used Priority lens less in *'decision'* was the priorities of the members of Group S especially related with their criterion naturalness, which were not provided enough by some *'alternatives'* of the artificial meat according to them as follows:

> *S1: They should dwell on artificial meat, I think. The process is obvious with artificial meat. We don't know the effects of changing DNA structures. I found it more difficult, too. There is an alteration there, too much of an alteration, I think. It's pretty artificial. It's a complete alteration, I think. In GMO, they change one thing directly, but in this one, they imitate something that already exists. (Priority→ Criteria: Being natural, Production procedure, Alternative: GM foods)*

The lenses Animal rights, Environmental rights and Societal-benefit were used very frequently in the whole DM process including *'decision'* by both Group U and

Group S. Being a socioscientific issue directly related with animals, animal husbandries and carbon releasing for the artificial meat explain why these three lenses were used so effectively in the whole DM process by both groups. For example, with the following quotation of U4, it can be seen that she voted 'YES' for the sale of the artificial meat under the dominant effect of these three lenses although she said 'NO' in her initial response.

> *U4: I said yes [for the sale of artificial meat at super markets]. Because people who know it defend that it is logical. See, the business of the man who owns a cattle farm will probably deteriorate, but there is always the option that they can take a stem cell from his cattle after all. Besides, it would be stupid to do something that will affect the whole society just for one person. We say that there will be a famine in the future because someone is not going to make money. Now, it would be stupid to say no to that.*
>
> *I found artificial meat beneficial for the balance of the ecology. I found it beneficial for everyone. Beneficial for global warming, animals, us, for everyone. If even some of the vegetarians say yes, then it is pretty beneficial..*

Moreover, Group U wore the lenses Personal experience, Prejudice, Risk factor and Economic in *'decision'* more frequently than Group S did. For example, U2 reflected her father's opinions and her experiences about the chickens in chicken farms to her *'decision'* as follows:

> *U2: Well, we are fed up with eating industrial chicken. This is something that I observe too because I see it at the market. It is more expensive, but they say they'd rather buy a village chicken. This is something I really notice; for example, my dad, no matter how expensive it is, he tries to go to the market and get one. He tells me not to eat the chicken served at the dining hall because you can get food poisoning. He lists me a lot of things, tells me not to eat it. I observe this around me a lot and really and people really know what natural meat is like. I do not have to provide any scientific explanation for that. Yes, people in Turkey know what natural meat tastes like. These people have also provided really logical explanations. When the cost of electricity and the like is taken into consideration yes, that's true in a sense. (Personal experience→Decision: NO shouldn't be sold)*

Usage of Economic lens was also effective in U2's decision by considering the cost of the production of the artificial meat in her decision. In addition to this, with the following quotation, it can be clearly seen that U2 looked through Prejudice lens by making a hasty generalization and she thought that the artificial meat is unhealthy although she did not have sufficient information about the healthiness of the artificial meat.

U2: The food reviewer says no, it is also harmful for the environment, the electricity and the such that are used, there are also other things that are used. They are harmful too… (Economic, Environmental rigths, Prejudice→ Decision: NO shouldn't be sold)

It was understood that Prejudice lens was also used by the members of Group U who voted 'YES' for the sale of the artificial meat. For example, with the following quotations of U1 and U3 respectively, it can be seen that the decisions of U1 and U3 were made very similarly under the effect of the combination of two lenses which are Prejudice and Risk factor. They made hasty generalizations about the healtiness of the artificial meat by only considering the production procedure of the artificial meat and reached quick conclusions such as the conclusion that the artificial meat does not have a negative effect on people and the one that artificial meat is as healthy as normal meat.

U1: When I look into the process myself, its genetics has not been changed, so I thought it would not have a negative effect on health. As they are at the production process, it should have been tested on animals any way and it must have been observed that it would not have a bad effect on people. (Prejudice, Risk Factor→Decision: YES should be sold)

U3: I thought it was like GMO. Because it is something from a stem cell, it did not have much to do with a doctor. I came to the conclusion that artificial meat is as healthy as normal meat. (Prejudice, Risk Factor→Decision: YES should be sold)

In fact, it was concluded that prejudice lens was related with NOS1, NOS3 and NOS4 just because considering scientific knowledge as absolute and certain (uNOS1), accepting that inference does not need to be aligned with data (uNOS3) and feeling that there is no need to look for scientific knowledge (uNOS4) seemed to encourage Group U participants to easily make a hasty generalization about the issues related with the artificial meat. On the other hand, although U5 and U6 who have less unsophisticated NOS understandings especially about NOS1 wore Prejudice lens in other parts of the DM process, they took off this lens in *'decision'* step and they used Risk factor lens differently from the other group members. The following quotation shows that U6 got rid of her prejudices and made an obvious risk evaluation about the healthiness of the artificial meat in her decision.

U6: I want more research to be done. I say it's not quite enough yet. Next time, whether it has any harm or anything? 'Cause we haven't tested it on people yet. We have done no other research yet. You ask for opinion from this one, from that one.

That doesn't work on opinion. There should be research on it. Well, but next time, if it turns out to be true that it is not harmful, I will definitely vote yes. (Risk Factor→ Decision: NO shouldn't be sold)

As regards Group S, in *'decision'* by prioritizing the scientists' opinions about the artificial meat, they used Credibility lens more than Group U did. With the following quotations of S2, it is understood that the scientists' opinions directly affected her decision.

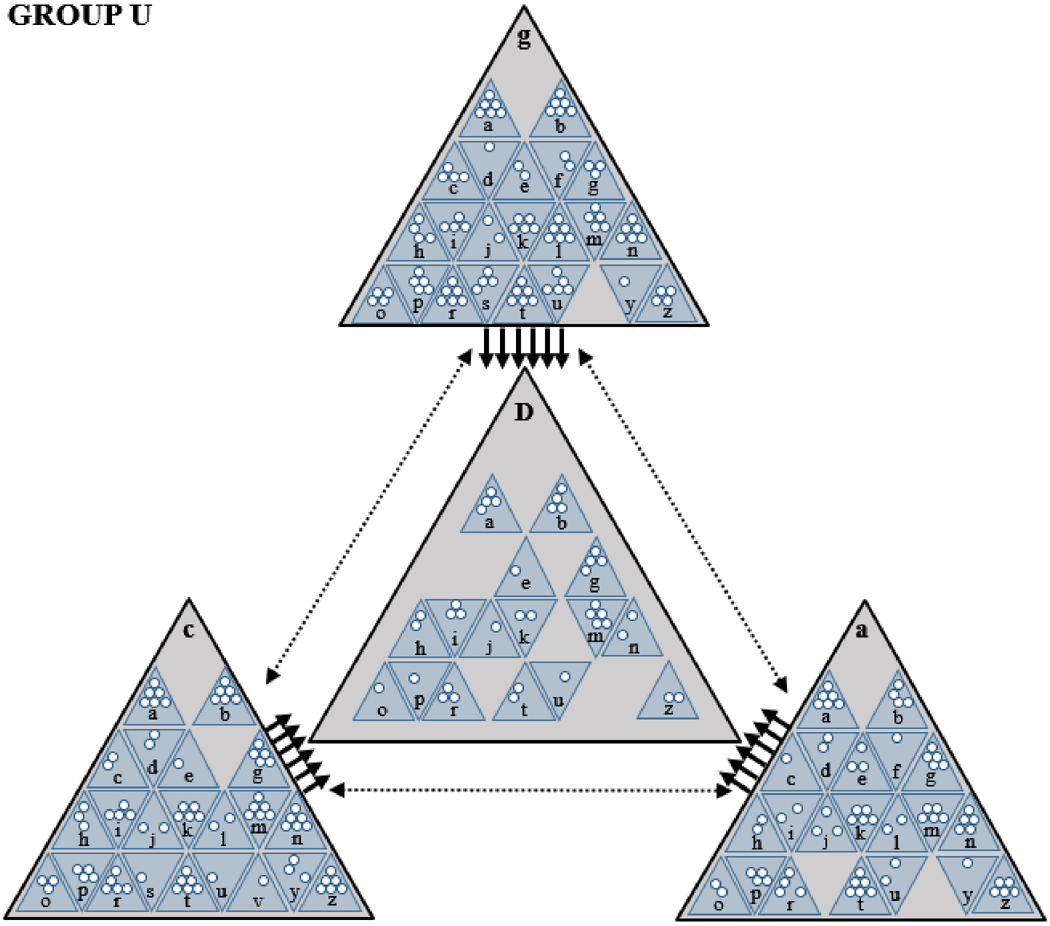
S2: The most effective one [on my decision making] is that no one objected to this except for the scientists, well, at least among the ones I have read. (Credibility→ Decision: YES should be sold)

Moreover, when the following quotation of S6 is examined, it can be seen that she considered credibility for the person who expresses an opinion about the artificial meat when she made her decision.

S6: There are ones that say it should not be, but they couldn't convince me. For example, the opinion that it should not be here, electricity transportation and alike, says a catering expert. Because I don't know how much a catering expert would know about electricity and transportation, I don't find it trustworthy... Just making rough guesses. There are vegans as well, and they approach it with sensitivity, and because I'm not as sensitive as they are on this, their point of view cannot change my opinion. (Credibility→Decision: YES should be sold)

As a conclusion, it was thought that because Group U had unsophisticated understandings about the 'Tentativeness of Scientific Knowledge (NOS1)', in their *'decision'*, they used Prejudice lens more frequently by giving certainty to the new knowledge about the artificial meat and also they did not avoid wearing Risk factor lens. In addition to these, Group U tried to complete the insufficient knowledge about the artificial meat by wearing Personal experience lens. However, because Group S had sophisticated understandings about NOS1, they did not tend to give certainty to knowledge but they wore Credibility lens in their *'decision'* and they gave priority to the scientists' opinions about the artificial meat. On the other hand, in *'decision'*, it was understood that the members of Group S took off Risk factor lens and they avoided mentioning the healthiness of the artificial meat which was not able to gain certainty in their mind. In order to demonstrate the differences in other lens usages between Group U and Group S better, the following Figure 4.9 and 4.10 were prepared. In these figures, each small triangle inside the thinking regions shows the usages of other lenses according to the written letter such as “a” for animal rights and “b” for environmental rights. Each sphere inside the small triangles represents a specific member of the related group according to its location in the order. For example, with Figure 4.9, it can be easily recognized that while considering the criteria of the artificial meat in DM process, no members of Group U mentioned the issues related with ‘curiosity’ lens because there is no small triangle labeled with “f” in thinking region *‘criteria’*. In addition to this, there is only one sphere in the small triangle labeled with “e” in thinking region *‘criteria’;* therefore, it is understood that only one member of Group U mentioned natural order in her speech about the criteria of the artificial meat, and the location of the sphere declares that it is U2. Moreover, with these demonstrations, it is easy to recognize the overall conclusions such as the conclusion that other lens usages sharply decreased in *‘decision’* for both Group U and Group S or that Group S needed other lenses less in each step of DM by comparing the existence of the small triangles in the related thinking region in Figure 4.9 and 4.10.

GROUP U



Thinking regions in decision making (DM) are g: goals, c: criteria, a: alternatives, D: decision

: Interaction between thinking regions

: Usages of other lenses

The order of lens usages of Group U members for each other lens in each thinking region:

U1
U2 U3
U4 U5 U6

The order of involvements of thinking regions of Group U members in their decision:

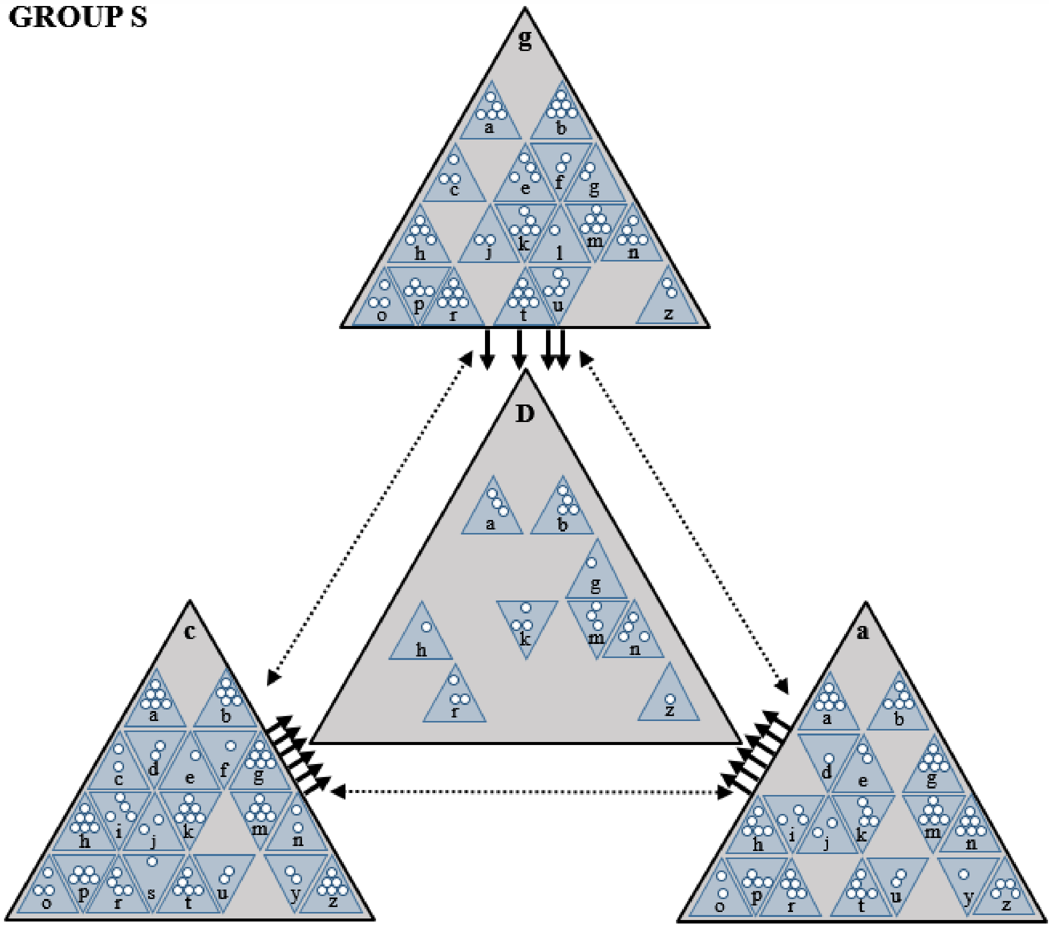
U1 … U6

Other lenses represented with small triangles in each thinking region

a: Animal Rights
b: Environmental Rights
c: Humanity
d: Information Rights
e: Natural order
f: Curiosity
g: Prejudice
h: Priority
i: Personal experience
j: P. experience (lesson)
k: Technology
l: Malicious use
m: Risk Factor
n: Credibility
o: Socio-cultural
p: Socio-economic
r: Societal benefit
s: Religious
t: Economic
u: Support science
v: Pop culture
y: Legal issues
z: Need more info

Figure 4.9 Other lens usages of Group U in DM.

GROUP S



Thinking regions in decision making (DM) are g: goals, c: criteria, a: alternatives, D: decision

◄┈┈┈► : Interaction between thinking regions

◯ : Usages of other lenses

The order of lens usages of Group S members for each other lens in each thinking region:

S1
S2 S3
S4 S5 S6

The order of involvements of thinking regions of Group S members in their decision:

S1 … S6

Other lenses represented with small triangles in each thinking region

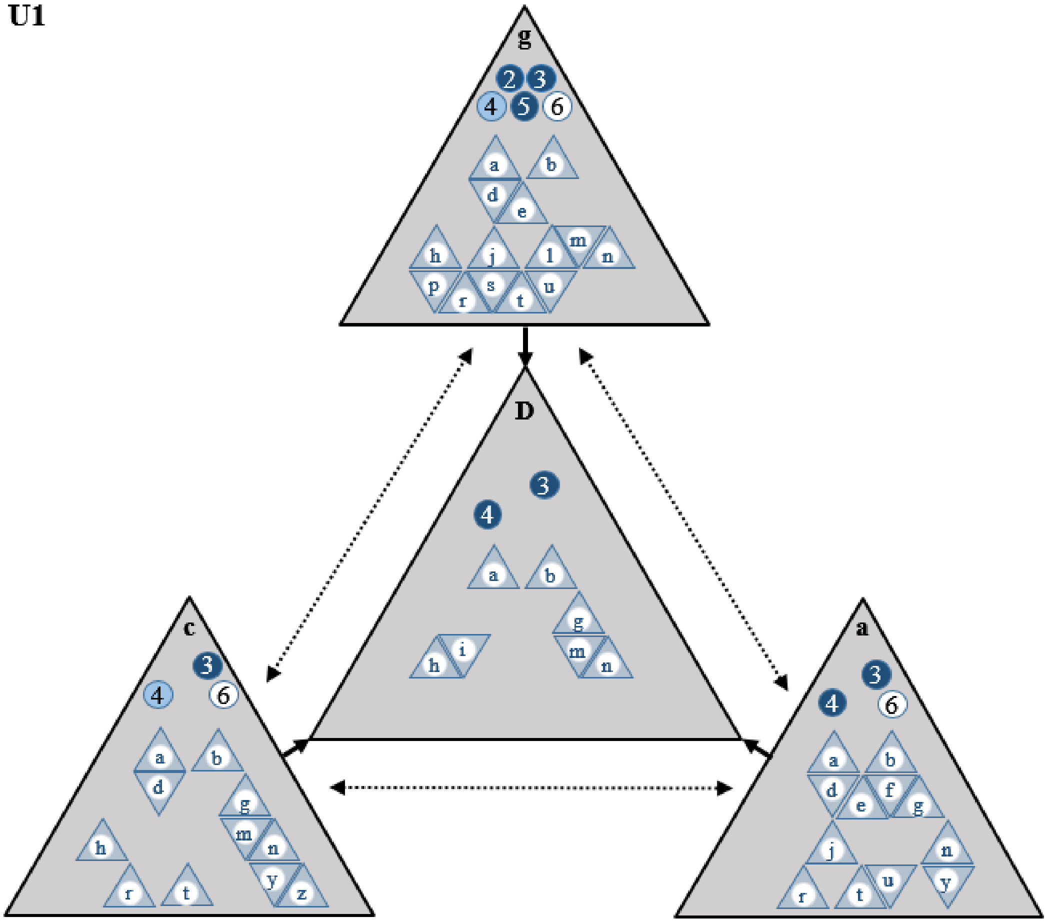
a: Animal Rights
b: Environmental Rights
c: Humanity
d: Information Rights
e: Natural order
f: Curiosity
g: Prejudice
h: Priority
i: Personal experience
j: P. experience (lesson)
k: Technology
l: Malicious use
m: Risk Factor
n: Credibility
o: Socio-cultural
p: Socio-economic
r: Societal benefit
s: Religious
t: Economic
u: Support science
v: Pop culture
y: Legal issues
z: Need more info

Figure 4.10 Other lens usages of Group S in DM.

4.3.3 Demonstrations of epistemological involvements in DM process (both NOS lenses and other lenses together) in the Fractal Model of DM

At this point, it is also important to give some personal examples about the usages of both NOS and other lenses together in DM in order to clarify more how epistemological involvement in DM can appear in the Fractal Model of DM. In order to do this, two members from each of Group U and Group S were selected according to their votes for sale of the artificial meat in terms of YES or NO. Therefore, in DM on SSI, the artificial meat, the NOS and other lens usages of U1 who voted YES and U5 who voted NO, S1 who voted YES and S5 who voted NO are presented in Figure 4.11, Figure 4.12, Figure 4.13, and Figure 4.14 respectively. Moreover, when these figures are compared, it is important to remember that in general U5 did not have unsophisticated understandings about NOS especially in terms of tentative nature of scientific knowledge (NOS1) as much as the most of the rest of Group U and S5 did not have sophisticated understandings about NOS especially in terms of tentative nature of scientific knowledge (NOS1) as much as the most of the rest of Group S. Furthermore, when these figures are compared, it can be easily concluded, for example, that whoever the participant was, a dramatic decrease in the usages of the lenses occurred in *'decision'* and the participants who used sNOS4 lens voted NO to the selling of the artificial meat. In addition to this, participants with sophisticated NOS understandings reflected those understandings directly to DM process in almost all thinking regions. However, the patterns of the lens usages in DM of the participants with unsophisticated understandings about NOS were more tangled especially in terms of NOS lens usages. This situation can be explicated that the DM process itself together with the selected SSI (the artificial meat) may lead the participants (especially the participants with unsophisticated NOS understandings) to evaluate the issues in more sophisticated ways than their NOS undestandings.

U1



Thinking regions in decision making (DM) are
g: goals, c: criteria, a: alternatives, D: decision

→ : Influent from thinking region to decision

↔ : Interaction between thinking regions

Numbers in the spheres represent
the aspects of NOS as follows

2: Creativity and imagination (NOS2)
3: Observation and inference (NOS3)
4: Empirical-basis (NOS4)
5: Subjectivity (NOS5)
6: Social and cultural embeddedness (NOS6)

○: sNOS-Sophisticated understanding
●: u-sNOS-Mixed understanding
●: uNOS-Unsophisticated understanding

Other lenses represented with blue letters in each small triangles in each thinking region

a: Animal Rights	m: Risk Factor
b: Environmental Rights	n: Credibility
c: Humanity	o: Socio-cultural
d: Information Rights	p: Socio-economic
e: Natural order	r: Societal benefit
f: Curiosity	s: Religious
g: Prejudice	t: Economic
h: Priority	u: Support science
i: Personal experience	v: Pop culture
j: P. experience (lesson)	y: Legal issues
k: Technology	z: Need more info
l: Malicious use	

Figure 4.11 In DM, usages of NOS and other lenses of U1 who voted YES to the selling of the artificial meat.

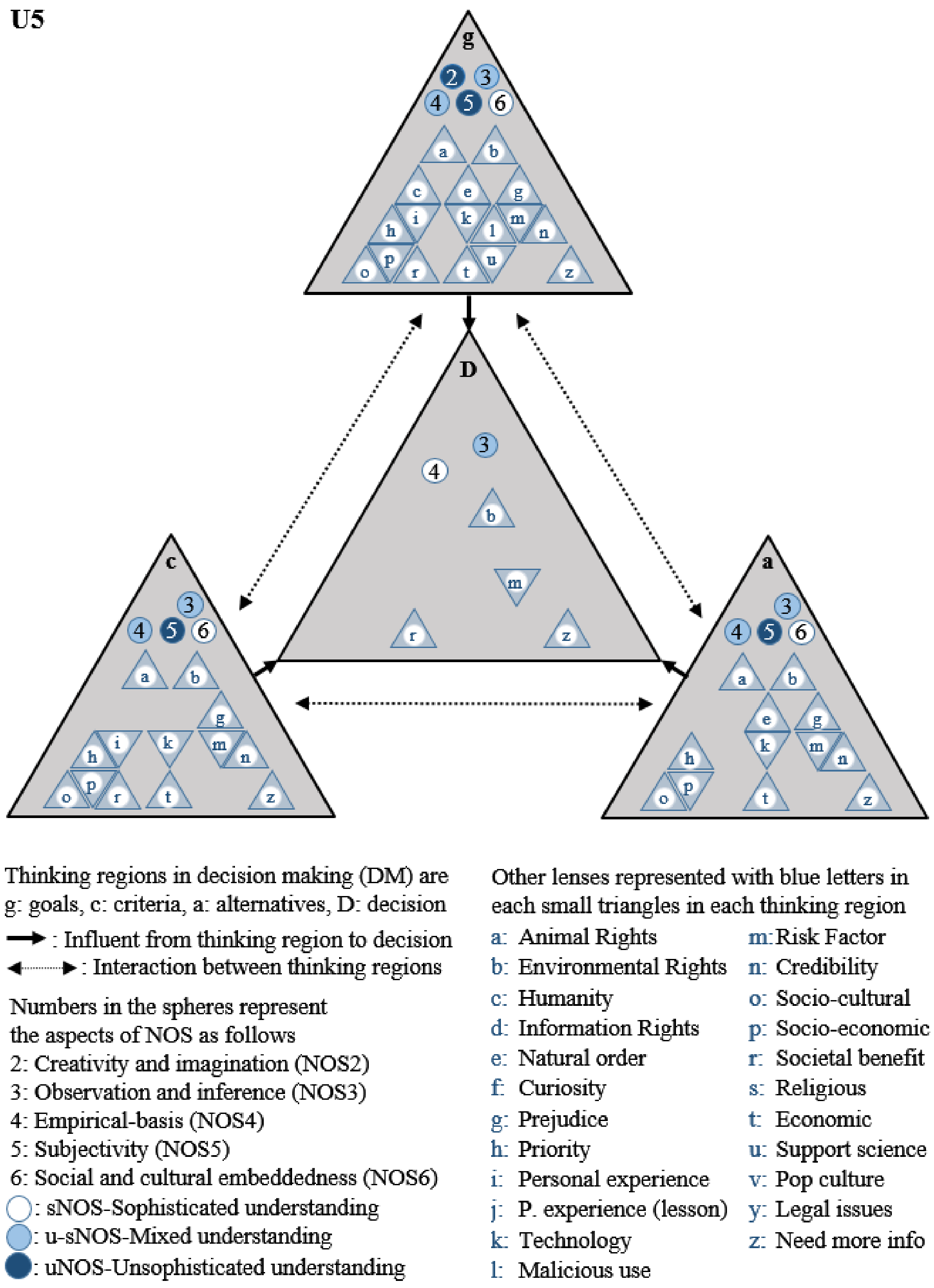
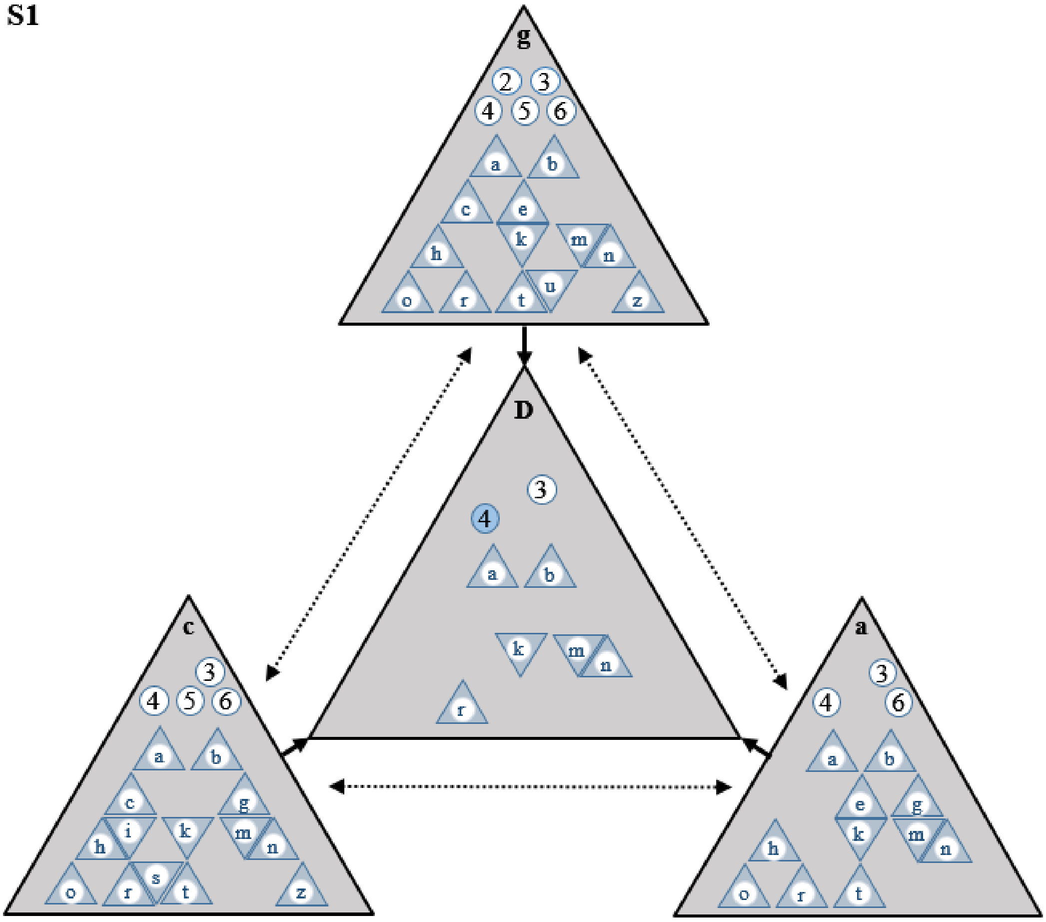


Figure 4.12 In DM, usages of NOS and other lenses of U5 who voted NO to the selling of the artificial meat.

S1



Thinking regions in decision making (DM) are
g: goals, c: criteria, a: alternatives, D: decision

→ : Influent from thinking region to decision

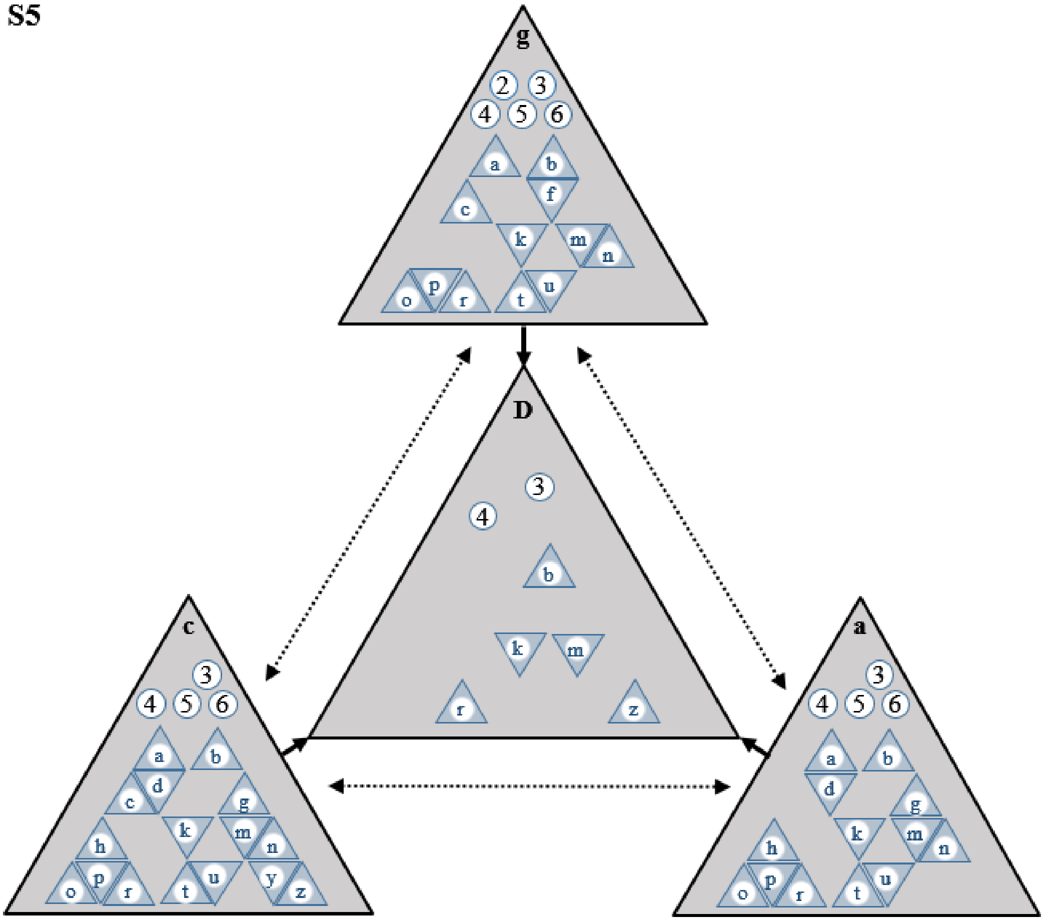
↔ : Interaction between thinking regions

Numbers in the spheres represent the aspects of NOS as follows
2: Creativity and imagination (NOS2)
3: Observation and inference (NOS3)
4: Empirical-basis (NOS4)
5: Subjectivity (NOS5)
6: Social and cultural embeddedness (NOS6)
○: sNOS-Sophisticated understanding
●: u-sNOS-Mixed understanding
●: uNOS-Unsophisticated understanding

Other lenses represented with blue letters in each small triangles in each thinking region
a: Animal Rights
b: Environmental Rights
c: Humanity
d: Information Rights
e: Natural order
f: Curiosity
g: Prejudice
h: Priority
i: Personal experience
j: P. experience (lesson)
k: Technology
l: Malicious use
m: Risk Factor
n: Credibility
o: Socio-cultural
p: Socio-economic
r: Societal benefit
s: Religious
t: Economic
u: Support science
v: Pop culture
y: Legal issues
z: Need more info

Figure 4.13 In DM, usages of NOS and other lenses of S1 who voted YES to the selling of the artificial meat.

S5



Thinking regions in decision making (DM) are
g: goals, c: criteria, a: alternatives, D: decision

→ : Influent from thinking region to decision
↔ : Interaction between thinking regions

Numbers in the spheres represent
the aspects of NOS as follows
2: Creativity and imagination (NOS2)
3: Observation and inference (NOS3)
4: Empirical-basis (NOS4)
5: Subjectivity (NOS5)
6: Social and cultural embeddedness (NOS6)
: sNOS-Sophisticated understanding
: u-sNOS-Mixed understanding
: uNOS-Unsophisticated understanding

Other lenses represented with blue letters in
each small triangles in each thinking region

a: Animal Rights	m: Risk Factor
b: Environmental Rights	n: Credibility
c: Humanity	o: Socio-cultural
d: Information Rights	p: Socio-economic
e: Natural order	r: Societal benefit
f: Curiosity	s: Religious
g: Prejudice	t: Economic
h: Priority	u: Support science
i: Personal experience	v: Pop culture
j: P. experience (lesson)	y: Legal issues
k: Technology	z: Need more info
l: Malicious use	

Figure 4.14 In DM, usages of NOS and other lenses of S5 who voted NO to the selling of the artificial meat.

4.4 Decision Making Strategies

With the analysis on the *'decision'* step of Group U and Group S, the codes listed Table 4.25 were reached about how DM strategies were operated by the members of groups.

Table 4.25

Codes and representative quotations about the DM strategies

DM Strategies	Codes	Representative quotations
Rationalistic	To focus on comprehensive information enough to know 'almost everything' (especially about healthiness) in order to make a decision about the artificial meat.	U1: It will have been tested on animals. What sort of reactions will have occured, what disseases occur and the outcomes of these will have been available. I wouldn't say yes to something whose results I do not know of. (Initial response)
Incrementalism	To focus on a very specific piece of information (especially about naturalness) in order to make a decision about the artificial meat.	U2: Why should we be eating things that we don't know what its content is for sure when we can buy these sources of food? I said no straight from that stand point.
Go-for-it approach	To tend to try everything new, in this case the artificial meat, without a proper analysis	S2: Yes, I think I don't know what will happen in terms of health, but necessary precautions can be taken. Some things can be done now. I can say yes to this now.
Rational ritualism	After realizing there is not enough comprehensive information to know 'almost everything' about the artificial meat, to act as if there was	U1: I answer this by assuming that this is all the information on this topic.
Mixed scanning	To start to focus on the piece of information which is top of priority by also considering the effect of this on the entire construction in order to make a temporary decision about the artificial meat.	U5: When I consider the times we are in now, I say it's not necessary. There is no scarcity, [no problem about] electricity, [they are] the future issues, I mean. If it gets worse, I could say yes.

In general, it was understood that voting YES or NO was led by different DM strategies. Moreover, operated DM strategies for voting YES were different in Group U and Group S. The following sections were mainly constructed to put forth these differences.

4.4.1 DM strategies operated by Group U

In their initial responses under the uninformed situation, only U3 was abstainer and all other member of Group U voted 'NO' for the artificial meat. After being informed about the artificial meat in the DM process, half of Group U turned 'YES' as it is seen in Table 4.26.

Table 4.26

DM strategies and votes of Group U in initial response vs 'Decision'

	Initial responses		Decision	
Sbj	**DM strategy**	**Vote**	**DM strategy**	**Vote**
U1	Rationalistic	NO	Rational ritualism	YES
U4	Rationalistic	NO	Rational ritualism	YES
U3	Rationalistic	Abstainer	Rational ritualism	YES
U5	Incrementalism	NO	Mixed scanning	NO
U6	Incrementalism	NO	Mixed scanning	NO
U2	Incrementalism	NO	Incrementalism	NO

Sbj: Subject

This half of Group U were the same half of Group U who operated rationalistic DM strategy in their initial responses as they focused on comprehensive information enough to know 'almost everything' (especially about healthiness) in order to make a decision about the artificial meat. The analysis showed that these members of Group U operated rational ritualism in the *'decision'* step after realizing that there was not comprehensive information enough to know 'almost everything' about the artificial meat and they tended to act as if there was, most probably because they were already convinced about the healthiness and benefits of the artificial meat. However, in fact, there was limited and incomplete information generally with lack of sufficient scientific proof about the artificial meat because in reality, the artificial meat is under research and development phase. For example, with the quotation of U1 it is clearly understood that in the *'decision'* step she chose to believe that she reached all possible information.

> *U1: Well, really, you have given me a lot information, but there was nothing about artifical meat being harmful for this or that, and in the light of this information I would go for yes [...] I'm responding to this supposing all this information being true. I mean, nothing negative about it. (Rational ritualism → Decision: YES should be sold)*

Very similar to U1, U3 behaved as if there was comprehensive and certain information about the artificial meat as it is seen in her following quotation. Moreover, when actually the information came insufficient, U3 did not avoid creating additional information as if artificial meat was ready for mass production, and made it her main reason for 'YES' vote.

> *U3: I mean not producing animals on farms, and they really are produced under nonsense conditions that could even harm people. It's really logical if it is something that can prevent it, or can be an alternative to it and if it is at a stage where mass production is possible and could be sold at supermarkets, which would possibly be the first reason. And when I have a look at its back round if it is not harmful, as healthy as possible, I would say that it has been created in a lab, but it has been produced from a real animal with the slightest harm to it. Also, I would say that astronauts can eat it. (Rational ritualism→Decision: YES should be sold)*

Furthermore, with the quotation below, it can be seen how easily U4 ignored the warning of Mark Post about the need for scientific research on healthiness of the artificial meat and behaved as if the scientists completed their research.

> *U4: Because people who know it defend that it is logical. See, the business of the man who owns a cattle farm will probably deteriorate, but there is always the option that they can take a stem cell from his cattle after all. [...] I found artificial meat beneficial for the balance of the ecology. I found it beneficial for everyone. Beneficial for global warming, animals, us, for everyone. If even some of the vegetarians say yes, then it is pretty beneficial. [...] The general overview of the scientists convinced me because they know what they are doing. While everyone is dicussing whether it is possible or not, these people are working on it to see if it is possible. (Rational ritualism→Decision: YES should be sold)*

The other half of Group U had operated incrementalism DM strategies in their initial responses as they focused on a very specific piece of information (especially about naturalness) in order to make a decision about the artificial meat, and after being informed they finished the DM process by keeping their 'NO' vote in their *'decision'*. As it is stated before, incrementalism is one of the DM strategies which is operated under the despair of impossibility to reach comprehensive information to consider the subject as a whole. On the other hand, with the analysis it was understood that only one of them, U2, continued to operate incrementalism in her *'decision'* as it is seen in the following quotation:

> *U2: But later I got confused. It had benefits said the scientists... But later, that VEG 2 deflected me again in a nice way. They said why it should be produced in a lab environment when there are other sources. They said "Why should we be eating*

things that we don't know what its content is for sure when we can buy these sources for food?" and the like. I said no straight from that standpoint. (Incrementalism → Decision: NO shouldn't be sold)

Moreover, U5 and U6, changed their DM strategy from incrementalism to mixed scanning in the DM process. In other words, they continued to focus on the piece of information which is top priority but at the same time because of the new information that they met in the DM process, they felt comfortable to consider the artificial meat as a whole. In addition to this, one characteristic of mixed scanning is making a temporary decision and different from all other members of Group U, only U5 and U6 emphasized that if the circumstances change, their decisions may change too, as it is clearly seen with the following quotations.

U5: I do not know the outcomes of this, whether there is a pilot study of this. Have they tested them on subjects? What has happened? I don't know. [...] But I won't feel very comfortable about it because after reading about energy savings and so I found it logical. Well, I thought we are going through hard times, we're not doing well with energy, and we do not want it to get worse, so I said yes. But when I consider the time we are in now, I say it is not necessary. There is no famine, and electricity is to do with future. If it gets worse, then I might say yes. (Mixed scanning → Decision: NO shouldn't be sold)

U6: Well, there was this Oxford research here, but that's not enough on its own, I think. My vote is still no. [...] Well, but next time, if it turns out to be true that it is not harmful. 'Cause we haven't tested this on people yet. We have not conducted any other research. You ask for opinion from this one, from that one. That doesn't work that anyway. There should be research on it. If, next time, it turns out to be safe, I'd definitely go for yes. I mean my vote. [...] (Mixed scanning →Decision: NO shouldn't be sold)

4.4.2 DM strategies operated by Group S

As it was stated before, while half of Group S had operated go-for-it DM strategy and voted 'YES' in their initial responses, the other half had voted 'NO' by operating either incrementalism or rationalistic DM strategy. After being informed in the DM process, almost all the members of Group S voted 'YES' in order to let the sale of artificial meat in the markets mainly by operating go-for-it DM strategy as it is seen in Table 4.27. Very similar to incrementalism, go-for-it approach is operated under the despair of impossibility to reach comprehensive information in order to make a decision. However, go-for-it approach seems to be loaded with much more despair because with it there is even no focus on any piece of information, but there is a tendency to try everything new without a proper analysis.

Table 4.27

DM strategies and votes of Group S in initial response vs 'Decision'

	Initial responses		Decision	
Sbj	**DM strategy**	**Vote**	**DM strategy**	**Vote**
S1	Go-for-it	YES	Go-for-it	YES
S3	Go-for-it	YES	Go-for-it	YES
S2	Incrementalism	NO	Go-for-it	YES
S4	Incrementalism	NO	Go-for-it	YES
S6	Rationalistic	NO	Rational ritualism	YES
S5	Go-for-it	YES	Mixed scanning	NO

Sbj: Subject

Ss who operated go-for-it DM strategy in their decision generally clearly stated that the healthiness of the artificial meat can be understood by only trying it as it is seen in the following quotations.

> *S1: I say yes. At first, I had said yes, but then changed it to no because just a few people have tried it and now I go back to yes. [...] They said they didn't know its outcomes in the long run, but they didn't say that it definitely has some kind of damage on human health. That's why it's satisfactory for me. I mean, we'll see its long term effects when we use it. [...] Well, if it weren't the scientists, and if I read all about it myself, I wouldn't be able to say yes straight away, but they were supportive about it. They increased it, but they didn't provide a great contribution to my decision to say yes by itself. (Go-for-it→Decision: YES should be sold)*

> *S2: In my opinion, yes, we don't know what will happen health wise, but necessary precautions can be taken now, and something can be done. I can say yes to it now. [...] Well, we can understand what kind of an effect it will have on us when we eat something depending on its taste and the reactions our bodies show. (Go-for-it→Decision: YES should be sold)*

Moreover, some members of Group S also mentioned that the artificial meat should be sold first, and then, the decision about the usage of it will be still under the control of customers.

> *S3: I don't feel discomfort any more by it being called meat. I could be artificial meat. Other delicacies are also meat that have been processed. This one is artificial and so is the other one. This one is completely artificial, but more open. [...] I mean, there, it's there. It's up to me whether to consume it or not. (Go-for-it→ Decision: YES should be sold)*

Furthermore, S4 also did not avoid expressing her own wonder about the taste of the artificial meat in her decision.

> *S4: I'd go for yes. I have a completely different opinion now. At first, I never thought that it was such a developed thing and thus, I had said I would say no. [...] I mean, although I'm a semi-vegetarian, I'd like to taste it just because there is curiosity about it. Ooo, What's it like? Is there a real difference? If they bring two servings; one with normal and the other with artificial meat, I'd try it because I'm curious about it, just for its taste at least. (Go-for-it→ Decision: YES should be sold)*

In addition to this, very similar to the half of Group U, S6 changed her vote from 'NO' in initial response to 'YES' in *'decision'* step after being informed about the artificial meat by changing her DM strategy from rationalistic to rational ritualism as follows:

> *S6: About the content of the substance s/he feeds on, for better quality, for the environment, for animal rights. This kind of views convince me because they have justifications. This reveals that it will be good, at what percentage it will affect etc. In terms of animal rights, how detrimental the previous method was on animals and how this new method will prevent this. See, PETA has some convincing rethoric. From the point of NASA; for example, we should consider astronauts. Artificial meat will be beneficial for them. So I'm convinced about it. (Rational ritualism →Decision: YES should be sold)*

Finally, S5 had a very dramatic change because she not only changed her vote from 'YES' to 'NO,' but also after being informed she changed her DM strategy from go-for-it to mixed scanning. With the quotations below, one of the characteristics of mixed scanning, which is making a temporary decision, is clearly seen.

> *S5: Now, I've changed my mind. I'd go for no. Because we still sort of see it through the stages we have read about. Its effects on people is still unknown, what it is. OK. Everything is done thoroughly. The data is obvious, but I still don't know. I believe that it should be tested on certain groups. It is still something that hasn't been tested out. [...] Of course, I wouldn't say it confidingly because I wouldn't go for it. I voted for it just because I thought it was a process. Maybe a year later, after all the tests are done I might go for yes. (Mixed scanning→ Decision: NO, it should not be sold)*

Moreover, with the following speech flow, it is also obviously understood how dramatic change occurred by shifting from go-for-it DM strategy to mixed scanning and by operating mixed scanning how she focused on healthiness of the artificial meat by also considering it as a whole with its benefit. This speech flow was also a very obvious example in order to understand that there was no proper analysis if go-for-it DM strategy was operated.

The researcher: Are you still wrapped up with yes then?

S5: Yes. Because when we see its benefits on humanity here, when we think about it, when we consider its benefits on global warming, and we consider being able to taste animals that will become extinct in the future I'm still wrapped up in it. But how it willl affect humans is not observed yet, not known. Maybe we'll develop a genetic reaction. Something might happen. It is not certain.

The researcher: Suppose that there is definite data that it is healthy would you have voted yes then?

S5: That would be yes then.

OK. Could you compare the yes vote that you have casted at the beginning with this one?

S5: I could. At first, I thought that we are completely independent, and people should eat whatever they want. We should leave this decision to them, but now, I would evaluate everything in terms of health and environmental conditions and would go for yes.

4.4.3 DM strategies of Group U vs Group S

The DM strategies operated by the members of Group U and Group S are listed in Table 4.28 below with their votes in *'decision'*. With the analysis it was clearly understood that the reasons for voting 'YES' were different between Group U and Group S because of operating different DM strategies in *'decision'* step and 'NO' votes were led by doing mixed scanning.

Table 4.28

DM strategies operated in decision by Group U vs Group S

Sbj	DM strategy	Vote	Sbj	DM strategy	Vote
U1	Rational ritualism	YES	S1	Go-for-it	YES
U2	Incrementalism	NO	S2	Go-for-it	YES
U3	Rational ritualism	YES	S3	Go-for-it	YES
U4	Rational ritualism	YES	S4	Go-for-it	YES
U5	Mixed scanning	NO	S5	Mixed scanning	NO
U6	Mixed scanning	NO	S6	Rational ritualism	YES

Sbj: Subject

In their initial responses with rationalistic approach, the members of Group U who required comprehensive information especially about the healthiness of the artificial meat decided that the artificial meat was healthy mainly after being informed about the production process of the artificial meat although they realized that they could not reach the information that they had required before. Exactly these members of Group U finished the referendum simulation about the sale of the artificial meat in the market with ‘YES’ by adopting rational ritualism.

On the other hand, almost all members of Group S who finished the referendum simulation with ‘YES’ vote were aware of the fact that the artificial meat could be unhealthy. Moreover, they believed that how healthy the artificial meat is could be understood by only letting its sale and they also generally meant that the effect of the artificial meat on human health will be different from one person to another. In addition to this, they also frequently stated that it is necessary to let the artificial meat in markets as long as everyone is free to buy or not. It was concluded that in the line with go-for-it DM strategy, these members of Group S did not approach the referendum simulation through deciding whether the artificial meat is ready to be sold in markets, but they approached through considering the existence of the information which is sufficient enough to block the sale of the artificial meat. In other words, by operating go-for-it DM strategy they did not focus well on the healthiness of the artificial meat; therefore, they did not make a proper analysis about it in their decision. They just wanted to make sure that after using the artificial meat if there are some health problems, the scientist should make a move to deal with these problems or only after these problems are seen, the sale of the artificial meat should be blocked.

In addition to this, when it came to the ‘NO’ votes, it was understood that adopting mixed scanning led the interviewers presently not to let the sale of the artificial meat because of lack of information about healthiness of it although they were convinced about some of the benefits of producing the artificial meat. Here, it is important to emphasize that the interviewers who were able to make mixed scanning in their *‘decision’* step were the two members of Group U who had relatively more sophisticated NOS understandings than the other group members and one of two members of Group S who had relatively more unsophisticated NOS understandings than the other group members. More specifically, it can be said that almost all interviewees who did not have too unsophisticated and too sophisticated NOS understanding especially about 'The Tentative Nature of Scientific Knowledge' in this study were clearly different from other interviewees as they adopted mixed scanning and voted 'NO'. Moreover, it is also important to remind that these three interviewees were the only three interviewees who had a proper sNOS4 lens usage which is related with 'The Empirical Nature of Scientific Knowledge' in their *'decision'* step. Therefore, it was concluded that having too unsophisticated and too sophisticated NOS understanding especially about 'The Tentative Nature of Scientific Knowledge' paralyzed the DM process because it led operating unsophisticated DM strategies such as rational ritualism and go-for-it approach, and then, this situation mainly paralyzed NOS4 lens usage in *'decision'* step.

4.5 Referendum vs Committee

In order to obtain participants' perceptions about the reliability of making a referendum for SSIs, the question 'which one is better to decide the artificial meat selling in the markets, by a referendum or by a committee' was asked both at the beginning and at the end of the interviews. Almost all participants stated that there will be a better decision by a committee with very similar explanations. In the following section, there are two representative quotations, one for Group U and one for Group S related with this issue. When these quotations are examined, it can be seen that both U1 and S1 mentioned that a committee consisting of experts should decide about SSIs because ordinary citizens may vote unconsciously and randomly without a proper consideration.

> *U1: You know, the people on the committee should be knowledgeable about this topic. And, I mean, up scale, who did research on this and who have a say and more in the loop of it. I would trust more on the decision of that kind of a committee. I highly approve of the committee and want it more than a referendum because in a referendum many people who know or don't know anything about it will vote for it insensibly.*

> *S1: I think we should set up a committee. Because when there is a referendum it involves politics and they manipulate people. For example, that's what happened with the swine flu injection. Some said the shots should be done, but others shouldn't... People decided randomly, according to how they feel about it, by going eeny meeny miney moe. An expert would say yes, and another one would say no.*

They should agree on that among themselves then. I wouldn't like to strive over it as a civilian. And our people do not do research on it. They hear it on TV being healthy and go for yes. They don't know what's behind it. They won't search for it.

Among all participants only S4 stated that there will be a better decision by a referendum because everyone should have the chance to express their own opinion and the referendums give them this chance as follows:

S4: The best one is the referendum. […] At least it sounds more democratic to me. Of course, I wouldn't like the whole nation affected by a single committee's decision; however, if there is a referendum, everyone states their own opinion and cast their own vote. I believe that a result comes out of it based on these.

Moreover, at the beginning of the interviews, the question 'if a committee is to decide whether the artificial meat should be sold in the markets or not, which people should take part in this committee' asked to the participants and at the end of the interviews they were asked to give a final shape to the committee they have created. With the analysis of these parts of the interviews, it was understood that the participants mentioned the possible members of a committee under 19 titles and all these members are listed Table 4.29 with their frequencies. In the coding, businessmen, restaurant owners, chefs and butchers, who can serve as expert opinions about whether the artificial meat is feasible to sell or not, were counted under a single title as people from food sector. In addition to this, economists, who can predict the possible economic effects of the artificial meat, and the animal husbandry owners, who are directly affected by the selling of the artificial meat, were counted as separate titles. Furthermore, in these parts of the interviews all participants gave brief explanations about the duties of the committee members and they considered the different backgrounds of the committee members by using plural nouns about them or by directly wishing more than one expert from each occupation. In this way, it was understood that only in this issue all participants used sNOS5 lens. The following quotations of U2 are representative for all participants.

U2: There should be a food scientist, not a food reviewer. The food scientist knows it, you know. How can I put it through? There should be scientists on it, dealing with this food. For example, popular cooks should come, scientists who do worldwide studies on these subtances. It should always be those. Chefs should be decision makers too. […] I think this committee is OK. I support this because there are food

> *engineers, there could also be chemists or so. They should be on it. Who else could be there? It should be the scientists. Chefs should be on it too something like a group of 15 of them, but not one of this and one of that. I mean two or three food engineers or so... I wouldn't trust only one of them. A few people should look into it.*

Moreover, when Table 4.29 is examined, at first sight, it was seen that there is no difference in terms of the varieties of the committees created by Group U and Group S.

Table 4.29

Committee members mentioned by Group U and Group S

Committee Members			**Group U**								**Group S**			
	U1	**U2**	**U3**	**U4**	**U5**	**U6**	**T**	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**T**
Scientists	x	x	x		x	x	5	x	x			x	x	4
Gastronomists	x	x	x	x	x	x	6		x	x	x			3
Food engineers	x	x		x			3		x	x	x			3
People from food sector (restaurant owners, chefs, butchers)		x			x	x	3				x	x	x	3
Doctors, sanitarians	x	x					2	x	x		x			3
Ordinary citizens	x	x			x		3				x		x	2
Geneticists				x	x	x	3							0
Politicians-ministers					x		1			x	x			2
Economists							0	x		x			x	3
Animal husbandry owners					x		1			x		x		2
Food critics		x			x		2		x					1
Animal rights supporters		x	x				2	x						1
TÜBİTAK							0	x	x		x			3
Biologists				x		x	2		x					1
Chemists		x				x	2		x					1
Sociologists				x			1			x				1
Anthropologists			x				1							0
Psychologists							0			x				1
NASA							0				x			1
Total	5	9	4	5	8	6	37	5	8	7	8	3	4	35

However, when Table 4.30, which includes the committee members mentioned by at least half of Group U and Group S, is examined, it was understood that Group S created a more comprehensive and effective committee than Group U did.

Table 4.30

Committee members mentioned by at least half of Group U and Group S

Committee members of Group U	F		Committee members of Group S	F
Gastronomists	6		Scientists	4
Scientists	5		Doctors, sanitarians	3
Geneticists	3		Economists	3
People from food sector (restaurant owners, chefs, butchers)	3		People from food sector (restaurant owners, chefs, butchers)	3
Food engineers	3		Food engineers	3
Ordinary citizens	3		TÜBİTAK	3
			Gastronomists	3

With this table, it was obvious that Group U had unsophisticated attitudes about the credibility of the experts especially because they added geneticists to the committee although they knew that there is no genetic intervention to the artificial meat and because they added ordinary citizens to the committee. Moreover, Group U were not able to give a proper importance to doctors and sanitarians and they did not give them a sufficient place in the committee although their main criterion was healthiness. Group U used uNOS5 lens in the selection of committee members and in this way they gave overcredibility to scientists. Following quotations from U4 and U6 show that under the effect of uNOS5 lens they concluded that there is no need for doctors in the committee as scientists can do the things that a doctor does.

> *U4: I think that these scientists have enough knowledge. Because the people we call doctors look for its causes or something when someone gets ill but it is actually you, I mean, the ones who tell doctors that this can cause the illness when you are educating them at medicine faculties, academics of this profession, their professors. Their views are of importance in a study like this. I think that they are also involved in these interpretations here.*
>
> *U6: I don't know, don't the scientists evaluate it like doctors anyway when they do this study? Of course, a doctor could still do the same evaluations, but they also could, if they are interested in biology as much as a doctor or something else. I think they know something. But, of course, I'm not against having doctors on it.*

CHAPTER 5

DISCUSSION AND RECOMMENDATIONS

In this chapter, a discussion on the impact of NOS on DM about SSI obtained through the findings of the content analysis of in-depth interviews conducted with 12 pre-service elementary science teachers and some relevant recommendations will be given.

5.1 Discussion

In this section, discussions are conducted under six headings, which correspond to six research questions of the present study which are also sections of Result chapter.

Initial responses

The initial responses of the participants referred to the participants' responses to the artificial meat just after they read the news about it. The analysis of the participants' initial responses showed that according to the participants, whether they were in Group U or Group S, the selected SSI, the artificial meat, contains unstructured problems in uncertainty conditions and it is interesting enough to consider. Unstructured problems are the problems that are new or unusual and for which information is ambiguous or incomplete and uncertainty conditions are the conditions in which the person is not certain about the outcomes and cannot even make reasonable probability estimates (Robbins & Coulter, 2012). In addition to these, uncertainty is a basic element of many decisions and according to Beyth-Marom et al. (1991), uncertainty should be one of the main concepts in curricula. In the present study, as the selected SSI the artificial meat had unstructured problems in uncertainty conditions, it is suitable to be adopted by future curriculum covering DM about SSI.

In addition to this, when the collected data from initial response were analyzed in terms of participants' initial decisions related with whether the artificial meat should be sold in Turkish markets or not, a difference was found between the choices and the way Group U and Group S made their choices in this lack of useful knowledge condition. While none of the members of Group U and half of the members of Groups S said 'yes' to the selling of artificial meat by using 'rationalistic' or 'incrementalism' DM strategies, half of Group S adopted 'go-for-it' DM strategy and said 'yes' to the artificial meat to be sold in Turkish markets. According to Etzioni (1989), with the rationalistic approaches, people supposed that they can collect any information they need, and therefore, they can learn everything before making a decision and after it was realized that it is not possible to collect and process that huge amount of knowledge; with the incrementalism, people tended to focus on a very specific piece of information in order to make a decision about it; or with the 'go-for-it' approach, they tried everything new without a proper analysis. Rationalistic DM is an old strategy and it was popular in the ages when even the scientists thought that the scientific knowledge is absolute and certain and that they can learn everything. It was not surprising to find that the half of Group U, who had more unsophisticated NOS understandings than the other half, opposed the artificial meat by rationalistic DM strategy and they wanted to know everything about it most probably because they see the scientific knowledge as absolute and certain and it waits for them to be found out. Moreover, the other half of Group U, who had less unsophisticated NOS understandings than the first half of Group U, and half of Group S, who had less sophisticated NOS understandings than the other half of Group S, said 'no' to thesales of the artificial meat by mainly using incrementalism and they just focused on very little piece of information about the artificial meat such as the naturalness to make a decision about it probably because they consider the scientific knowledge to be absolute and certain at the end, but there will be too much information to deal with in order to make a decision. In addition to these, in their initial responses, the half of Group S, who had more sophisticated NOS understandings than the other half of Group S, used the 'go-for-it' DM strategy and said 'yes' to the artificial meat in order to be sold in Turkish markets. It was concluded that having sophisticated understandings of the nature of science can make the people closer to activating ‘go-for-it’ DM strategies, and then, try everything new without a proper analysis. This situation can arise because of the tentativeness of scientific knowledge. It seems that according to the participants who had highly sophisticated NOS understandings, scientific knowledge is so uncertain and never-to-be absolute that there is no need to collect and analyze the data in order to make a decision; the only real conclusion comes after trying something new.

Thinking Regions: Steps of DM in referendum situation about an SSI

In this study, it was understood that because of their linear structure, the previous normative models about DM such as the normative model of Beyth-Marom et al. (1991), Carroll and Johnson (1990), Ratcliffe (1997) and Robbins and Coulter (2012) were not appropriate to reflect the DM in referendum situation. Moreover, referendum situations about SSI are important for educational research because they happen with the participation of all citizens, and therefore, they provide one of the best cases to see the importance of having scientifically and technologically literate citizens (UNESCO, 1999; see also Donnelly, Jenkins & Layton, 1994). In addition to this, as NOS is a critical component of scientific literacy (NSTA, 1982), the referendum situation provides a good medium to see why we try to teach NOS to “all students” as science teachers. The present study is the first study to focus on the impact of NOS on DM about SSI in a referendum situation, and therefore, a new normative model reflecting the participants’ DM process in a referendum about an SSI was constructed under the light of the previous normative models and the data collected from the semi-structured interviews.

The analysis show that in this referendum case, the participants thought through three thinking regions which were *thinking region about ‘goals’, thinking region about ‘criteria’, thinking region about ‘alternatives’*. In addition to these three thinking regions, *thinking region ‘decision’* could not exist by itself but seems to exist through the interactions of *‘goals’*, *‘criteria’* and ‘*alternatives’*. In other words, it was understood that the interactions among three thinking regions produce a new region *‘decision’* which is continuously fed from these three thinking regions.

Moreover, these thinking regions appeared simultaneously in the model, which is different from the linear steps in other models where they follow each other one by one.

In the interviews, 17 *'goals'* about the artificial meat were mentioned and 8 of 17 were common for both groups. Although the general density to use thinking region *'goals'* and the number of *'goals'* were very similar in both groups, the focused *'goals'* and interaction between *'goals'* and *'decision'* were different between Group U and Group S. Group U focused more on the *'goals':* '*to question the hidden aim'* and '*to provide everyone with quality, cheap and healthy meat'* than Group S did. Therefore, it can be concluded that although according to Group U, scientific knowledge is absolute and certain, they did not stop questioning the usage of this knowledge and correlatively, they considered the social benefit much more. Moreover, Group S was interested in human prosperity as they focused more on the *'goals': 'to provide economic development/ to open up new employment opportunities'* and *'to meet people's increasing needs for meat with the increase in population'*. Furthermore, the analysis showed that while all members of Group U mentioned at least one of the *'goals'* in their decisions, 2 members of Group S did not mention the *'goals'* in their decisions. Thus, it was thought that although the importance they gave to the *'goals'* looked equal in the DM, the linkage between the *'goals'* and the *'decision'* of Group S was not as strong as that of Group U.

The participants mentioned 16 *'criteria'* about the artificial meat and 7 of them were common for both groups. These findings are in contrast with Kortland's (1996) findings about the usage of criteria in DM about an SSI. Kortland (1996) stated that the range of the criteria mentioned by 8th grade level students was limited. However, the sample of the present study consisted of pre-service science teachers; therefore, to encounter wide ranged and high referenced criteria in DM on an SSI seemed not surprising. In addition to this, whether they were in Group U or Group S, almost all participants talked about 'Price' and 'Being natural' and it was also not surprising because of easily established cost-price relations in the issue of sales of the artificial meat and because being natural is the opposition of being artificial. Moreover, although the general densities of Group U and Group S to use thinking region *'criteria'* in DM were equal, there were some differences in the focused *'criteria'* and the relation of *'criteria - decision'* between the Group U and Group S. Parallel with Group S's general attitudes towards human prosperity, all members of Group S mentioned and thought through the criterion 'Economic effects' but only 2 members of Group U considered it in DM. Moreover, Group S focused on 'Effects on society' as a criterion more than Group U did. Although this situation seems to be inconsistent with the general attitude of Group S, it was understood that the members of Group S did not consider social benefit when they mentioned the criterion 'Effects on society,' but they thought how the artificial meat is voiced in society and in which way the artificial meat can be more acceptable. In addition to this, almost all members of Group U thought about the 'Legality' of the artificial meat while only half of Group S stated 'Legality' as a criterion. This situation was also concluded to be related with the differences between the groups in general approaches to society's needs. Furthermore, Group U had more connections between *'criteria'* and '*decision'* than Group S did and in their decisions the members of Group U focused on three criteria which were 'Healthiness,' 'Effects on animals' and 'Being experimented' more than the members of Group S did. Firstly, giving much more place to the criterion 'Healthiness' in *'decision'* can be explained by the unsophisticated understandings of Group U related with the tentativeness of the scientific knowledge. Because, according to them, the scientific knowledge is absolute and certain, Group U generally tried to collect all the information from the texts but they did not ask for additional research about it. In the informing part, it was stated that the scientists thought that the artificial meat would not give any harm to human health, and the members of Group U did not avoid mentioning 'Healthiness' in *'decision'*. On the other hand, the members of Group S avoided mentioning healthiness of the artificial meat as they believed that it would never be possible to certainly know whether the artificial meat is healthy or not. Secondly, it was understood that more members of Group U focused on the criterion 'Effects on animals' in their *'decision'* most probably due to being unsophisticated in tentative nature of scientific knowledge again. They focused on informing parts of the interview, which also included some explanations about the effects on animals, more in order to gain as much information as they can in order to use it in *'decision'*. Finally, while most of Group U mentioned 'Being experimented' as a criterion in *'decision'*, only one member of Group S mentioned it. This situation may be caused by the Group S's sophisticated understandings about tentative nature of the scientific knowledge. Probably, they gave up looking for scientific evidence about the artificial meat because it will never be absolute or certain.

The analysis showed that participants mentioned 12 *'alternatives'* in the interviews. It was understood that at the beginning of the interview, the participants thought about the *'alternatives'* in order to understand what the artificial meat is. In other words, they tried to load meanings to the artificial meat through the *'alternatives'.* However, as the DM process proceeded, they started to evaluate the effectiveness of the artificial meat by comparing it with its 'alternatives'. These findings are parallel to Piaget's Theory. According to Piaget, when people meet a new situation, they try to fix the new knowledge to their existing schema and this helps people to improve existing schemes and to develop new schemas (Erden & Akman, 1995). Therefore, it was concluded that as the artificial meat was new for all participants, in the beginning they tried to understand it through the possible alternatives and after they met some information about the artificial meat, they established a new feeding type in their mind. Moreover, all the participants mentioned 'Normal meat,' 'Genetically modified foods (GMO),' 'Plant-based meat-like product' and 'Synthetic meat' as the *'alternatives'* of the artificial meat and almost all participants focused on 'Animal husbandry' as an alternative to the artificial meat in the whole DM process. The frequencies of the other alternatives apart from mentioned above sharply decreased. It was understood that just because the participants had no prior knowledge about artificial meat, they generally focused on the *'alternatives'* related with the informing parts. Furthermore, in the *'decision',* regardless of which group they are in, all the participants almost only focused on two *'alternatives'* one of which was 'Normal meat' and the other was 'Animal husbandry'. 'Normal meat' and 'Animal husbandry' were the naturally closest alternatives to the artificial meat and it was not surprising to find that these alternatives had high frequency in *'decision'*. Moreover, disappearance of the other alternatives in ‘decision’ can be explained as, whether they voted ‘yes’ or ‘no’, after all informing parts in the interview, the participants thought the artificial meat as a unique product.

NOS lens usages in DM

In this study, the codes about the usages of NOS lenses were established in the light of the studies of Lederman (2006) and Khishfe (2012) by using the data collected from the interviews. Parallel with the studies of Zeidler, Walker, Ackett, and Simmons, (2002), Walker and Zeidler (2003), Sadler, Chambers and Zeidler (2004), in the present study, although there was a very wide gap between the understandings of Group U and Group S in terms of tentative nature of scientific knowledge, no direct lens usage of this aspect was detected. On the other hand, although Bell (1999) reached some clues about the fact that some participants' understandings about tentativeness of scientific knowledge were active in DM, his findings were limited to only 1 of 4 scenarios and with 2 of 18 participants and this did not affect the participants' decisions (Bell & Lederman, 2003). Moreover, Khishfe (2012) found a better clue for the reflection of the understandings about tentativeness of scientific knowledge, but the findings came from the treatment group members who were instructed about application of NOS to DM.

In the present study, the participants, regardless of which group (Group U or Group S) they are in, had similar and generally sophisticated understandings about the creative and imaginative nature of scientific knowledge. However, when the issue comes to the usages of this understandings in DM, it was understood that while all members of Group S reflected sophisticated understandings about it in DM, most of Group U reflected unsophisticated understandings about the creative and imaginative nature of scientific knowledge. It can be concluded that having unsophisticated understandings in other aspects of NOS may paralyze the usages of the sophisticated understandings about the creative and imaginative nature of scientific knowledge in DM. However, in the present study, which focused on the artificial meat as a socioscientific issue, this aspect of NOS was observed only in *‘goals’* step with a very specific issue and Zeidler, Walker, Ackett, and Simmons, (2002), Lederman and Bell (2003), Walker and Zeidler (2003), Sadler, Chambers and Zeidler (2004) and Khishfe (2012) did not identify any appearance of this aspect in their participants' comments about the socioscientific issues when they made a decision. Therefore, it was concluded that the effectiveness of the creative and imaginative nature of scientific knowledge lens in ruling the DM process is so low that it may not be observable due to the selected issue.

On the other hand, different from the general findings of the related literature (Zeidler, Walker, Ackett, & Simmons 2002; Lederman & Bell, 2003; Walker & Zeidler, 2003; Sadler, Chambers & Zeidler, 2004; Liu et al., 2010; Khishfe, 2012), it was understood that the understandings about NOS aspect "Observation and Inference in Science" were very active in the whole DM process including *'decision'* step. Moreover, parallel with their understandings, the members of Group U used unsophisticated lens and Group S used sophisticated lens in DM. Because of their unsophisticated lens about observation and inference in science, the members of Group U generally ignored the search for data or dependence on observation for the opinions which they met in the DM process about artificial meat. Moreover, they even could not consider properly the scientific inferences based on data. In contrast, under the effect of sophisticated lens usage, all members of Group S considered heavily the dependence of scientific data and observation for the opinions that they met about the artificial meat in DM process. Moreover, they gave an obvious priority to the scientists' opinions which included scientific data in the *'decision'* step.

Just like the NOS aspect observation and inference in science, the NOS aspect "The Empirical Nature of Scientific Knowledge" was very active in all steps of DM for both groups. Zeidler, Walker, Ackett and Simmons (2002) stated that there was a relationship between NOS aspect empirical nature of science and decision and Khishfe (2012) found very clear clues for reflection of understandings about this aspect in decision about a socioscientific issue. Therefore, the results of the present study about this aspect were parallel to them. However, in the present study, although all participants' understandings about this aspect were very close and sophisticated, only the members of Group S remained generally sophisticated related with this aspect in DM, but the almost all members of Group U were not able to reflect their sophisticated understandings to their DM process and they frequently fell unsophisticated approaches about the empirical nature of scientific knowledge. Therefore, it was concluded that unsophisticated NOS understandings in other NOS aspects may paralyze 'the empirical nature of scientific knowledge' lens usage by making it blurred even if a person has sophisticated understandings in this aspect. More specifically under the effect of unsophisticated 'observation and inference in science' lens "not seeing scientific inferences as scientific knowledge" triggered the usage of unsophisticated 'the empirical nature of scientific knowledge' lens for the members of Group U by not considering the empirical basis in the new knowledge they met. In addition to this, it is interesting that although Group S used sophisticated 'empirical nature of scientific knowledge' lens in other steps of the DM process, they also used unsophisticated 'empirical nature of scientific knowledge' lens in *'decision'*. It was concluded that having sophisticated understanding about tentativeness of the scientific knowledge might cause the member of Group S to give up looking for scientific evidence for their main criterion healthiness of the artificial meat because it will never be absolute or certain.

An effect of the NOS aspect 'The Theory-Laden Nature (Subjectivity) of Scientific Knowledge" on decision was found in none of the previous studies related with this issue (Zeidler, Walker, Ackett & Simmons, 2002; Lederman & Bell, 2003; Walker & Zeidler, 2003; Sadler, Chambers & Zeidler, 2004) but the study of Khishfe (2012). With the study of Khishfe (2012) it was understood that even before the instruction about application of NOS aspects to DM, the participants made a direct reference to 'subjectivity' in their decision. In the present study, it was found that although the effectiveness of 'subjectivity' lens was less than observation and inference in science and about the empirical nature of scientific knowledge, it was active in almost all steps of DM for all participants. Moreover, the members of Group U used unsophisticated 'subjectivity' lens while the members of Group S used sophisticated 'subjectivity' lens. However, none of the participants made a direct reference to this aspect in the step *'decision'*. At first sight, these findings look similar to that of most of the previous studies. However, after a deeper analysis which showed that Group U gave overcredibility to the scientists who work on the artificial meat and they thought that these scientists can decide on the healthiness of the artificial meat like a doctor can, it was understood that 'subjectivity' lens may behave as contact lenses on eyes instead of lenses used in eyeglasses, and therefore, 'subjectivity' lenses were on the participants' eyes in all DM process. It was concluded that this situation might make it difficult to detect the usage of 'subjectivity' lens especially in decision.

With the analysis, it was understood that usage of 'The Social and Cultural Embeddedness of Scientific Knowledge'(NOS6) lens was sophisticated and very similar in Group U and Group S although their understandings about this aspect were different from each other. Therefore, it was concluded that as the artificial meat issue was highly socioscientific, it made the participants, even the members of Group U, consider the interaction between the science behind the artificial meat and the society in which the artificial meat is used. It means that the nature of the issue in referendum, a socioscientific issue-artificial meat, affected the usage of NOS6 lens in the DM. On the other hand, usage of this lens was not observed in the step *'decision'*. In the literature, interestingly only Zeidler et al. (2002) reached the direct references of the participants to the social and cultural embeddedness of scientific knowledge; however, just like all previous studies did Zeidler et al. focused only on *'decision'* itself. In the present study, although no findings about the effect of 'the social and cultural embeddedness of scientific knowledge' lens could be reached in *'decision'* step just like most of the previous studies (Lederman & Bell, 2003; Walker & Zeidler, 2003; Sadler, Chambers & Zeidler, 2004; Liu et al., 2010; Khishfe, 2012), it was understood that this aspect was very active in other steps of DM. Related with the social and cultural embeddedness of scientific knowledge, it was observed that Group S directly reflected their sophisticated understandings to the DM process. However, although Group S had unsophisticated understandings about this aspect, just like Group S did, they used sophisticated lens in their DM process about the artificial meat. Therefore, it was concluded that as the artificial meat issue was highly socioscientific, it made the participants, even the members of Group U, consider the interaction between the science behind the artificial meat and the society in which the artificial meat is used. In other words, nature of referendum issue, a socioscientific issue-artificial meat, might affect the usage of the social and cultural embeddedness of scientific knowledge lens in DM process. The nature of the referendum issue might trigger them to make connections about social context with sophisticated lens usage as the selected issue already included a social context.

Other Lenses

Other lenses are epistemologies or subgroup of the epistemologies which are different from NOS and which can affect DM. With the analysis it was understood that 23 other lenses were used by participants in DM. The effectiveness of the lenses animal rights, environmental rights, humanity, information rights, curiosity, prejudice, priority, personal experience (lesson) on DM were identified firstly with the present study which focused on the artificial meat as a socioscientific issue. However, most of the other lenses were identified with the present study which were natural order, personal experience, technology, malicious use, risk factor, credibility, socio-cultural, socio-economic, societal benefit, religious, economic, support science, pop culture, legal issues, need for more info were parallel with the related literature (Lederman & Bell, 2003; Sadler & Zeidler, 2004a; Halverson et al., 2009; Lee & Grace, 2012; Cebesoy 2014).

Moreover, in contrast with Kortland (1996), Hogan (2002) and Liu et. al. (2010), in the present study, with the analysis it was understood that all of the participants in both groups used multiple lenses in DM just like Halverson et al. (2009), Lee and Grace (2012), and Cebesoy (2014) stated in their studies. Furthermore, according to Bell and Lederman (2003), Sadler and Zeidler (2004a), Khishfe (2012), and Cebesoy (2014), the *'decision'* about socioscientific issue was affected by social considerations and/or moral considerations. Parallel with this, in the present study, it was found that the lenses animal rights, environmental rights which is related with morality and societal-benefit which is related with social considerations were used very frequently by both Group U and Group S in not only *'decision'* step but also in the whole DM process about the artificial meat.

In addition to this, in the present study it was revealed that the members of Group S made less usages of lenses than the members of Group U in *'goals'* step of DM. As it was stated before, the connection between the *'goals'* and *'decision'* was not as strong in Group S as in Group U. Therefore, it was seen that these findings support each other. Furthermore, while the usages of six lenses which are prejudice, personal experience, malicious use, religious, economic and need for more info are higher for Group U, only usages of three lenses which are natural order, priority and credibility are higher for Group S. Liu et al. (2010) reported that non-science college students or college students who had tentative beliefs about scientific knowledge tended to consider an SSI with multi-perspective. It is important to emphasize again that one of the most distinct understandings between Group U and Group S was about tentative nature of scientific knowledge. Moreover, with the analysis on the usage of other lenses, in the present study it was concluded that because of their unsophisticated understandings about the tentativeness of scientific knowledge, Group U might use prejudice lens more frequently in their *'decision'* by giving certainty to the new knowledge about the artificial meat. Moreover, by wearing personal experience lens more, Group U might try to complete the insufficient knowledge about the artificial meat in *'decision'* step. However, because of their sophisticated understandings about the tentativeness of scientific knowledge, Group S did not tend to give certainty to knowledge and by wearing credibility lens in their *'decision'* they gave priority to the scientists' opinions about the artificial meat. On the other hand, in *'decision'*, it was understood that Group S took off risk factor lens and they avoided mentioning the healthiness of the artificial meat which was not able to gain certainty in their mind.

Decision making strategies

It was understood that voting 'YES' or 'NO' was led by different DM strategies. Moreover, operated DM strategies for voting YES were different in Group U and Group S. All the members of Group U who used rationalistic approach in their initial responses, mainly after being informed about the production process of the artificial meat although they realized that they could not reach the information especially about healthiness of the artificial meat that they had required before, acted as if there was and then voted ‘YES’ in their *‘decision’* by using rational ritualism. Furthermore, all the members of Group S who finished the referendum simulation with ‘YES’ used ‘go-for-it’ decision making strategy. They believed that as the scientific knowledge is not absolute and certain, how healthy the artificial meat is could be understood by only letting its sale and they also generally meant that the effect of the artificial meat on human health will be different from one person to another. In addition to this, they frequently stated that it is necessary to let the artificial meat in markets as long as everyone is free to buy it or not. In the line with ‘go-for-it’ decision making strategy, they did not focus on whether the artificial meat is ready to be sold in markets, but they approached through considering the existence of the information which is sufficient enough to block the sale of the artificial meat.

Moreover, the interviewers who adopted mixed scanning decision making strategy voted ‘NO’ to the sale of the artificial meat because of lack of information about healthiness of it although they were convinced about some of the benefits of producing the artificial meat. In the present study, the two members of Group U who had relatively more sophisticated NOS understandings than the other group members and one of two members of Group S who had relatively more unsophisticated NOS understandings than the other group members were able to make mixed scanning in their *‘decision’*. In other words, different from all other participants, only 3 interviewees who did not have too unsophisticated and too sophisticated NOS understanding especially about ‘The Tentative Nature of Scientific Knowledge’ adopted mixed scanning and voted ‘NO’. In addition to this, they were the only three interviewees who had a proper sophisticated ‘The Empirical Nature of Scientific Knowledge’ lens usage in their *‘decision’* step.

These findings are different from the findings of Lederman and Bell (2003) and Khishfe (2012) who stated that there were no differences between the decisions (in terms of yes or no) of two groups. In the present study, it was found that although they gave the same 'YES' response to the sale of the artificial meat, the members of Group U and Group S operated different decision making strategies because of their different understandings about the tentativeness of scientific knowledge. Moreover, only the participants who had moderate understandings about NOS gave 'NO' response by adopting mixed scanning. Therefore, it was understood that having too unsophisticated and too sophisticated NOS understanding especially about 'The Tentative Nature of Scientific Knowledge' may paralyze the DM process as it led to operating unsophisticated DM strategies such as rational ritualism and go-for-it approach (Etzioni, 1989), and then, it mainly may paralyze 'The Empirical Nature of Scientific Knowledge' lens usage in *'decision'* step. Thus, it was concluded that although the direct effect of 'The Tentative Nature of Scientific Knowledge' was not reached in the present study, there was a hidden effect of it on DM.

Referendum vs Committee

The question 'which one is better to decide the artificial meat selling in the markets, by a referendum or by a committee' was asked both at the beginning and at the end of the interviews. Almost all participants, regardless of which group they were in, emphasized the possible higher credibility of the experts in a committee, and then, they stated that a better decision about the sale of the artificial meat will arise by a committee. At the end of the interview, when the participants were asked to construct an ideal committee to make a decision about the sale of the artificial meat, while Group S constructed a committee generally dominated by scientists, doctors and sanitarians, economists, people from food sector (restaurant owners, chefs, butchers), food engineers, TÜBİTAK and gastronomists, the committee constructed by Group U were dominated by gastronomists, scientists, geneticists, people from food sector (restaurant owners, chefs, butchers), food engineers and ordinary citizens. Therefore, it was understood that Group U had unsophisticated attitudes about the credibility of the experts especially because although they knew that there is no genetic intervention to the artificial meat, they added geneticists to the committee and because they added ordinary citizens to the committee who have no special credibility about the artificial meat. In addition to this, although the main criterion of Group U was healthiness, most of them did not give doctors and sanitarians a sufficient place in the committee and they stated that the scientists who work on the artificial meat can decide on the healthiness of the artificial meat like a doctor can. In fact, Group U gave overcredibility to the scientists most probably because of their unsophisticated understandings about the theory-laden nature (subjectivity) of scientific knowledge.

Conclusion

In the present study, DM was considered as a process with its steps and this helped to look closer into how this process works on the participants who had unsophisticated NOS understandings and the participants who had sophisticated NOS understandings. Therefore, it was understood that almost all aspects of NOS directly involved in the DM about a socioscientific issue and the understandings about tentative nature of scientific knowledge may have a hidden but a determinant effect on DM. Moreover, the understandings of observation and inference in science and the empirical nature of scientific knowledge directly affected 'decision'.

The member of Group U and Group S were different in their initial responses, in thinking in DM steps, in usages of many of NOS lenses in DM, in usages of some other lenses in DM, in using decision making strategy and in selection of an ideal committee. However, although their understandings about NOS and their related attitudes in DM were generally very different from each other, the final *'decision'* (in terms of yes or no) of the participants who had too unsophisticated NOS understandings and the participants who had too sophisticated NOS understandings were the same. Only the participants who had moderate understandings about NOS were able to proceed a sophisticated decision making strategy mixed scanning by a proper sophisticated understanding about the empirical nature of scientific knowledge to their *'decision'* and their decision was different from all others. Therefore, the findings of the present study give the signals of the fact that the hybrid of unsophisticated and sophisticated NOS understandings leads to a better decision about socioscientific issues.

5.2 Recommendations

The number and importance level of the SSIs are increasing day by day. Science teachers are not only ordinary citizens who have responsibility in SSIs but also the educators who lead students to take responsibility in SSIs. Therefore, developing in-service educations which include the issues about NOS and informed DM about SSIs for science teachers, and developing course programs which cover the relationships between NOS and DM on SSIs for pre-service science teachers are vital to be more prepared for the future world. Besides the existing NOS course, a course with explicit instruction which specifically focuses on DM process should be constructed; in this way, not only skills about informed DM about SSIs but also skills about making better decisions will improve. Moreover, in order to simulate the real life situations better, the instruments of these in-service educations and course programs should be designed through a normative DM model which shows the steps of DM as a process. However, in the literature there is no normative DM model which reflects the referendum case about SSIs which is one of the best cases to understand why we try to teach NOS to "all students" as science teachers. The present study recommends a new DM model which was directly constructed through analyzing the pre-service science teachers' responses in DM process. This new DM model puts forward the spirit of the natural thinking process especially with its nonlinear fractal structure, and double way relationships among steps. Thus, using this new DM model in in-service education of science teachers and program of pre-service science teachers will be more efficient as it was specifically constructed to reflect the real life situation about DM on SSI.

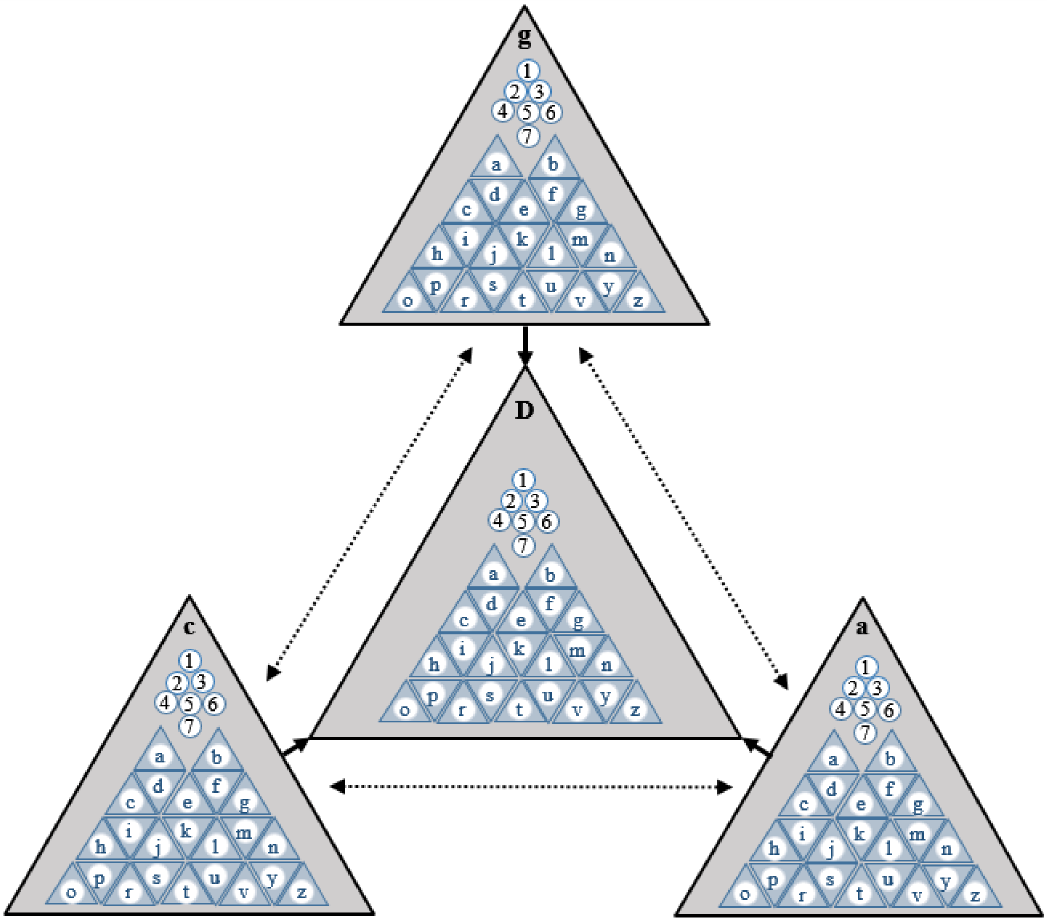
In DM, the readiness of a person such as his/her priorities among the issues and his/her sources of information about an issue can highly affect the DM process. It was understood that in order to make a proper analysis to understand the NOS effect on DM, selected SSI should be interesting, familiar to be discussed and clearly understandable. Therefore, before selecting a socioscientific issue for the present study, Focus Group interviews was conducted with pre-service science teachers. Beside many other characteristics about pre-service science teachers' attitudes towards SSIs, the analysis showed that courses taken in teacher education program make them interested in SSIs more, that they are not interested in all kinds of SSIs, and that their primary source of news about SSIs is based on the Internet. Thus, in order to develop better informed DM skills about SSI, the departmental courses seem to be suitable to draw their attention to SSIs and more weight should be given to SSIs in terms of both number and duration in the teacher education programs. Moreover, in these courses, the SSIs to be used should be selected by considering the pre-service science teachers' interests and questionnaires, focus group interviews and/or findings of related research studies such as those of the present study can be useful to understand the general tendencies of the pre-service science teachers about SSIs. In addition to this, these courses should be operated mainly through web based activities as the pre-service science teachers' primary source about SSIs is internet web pages; in this way, their informed DM skills about SSIs can be improved in their natural habitat of being informed. Furthermore, in order to enable pre-service science teachers to develop abilities which help them to be better informed decision makers about SSIs, these courses should be supported by the lessons which cover the topic of 'digital literacy,' which is defined as an individual's ability to find, evaluate, and compose clear information through mediums on digital platforms.

As a sociocientific issue the artificial meat was firstly studied with this study and it was selected by analyzing the pre-service elementary science teachers' interests about SSIs collected via Focus Group interviews. It was understood that the artificial meat is an effective socioscientific issue to be used in the lessons; therefore, it should be used in the curriculum. Many findings about how pre-service elementary science teachers approached making decision about this issue were reached with the analysis of the present study. These findings will be helpful to re-organize the lessons related with NOS and design DM lessons in the universities. Furthermore, in order to get a more meaningful place in elementary science curriculum, similar studies with artificial meat should be done with both K12 students and teachers.

Parallel with the literature, in the present study it was found that DM is affected by many other epistemologies other than NOS such as moral considerations, religion and economic considerations. Moreover, it was understood that although having sophisticated NOS understandings made the participants tend to use other epistemologies less than the participants with unsophisticated NOS understandings did in DM, the DM processes of the participants with sophisticated NOS understandings were still dominated by the other epistemologies especially moral considerations just as the DM processes of the participants with unsophisticated NOS understandings. Therefore, it was concluded that the explicit NOS instructions, well prepared SSI activities and even explicit DM instructions may not be sufficient in order to improve informed DM skills related with SSIs if a well prepared instruction about epistemologies are not added to them. Being informed about the epistemologies will help the students to have control over their DM process more consciously and to re-organize the information when they need in DM process as they will understand how they are informed in DM process.

For pre-service science teachers, being well educated about informed DM on SSIs with sophisticated NOS understandings may not be necessarily sufficient enough to guide their students to gain expected attitudes towards SSIs when they become science teachers. Moreover, SSIs are interdisciplinary issues which means that they need to be considered with not only NOS but also other epistemologies, and science teachers may have some difficulties related with this while constructing and operating SSIs activities in the classrooms even if they have a sophisticated interdisciplinary view. Furthermore, SSIs are controversial issues and in order to improve the students' informed DM skills about SSIs, students' reading skills, reasoning skills, argumentation and discussion skills, academic search skills and (in today's world) internet based search skills also need to be improved. Thus, although science curriculum is the 'habitat' for the learning outcomes covering informed DM about SSIs as the core of this issue is dependent vitally on NOS, the supports from other disciplines such as language lessons (Turkish, English etc.), social science lessons, and information technologies lessons are also essential. Therefore, curriculum developers should make connections among disciplines with clear learning outcomes about SSIs by considering the general conditions of the classrooms. In addition to this, booklets for SSI activities which contain cases from both Turkey and worldwide should be prepared according to grade level of the students. Moreover, especially in order to draw the students' attentions to the SSIs more, these booklets should include current local examples at least from each city. However, the science teachers should not be obligated to cover all the cases in these booklets; instead, with an in-service education, they should know how to select an SSI activity from these booklets by considering their students' interests and needs.

In addition to these, the Fractal Model of DM can be easily adopted by elementary and higher education if at least the initial response of the students to an SSI can be classified as considering *'goals', 'criteria', 'alternatives'* and *'decision'* resulted from the double-way interaction among *'goals', 'criteria'* and *'alternatives'*. At first, it was thought that it will be easier if the Fractal Model of DM represented in the present stduy is used like a check list during the introduction of an SSI in the classroom. In order to do that, an example of Fractal Model of DM check list, which is seen in Figure 5.1, and was constructed to show all possible lenses appeared in DM on the artificial meat, can be used in the classroom implications. However, this check list is an example and it will be possible to change and/or add some lenses when it is needed especially because of the selected SSI, grade levels, activity duration. Moreover, the studies about implementations of the Fractal Model of DM about SSI for K12 students' education will be conducted in future.



Thinking regions in decision making (DM) are
g: goals, c: criteria, a: alternatives, D: decision

→ : Influent from thinking region to decision
↔ : Interaction between thinking regions

Numbers in the spheres represent
the aspects of NOS as follows
1: Tentativeness (NOS1)
2: Creativity and imagination (NOS2)
3: Observation and inference (NOS3)
4: Empirical-basis (NOS4)
5: Subjectivity (NOS5)
6: Social and cultural embeddedness (NOS6)
7: Laws and theories (NOS7)

○: sNOS-Sophisticated understanding
○: u-sNOS-Mixed understanding
●: uNOS-Unsophisticated understanding

Other lenses represented with blue letters in
each small triangles in each thinking region

a: Animal Rights
b: Environmental Rights
c: Humanity
d: Information Rights
e: Natural order
f: Curiosity
g: Prejudice
h: Priority
i: Personal experience
j: P. experience (lesson)
k: Technology
l: Malicious use
m: Risk Factor
n: Credibility
o: Socio-cultural
p: Socio-economic
r: Societal benefit
s: Religious
t: Economic
u: Support science
v: Pop culture
y: Legal issues
z: Need more info

Figure 5.1 An example of the Fractal Model of DM check list.

Apart from all the implementations in pre-service science teachers' education, science teachers' in-service education and science curriculum, the findings of the present study might open a new path for the future studies related with NOS effect on DM about SSI. The present study is the first study which covered DM as a process as stated in DM literature among the studies which focused on NOS effect on DM about an SSI. Moreover, different from the general findings of the previous studies, the findings of the present study showed that aspects of NOS were involved directly or indirectly in DM about SSI. It was understood that there is a gap between DM literature and literature about NOS effect on DM about SSI. Therefore, it was concluded that the educational researchers should focus on DM literature more in their research about NOS effect on DM about SSI. More specifically, in the line with DM literature, more research in which DM is considered as a process with its steps should be done for educational research. In this way, the researchers will find a chance for a deeper look into the whole process of decision making, not only the *'decision'* itself; therefore, they will collect deeper data related with NOS effects on DM about SSI.

The previous studies about NOS effect on DM about SSI mainly focused on understanding the effect of NOS on DM; however, the findings of the present study made it possible to conclude that in some cases DM can affect the expressions of the aspects of NOS in the case of having socioscientific issue which has unstructured problems in uncertainty conditions. In order to make the issue more clear, the methodology of the future studies should be constructed in a way to show this possible linkage. Therefore, identifying the problem types of the selected socioscientific issue as being constructed or unconstructed and having certainty or uncertainty should be the starting point of the future study if they research the double-way interaction between NOS and DM about SSI.

Like the other studies, in the present study the participants were separated into two groups according to their NOS understandings as unsophisticated and sophisticated. In the present study, different from general findings of the previous studies, although many differences between the participants with too sophisticated or too unsophisticated understandings about NOS were detected in DM, just like general findings of the previous studies there were no differences in their decision (in terms of yes or no). However, interestingly the main difference came from the participants who were in unsophisticated group but who were not unsophisticated as much as the rest of the group and the participants who were in sophisticated group but who were not sophisticated as much as the rest of the group. Therefore, it was concluded that in order to illuminate the differences in DM in terms of NOS understandings, the studies should be conducted with, and then, the analysis should be made through three groups as unsophisticated, sophisticated and moderate.

In the literature there is only one study (Khishfe, 2012) in which the treatment group gave explicit instructions about the application of NOS aspect to decision. However, there is no study related with this issue conducted with the people who had a direct instruction about DM. As being informed may change the effectiveness of NOS aspects in DM, the studies which focused on this issue should be made and with the light of the findings of these studies, DM lessons covering NOS should be added firstly to the pre-service elementary science teachers' curriculum, and then to elementary science curriculum. It is also believed that in this way, it will be more obvious how better decisions are made under the effect of NOS and therefore, why we teach NOS as a science teacher will gain a stronger meaning.

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APPENDICES

APPENDIX A: APPROVAL OF METU ETHICAL COMMITTEE (FOR FOCUS GROUP INTERVIEWS)

UYGULAMALI ETİK ARAŞTIRMA MERKEZİ
APPLIED ETHICS RESEARCH CENTER

ORTA DOĞU TEKNİK ÜNİVERSİTESİ
MIDDLE EAST TECHNICAL UNIVERSITY

DUMLUPINAR BULVARI 06800
ÇANKAYA ANKARA/TURKEY
T: +90 312 210 22 91
F: +90 312 210 79 59
ueam@metu.edu.tr
www.ueam.metu.edu.tr

Sayı: 28620816 /187

03 MAYIS 2016

Gönderilen: Prof.Dr. Jale ÇAKIROĞLU

İlköğretim Bölümü

Gönderen: Prof. Dr. Canan SÜMER

İnsan Araştırmaları Etik Kurulu Başkanı

İlgi: Etik Onayı

Sayın Prof.Dr. Jale ÇAKIROĞLU'nun danışmanlığını yaptığı Elif Ece ADAL'ın "Fen Bilgisi Öğretmen Adaylarının Sosyobilimsel Konulara Yönelik İlgi ve Tutumları" başlıklı araştırması İnsan Araştırmaları Etik Kurulu tarafından uygun görülerek gerekli onay **2016-EGT-083** protokol numarası ile **23.05.2016-23.07.2016** tarihleri arasında geçerli olmak üzere verilmiştir.

Bilgilerinize saygılarımla sunarım.

Prof. Dr. Canan SÜMER

İnsan Araştırmaları Etik Kurulu Başkanı

APPENDIX B: APPROVAL OF METU ETHICAL COMMITTEE

(FOR IN-DEPTH INTERVIEWS)

UYGULAMALI ETİK ARAŞTIRMA MERKEZİ
APPLIED ETHICS RESEARCH CENTER

ORTA DOĞU TEKNİK ÜNİVERSİTESİ
MIDDLE EAST TECHNICAL UNIVERSITY

DUMLUPINAR BULVARI 06800
ÇANKAYA ANKARA/TURKEY
T: +90 312 210 22 91
F: +90 312 210 79 59
ueam@metu.edu.tr
www.ueam.metu.edu.tr

Sayı: 28620816/240

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Konu: Değerlendirme Sonucu

Gönderilen: Prof.Dr. Jale ÇAKIROĞLU,

İlköğretim Anabilim Dalı

Gönderen: ODTÜ İnsan Araştırmaları Etik Kurulu (İAEK)

İlgi: İnsan Araştırmaları Etik Kurulu Başvurusu

Sayın, Prof.Dr. Jale ÇAKIROĞLU;

Danışmanlığını yaptığınız Elif Ece ADAL'ın "Bilimin Doğası Anlayışının Karar verme Üzerine Etkisi" başlıklı araştırması İnsan Araştırmaları Kurulu tarafından uygun görülerek gerekli onay **2016-EGT-153** protokol numarası ile **21.11.2016-28.02.2017** tarihleri arasında geçerli olmak üzere verilmiştir.

Bilgilerinize saygılarımla sunarım.

Prof. Dr. Canan SÜMER

İnsan Araştırmaları Etik Kurulu Başkanı

Prof. Dr. Mehmet UTKU

İAEK Üyesi

Prof. Dr. Ayhan SOL

İAEK Üyesi

Prof. Dr. Ayhan Gürbüz DEMİR

İAEK Üyesi

Doç. Dr. Yaşar KONDAKÇI

İAEK Üyesi

Yrd .Doç.Dr. Pınar KAYGAN

İAEK Üyesi

Yrd. Doç. Dr. Emre SELÇUK

İAEK Üyesi

APPENDIX C: DATA GATHERING TOOL FOR FOCUS GROUP INTERVIEWS

1. Öğretmen olmak konusunda ne düşünüyorsunuz, bu bölümü isteyerek mi kazandınız?
2. Fen bilgisi öğretmenliğinin diğer branşlardan daha önemli olduğunu düşünüyor musunuz?
3. Fen ve Teknolojideki gelişmeleri takip ediyor musunuz? Bu gelişmeleri hangi iletişim araçlarıyla takip ediyorsunuz?
4. Genel olarak sosyobilimsel konulardan nasıl haberdar oluyorsunuz?
5. Günlük hayatınızda sosyobilimsel konularla ne kadar ilgileniyorsunuz? Derslerinizde, arkadaş sohbetlerinizde ve aile içinde gündeme gelen, beraberce tartıştığınız sosyobilimsel konular oluyor mu?
6. Sosyobilimsel konular üzerine kafa yormak ilginizi çekiyor mu?
7. Sosyobilimsel konular üzerine düşünmek, tartışmak ve emek sarf etmek sizce ne kadar anlamlıdır?
8. Bu aralar karşılaştığınız, üzerinde düşündüğünüz sosyobilimsel konular nelerdir?
9. Sizce hangi sosyobilimsel konular daha önemli ve öncelikli olarak tartışılmalıdır? Neden bu konular diğerlerine göre daha önemli olduğunu düşünüyorsunuz?
10. Çok acil gördüğünüz sosyobilimsel konular var mı? Sizce neden bunlar acil olarak çözüme ulaştırılmalıdır?
11. Sizce sosyobilimsel konularda kimlerin bilgi sahibi olması gereklidir?
12. Sosyobillimsel konulara ilişkin kararları kimler, nasıl almalıdır?
13. Öğretmenlerin sosyobilimsel konulara ilişkin görevleri olduğunu düşünüyor musunuz?
14. Sizler bireysel olarak günlük hayatlarınızda sosyobilimsel konuların çözümüne yönelik üzerinizde sorumluluk hissediyor musunuz? Neden sorumluluk hissediyorsunuz/ neden sorumluluk hissetmiyorsunuz?
15. Şu anki konumunuzda kendinizi ilgilendiğiniz sosyobilimsel konuların çözümünde etkin görüyor musunuz? Neden?
16. Sizce ileride bu ilgilendiğiniz sosyobilimsel konuların çözümünde etkin olacak mısınız?

APPENDIX D: DATA GATHERING TOOL FOR IN-DEPTH INTERVIEWS

Bilim insanları çiftlikte yetişmemiş, laboratuvarda üretilmiş etten yapılan hamburgeri dün tanıttı, pişirdi ve yedi (06.08.2013-gazeteler)

Hollandalı bilim insanları çiftlikte yetişmemiş, laboratuvarda üretilmiş etten yapılan hamburgeri dün tanıttı, pişirdi ve Batı Londra sanat ve televizyon stüdyosunda yedi.

The Wall Street Journal gazetesinin haberine göre, 'laboratuvar hamburgeri' çiğ dana kıymasına benziyordu ama pembe rengi kırmızı pancar şerbeti ve safran kullanılarak verilmişti. Ekmek kırıntıları ve eti bir arada tutması için bağlayıcı madde de içeren hamburger köftesi ayçiçek yağında kızartıldı ve yaklaşık 200 katılımcının bulunduğu basın toplantısında, araştırmada yer almayan bir yemek yazarı ve yemek bilimci tarafından test edildi.

Hollanda Maastricht Üniversitesi'nden fizyoloji profesörü Mark Post laboratuvarda üretilmiş eti tanıtıyor.

İlk tespit: sığır etinin genelde sahip olduğu yoğun çeşniye sahip olmasa da benzer bir dokuda.

Tadına bakanlar laboratuvarda üretilen köftenin, sığır etinin genelde sahip olduğu yoğun çeşniye sahip olmasa da benzer bir doku ve sulu yapıda olduğunu belirtti. Bu kişiler etin çeşnilendirilmesi gerektiğini belirttiler. Muhabirlere ise eti tatma fırsatı verilmedi, etkinliğin organizatörü herkes için yeterli et bulunmadığını açıkladı.

Profesör Mark Post tarafından laboratuvarda üretilmiş etten yapılan hamburger. Fotoğraf: (C) David Parry/PA

Birkaç yıldır devam eden çalışmanın maliyetinin 250 bin Euro'nun üzerine olduğu belirtildi.

Yapay Etin Üretim Süreci	
	Yaşayan hayvanlardan biyopsi yoluyla kas dokusu alınır.
	Doku parçasından kök hücreler elde edilir.
	Kök hücreler kültür ortamında çoğaltılır.
	Kök hücreler bir araya gelerek kas liflerine dönüşür.
	Kas liflerine sürekli egzersiz yaptırılarak protein içeriği ve dokusu arttırılır, kas dokusu zamanla et parçasına dönüşür.
	Tat vermesi için yağ, demir ve diğer bazı içerikler eklenen yapay et kullanılmaya hazır hale gelir.

(Yapay et genel) Bildiğimiz et, ama kaynağı biraz farklı. Bu et şimdilik laboratuvarda, petri kabında, saydama yakın grimsi beyaz renkli küçük bir kas kitlesi halinde duruyor.

Yapay et üretmek için temel olarak yaşayan hayvandan biyopsi yoluyla kas parçası alınarak kök hücreler elde ediliyor. Daha sonra bu kök hücreler, bölünmeye ve büyümeye teşvik edilerek kas dokusu liflerine dönüşüyorlar.

(1) Kök hücrelerin gelişmesi için beslenmeye ihtiyacı var, bu amaçla şimdilik deneme amaçlı bazı ölü hayvanların cenin serumları kullanılıyor. Ancak hayvan cenini serumları kullanılarak beslenen kök hücrelerden elde edilen yapay etlerin tüketilmesi, birtakım hastalık taşıyan bulaşıcı protein molekülleri olan prionları ve diğer bazı zararlı bileşenleri az da olsa barındırma olasılığından dolayı riskli olabilir. Hollanda ekibi kök hücreleri beslemek için aminoasit, şeker ve yağ içeriği bakımından zengin olan siyanobakteri özütlerini kullanmayı amaçlıyor.

(2) Bölünmeye ve büyümeye teşvik edilen kök hücreleri kas dokusu liflerine dönüşüyorlar. Bu doku liflerinin her gün basınçla gerdirilmesi, liflere düzenli egzersiz yaptırılması gerekiyor, aksi takdirde gerçek kas dokusuna dönüşemiyorlar. Bu gerilme işlemi kaslara kondisyon sağlayarak protein içeriğinin artmasını sağlıyor. Ayrıca, büyümekte olan kas parçalarına belirli zaman aralıklarında 10 voltluk elektrik şoku uygulanıyor ve parçaların kasılması sağlanıyor. Tüm bunlar enerji gerektiren ve maliyeti artıran işlemler.

(3) Petri kabındaki grimsi beyaz renkli doku parçasının görüntüsü gerçek eti andırmıyor, çünkü hiç kan içermiyor. Ayrıca, demir içeren myoglobin protein miktarı da çok az. Uzmanlar myoglobin içeriğini artırarak yapay etin alışıldık kırmızı et rengini almasını sağlamaya çalışıyorlar.

(GDO'dan farkı) Laboratuvarda üretilen sığır eti genetik olarak modifiye edilmiş gıda olarak sayılmıyor çünkü etteki hücreler ineklerde kas hücresi yapan kök hücrelerle aynı kökene sahip.

Genetiği değiştirilmiş gıdaların aksine, yapay olarak üretilen etin DNA'sına dokunulmuyor, genetiği aynı kalıyor. Burada yapılan işlem doğayı farklı bir şekilde taklit etmek, yani doğal olarak hayvanın vücudunda gelişen kas dokusunu, hayvanın bazı istenmeyen kısımlarını elimine ederek, yapay olarak dışarıda çoğaltmak.

Dr. Post laboratuvarda üretilen etin de normal et kadar güvenli olması gerektiğini ancak insanlar üzerindeki etkisini anlamanın yıllar alabileceğini belirtti.

YAPAY ET ÇALIŞMALARI YAPAN BİLİM İNSANLARININ GENEL GÖRÜŞLERİ

GRUP 1
BİLİM İNSANLARI

Büyükbaş hayvanların kök hücrelerinden üretilen yapay et, bilim dünyasında heyecan yarattı. Bu ürünün gelecekte açlığa çare olabileceğine inanıyoruz. İnsanoğlunun önümüzdeki yıllarda gıda sıkıntısı çekeceği, özellikle de et ihtiyacının çok artacağı tahmin ediliyor. Gelecekte dünyanın karşı karşıya kalabileceği açlık riskine karşı yapay eti bir çare olarak görüyoruz.

Laboratuvarda üretilecek etler çok daha sağlıklı olabilir, bakteri riskinin azalacağını savunuyoruz. Ayrıca yapay ete etin tadını bozmayacak şekilde fazladan omega-3 yağ asitleri ve sağlıklı bir takım tamamlayıcıların eklenebileceğini düşünüyoruz.

GRUP 2
BİLİM İNSANLARI

GRUP 3
BİLİM İNSANLARI

Bu et sadece dana, koyun ya da tavuk eti değil, belki de panda gibi bugüne kadar tatmayı aklınızın ucuna bile getirmediğiniz bazı egzotik hayvanların eti de olabilir. Rahat olun, bu eti elde etmek için hayvanlar öldürülmüyor, sadece onlardan birazcık doku parçası alınarak kök hücreleri kullanılıyor.

Oxford Üniversitesi'nde yapılan bir araştırmaya göre, yapay et üretmek için, sığır eti işletmeciliğine göre % 99 daha az araziye ihtiyaç duyuluyor. Benzer şekilde, yapay et üretiminde sığır eti üretimine göre % 95 daha az su ve % 50 daha az enerji kullanılıyor. Sera gazı salımı ise % 90 daha az. Tüm veriler incelendiğinde laboratuvarda üretilecek olan etin hayvanların kesilmesini önlemenin yanı sıra çevre dostu olacağını hatta yapay etin küresel ısınma ile mücadelede de etkili olabileceğini düşünüyoruz.

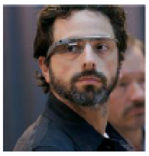
GRUP 4
BİLİM İNSANLARI

YAPAY ET ÇALIŞMALARIYLA İLGİLİ YURT DIŞI GÖRÜŞLER NELERDİR?

National Aeronautics and Space Administration USA

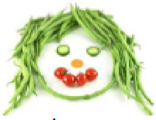
2000'li yılların başında özellikle uzayda uzun süre kalacak olan astronotların tüketebilmesi amacıyla yapay et üretimi projesini destekledik. Bu proje ile Japon balığı kullanılarak yüksek protein içerikli yenilebilen kas parçacıkları elde edildi.

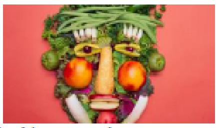
Dr. Mark Post'un yapay et üzerine yaptığı çalışmaları finansal olarak destekliyorum. Bu çalışmada, yapay et üretimi için bu güne kadar 300.000 Avro'ya yakın para harcandı. Yapay etten yapılmış ilk hamburgerimizi tattık.


Google'ın kurucu ortağı

Daha önce Haziran 2012'ye kadar yenilebilir ilk ticari yapay eti üretecek araştırma ekibine 1 milyon dolar vermeyi taahhüt etmiştik. Sonrasında 4 Mart 2014 tarihine kadar "gerçek tavuk etinden farklı olmayan, üretimi sırasında hayvan testi yapılmamış, başlangıç hücreleri hariç hayvansal ürün kullanılmamış ticari olarak kabul edilebilir" ilk yapay tavuk etinin üreticisine 1 milyon dolarlık bir ödül vereceğimizi açıkladık. Laboratuvar ortamında üretilen dünyanın ilk hamburgerini memnuniyetle karşılıyoruz ve bu icadı "hayvan hakları alanında büyük bir gelişme" olarak nitelendiriyoruz.

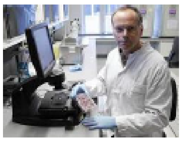
Hayvanları öldürmeden et üretilebilmesi bizim için çok sevindirici bir gelişme.


Bir grup vejetaryan ve vegan


Başka bir grup vejetaryen ve vegan

Yapay et üretimine karşıyız çünkü bunun için yine hayvanlardan alınan kök hücreler kullanılıyor. Ayrıca etin geliştirilmesinde hamile sığırlardan alınan sıvının kullanılmasını da hiç doğru bulmuyoruz. Hem diğer besin kaynakları dururken laboratuvar ortamında oluşmuş bir şeye gitmek çok yanlış. Kök hücreden üretilen ve içeriğinin tam olarak bilinmediği bir şeyin tüketilmesini doğru bulmuyoruz. Böyle bir eti asla kabul edemeyiz.

Vejetaryenler vejetaryen kalmalı, bu çevre için de çok faydalı diyerek vejetaryanların zaten yapay eti yememesi gerektiğini savunuyorum.


Yapay et çalışmalarını sürdüren Mark Post

Twitter'ın kurucuları Biz Stone ve Evan Williams

Biz yapay et değil de bitki bazlı, et benzeri ürünlerin yaygınlaşmasını uygun buluyoruz. ABD'de ve Avrupa'da pek çok gıda firması tarafından üretilen bitki bazlı, et benzeri bu ürünleri hali hazırda vejetaryenler pek çok ülkede uygun fiyatlarla alabilmekte. Biz de bu tip et üretimi yapan bir şirketinin en büyük finansal destekçileri arasındayız.

TÜRKLER YAPAY ET İÇİN NELER SÖYLEDİ?

Yeme-içme üzerine yazılar yazan bir gazeteci

Gazetecilik hayatımın çeşitli dönemlerinde, bu tip haberlerle karşılaştım. Ancak bugüne kadarki denemelerin hiçbiri başarılı olmadı. Lezzet açısından gerçek etin yerini hiçbir şeyin alabileceğine inanmıyorum. Çünkü lezzetin bambaşka faktörleri vardır. Örneğin kapalı alanda, suni yemle beslenen hayvanın etiyle, açık alanda, temiz havayla beslenen hayvanın eti farklıdır. Diğer yandan artık insanlarda yapaylığa değil, doğallığa eğilim var. Fabrika tavuğu yemekten bıktık. İmkânı olanlar, daha pahalı da olsa doğal tavuk yemek istiyor. Sonuç olarak, bence yapay et bir fantezi. Ben ömrü hayatımda yapay etin önüme geleceğini düşünmüyorum. Diyelim ki geldi, ağzının tadını bilen biri olarak, lezzetini seveceğimi sanmıyorum. Ayrıca üretiminde harcanacak elektrik ve nakliyat unsurları hesaba katıldığında, çevreye de düşünüldüğü kadar faydalı olacağına inanmıyorum.

TÜBİTAK Bilimsel Programlar Başuzmanı

Yapay et üretimi, insanoğlunun geleceği için bir gereklilik. Bunun birkaç sebebi var: Öncelikle dünya genelinde yaşayan aç insanları, normal hayvancılıkla doyurmak mümkün değil; yapay et şart. Ayrıca besi hayvanlarının pek çok bölümü, kesildiklerinde telef oluyor. Laboratuvarda yalnızca beslenmek üzere et üretileceğinden, hayvanlar kesilmekten kurtulacak. Yapay et üretiminin yaygınlaşmasının, çevreye de son derece olumlu etkileri olacak. Bu etkilerden en önemlisi, küresel ısınmaya neden olan ve büyük bölümü büyükbaş hayvanlar tarafından atmosfere salınan sera gazı miktarının yüzde 90 oranında azalacak olması. Ayrıca Oxford Üniversitesi'nde yapılan bir araştırmaya göre, yapay et üretmek için, besi hayvancılığında kullanılandan yüzde 99 daha az araziye, yüzde 95 daha az suya ve yüzde 50 daha az enerjiye ihtiyaç duyuluyor. Diğer yandan yapay etin 'normal' ete göre daha sağlıklı olacak sekilde tasarlanabileceği de iddia edilivor.

Bir hayvan hakları derneği başkanı

Bir vejetaryen olarak bilimdeki bu gelişmeyle ilgili mutlu ve umutluyum. Çünkü dünyadaki yedi milyar insana artık doğal yollardan hayvan yetiştirmek, ancak hayvanların daha hızlı üretilmesi ile mümkün. Yani ancak hormonlarla, kimyasal yöntemlerle doğum süresi azaltılıyor; inekler, tavuklar meralara çıkmıyor, gün yüzü görmüyor. Bu hayvanların etini tüketen insanlar da başta kanser ve deli dana olmak üzere pek çok hastalığa yakalanıyor. Dünya düzeni böyle yerleşmiş ama ben buna isyan ediyorum. Memeli hayvan dostlarımıza karşı gerçek bir vicdansızlık ve ahlaksızlık sergiliyoruz. Ben et yemeden de çok güzel ve kaliteli bir hayat sürüyorum. Dahi olarak kabul edilen Einstein, Leonardo Da Vinci, Galileo, Edison, Rousseau, Newton gibi birçok insan et yememiştir. Bu bir tesadüf olabilir mi? Hiç biri, midesinde hayvan mezarlığı olsun istemedi. Tabii ki bilim hemen bu işe çözüm bulamayacaktır. Laboratuvar koşullarında üretilen etin sağlıklı olup olmadığının çok sıkı denetlenmesi gerekir. Eğer sağlığa bir zararı yoksa yapay et sayesinde binlerce etobur yaşamayı tercih eden insan, en azından daha fazla hayvanların yavrularını gasp edemeyecektir. Onlar adına seviniyorum.

Şehir Barosu Hayvan Hakları Komisyonu Başkanı

Bazı hayvanların besi hayvanları kategorisinde değerlendirilmesi, beni çok rahatsız ediyor. Bu nedenle yapay et üretme girişimini olumlu buluyorum. Ama yapay ette bile bazı hayvanlar, kök hücre alınması için damızlık olarak kullanılacak. Benim isteğim, tamamen sentetik şekilde et üretilmesi. Eğer hayvanla hiçbir alakası olmadan sentetik şekilde et üretilirse ve tadı da normal ete benzerse, ben tüketmek isterim. Diğer yandan yapay etin üretilip üretilemeyeceği konusunda şüphelerim var. Hayvan severlerin son yıllarda artan tepkilerine karşı, onları sakinleştirmek için üretilmiş bir spekülasyon olabilir.

Ünlü bir lokanta sahibi

Etin lezzeti, doğallığındadır. Bu nedenle biz, laboratuvarda yetiştirilmiş etlere restoranımızda asla yer vermeyiz. Zaten yapay bir ürünün, gerçek etin lezzetine veya besleyiciliğine ulaşabileceğine inanmıyorum. Böyle bir eti müşterilerime sunmam.

(1) HABER

1. Bu haberi duymuş muydun?

2. Bu konuyla ilgili bilgin var mı?

3. Bu haber sen de merak uyandırdı mı?

4. Pekiyi, bu haberle ilgili en çok ne dikkatini çekti?

5. Sence bu eti nasıl üretmişlerdir?

6. İyi ya da kötü, sence nasıl bir gelişme bu? Niye?

7. Yapay etin yararları/avantajları ne olabilir senece?

8. Yapay etin zararları/dezavantajları ne olabilir sence?

Yapay et ürünlerinin market raflarında yer alıp almamasıyla ilgili tüm Türkiye'de oylama yapılıyor. Sen de bu oylamaya katılacaksın, sana oy zarfını ve oy pusulalarını veriyorum.

Evet: Yapay et ürünlerinin marketlerde satışına izin verilsin.
Hayır: Yapay et ürünlerinin marketlerde satışına izin verilmesin

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Buyur oyunu kullanabilirsin.

(A) Eğer oyunu kullandıysa…

9.1. Neden oyunu bu yönde kullandın?

10.1. Kullandığın oy içine sindi mi?

11.1. Ne ya da neleri bilsen oyunun yönü değişirdi?

(B) Eğer oy kullanmak istemiyorsa…

9.2. Neden oy kullanmak istemedin?

10.2. Oy kullanmamak içine sindi mi?

11.2. Ne ya da neleri bilsen oy vermek isterdin?

Şimdi oy kullanmak istemeyebilirsin ama bu görüşmemizin sonunda net bir karar verip oraya gidip oyunu kullanman gerekecek.

12. Peki bu eti deneyenler hakkında ne düşünüyorsun?

13. Sen bu yapay etle yapılmış köfteyi yemek ister misin? Neden?

Pekiyi, sana desem ki referandum yapmayacağız da bir kurul toplayacağız onlar karar verecek bu konuya…

14. Ne dersin bu duruma?

15. Kimlerden oluşmalı bu kurul? Neden böyle düşündün?

16. Sence bu kurulun kararı ne olurdu? Neden böyle düşündün?

(2) YAPAY ETİN ÜRETİM SÜRECİ

İstersen yapay etin üretim sürecine bakalım biraz (yapay et üretim süreci basamakları gösterilir)

17. Bu basamaklarda neler yapıldığını anlayabildin mi?

18. Yapay et üretim süreci ile ilgili ne düşünüyorsun? (Olumlu/olumsuz)

19. Bu basamaklardan en çok hangisi dikkatini çekti? Neden?

Yapay etin üretimine biraz daha detaylı bakalım

(özellikle kültür ortamı ile ilgili detay ve GDO'dan farkı)

20. Şimdi yapay etin üretimi ile ilgili ne düşünüyorsun? Açıklar mısın?

21. Farklı kültür ortamları ile ilgili ne düşünüyorsun?

22. GDO'lu besinler hakkında ne düşünüyorsun? Yapay et ile karşılaştırır mısın?

(3) YAPAY ET ÇALIŞMALARI YAPAN BİLİM İNSANLARININ GENEL GÖRÜŞLERİ

Şimdi de istersen yapay et üretmek üzerine çalışan bilim insanları üzerinde düşünelim…

23. İlk kez yapay et fikrini ortaya atıp bu konu üzerine çalışmaya başlayan bilim insanını düşün, sence böyle bir şey yapılabileceğine nasıl karar vermiştir?
24. Mark Post yapay et çalışmaları yaparak neye çözüm üretmeye çalışıyordur? Sence bunlar önemli sorunlar mı?
25. Bu konu üzerinde çalışan bir Türk bilim insanı olsa sence neye çözüm üretmeye çalışıyordur?
26. Sence bu konu üzerine çalışan diğer bilim insanları da benzer sebeplerden ötürü mü yapay et çalışmaları yürütürler?
27. Farklı sebeplerle yapay et üretmeye çalışanların yapay etin kendisiyle ilgili ulaştıkları/ürettikleri bilimsel bilgiler farklılaşır mı?
28. Peki sen böyle bir çalışmanın içine girer miydin? Neden?
29. Yapay et çalışmaları yürüten bilim insanlarının bu çalışmalarını yürütürken hayal güçlerini veya yaratıcılıklarını kullanması gerekir mi?
30. (Eğer gerekir dediyse)Yürüttükleri çalışmanın hangi aşamalarında gerekir?
31. Mark Post kimlerden veya hangi kurumlardan destek görüyordur? Bunların destekleme nedenlerini ve nasıl destek olabileceklerini açıklar mısın?
32. Türkiye'de böyle bir çalışma yapılsa kimler ya da hangi kurumlar destek olur? Yine bunların destekleme nedenlerini ve nasıl destek olabileceklerini açıklar mısın?
33. Yapay et çalışmalarını eleştirenler belirttiğin sorunlara çözüm olması için alternatif olarak başka ne gibi bilimsel çalışmaları destekliyor olabilirler?
34. Bu diğer tip çalışmaları yürüten bilim insanları neden yapay et yerine bu konular üzerinde çalışmalar yapıyorlardır? Açıklar mısın?
35. Sen bu alternatif çalışmalar hakkında ne düşünüyorsun?
36. Sen yapay et hangi özelliklere sahip olunca gönül rahatlığıyla bu yapay etin marketlerde satışına tamam dersin? Neden böyle düşünüyorsun?
37. Bilim insanları yapay etin hangi özelliklere sahip olduğunu anlayınca gönül rahatlığa yapay etlerin satışına tamam derler?
38. Yapay etin bu özelliklere sahip olduğunu nasıl anlayabilirler?
39. Gerekli çalışmaları yaptıktan sonra bilim insanları yapay etin bu özellikleri taşıdığı ya da taşımadığı konusunda hem fikir olabilirler mi? Neden böyle düşündün biraz açıklar mısın?
40. Yapay etin bu özelliklere sahip olduklarından yüzde yüz emin olabilirler mi?
41. Sence bilim insanları inek eti üzerine yeterli bilgiye sahipler midir? Neden böyle düşündün?
42. Bilim insanlarının inek eti ile ilgili ne tip bilgilerinin kesinliği vardır? Neden?
43. Bilim insanlarının inek eti ile ilgili ne tip bilgilerinin kesinliği yoktur? Neden?
44. İlerleyen zamanlarda kesin olmayan bilgiler gerekli çalışmalar yapılınca kesinlik kazanabilir mi?

Bak burada bu konu üzerinde çalışan bilim insanların konuyla ilgili yayımlanmış genel görüşleri var… ***(Bilim insanlarının görüşleri tek tek sunulur ve her seferinde bu görüşle ilgili ne düşündükleri sorulur.)***

45. Sen ne düşünüyorsun bu yaklaşımla ilgili?

46. Sence bu yaklaşım bilim insanları açısından tutarlı mı/beklendik mi?

(&Tüm görüşler sunulunca genel olarak tekrar görüşleri alınır)

47. Sen bu görüşlerden en çok hangisine yakınsın? Hangisini daha ikna edici buldun?

48. Yersiz bulduğun bir görüş var mı? Açıklar mısın? Başka var mı?

49. Peki mesela yapay et konusunda çalışma yapan bir bilim insanı olsan hangi grupla birlikte çalışırdın? Neden?

50. Böyle bir çalışmanın içinde yer aldın peki sen yapay etle yapılmış köfteyi denemek ister misin? Neden?

51. Peki elimizde sınırlı bir bütçe var bu bilim insanları grubundan sadece bir tanesi yapay et çalışmalarına devam edebilecek hangisi olsun? Neden?

52. Şu grup bilim insanlarına yapay et çalışmaları için bütçeden zerre para ayrılmamalı dediğin var mı?

53. Neyse ki biraz daha bütçe ayırabiliyoruz bunlarla beraber başka hangi grup yapay et çalışmalarını yürütsün?

54. Peki biraz daha bütçemiz varmış merak etme, şu diğer gruba da ödenek ayıralım mı sence?

55. Bütçeleri oldukça iyi idare etmişiz, bir grubu destekleyebilecek kadar daha ödeneğimiz var. Ne dersin sence şu gruba*(daha önce para ayrılmasın dediği gösterilecek) da biraz destek olalım mı?

56. Sence bu dört farklı görüşteki bilim insanı grubunun hangisi senin gönlüne göre olan yapay eti üretmeyi eninde sonunda başaracak? Neden böyle düşündün?

57. Bu dört farklı görüşteki bilim insanı grubunun hepsi senin gönlüne göre olacak yapay eti üretmeyi başarıyor, bu üretilen yapay etlerden hangisini yemek istersin? Neden?

(4) YAPAY ET ÇALIŞMALARIYLA İLGİLİ YURT DIŞI GÖRÜŞLER NELERDİR?

İstersen bir de bazı kişi ve kuruluşların yapay et konusuna yaklaşımlarına bakalım... ***(Bu görüşler tek tek sunulur ve her seferinde bu görüşle ilgili ne düşündükleri sorulur.)***

58. Sen ne düşünüyorsun bu görüş/davranışla ilgili?

(&Tüm görüşler sunulunca genel olarak tekrar görüşleri alınır.)

59. En yakın bulduğun görüş/davranış hangisi? Neden?

60. En uzak bulduğun görüş/davranış hangisi? Neden?

61. Görüşlerden bağımsız olarak iyi ki bu kişinin/kurumun görüşü alınmış dediğin var mı?

62. Görüşlerden bağımsız olarak neden bu kişinin/kurumun görüşü alınmış ne gereği vardı dediğin var mı?

63. Genel olarak görüşünü merak ettiğin başka bir kişi/kurum var mı?

64. Biraz da şu Google ve Twitter'ın ortaklarına daha yakından bakalım, bu kadar çok paran ve etkin olsaydı sen hangisi gibi davranırdın? Neden?

(5) TÜRKLER YAPAY ET İÇİN NELER SÖYLEDİ?

65. Biliyorsun bu oylama Türkiye'de yapılacak, sence Türkler yapay et konusuna nasıl yaklaşır? Neden?

66. Kendileri yemek isterler mi?

67. Marketlerde satışına ne derler?

68. Bu durumda referandum yapmamıza gerek var mı? Neden?

Dilersen Türkler 'in konuyla ilgili yaptığı yorumlardan gazetelerde yayımlananlara bakalım ***(Bu görüşler tek tek sunulur ve her seferinde bu görüşle ilgili ne düşündükleri sorulur.)***

69. Sen ne düşünüyorsun bu söylenenlerle ilgili?

(&Tüm görüşler sunulunca genel olarak tekrar görüşleri alınır.)

70. Sen bu görüşlerden en çok hangisine kendini yakın hissediyorsun?

71. Bu görüşlerden en çok hangisi sana uzak?

72. Görüşlerden bağımsız olarak iyi ki bu kişinin görüşü alınmış dediğin var mı?

73. Görüşlerden bağımsız olarak neden bu kişinin görüşü alınmış ne gereği vardı dediğin var mı?

74. Genel olarak görüşünü merak ettiğin başka birileri veya bir kurum var mı?

75. Şimdi tekrar oy kullanmanı istiyorum

Yapay et ürünlerinin market raflarında yer alıp almamasıyla ilgili tüm Türkiye'de oylama yapılıyor. Sen de bu oylamaya katılacaksın, sana oy zarfını ve oy pusulalarını veriyorum.

....

Evet: Yapay et ürünlerinin marketlerde satışına izin verilsin.
Hayır: Yapay et ürünlerinin marketlerde satışına izin verilmesin

....

Buyur oyunu kullanabilirsin.

76. Neden oyunu bu yönde kullandın?

77. Kullandığın oy içine sindi mi?

78. Oyunun yönünün değişmesinde/değişmemesinde neler etkili oldu?

79. Pekiyi sen bu yapay etle yapılmış köfteyi yemek ister misin? Neden?

Pekiyi, sana desem referandum yapmayalım da şu kurulu toplayalım onlar karar verecek bu konuya…

80. Ne dersin bu duruma?

81. Kimlerden oluşmalı bu kurul? Neden böyle düşündün?

82. Sence bu kurulun kararı ne olurdu? Neden böyle düşündün?

82. Mülakata katıldığın için teşekkür ederim, eklemek istediğin bir şey var mı?

APPENDIX E: CONSENT FORM FOR FOCUS GROUP INTERVIEWS

GÖNÜLLÜ KATILIM FORMU (Görüşme ve Ses Kaydı)

Bu çalışma ODTÜ İlköğretim Bölümü öğrencilerinden Elif Ece Adal tarafından yürütülen doktora tez çalışması kapsamında yapılmaktadır. Bu çalışmanın amacı 2. Sınıf İlköğretim Fen Bilgisi Bölümü öğrencilerini odak grup olarak tanımak, günlük hayatlarında etkisi altında kaldıkları sosyobilimsel konuları (socioscientific issues) belirlemek ve sosyobilimsel konulara yönelik ilgi ve sorumluluk düzeylerini ortaya koymaktır.

Bu amacı gerçekleştirmeye yönelik olarak veri toplama süreci nitel araştırma tekniğine uygun olacak şekilde yarı yapılandırılmış odak grup görüşmeleri ile gerçekleştirilecektir. Görüşmelerde verilerin ses kayıt cihazıyla kaydedilmesi planlanmaktadır. Çalışmaya katılım tamamen gönüllülük esasına dayanmaktadır. Tüm görüşmelere ait ses kayıtları gizli tutulacak ve sadece araştırmacı tarafından değerlendirilecektir; elde edilecek bilgiler bilimsel yayınlarda kullanılacaktır.

Görüşme kişisel bir rahatsızlık vermeyecek şekilde yapılandırılacaktır. Ancak görüşme esnasında herhangi bir nedenden ötürü kendinizi rahatsız hissetmeniz durumunda görüşmeyi sonlandırma hakkına sahipsiniz. Böyle bir durumda görüşmeyi yapan kişiye rahatsız olduğunuzu söylemeniz yeterli olacaktır. Görüşme sonunda çalışma ile ilgili sorularınız cevaplandırılacaktır. Bu çalışmaya katıldığınız için şimdiden teşekkür ederiz. Çalışma hakkında daha fazla bilgi almak için Elif Ece Adal (elifecea@yahoo.com) ile iletişime geçebilirsiniz.

Bu çalışmaya tamamen gönüllü olarak katılıyorum ve istediğim zaman yarıda kesip çıkabileceğimi biliyorum. Verdiğim bilgilerin bilimsel amaçlı yayımlarda kullanılmasını kabul ediyorum. (Formu doldurup imzaladıktan sonra uygulayıcıya lütfen geri veriniz).

Ad- Soyad Tarih Imza

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APPENDIX F: CONSENT FORM FOR IN-DEPTH INTERVIEWS

GÖNÜLLÜ KATILIM FORMU (Görüşme ve Ses Kaydı)

Bu çalışma ODTÜ İlköğretim Bölümü öğrencilerinden Elif Ece Adal tarafından yürütülen doktora tez çalışması kapsamında yapılmaktadır. Bu çalışmanın amacı bilimin doğasının sosyobilimsel konular üzerine karar vermede etkisini ortaya koymaktır.

Bu amacı gerçekleştirmeye yönelik olarak veri toplama süreci nitel araştırma tekniğine uygun olacak şekilde yarı yapılandırılmış bire bir görüşmeler ile gerçekleştirilecektir. Görüşmelerde verilerin ses kayıt cihazıyla kaydedilmesi planlanmaktadır. Çalışmaya katılım tamamen gönüllülük esasına dayanmaktadır. Tüm görüşmelere ait ses kayıtları gizli tutulacak ve sadece araştırmacı tarafından değerlendirilecektir; elde edilecek bilgiler bilimsel yayınlarda kullanılacaktır.

Görüşme kişisel bir rahatsızlık vermeyecek şekilde yapılandırılacaktır. Ancak görüşme esnasında herhangi bir nedenden ötürü kendinizi rahatsız hissetmeniz durumunda görüşmeyi sonlandırma hakkına sahipsiniz. Böyle bir durumda görüşmeyi yapan kişiye rahatsız olduğunuzu söylemeniz yeterli olacaktır. Görüşme sonunda çalışma ile ilgili sorularınız cevaplandırılacaktır. Bu çalışmaya katıldığınız için şimdiden teşekkür ederiz. Çalışma hakkında daha fazla bilgi almak için Elif Ece Adal (elifecea@yahoo.com) ile iletişime geçebilirsiniz.

Yukarıdaki bilgileri okudum ve bu çalışmaya tamamen gönüllü olarak katılıyorum ve istediğim zaman yarıda kesip çıkabileceğimi biliyorum. Verdiğim bilgilerin bilimsel amaçlı yayımlarda kullanılmasını kabul ediyorum. (Formu doldurup imzaladıktan sonra uygulayıcıya lütfen geri veriniz).

Ad- Soyad Tarih Imza

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APPENDIX G: CURRICULUM VITAE

PERSONAL INFORMATION

Surname, Name: Adal, Elif Ece
Nationality: Turkish (TC)
Date and Place of Birth: 22 May 1982, Malazgirt
Marital Status: Single
Phone: +90 532 660 31 95
email: elifecea@yahoo.com

EDUCATION

Degree	**Institution**	**Year of Graduation**
MS	METU Elementary Science and Mathematics Education	2011
BS	METU Elementary Science Education	2004

WORK EXPERIENCE

Year	**Place**	**Enrollment**
06.2008 - 09.2008	TEA A.Ş. (BİLGİN EĞİTİM)	Project Coordinator
10.2007 - 03.2008	TÜRKOBASI İLKÖĞRETİM OKULU	Science and Technology Teacher
10.2006 - 03.2007	VALÖR KONGRE ORGANİZASYONLARI	Project Coordinator
11.2004 - 02.2006	ÜNER YAYINCILIK A.Ş	Product Coordinator
07.2004 - 11.2004	EĞİSOFT (ÜNER A.Ş.)	Elementary Science Expert

FOREIGN LANGUAGES

Advanced English

PUBLICATIONS

Articles

Adal, E. E., & Çakıroğlu, J. (2015). Science teachers' perceptions of the Turkish Elementary Science and Technology Curriculum. *İstanbul Aydın Üniversitesi Eğitim Fakültesi Dergisi, 1*(1), 85-116.

Conference Papers

Adal, E. E., & Çakıroğlu, J. (2011). *Teachers' perceptions of the Elementary Science and Technology Curriculum.* Paper presented at the meeting of 9th Conference of European Science Education Research Association (ESERA), Lion, France.

Adal, E. E., & Çakıroğlu, J. (2012). *Science teachers' attitudes towards students'misconceptions*. Paper presented at the meeting of European Conference on Education Research (ECER), Cádiz, Spain.

Adal, E. E., & Sungur, S. (2013). *How does a teacher destroy a student's motivation?.* Paper presented at the meeting of European Conference on Education Research (ECER), İstanbul, Turkey.

Workshops

Adal, E. E (2012). *Dodo nedir?.* Workshop presented at the meeting of Orta Doğu Teknik Üniversitesi Uygulamalı Egitim Kongresi, Ankara, Turkey.

HOBBIES

Physics, Sociology, Music, Movies, Basketball, Swimming

APPENDIX H: TURKISH SUMMARY/ TÜRKÇE ÖZET

1. GİRİŞ

Bilimin doğası, bilimin epistemolojisi (bilgi kaynağı) olarak gösterilir (Lederman, 2006) ve pek çok programın ana amacı olan bilimsel okuryazarlığın (UNESCO, 1999; Donnelly, Jenkins & Layton, 1994; MNE, 2006; MNE, 2018) önemli bir bileşeni olarak görülür (NSTA, 1982). Karar, basitçe, seçeneklerden bir tanesini seçmek olarak tanımlanır fakat bu onun çok küçük bir kısmıdır (Daft, 2003). Aslında karar vermek problemi tanımlamak ve sonuca bağlamak için bir süreçtir. Karar vermek o ladar önemli bir konudur ki eğitimciler tarafından yaşam becerisi olarak sınıflandırılır. Sosyobillimsel konular ise ahlaki ve etik muhakeme gerektiren, bilimsel ve toplumsal boyutları olan, tartışmalı konulardır (Sadler, 2004a, 2004b; Zeidler, Sadler, Simmons & Howes, 2005; Zeidler & Sadler, 2008). Demokratik bir toplumda, sonuçları herkesi etkileyeceği için, vatandaşların sosyobilimsel konularda sorumluluk almaları ve kararlar vermeleri gerektiği hakkında görüşbirliği vardır (Zoller, 1982; Roth & Lee, 2004; Deober, 2011; Hofstein et. al, 2011). Ayrıca pek çok eğitimciye göre sosyobilimsel konular bilimsel okuryazarlığın bileşeni olmalıdır (e.g. Bodmer, 1986; Bingle & Gaskell, 1994; Kolstø, 2001b; Zeidler & Keefer, 2003; Sadler, 2004a). Bu görüşlerin kabulüyle, sosyobilimsel konular dünya genelinde fen programlarının bir parçası olmuştur (e.g. KMK, 2005; DFE, 2014; MNE, 2018). Bilimin doğası, karar verme ve sosyoblimsel konular Driver, Leach, Millar, ve Scott'un (1996) neden bilimin doğası önemllidiri ortya koyan demokratik savında beraberce bulunmaktadır. Bu sava göre bilimin doğası anlayışısosyobilimsel konularda bilinçli karar vermek için gereklidir.

Sonuçta, karar verme, bilimsel konular ve bilimin doğası berbirine doğal olarak bağlıdır. Sosyobilimsel konular tartışmalıdır ve eğer bir karar verme süreci izlenmezse bu konular üzerinde yapılan tartışmalar boşa gidecektir. Bununla birlikte, daha iyi bir çözüm için diğer epistemolojiler ya da merceklerin yanı sıra sosyobilimsel konularda karar vermede bilimin doğası merceklerinin kullanılması gerekir. Bu çalışma en geniş anlamda, neden bilimin doğasını öğretmemiz gerektiğini onun en hayati etkisine yani sosyobilimsel konularda kararvermeye odaklanarak ortaya koyma girişimidir.

Buna ek olarak, referendumlar vatandaşların en azından oy kullanımıyla sorumluluk aldığı gerçek hayat durumlarıdır ve bu yüzden sosyobilimsel konularla bağlanıtılı olarak referandumlar fen öğretmenleri olarak neden tüm örencilerimize bilimin doğasını öğretmeliyiz konusuna ışık tutan en iyi durumdur. Referendum durumu için, bu çalışmada araştırmacı tarafından Fraktal Model olarak adlandırılan yeni bir karar verme modeli kullanıldı. Hali hazırdaki karar verme modellerinde birbirini takip eden düzgüsel basamaklar vardır ve bunlar gerçek hayat durumu olan referendum durumunu açıklamakta yetersizdir. Bu çalışmada kullanılan ve doğrudan katılımcıların karar verme süreçlerinden edilinen veriler üzerinden yapılandırılmış Fraktal Model de ise sıradan bir insanın düşünme sistemini yansıtan 'amaçlar', 'kriterler', 'altenatifler' olarak adlandırılıan düşünme alanları ve bu üç alanın karşılıklı ilişkileriyle ortya çıkan 'karar' düşünme alanı bulunmaktadır.

1.1 Çalışmanın amacı

Bu çalışmanın amacı bilimin doğası anlayışlarının sosyobilimsel konudaki etkisini incelemektir. Bu amacı gerçekleştirmek için bilimin doğasına dair gelişmemiş anlayışlara sahip üyelerden oluşan Grup U ve bilimin doğasına dair gelişmiş anlayışlara sahip üyelerden oluşan Grup S olmak üzere farklı iki grubun karar verme örüntüleri karşılaştırılmıştır. Araştımanın ana sorusu ve alt soruları aşağıdaki gibidir.

Grup U ve Grup S katılımcılarının referendumda sosyabilimsel konuda karar vermeleri nasıl işliyor?

1. Grup U ve Grup S katılımcılarının yeni bir sosyobilimsel konuyla karşılaşmalarından hemen sonraki ilk tepkieri nasıldır?
    1.1. Grup U ve Grup S katılımcılarının yene sosyobilimsel konu hakkında algıları nedir?

1.2. Grup U ve Grup S katılımcılarının yeni bir sosyobilimsel konu üzerine bilgilenmeye yaklaşımları nasılsır?

1.3. Grup U ve Grup S katılımcılarının yeni bir sosyobilimsel konu üzerinde bilgilenmeden önceki ilk karar verme stratejileri nasıldır?

2. Karar Vermenin Fraktal Modeli'ne göre, Grup U ve Grup S katılımcılarının referendum durumunda sosyobilimsel konuda karar verme süreçlerinin genel yapıları nasıldır?

   2.1 Grup U ve Grup S katılımcılarının referandumdaki sosyobilimsel konu hakkındaki 'amaçlar' düşünme alanı nasıl ortaya çıkar?

   2.2 Grup U ve Grup S katılımcılarının referandumdaki sosyobilimsel konu hakkındaki 'kriterler' düşünme alanı nasıl ortaya çıkar?

   2.3 Grup U ve Grup S katılımcılarının referandumdaki sosyobilimsel konu hakkındaki 'alternatifler' düşünme alanı nasıl ortaya çıkar?

   2.4 Grup U ve Grup S katılımcılarının Karar Vermenin Fraktal Modeli'ndeki üç düşünme alanı ('amaçlar', 'kriterler' ve 'alternatifler') onların referandumdaki sosyobilimsel konu hakkındaki 'karar' düşünme alanını nasıl yapılandırır?

3. Grup U ve Grup S katılımcılarının mercekleri referendumda sosyabilimsel konuda karar verme sürecinde nasıl etkin hale geliyor?

   3.1. Grup U ve Grup S katılımcılarının bilimin doğası mercekleri referendumda sosyabilimsel konuda karar verme sürecinde nasıl etkin hale geliyor?

   3.2. Grup U ve Grup S katılımcılarının diğer mercekleri referendumda sosyabilimsel konuda karar verme sürecinde nasıl etkin hale geliyor?

4. Grup U ve Grup S katılımcıları karar verme stratejilerini referendumda sosyabilimsel konuda karar verme sürecinde nasıl kullanıyor?

5. Grup U ve Grup S katılımcılarının sosyobilimsel konuda karar verme otoritesi olarak 'Referendum' ve 'Komite' arasındaki tercihi nasıldır?

1.2 Çalışmanın önemi

Bilimin doğasına dair gelişkin anlayışının özellikle sosyobilimsel konularda karar verme üzerindeki öneminden pek çok araştırmacı bahsetmesine rağmen (ör. Bodmer, 1986; Hoolbrook & Ranikmae, 2009; Zoller, 2009), sadece birkaç çalışma (ör. Bell, 1999; Khishfe, 2012 doğrudan bilimin doğası ve karar verme arasındaki ilişkiye odaklanmıştır. Tüm bu ilk girişimler bilimin doğasının sosyobilimsel konuya ilişkin karar vermedeki etkisine ışık tutmuştur ama bu çalışmaların bulguları bazen tartışmalıdır. Bu çalışma ise, temel olarak dört bakımdan öncüllerinden ayrılır. Alandaki karar vermeyi süreç olarak ele alıp konuyu karar verme modeli üzerinden açıklayan ilk çalışmadır. Alandaki üzerinde çalışılacak sosyobilimsel konunun belirlenmesini doğrudan potansiyel katılımcıların gerçek ilgi alanlarını gözeterek yapan il çalışmadır. Alandaki katılımcıların bilimin doğasına dair anlayışlarını doğrudan belirlenen sosyobilimsel konu (yapay et) üzerinden ölçen ilk çalışmadır. Ayrıca bu çalışmadaki ana veri kaynağı katılımcıların yazılı değil sözlü açıklamalarıdır. Umulmaktadır ki bu çalışma bilimin doğası anlayışlarının sosyobilimsel konuda karar vermeye etkisini içeren alanyazında önemli yöntemsel geliştirmeler sunar. Bu çalışma alandaki referandum durumunu ortaya koyan bir karar verme modelinin eksikliğini gidermektedir. Bu çalışmada doğrudan katılımcıların karar verme süreçlerinden elde edilen veriler üzerinden ortaya konan Karar Vermenin Fraktal Modeli karar verme alanyazınındaki fraktal geometri içeren ilk modeldir. Fraktal geometri, Kaos Teorisi'nin devamıdır ve girdilerin çıktı olduğu durumların açıklamakta kullanılır, aynı karar verme sürecinde olduğu gibi. Karar vermede, problem çözümün bir parçasıdır ve karar problem yaratır (Adair, 2000), böylelikle problem ve karar karar verme sürecinin hem girdisi hem de çıktısı olarak davranır. Sonuç olarak, fraktal geometri karar verme sürecindeki bileşenlerde süregelen ontolojik değikiliğe izin verir bunu hali hazırda içerir.

Bununla birlikte, bu çalışmaın örneklemini öğretmen adayları oluşturmaktadır. Öğretmenler sadece sosyobilimsel konularda sorumluk sahibi olan sırasan insanlar değil ayrıca öğrencileri sosyobilimsel konularda sorumluluk sahibi olmaya yönlendirecek eğitimcilerdir. Umulmaktadır ki, geleceğin fen öğretmenleri olan öğretmen adaylarının bilimin doğası üzerinden sosyobilimsel konuda karar vermeye nasıl yaklaştıklarını anlamak eğitimcilerin üniversitelerdeki bilimin doğası, karar verme ve sosyobilimsel konularla ilgili ders programlarını geliştirmesinde ve fen sınıflarında sosyobilimsel konuda karar vermede kullanılacak yöntem ve araçların seçimini aydınlatmada yardımcı olacaktır çünkü gelecekteki bu etkinlikleri bugünün öğremen adayları yürütecek. Ayrıca, umulmaktadır ki bu çalışmanın bulguları program geliştiricilerine ve öğretmenlere toplumun çok daha fazla yararnına olacak şekilde öğrencilerin sorumluluk alarak sosyobilimsel konularda bilinçli karar verici olması içinfen eğitimini ve öğretim yaklaşımlarını yeniden düzenlemede kullanılacak etkin bilgiler sağlayacaktır.

2. ALANYAZIN İNCELEMESİ

2.1 Karar verme

Karar vermenin basamaklarını, bu basamaklar arasındaki ilişkileri açıklamak için düzgüsel modeler kullanılmıştır. İlk düzgüsel modeler felsefeciler ve ekonomistler tarafından gelişiştirilmiştir sonra psikoloklar tarafından benimsenmiştir (Edwards, 1954; Coombs vd., 1970). İlk düzgüsel modelere göre rasyonel bir karar verme için kişi şunları yapmalıdır:

(a) ilgili eylem seçeneklerini listelemek

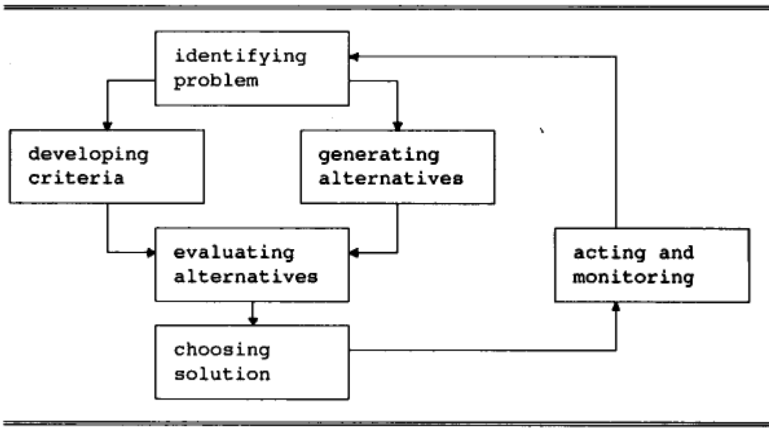
(b) bu eylemlerin muhtemel sonuçlarını tanımlamak

(c) her eylemin her sonucunun olasılığını ölçmek

(d) her sonucun göreceli önemini belirlemek

(e) savunulabilir bir karar için bu önemleri ve olasılıkları en çekici hareket biçimini tanımlamak için biraraya getirmek (Beyth-Marom et al., 1991, p.21)

Karar verme modelleri genelde aynı temelidir ama farklı disiplinler farklı karar verme modelleri sunar. Örneğin Robbins ve Coulter (2012) ekonomi yönetimi için güncel bir karar verme modeli tanıtmıştır, ayrıca sağlık alanında karar vermek ve iyileşme planları yapmak için Karar Vermenin Domino Modeli bulunmaktadır (Glasspool & Fox, 2005). Düzgüsel modellerin eğitim alanında görülmesi görece yenidir. Fen eğitimiyle ilgili araştırmalarda ise önceleri farkı disiplinlerden modeler benimsenmiştir, örneğin , Kortland (1996) Hollandalı lise öğrencilerinin varolan karar verme becerilerini tartışmak üzere Carroll ve Johnson'ın (1990) aşağıdaki modelini kullanmıştır.



Figür 2.1 Carroll and Johnson'ın önerdiği karar verme sürecinin düzgüsel modeli (Kortland, 2006, p. 675).

Giderek bu tutum yerini başka disiplinlerin modellerindeki karar verme basamaklarının yeniden formule edilmesine bırakmıştır. Örneğin, Ratcliffe (1997) sınıfta kaliteli grup tartışmalarını teşvik etmek için Janis ve Mann (1977), Hirokawa ve Scheerhorn (1986), ve Beyth-Marom ve dğr. (1991) tarafından ortaya konmuş düzgüsel modellerdeki basamaklardan eğitim ihtiyaçlarına uygun olacak şekilde seçim ve geliştirme yaparak aşağıdaki karar verme modelini önesürmüştür:

1. *Seçenekler*: Mümkün eylem seçeneklerini tanımlamak ve listelemek
2. *Kriterler*: Seçenekleri karşılaştırmak için uygun kriterleri geliştirmek ya da tanımlamak
3. *Bilgi*: Tanımlanmış kriterlere ve bilimsel bilgi ve kanıtlara belirgin gönderme yaparak mümkün seçenekler hakkındaki bilgiyi açıklığa kavuşturmak
4. *Araştırma*: Tanımlanmış kriterlere karşı her seçeneğin avantaj ve dezavantajarını değerlendirmek
5. *Seçim:* Yapılan analize dayalı olarak bir seçeneği seçmek
6. *Değerlendirme*: Yapılan karar verme sürecini değerlendirme, muhtemel iyileştirmeleri tanımlama (p.169)

Güncel olarak, Fang, Hsu, ve Lin (2019) temel olarak Svenson (1992), Ratcliffe (1997), ve Betsch ve Haberstroh'un (2005) karar vermedeki süreç yaklaşımlarının ışığı altında bir sosyobilimsel karar veme çerçevesi önermiştir. Bu karar verme çerçevesinin üç fazı vardır: (1) karar verme alanını formule etmek (2) bir karar verme stratejisi yerleştirmek, karar, (3) karar sonrası faz olan değerlendirme ve yansıtma. Fang vd. (2019) bu üç fazlı çerçeve üzerinden sosyobilimsel karar vermeyi ele alan 24 makaleyi incelemiş ve bulgularını bu çerçevede özetleyerek birarada sunmuştur.

Karar verme modelleri sosyobilimsel konuların öğrenim ve öğretimde yaygın olarak kullanılmaktadır(Fang vd., 2019) ama sosyobilmisel konulara ilişkin çalışmalardaki modeller eğitim dışındaki disiplinlere dayanmaktadır. Bu çalışmalardaki karar verme modelleri öğretmen veya öğrencilerin sosyobilimsel konudaki karar verme süreçlerine ilişkin toplanan veriler üzerinden evrilmemiştir ve sınıf içindeki belirli etkinlikler için uygun bulunmamıştır ayrıca karmaşık gerçek hayat durumları için çok fazla zor bulunmuştur (Aikenhead, 1989; Ratcliffe 1997; Kolstø 2006).

2.2 Sosyobilimsel konularda karara verme üzerine çalışmalar

Sosyobilimsel konular bilgi ve teknoloji ürünüdür ve sadece bilimsel bir değerlendirmeye tabii değildir. Sosyobilimsel konular politik ve ekomomik gibi pek çok perspektife sahiptir ve ahlaki ve etik bağlantılı ihtilaflı doğaları sosyobilimsel konuları topumlumun için uygun mu değil mi diye tartışmalı hale getirdiği için bu konularda toplum içinde tartışmalar ve eliştiriler oluşur (Sadler & Zeidler, 2004a; Sadler & Zeidler, 2005; Eggert vd., 2013; Siribunnam vd., 2014). Sonuçta, eğer bir konu bilimden ve toplumdan ortaklaşa etkilenmiyorsa sosyobilimsel konu değildir ve etik sorgulamalara yol açan modern bilimin herhangi bir konusu sosyobilimsel bir konu olabilir (Sadler & Zeidler, 2005; Fang vd., 2019). Sosyobilimsel konular karmaşıktır çünkü içerdikleri açık uçlu problemler yüzünden çoklu perspektife ve çoklu çözmlere sahiptirler (Zohar & Nemet, 2002; Sadler & Zeidler, 2004b; Sadler, 2009). Bu yüzden günlük hayattaki pek çok karardan farklı olarak, sosyobilimsel konularda gelişkin karar verme stratejileri kullanmak gerekir (Seethaler & Linn, 2004; Eggert & Bögeholz, 2009) ve ayrıca eliştirel düşünme becerisi ile bilim ve toplum arasında bağlantı kurmak gerekir (Kuhn, 2005; Kolstø, 2006).

Pek çok eğitimci sosyobilimsel konuların bilimsel okuryazarlığı geliştirmek için kullanılabileceğinde (ör. Zeidler, 1984; AAAS, 1989; Driver vd., 2000; Kolstø, 2001b; Ratcliffe & Grace, 2003; Zeidler vd., 2005; Sadler vd., 2007; Hofstein vd., 2011; Leevd., 2012) ve sosyobilimsel konularda karar vermemenin bilimsel okuryazarlığın bileşeni olması (ör. Bodmer, 1986; Bingle & Gaskell, 1994; Kolstø, 2001b; Zeidler & Keefer, 2003; Sadler, 2004a) hakkında hemfikirdir. Bu görüşlerin kabulüyle sosyobillimsel konular dünya genelinde fen programının bir parçası olmuştur (ör. KMK, 2005; DFE, 2014). Türkiye'de ise 2005'te sosyobilimsel konular fen programına entegre edilmiştir (MNE, 2005). Bugün, sosyobilimsel konuları kullanarak muhakeme yeteneği, bilimsel düşünme alışkanlıkları ve karar verme becerileri geliştirmek Türkiye Cumhuriyeti Milli Eğitim Bakanlığı'nın hazırladığı fen bilimleri dersi programının on özel amacından biridir (MNE, 2018, s.9).

2.3 Bilimin doğası anlayışlarının soyobilimsel konuda karar vermeye etkisi üzerine araştırmlar

Felsefeciler, tarihçiler ve fen eğitimcileri arasında bazı fikir ayruılıkları olsa da, bilimin doğasının yedi boyutu: (1) bilimsel bilginin belirsizliği (NOS1) (2) bilimsel bilgideki yaratıcılık ve hayalgücü (NOS2) (3) gözlemler ve çıkarımlar arasındaki ayrım (NOS3) (4) bilimsel bilginin deneysel temelliliği (NOS4) (5) bilimsel bilginin öznelliği (NOS5) (6) bilimsel bilginin toplumsal ve kültürel bağlılığı (NOS6) (7) kanunlar ve kuramlar arasındaki işlev ve ilişkiler (NOS7) üzerinde genel bir fikir birliği sağlanmıştır (Lederman, 2006).

Bilimin doğaısına ilişkin çalışmalar yarım yüzyılı aşkın bir süredir devam etmektedir ama doğrudan bilimin doğasının sosyobilimsel konuda karar veremeye etkisine yönelik olarak sadece altı tane çalışma vardır: (i) Zeidler, Walker, Ackett ve Simmons (2002), (ii) Bell ve Lederman (2003), (iii) Walker ve Zeidler (2003), (iv) Sadler, Chambers ve Zeidler (2004), (v) Liu, Lin ve Tsai (2010) ve (vi) Khishfe (2012). Bu çalışmalarda farklı sosyobilimsel konular ele alınmıştır ama bu altı çalışmanın tamamı bilimin doğasına dair yukarıdaki yedi boyuta dayanmaktadır. Bu çalışmaların bulguları sınırlı ve karışık sonuçlar ortya koysa da şu şekilde özetlenebilir: karar vermede epistemoloji kullanımı tespit edilmişse de (genelde çoklu perspektiften muhakeme yapma olarak), bilimin doğası anlayışının sosyobilimsel konuda karar vermeye etkisi hiç, dolaylı ya da çok sınırlı olarak raporlanmıştır.

Alanyazında, bu konudaki ilk dorudan girişim Bell ve Lederaman'ın çalışmasıdır (Bell, 1999; Bell & Lederman, 2003) ve bu girişim eğitim araştırmalarında yeni bir yol açmıştır. Diğer çalışmlar bazı yöntemsel ayarlamalar yaparak ve farklı sosyobilimsel konuları ele alarak genel olarak bu yolu takip etmiştir ve bu çalışmaların tamamı da alanyazına değerli bilgiler sunmuştur. Yine de Bell'den (1999) Khishfe'ye (2012) kadar bu konuda yapılan altı çalışmanın tamamı yönetemlerinde aynı dört eskikliği taşımaya devam etmiştir: (I) karar vermeyi süreç olarak ele alıp bir karar verme modeli üzerinden değerlendirme yapmamak (ii) sosyobilimsel konu seçiminde katılımcılarının ilgi alanlarını ve önbilgilerini bgözetmemek (iii) bilimin doğası anlayışlarını kendi kullandıkları sosyobilimsel konudan farklı konularla ölçmek (iv) temelde verilerini yazılı açıklamalar üzerinden toplamak

3. YÖNTEM

3.1 Araştırma tasarımı

Bu bir nitel gömülü kuram çalışmasıdır. İlk olarak yarı yapılandırılmış odak grup görüşmeleriyle ön çalışma yapılmıştır ve bu çalışmanın bulguları üzerinden ana çalışmanın veri toplama aracı geliştirilmiştir. Ana çalışmada ise amaçlı ve elverişli örnekleme ile 12 fen öğretmen adayıyla yarı yapılandırılmış derinlemesine görüşmeler yapılmıştır.

Önceki çalılmalar (ör. Bell, 1999; Khishfe, 2012) karar vermeyi bir süreç olarak ele almadığı için bilimin doğasının sosyobilimsel konuda karar vermeye etkisine dair dinamikler hala çok büyük ölüçüde keşfedilmemiştir. Ayrıca bu çalışma sosyobilimsel onuyla ilgili olarak referendum durumunu ele alan ilk çalışmadır ve öncesinde alanyazında referendum katılımcılarının sosyobilimsel konuya dair düşünme yollarını açıklayan bir karar verme modeli bulunmamaktadır.Böylece, bu çalışmadaki ana arşatırma soru 'NASIL' sorusudur ve konuyla ilgili bir anlayış geliştirebilmek için doğrudan katılımcılardan elde edilecek çok kapsamlı veriye ihtiyaç duyulmuştur. Böylelikle, veriden kuram oluşturmanın sistemli keşfi için araştırma stratejisi olan gömülü kuram çalışmasına başvurulmuştur (Glaser & Strauss, 1967). Gömülü kuramda vurgu araştırma sırasında edinilen bilgi üzerinedir (Hunter et al, 2005).

Thornberg ve Charmaz'ın (2012) önerisi doğrultusunda ilk veri toplanmasından tüm analizlerin bitimine kadar olan sürede hafıza notları tutulmuştur. Hafıza notlarındaki düşünce ve sorular gömülü kuram çalışmasının basamaklarında ihtiyaç duyuldukça tekrar ve tekrar kullanılmıştır. Ayrıca sık sık uzman görüşlerine baçvurulmuştur ve bunlar gömülü kuram arşatırmasının sürecini doğrudan şekillendirmiştir. Özellikle uzamanlarla yapılan tartışmalar (çoğunlukla üniversitede profesör olarak görev yapmakta olan üç fen eğitimi uzmanı ile) aynı Corbin ve Strauss'un (1990) vurguladığı gibi gömülü kuram çalışmasında araştımacının yeni içgörüler geliştirmesine ve kuramsal hassaslığının artmasına yardımcı olmuşur. Ayrıca, bu çalışmada gömülü kuram çalışmasının bir gereği olarak veri toplama süreci ve analiz süreci içiçe geçik olarak yürütülmüştür.

3.4 Veri toplama yöntemi

3.4.1 Odak grup görüşmeleriyle yapılan ön çalışma

Ön çalışmanın genel amacı ana çalışmada kullanıcak veri toplama aracını geliştirmektir. İlgili alanyazın incelendiğinde kişinin bir konuda karar vermesindeki hazırbulunuşluluğunun, konular arasındaki öncelemelerinin ve konuyla ilgili haber kaynaklarının karar verme sürecini yüksek düzeyde etkilediği anlaşılmıştır (Bettman vd., 1991; Svenson, 1996). Ayrıca, uygun bir analizin yapılabilmesi için seçilen sosyobilimsel konun, ilgi çekici, tartışabilmek için tanıdık, açıkça anlaşılır ve olması gerekmektedir, bunlarla birlikte katılımcıların konuya ilişkin önbililerinin benzer olması gerekir (Fraenkel & Wallen, 2006).

Ön çalışmadaki araştırma soruları aşağıdaki gibidir:

1. Fen öğretmen adaylarının sosyobilimsel konulara ilgi düzeyi genel olarak nedir?

2. Fen öğretmen adayları sosyobilimsel konular hakkında nasıl bilgi toplarlar?

3. Fen öğretmen adayları en çok ilgilendikleri sosyobilimsel konular nelerdir?

4. Fen öğretmen adayları sosyobilimsel konuları nasıl tartışmaktan hoşlanırlar?

  4.1. Fen öğretmen adaylarının sosyobilimsel konuları tartışması için görüşmelerilerin süresi nasıl ayarlanmalarıdır?

  4.2. Fen öğretmen adaylarının sosyobilimsel konuları tartışması için görüşmelerilerin fiziksel çevresi nasıl ayarlanmalarıdır?

  4.3. Fen öğretmen adayları sosyobilimsel konuları tartışırken hangi tür iletişim tarzını tercih ediyorlar?

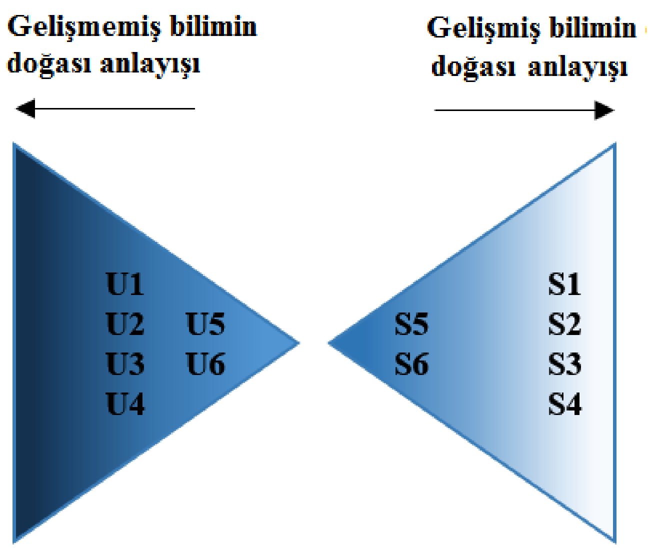
Bu araştırma soruları çerçevesinde yapılan odak grup görüşmelerinden elde edilen verilerin analizi ışığında ana çalışmanın sosyobilimsel konu olarak yapay et üzerine yarı yapılandırılmış derinlemesine görüşmeler içeren bir referendum simulasyonu ile yürütülmesine karar verilmiştir. Yapay et, hala bilim insanları üzerinde çalıştıkları için, belirsizlik koşulunda yapılandırılmamış problemler içermektedir. Yapay et odak grubun en çok tartışmaktan hoşlandığı ve en tanıdık olduğu gıda teknolojileri ve sağlık konularıyla doğrudan ilgilidir. Yapay et geçtiğimiz 10 senelik döenmde gündeme geldiği için odak grubun ilgilendiği sosyobilimsel konuların zaman aralığının içindedir. Ayrıca bütün analiz ile anlaşılmıştır ki odak grubun yapay et üzerine derinlemesine bilgisinin olması çok düşüktür ve bu durum katılımcı kişilik özellikleri tehtidinin en aza indirgenmesini sağlar.

3.4.2 Ana çalışmada kullanılan veri toplama aracı

Yapay etle ilgili olarak referendum simulasyonunu derinlemesine görüşmeler üzerinden yürütmek için odak grubun temel bilgi kaynağı olan internet web sitelerinden 2011, 2012 ve 2013 yayınlanmış yapay et haberleri derlenmiştir ve yapay etle ilgili beş kısımlık bir bilgilendirme hazırlanmıştır: (1) Yapay et hakkındaki haber (2) Yapay etin üretim süreci (3) Yapay et üzerine çalışan bilim insanlarının görüşleri (4) Dünya genelinden yapay etle ilgili görüşler (5) Türklerin yapay etle ilgili görüşleri. Bu bilgilendirme kısımlarına 82 tane yarı yapılandırılmış olarak tasarlanmış 82 eşlik eder ve görüşmecilerin bilimin doğasına ilişkin görüşlerini ölçmeye yarayan 22 soru ile referendum ve komite karşılaştırması için 3 soru bunların içindedir. Görüşmelerin en uzunu pilot görüşmelerden biridir ve 3 saat 17 dakika sürmüştür, en kısası ise 1 saat 57 dakika sürmüştür.

3.5 Bilimin doğası analizi: Katılımcıları bilimin doğası anlayışlarına göre gruplara ayırmak

Bu çalışmada katılımcıları bilimin doğası anlayışlarına göre gelişmemiş (Grup U) ve gelişmiş (Grup S) olarak iki gruba ayırmak üzere yukarıda alanyazın inceleme kısmında değinilen Lederman'ın (2006) belirttiği yedi boyuttan kanunlar ve kuramlar arasındaki ilişkileri içeren boyun dışındaki 6 boyutun tamamına odaklanılmıştır: Bilimin doğası anlayışlarına yönelik analiz doğrudan yapay etle ilgili toplanan veriler üzerinden yapılmıştır. Katılımcıların kimliklerini gizli tutmak için onlara yerleştirildikleri gruplara göre kodlar verilmiştir, katılımcıların grup içindeki bilimin doğası anlayışları üzerinden konumları Figür 3.7 gösterilmiştir.



v

Figür 3.7 Grup U ve Grup S katılımcılarının bilimin dağıs anlayışlarındaki gen düzeylerine göre konumları.

Gruplar arasındaki açıklık NOS1, NOS3, NOS5 and NOS6 boyutları bakımından geniştir ama NOS2 bakımından görece küçüktür. Ayrıca tüm katılımcıların NOS4 boyutundaki anlayışları birbirine çok yakındır. U5 ve U6, S5 ve S6 özellikle NOS1 bakımından benzer yapıya sahiptir ama diğer özelliklerikleri doğrultusunda ilgili gruplara yerleştirilmiştir.

3.6 Bu çalışmda yapılandırılan karar verme modeli

Katılımcıların sosyobilimsel konudaki karar verme sürecindeki açıklamaları üzerinden yapılan içerik analiziyle anlaşılmıştır ki referandumda durumunda katılımcılar aşağıda verilen bazı temel sorular züerinden düşünmüşlerdir:

1. Hangi sebeple yapay et üretilmiştir?/ Neden yapay eti kullanacağız?/ Yapay et neye sebep olacak?- *bu çalışmada 'amaçlar' hakkındaki düşme alanı olarak sınıflandırılmıştır.*

2. Yapay et hangi özelliklere sahip olmalıdır? *bu çalışmada 'kriterler' hakkındaki düşme alanı olarak sınıflandırılmıştır.*

3. Yapay et ile ne karşılaştırılabilir? *bu çalışmada 'alternatifler' hakkındaki düşme alanı olarak sınıflandırılmıştır.*

Bu üç düşünme alanı ('amaçlar', 'kriterler', 'alternatifler') refarandum simülasyonundaki karar verme sürecinin hemen başında *yöneltilen 'Bu haberi duymuş muydun?', 'Konu hakkında bir bilgiye sahip misin?', ' Bu haber sende merak uyandırdı mı?'* gibi sorulara ilgili olan katılımcı tepkilerinde bile kendini göstemektedir. Bununla birliklete, katılımcılar en erken tepkilerinde dahi doğrudan kendilerine sorulmadığı halde sıklıkla yapay et hakkında karar vermeye çalışmışlardır. Sonuçta, yukarıdaki düşünme alanlarına ek olarak 'karar' olarak sınıflandırılan dördücü bir düşünme alanı daha vardır. Fakat diğerlerinden farklı olarak 'karar' düşünme alanı kendi başına varolamaz bunun yerine 'amaçlar', 'kriterler', 'alternatifler' arasındaki etkileşim üzerinden kendini gösterebilir ve sürekli bu üç alandan beslenir.

Bu çalışmada elde edilen veriler üzerinden gidilerek sosyobilimsel konudaki referendum durumunu yansıtan Karar Vermenin Fraktal Modeli'i temel olarak dört özelliğiyle anayazındaki düzgüsel modellerden ayrılır.

1. Karar Vermenin Fraktal Modeli'nde düşünme alanları 'amaçlar', 'kriterler', 'alternatifler' ve 'karar' düzgüsel modellerdeki karar vere basamaklarının yerini alır ve birbirini takip eden basamaklardan farklı olarak düşünme alanları modelde eş zamanlı olarak belirir.

Analizle anlaşılmıştır ki, kimi görüşmeciler konuşmalarına amaç vurgusu yaparak başlarken kimileri kriter, kimileri ise alternatifler üzerinden başlamışlardır. Bir diğer soruya geçince, örneğin bir önce amaç ile başlamış kişi bu kez kriter vurgusu ile lafa girmiştir. Ayrıca amacın hemen ardından kriterden bahsetmek veya tam tersi gibi durumlar tüm karar bileşenleri için görüşmenin tamamında sıklıkla gözlemlenmiştir. Böylelikle varolan düzgüsel modellerin referandum durumunun doğasını açıklamakta yetersiz olduğu görülmüştür.

2. Karar Vermenin Fraktal Modeli 'amaç-kriter-alternatif arasında çift yönlü ilişkiler ve bu ilişkilerin hatlarını belirlediği karar' gösterimiyle alanyazında aşağıdaki gibi tanımlanan doğal düşünme sürecinin ruhunu da ortaya koyabilme özelliğine sahip olarak daha önce oluşturulmuş karar verme süreç basamaklarının bir biri ardına gelen yapısını aşan yorumlara kendi içinde olanak tanır.

- ✓ Eğer siz dağların içinden akan bir dereyi karşıdan karşıya geçmek istiyorsanız, taştan taşa zıplar ya da zig zağlar yaparsınız. Bu karşıdan karşıya geçiş düşünmeye benzer, karışık ya da düzensiz ancak amaca yönelik bir etkinliktir (Adair, 2000, p.35).

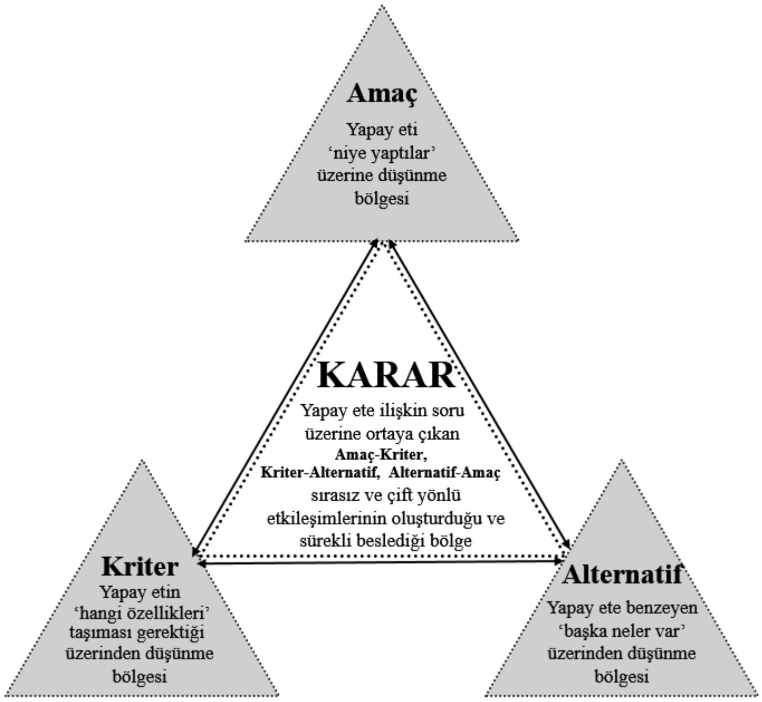
3. Karar Vermenin Fraktal Modeli hareketli (netleşip flulaşan çizgiler) bir fraktal (bütün ve parçanın benzer olması) yapı yansıtır ve karar verme basamaklarında ontolojik değişime olanak tanıdığı için özellikle ardarda karar vermenin gerektiği daha karmaşık durumlarda kullanılmaya uygundur. Fraktal Model ileride yapılacak çalışmalar için alanyazında karar verme sürecine ilişkin aşağıda yer alan açıklamaları bünyesinde barındırabilme özelliğine sahiptir.

- ✓ Karar problem yaratır. Çözümler yeni problemlerin tohumlarıdır. Bu durumda bu yeni ortaya çıkan problemleri çözebilmek için tekrar başa dönmeli ve sorunu tespit etmekle başlayan ve diğer bir öncekini tamamen kapsayan yeni bir karar verme sürecine girmeliyiz. Tüm süreci işlettiğimizde yeni sorunu çözen yeni bir karar verip uygulayacağız ve bu bize yep yeni problemler getirecektir (Adair, 2000).

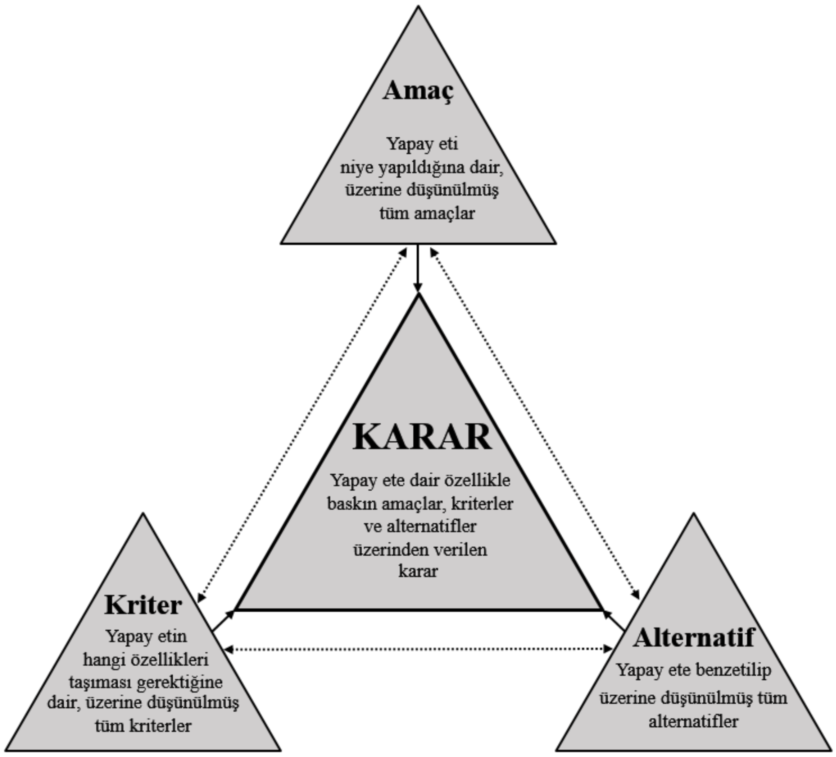
- ✓ "Uygulanmayan karar karar değildir. Olsa olsa bir niyetten ibarettir." ifadesiyle karşılaşmaktayız (Drucker, 1967). Yani kararın uygulaması da karar verme sürecine içkindir ve iyi sonuçlar elde edilebilmesi için denetlenmeye muhtaçtır. Bu durumda kararın etkinliğini denetlemek de karar verme sürecine içkindir (Robbins & Coulter, 2012).

4. Karar Vermenin Fraktal Modeli sözcük köken bilim açısından hem dilimize yerleşimiyle hem de tezin yazım dili olan İngilizce ile uyumludur. Karar kelimesi Arapça'dan Türkçe'ye geçmiştir. 'krr' kökünden gelen karar Arpaça'da durma, sabit olma, istikrar, kesin görüş veya tercih anlamlarına gelmektedir. İngilizce "decision" kelimesine baktığımızda Latincede kesmek, makas, ayırmak sözcüğüyle bağlantılı olduğunu görüyoruz. Fraktal Model'de amaç-kriter-alternatif etkileşimleriyle şekillenen karar, karar verme sonrası bileşenlerinden ayrılarak istiktikrarlı hale gelmekte ve kendi başına bir varlık olarak görülebilmektedir (hem de başka problemlere eklemlenebilecek şekilde). Aynı zamanda karardan bakılınca ayrılan amaç, kriter ve alternatifler son formunu almaktadır. Figür 3.8'de bu çalışmada referandumda karar vermeyi ortaya koymak için yapılandırlan Karar Vermenin Fraktal Modeli yer almaktadır.

a. Karar verme sürecinin işleyişi



b. Verilmiş bir karar sonrası karar verme sürecinin geriye dönük yapısı



Figür 3.8 Karar Vermenin Fraktal Modeli

3.8 Çalışmanın güvenirliliği ve geçerliliği

Bu çalışmanın güvenirliliğini ve geçerliliğini yapılandırmak için özellikle Lincoln ve Guba (1985) ve Gasson (2004) önerileri doğrultusunda güvenilebilirlik, itibar, nakledilebilme, teyitedilebilirlik konuları ele alınmıştır. Güvenilebilirlik için tüm içerik analizlerinde verinin %15'inden daha fazlasını kapsacak şekilde ikinci bir kodlamacı tarafından kodlama yapılmış, araştırmacının analiziyle karşılaştırılmış ve yeterli düzeyde mutabakat sağlanana kadar süreç devam ettirilmiştir. İtibar için hem odak grup görüşmeleri de dahil olmak üzere katılımcılarla yeterli zaman geçirilmiştir hem de veri toplama aracı kendi içinde çeşitlilik barındıracak şekilde tasarlanmıştır. Nakledilebilme için özellikle araştımanın tasarımına ve sonuçlarına yönelik çok detaylı açıklamalara yerverilmiştir. Teyitedilebilirlik için ise ayrımının yapılabilimesi için ilgili kısımlarda katılımcıların doğrudan alıntılarına yerverilmiştir ve bu alıntıların çalışmanın yürütme dili olan Türkçe'den çalışmanın yazım dili olan İngilizce'ye çevrilmesinde anlam kaybının ya da fazladan anlam yüklemenin önüne geçmek için birlikte çalışacak şekilde iki çevirmen görevlendirilmiştir. Ayrıca katılımcıların yapay etin üretim sürecini benzer şekilde algıladıkları ortaya çıkmıştır.

4. Sonuçlar

4.1. İlk tepkiler

Katılımcıların yapay etle ilgili bilgilendirme süreci başlamadan sadece tanıtıcı haberi okuduktan sonraki ilk tepkileri analiz edildiğinde katılımcılara göre yapay etin yapılandırılmamış problemler içerdiği ve ilgi çekici olduğu anlaşılmıştır. Grup U' nun tamamı ilk tepkilerinde ya rasyonel ya da parça-parça karar verme stratejisini kullanmış ve yapay etin Türkiye'deki marketlerde satışına karşı durmuştur. Grup S'in de yarısı ilk tepkisinde daha çok parça-parça karar verme stratejisi ile yapay etin satışına hayır demiş, diğer yarısı ise tam gaz ileri stratejini kullanmış ve sadece bir haber üzerinden yeni tanıdıkları yapay etin satışına evet demiştir.

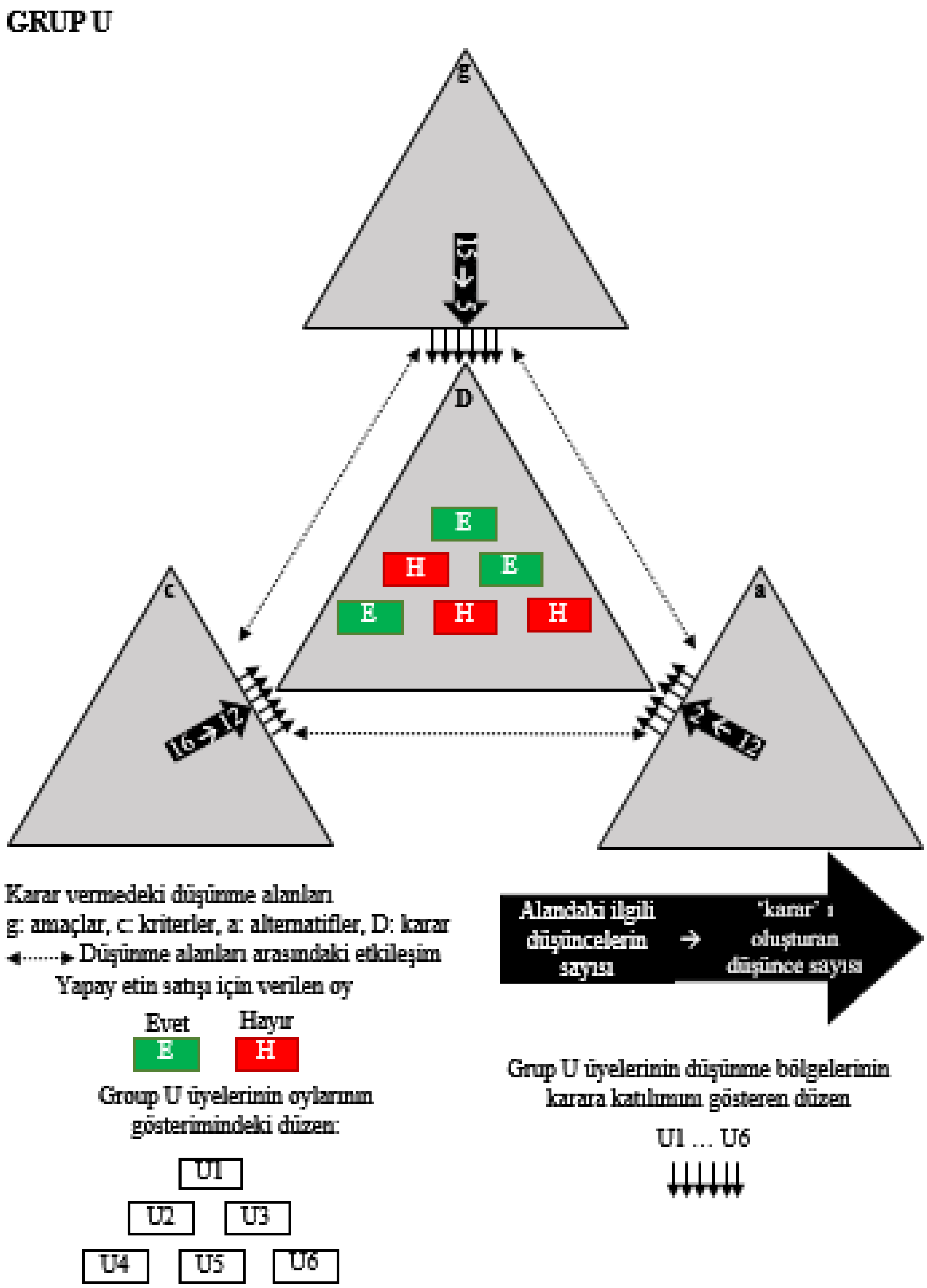
4.1. Düşünme alanları: sosyobilimsel konu hakkındaki referanum durumunda karar vermenin basamakları

Görüşmelerde düşünme alanı ‘amaçlar’ı gösteren toplam 17 kod belirlenmiştir. 8 amaç tüm katılımcılar tarafından dile getirilmiştir (açlık ve kıtlıkla mücadele, hayvanları hayvan çiftliklerinden korumak/ hayvanların besinleri için öldürülmesini engellemek, bilimsel merakı tatmin/ bilimin ilerlemesi, daha sağlıklı ve kaliteli et üretmek, küresel ısınmayla mücadele, kar sağlamak, egzotik veya nesli tükenen hayvanların etlerinin tadına bakabilmek ve etlerini tüketebilmek, uzaydaki astronotlara taze et sağlamak). Düşünme alanı ‘karar’ da iki Grup S üyesi yapay ete dair hiçbir amacı gözetmemiştir, buyüzden Grup S’in ‘amaç-karar’ bağlantısının Grup U’nunki kadar güçlü olmadığına kanaat getirilmiştir.

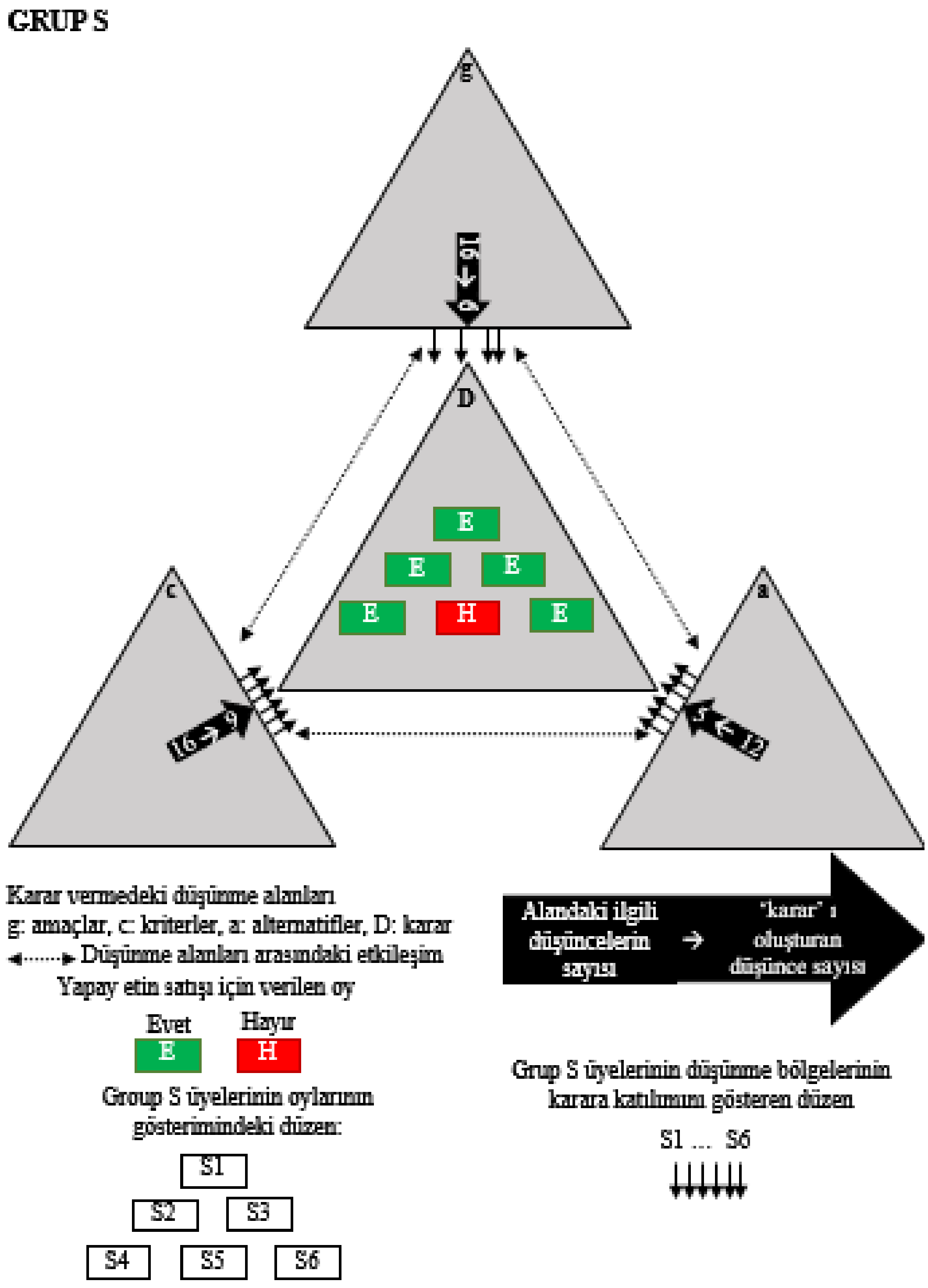
Çalışmada düşünme alanı ‘kriterler’e dair toplam 16 kod tespit edilmiş ve sağlıklılık, içerik ve besin değeri, lezzet, hayvanlara etkisi, maliyet, üretim yöntemi, denenmişliği olmak üzere 7 kriterin tüm katılımcılar için ortak olduğu anlaşılmıştır. Düşünme alanı ‘karar’ da Grup üyeleri üç kritere (sağlıklılık, hayvanlara etkisi, denenmişliği) Grup S’den çok daha fazla odaklanmıştır, böylelikle ‘kriter-karar’ ilişkisinde iki grup arasında farklılık olduğu anlaşılmıştır.

Düşünme alanı ‘alternatifler’e dair 12 kod tespit edilmiş bunlardan 5 tanesi (normal et, genetiği değiştirilmiş organizmalar, bitki temelli et benzeri ürünler, sentetik et) tüm katılımcıların gözönünde bulundurduğu ortak amaçtır. Ayrıca neredeyse tüm katılımcılar karar verme sürecinin tamamında hayvan çiftliklerini yapay ete alternatif olarak ele almıştır. Katılımcıların ilk başta ‘alternatifler’ hakkında yapay etin ne olduğunu anlamak için düşündükleri ama karar verme süreci işlemeye devam ettikçe yapay etin ne kadar etkin olduğunu ‘alternatifler’ ile karşılaştırarak değerlendirdikleri ortaya çıkmıştır. Neredeyse tüm katılımcılar ‘karar’da neredeyse sadece normal et ve hayvan çiftliği ‘alternatifler’ine yer vermiştir ki bu ikisi yapay etin doğal alternatifleridir.

Figür 4.3 and 4.4 ‘amaçlar-karar’, ‘kriterler-karar’ ve ‘alternatifler-karar’ bağlantılarıyla ilgili ortaya çıkan Grup dinamiklerini göstermektedir.



Figüre 4.3 Grup U'nun karar verme sürecindeki 'amaçlar-karar', 'kriterler-karar' ve 'alternatifler-karar' bağlantıları.



Figür 4.4 Grup S'in karar verme sürecindeki 'amaçlar-karar', 'kriterler-karar' ve 'alternatifler-karar' bağlantıları.

4.3 Karar vermede mercek kullanımları

4.3.1 Karar vermede bilimin doğası mercekleri kullanımları

Sosyobilimsel konu hakkındaki referandumda karar vermeye ilişkin yapılan analizle ve Lederman (2006) ve Khishfe (2012) uyumlu olan ve bilimin doğasının boyutlarından NOS2, NOS3, NOS4, NOS5 ve NOS6'ya dair gelişmiş ve gelişmemiş kullanımlar olmak üzere toplam on çeşit mercek ortyaya çıkmıştır ve bunlar Tablo 4.13'de kodlarıyla birlikte listelenmiştir. Tablo 4.14'de ise bu bilimin daoğası merceklerinin herbirinin karar verme sürecindeki kullanımlarını temsil eden doğrudan alıntılar yer almaktadır. NOS1 ve NOS7 merceklerinin kullanımına dair bir ise bulguya ulaşılamamıştır. Bununla birlikte sırasyla Figür 4.7 ve Figür 4.8'de bilim doğası merceklerinin karar verme sürecinde Grup U ve Grup S üyelerinin düşünme alanlarında nasıl etkin hale geldiği topluca gösterilmektedir.

Tablo 4.13 Yapay et ve alternatifleriyle ilgili olarak karar verme sürecinde bilimin doğası mercek kullanımlarına dair kodlar

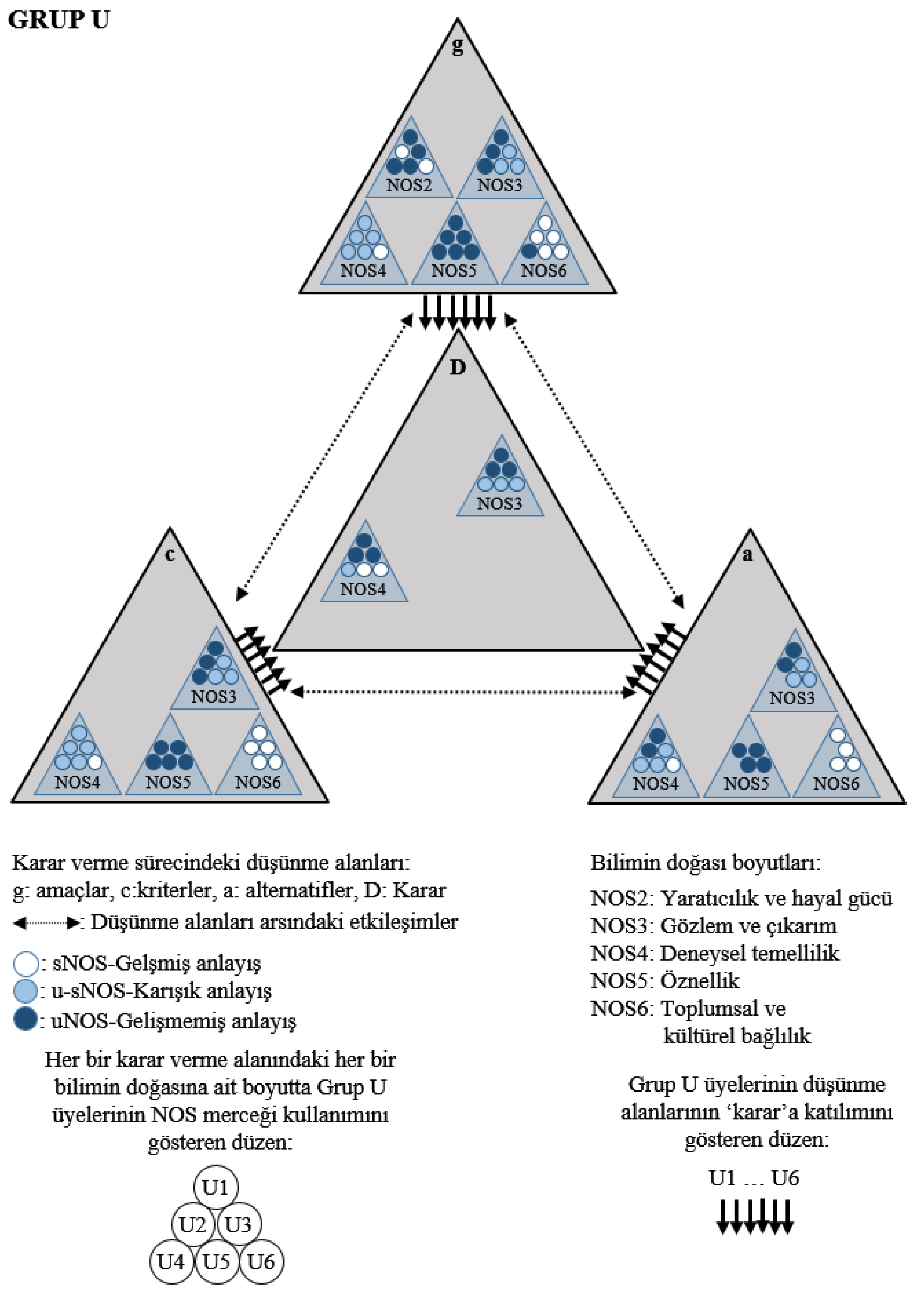
NOS mercekleri	Gelişmiş NOS merceği kullanımı için kodlar	Gelişmemiş NOS merceği kullanımı için kodlar
Yaratıcılık ve hayal gücü (NOS2)	Bilim insanlarının bilim yaparken ki yaratıcılık ve hayal güçlerine değer verme (sNOS2)	Bilim insanlarının yaratıcılığını ve hayal gücünü yadırgamak/ Yaratıcılık ve hayal gücü kullanımını bilimin dışına çıkmak olarak görmek (uNOS2)
Gözlem ve çıkarım (NOS3)	Data veya gözleme dayalı olan çıkarımları ön plana almak/ Gözlemler ve çıkarımların farklı tür bilgi olmasından dolayı verinin farklı çıkarımlara yol açabileceğini kastetmek (sNOS3)	Data veya gözleme dayalı olmayan çıkarımları ön plana almak/ Çıkarımı gözlemlerin bir toplamı olarak görerek verinin sadece tek bir çıkarım yapılabileceğini kastetmek (uNOS3)
Deneysel temellilik (NOS4)	Bilimsel süreç ve sorgulama sonucunda üretilmiş bilimsel bilgileri talep etmek ve gözetmek (sNOS4)	Bilimsel süreç ve sorgulama sonucunda üretilmiş bilimsel bilgilere eksik gereksinim duymak (uNOS4)
Öznellik (NOS5)	Bilim insanlarının farklı kişilikleri, özellikleri, deneyimleri ve çalışma altyapıları yüzünden farklı ve kişisel bakış açılarına sahip olduğunu gözetmek (sNOS5)	Bilim insanlarına kalıplaşmış tek tip kişilik, özellik, davranış yüklemek/ Bilim insanlarının tamamen nesnel olmasını ummak/ Bilim insanlarının çalışma alanlarındaki farklılıkları göz ardı edip onlara çok aşırı güven duymak (uNOS5)
Toplumsal ve Kültürel bağlılık (NOS6)	Toplum ve bilim arasındaki etkileşimi gözetmek (sNOS6)	Toplum ve bilim arasındaki etkileşimi göz ardı etmek/ Bilim insanını içinde bulunduğu toplumdan yalıtılmış olarak görmek (uNOS6)

Tablo 4.14 Yapay et ve alternatifleriyle ilgili olarak karar verme sürecinde bilimin doğası (NOS) mercek kullanımlarını temsil eden alıntılar

NOS merceği	NOS merceğinin gelişmiş kullanımı için alıntılar	NOS merceğinin gelişmemiş kullanımı için alıntılar
Yaratıcılık ve hayal gücü (NOS2)	S6: Bilim insanları açısından da beklendik tutarlı bir görüş bu. Bilim insanları açık oluyorlar yeniliklere… […] Bu fikir çoğu insanın aklına gelmeyebilir. Mesela benim bile kabul etmiyor oluşum benim bunu hayal edemiyor oluşumdan olabilir. O yüzden bilim insanı bunu hayal etmiş ve ne tarz ortamda gerçekleşebilir ya da nasıl bir forma sokarım gibi bu imagination yapmış olabilir. *(sNOS2→Amaç: İstenildiğinde egzotik veya nesli tükenmekte olan hayvanların bile tadına bakabilmek/etini tüketebilmek)*	U4: [En yakın olduğum görüş] Grup 4. [...] İşte durduk yere panda eti yiyelim gibi benimle çelişen bir görüşü de olmadığı için [...] Bunlar [Grup 4] her açıdan bakıyor, böyle bilim insanı diye [Grup 3 gibi] çılgınlıklar peşinde olmaktan ziyade... *(uNOS2→Amaç: İstenildiğinde egzotik veya nesli tükenmekte olan hayvanların bile tadına bakabilmek/etini tüketebilmek)*
Gözlem ve çıkarım (NOS3)	S6: (İkinci tip vejetaryenlerin veri veya gözleme dayalı olmayan çıkarımlarını değerlendirirken) Hamile sığırlardan alınan sıvıları kullanıyorlar o sıvı ne dozda alınacak o işte diyelim o doğacak bebeğe bir zararı olacak mı onun, dozunu bilmeden konuşuyorlar. Direkt komple zararlıdır diye bir ön yargıları var. *(sNOS3→ Kriter: Hayvanlara etkisi)*	U2: (İkinci tip vejetaryenlerin veri veya gözleme dayalı olmayan çıkarımlarını değerlendirirken) Bir kere bir şeyler hayvanlardan yine alınıyor diyor ve şu çok güzel hamile sığırlardan alınan sıvıların kullanılmasını hiç doğru bulmuyoruz [demişler]. Bu doğru bir kere doğal hamilelik sürecini bozuyorsun onların. [...] Ve üretimin içeriğinin de ne olduğunu tam olarak bilmiyoruz [demişler]. İşte ben tam olarak bunu demek istiyorum ya. Hiçbir şeyi tam olarak bilmiyoruz o içindeki ne var ne yok, işte bilmediğimiz bir şeyi de tüketiyoruz aslında… Ha bir sürü şeyi zararları var aslında işte tam olarak başından beri bunu demek istiyorum. *(uNOS3→Amaç: Hayvanların kesilmesini/kötü koşullarda üretilmesini önlemek → Kriter: Sağlık içeriği/besin değeri, Üretim yöntemi/süreci)*

Tablo 4.14 (devam ediyor)

NOS merceği	NOS merceğinin gelişmiş kullanımı için alıntılar	NOS merceğinin gelişmemiş kullanımı için alıntılar
Deneysel temellilik (NOS4)	S1: TÜBİTAK tabii bilimsel açıdan ele almış bir de açlığa çözüm olacağı açıdan ele almış ama hayvan için de bir şeyler söylemiş yani bunu dinleyen birisi yani bu görüş hem bilimsel bir şeyi hem hayvan hakları savunucusunun görüşlerini yansıtıyor. Araştırmacı: Bilimsel bir görüşü savunduğunu nerden anladın? S1: Çünkü araştırmalara bakılmış veriler üzerinden gitmiş. *(sNOS4→ Amaç: Açlık ve kıtlık ile mücadele etmek, Hayvanların kesilmesini/kötü koşullarda üretilmesini önlemek)*	U1: Evet oyu kullandım bir sürü faydası falan var ama uzun vadede benim sağlığıma nasıl bir etkisi olacak bunu bilmiyorum ya o yüzden minik bir soru işareti olurdu. [...] Ben de sürece baktığım zaman genetik değiştirilmemiş falan o yüzden sağlığa olumsuz etki olmayacağını düşündüm. *(uNOS4→Karar: EVET satılsın)*
Öznellik (NOS5)	S1: Bir tane bilim insanı kendi belki bir şey göremiyordur o sadece belirli testler yapıyordur ama başka bir bilim adamı gelir onun bakış açısı daha farklıdır... O der ki şimdi şunlar şunlar olsun. Onlarda bir baksın hani belki şu açıdan bir zararı olur diye hani bilim insanı arttıkça bakış açısı da artacağı için. Araştırmalar da belki derinleşirler aynı şeyleri araştırmayacakları için. *(sNOS5 → Kriter: Sağlık)*	U6: GDO üzerinde de bilim insanları hem fikir değiller çünkü bilinmiyor sonuçları. Ama genelde karşılar insanlar. Hem fikir olmama durumu herkes farklı düşündüğü için oluyor. Bir kere bir zararı vardır ortada ama o, o insana göre zararlı olmayabilir. Çok bilimsel çalışmıyorsa objektif bakmıyorsa böyle düşünebilir. Ama bilim insanı objektif bakmalıdır. *(uNOS5 → Alternatif: GDO'lu ürünler → Kriter: Sağlık)*
Toplumsal ve Kültürel bağlılık (NOS6)	S5: Mesela genelde böyle şeyler GDO'lu ürünler falan maliyeti düşürmek üzere yapılıyor sonuçta. Ama burada 250.000 Euro'nun üzere çıkan bir maliyetle bunu yapmışlar. Yani ne gerek vardı gibisinden. Yani bir bilim yapılırken bunun maliyetinin de düşünülmesi gerekiyor sonuçta. Çünkü bilimi ekonomik olarak siyasi olarak hiçbir şeyden ayıramıyoruz *(sNOS6 → Amaç: Satış fiyatını düşürmek/alım gücü düşük insanların et yemesini sağlamak → Kriter: Üretim yöntemi/süreci, Üretim maliyeti → Alternatif: GDO'lu ürünler)*	U4: (Grup 3 bilim insanlarının görüşleri üzerine yapılan değerlendirme) Ben bunu [farklı hayvanların etlerini yapmayı gereksiz bulduğumu] söylerken şimdi neyi düşünüyorum, yaşadığım ortam beni etkiliyor benim kişisel inancım beni etkiliyor dini inancım beni etkiliyor. Ama bilim insanı daha objektif yaklaşmalı *(uNOS6→ Amaç: İstenildiğinde egzotik veya nesli tükenmekte olan hayvanların bile tadına bakabilmek/etini tüketebilmek)*



Figür 4.7 Group U üyelerinin karar verme sürecinde bilimin doğası merceklerini kullanımının topluca gösterimi.

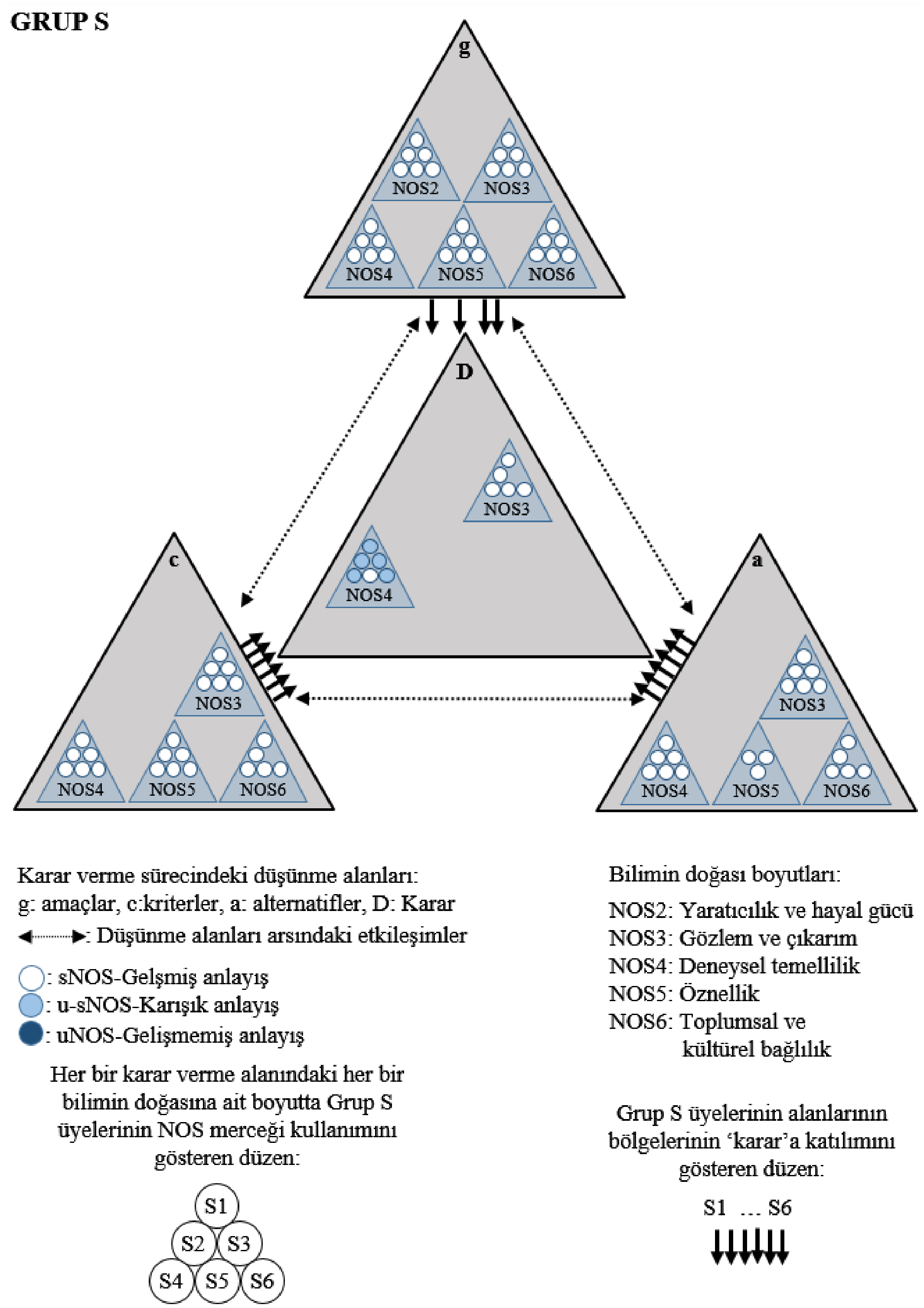
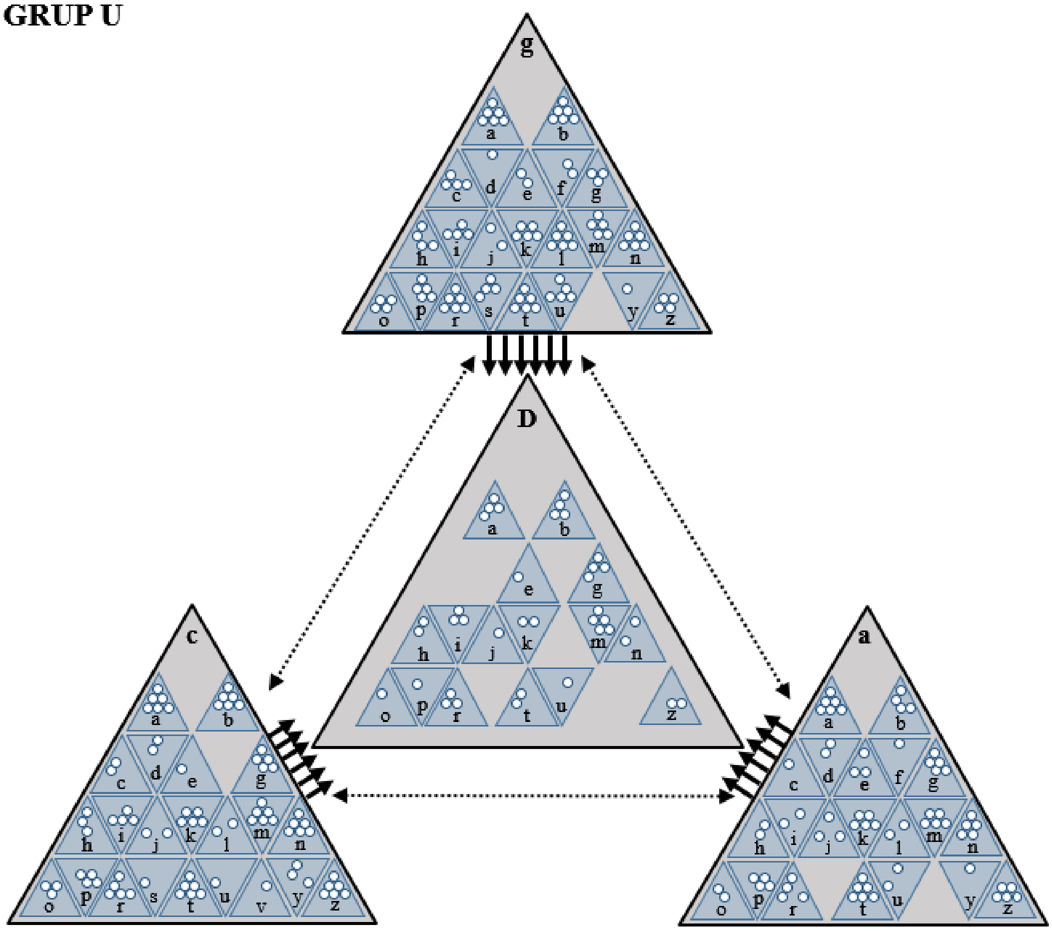


Figure 4.8 Group S üyelerinin karar verme sürecinde bilimin doğası merceklerini kullanımının topluca gösterimi.

4.3.2 Diğer mercekler

Sosyobilimsel bir konu olarak yapay etin Türkiye marketleirninde satışına izin verilip verilmemesiyle ilgili olarak yapılan referandum simülasyonunda katılımcıların karar verme sürecini bilimin doğası merceklerine ek olarak 23 diğer merceğin şekillendirdiği tespit edilmiştir. Fraktal Model'e üzerinden Grup U ve Grup S'in karar veme sürecindeki diğer mercekleri sırasyla Figür 4.9 ve Figür 4.10'da yer almaktadır. 'karar' dışındaki düşünme alanlarında Grup U kötüye kullanım, din ve daha çok bilgi merceklerini Grup S'e göre daha sıklıkla kullanırken, Grup S öncelikler merceğini daha sıklıkla kullanmıştır. 'karar' da ise Grup U önyargı, kişisel deneyim, risk faktörü ve din, merceklerine daha çok yer vermiştir, Grup S ise işbilirlik merceğini daha çok ön plana çıkarmıştır. Bununla birlikte her iki grubun en az yarısının 'karar' ında ortak olarak hayvan hakları, çevre hakları, risk faktör ve toplumsal fayda merceklerinin kullanımı tespit edilmiştir.

GRUP U



Karar verme sürecindeki düşünme alanları:
g: amaçlar, c:kriterler, a: alternatifler, D: Karar
◄·········►: Düşünme alanları arsındaki etkileşimler

○: Diğer mercek kullanımı

Her bir karar verme alanındaki her bir diğer diğer mercekteki Grup U üyelerinin diğer mercek kullanımını gösteren düzen:

U1
U2 U3
U4 U5 U6

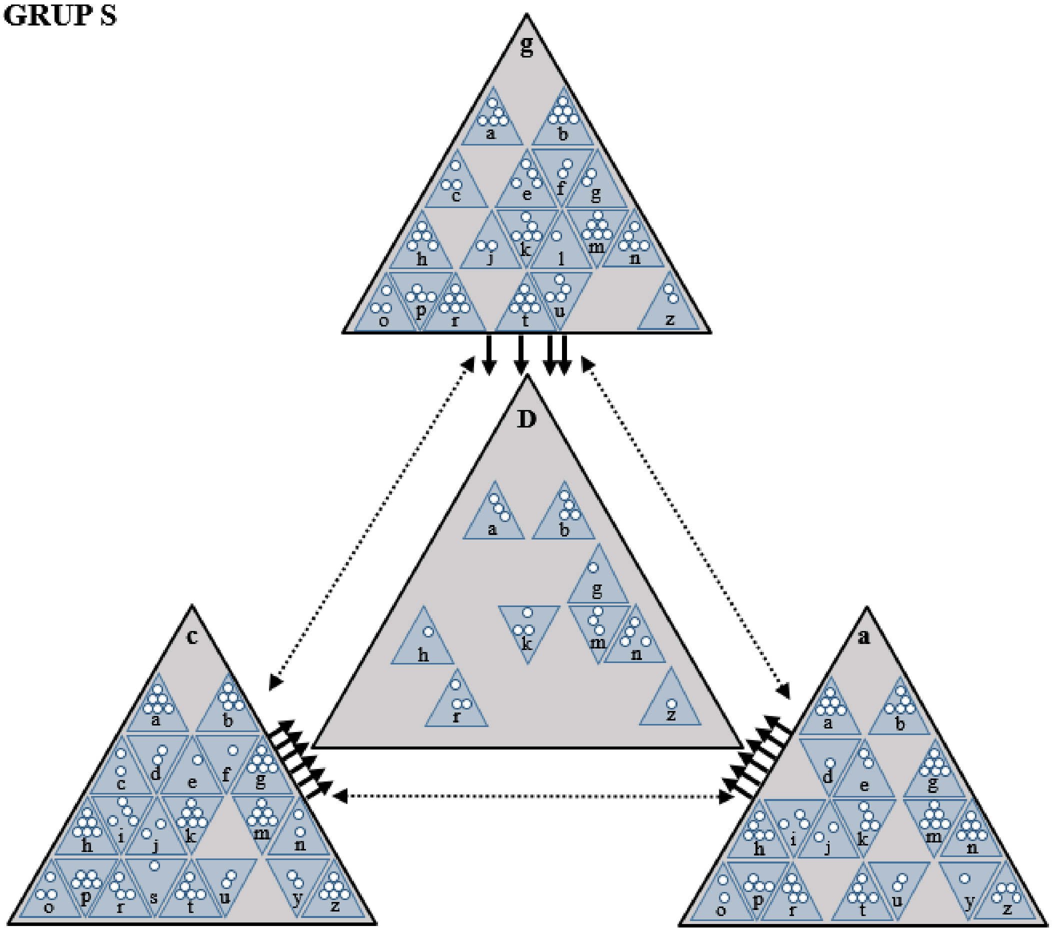
Grup U üyelerinin düşünme alanlarının 'karar'a katılımını gösteren düzen:
U1 … U6
↓↓↓↓↓↓

Her bir düşünme alanında küçük üçgenlerle gösterilen diğer (bilimin doğası dışındaki) mercekler:

a: Hayvan hakları	m:Risk faktörü
b: Çevre hakları	n: İşbilirlik
c: İnsanlık	o: Sosyokültürel
d: Bilgilendirilme hakkı	p: Sosyoekonomik
e: Doğanın dengesi	r: Toplumsal fayda
f: Merak	s: Din
g: Önyargı	t: Ekonomi
h: Öncelik	u: Bilimi destekleme
i: Kişisel deneyim	v: Pop kültürü
j: Ders deneyimleri	y: Yasal konular
k: Teknoloji	z: Daha çok bilgi
l: Kötüye kullanım	

Figür 4.9 Grup U'nun karar verme sürecindeki diğer mercek kullanımları.

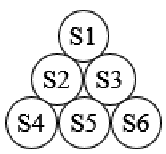
GRUP S



Karar verme sürecindeki düşünme alanları:
g: amaçlar, c:kriterler, a: alternatifler, D: Karar
◄·········►: Düşünme alanları arsındaki etkileşimler

◯: Diğer mercek kullanımı

Her bir karar verme alanındaki her bir diğer diğer mercekteki Grup S üyelerinin diğer mercek kullanımını gösteren düzen:



Grup S üyelerinin düşünme alanlarının 'karar'a katılımını gösteren düzen:
S1 ... S6

Her bir düşünme alanında küçük üçgenlerle gösterilen diğer (bilimin doğası dışındaki) mercekler:

a: Hayvan hakları
b: Çevre hakları
c: İnsanlık
d: Bilgilendirilme hakkı
e: Doğanın dengesi
f: Merak
g: Önyargı
h: Öncelik
i: Kişisel deneyim
j: Ders deneyimleri
k: Teknoloji
l: Kötüye kullanım
m:Risk faktörü
n: İşbilirlik
o: Sosyokültürel
p: Sosyoekonomik
r: Toplumsal fayda
s: Din
t: Ekonomi
u: Bilimi destekleme
v: Pop kültürü
y: Yasal konular
z: Daha çok bilgi

Figür 4.10 Grup S'in karar verme sürecindeki diğer mercek kullanımları.

4.4. Karar verme stratejileri

Katılımcıların yapay etle ilgili karar verme sürecinde işlettikleri karar verme stratejileri kodları ve örnek alıntılarıyla birliklte Tablo 4.25’te sıralanmıştır.

Tablo 4.25

Karar verme stratejieliyle igili kodlar ve örnek alıntılar

Karar verme stratejileri	**Kodlar**	**Örnek alıntılar**
Rasyonel yaklaşım	‘neredeyse her şeyi’ bilmek üzere çok kapsamlı bir bilgi yığınına odaklanmak	U1: Hayvanlar üzerinde denenmiş olur, hayvanlarda nasıl tepkiler ortaya çıkmış hayvanlarda nasıl hastalıklar oluşmuş bütün bunların sonuçlarına ulaşılmış olur. Sonuçlarını bilmediğim bir şeye evet demem yani (ilk tepkide’den alıntı)
Parça-parça karar verme	‘doğallık’gibi bilgilendirmenin çok küçük bir kısmına odaklanmak	U2: Biz o kaynakları besin olarak alabiliyorken içeriğini bile tam olarak bilmediğimiz bir şeyi niye yiyelim falan. Direkt bununla hayır dedim.
Tam gaz ileri	Doğru düzgün bir analiz yapmadan yeni olan her şeyi deneme eğilimi	S2: Bence evet sağlık açısından ne olacağını bilmiyorum ama gerekli tedbirler alınabilir artık bir şeyler yapılabilir. Ben evet diyebilirim buna artık.
Rasyonel ritüalizm	‘Neredeyse her şeyi’ bilecek kadar kapsamlı bir bilgi yığınının olmadığını farkettikten sonra sanki böyle bir bilgi varmışçasına davranmak	U1: Ben bu konu hakkındaki bütün bilgilerin bu olduğunu düşünerek şu anda bunu cevaplıyorum.
Karma tarama	Geçici bir karar vermek üzere, öncellik sıralamasının en üstündeki bilgilendirmeye bu bilginin tüm yapı üzerindeki etkisini gözeterek odaklanmak	U5: Şu anki zamanı değerlendirince gerek yok diyorum. Kıtlık yok, elektrik gelecek konuları hani. Biraz daha kötüye düşse evet diyebilirim.

Yapılan analiz sonucunda açıkça anlaşılmıştır ki yapay etle karşılaşır karşılaşmaz ortaya çıkan ilk tepkilerinde rasyonel yaklaşım gösteren Grup U üyelerinin tamamı bilgilendirme sonrası ‘karar’larında rasyonel ritüalizim kullanmışlardır. ‘Karar’ da ise katılımcıların çoğu her ne kadar ağırlıkla yapay etin satışına EVET dese de Grup U ve Grup S birbirinden farklı karar verme stratejileri işletmiştir. Bununla birlikte, Grup U veya Grup S üyesi olsun HAYIR oyunu verenlerin neredeyse tamamının karma tarama stratejisini işlettiği anlaşılmıştır. Katılımcıların kararları ve kararlarlarında işlettikleri stratejiler Tablo 4.28'de iki grup karşılaştırmaları olarak görülebilmektedir.

Tablo 4.28

'karar'da işletilen karar verme stratejileri, Grup U ve Grup S karşılaştırmalı

	Strateji	Oy		Strateji	Oy
U1	Rasyonel ritüalizm	YES	S1	Tam gaz ileri	YES
U2	Parça-parça	NO	S2	Tam gaz ileri	YES
U3	Rasyonel ritüalizm	YES	S3	Tam gaz ileri	YES
U4	Rasyonel ritüalizm	YES	S4	Tam gaz ileri	YES
U5	Karma tarama	NO	S5	Karma tarama	NO
U6	Karma tarama	NO	S6	Rasyonel ritüalizm	YES

4.5 Referandum – Komite karşılaştırması

Katılımcıların neredeyse tamamı sıradan vatandaşların yeterince değerledirme yapmadan, biliçsiz ve gelişigüzel oy kullanacağını önesürerek yapay et gibi sosyobilimsel konularda karar verici olarak uzmanlardan oluşan bir komiteniyi savunmuştur. Bununla birlikte, yapay etin satışıyla ilgili kararı verecek komiteyi belirlemede Grup U'nun Grup S'ten daha yüzeysel bir tutum sergilediği görülmüştür. Grup U'nun en az yarısı komitede, karar vereci olarak eliştirdikleri sıradan vatandaşların ve yapay ette genetik müdahale olmadığını bildikleri halde genetikçilerin bulunmasını istemişitir. Ayrıca yapay ete ilişkin kendi ana kriterleri sağlık olmasına rağmen sağlık uzmanlarına komitede yer vermemiştir. Grup U üyeleri, yapay et üreten bilim insanlarını, bu etin ne kadar sağlıklı olduğunu en az sağlık uzmanları gibi ortaya koyabilecek donanımda görmektedirler. Anlaşılmıştır ki Grup U üyeleri genel olarak bilim insanlarına aşırı güven duymaktadır.

5. Tartışma ve öneriler

Bu çalışmanın bulguları üzerinden yapılandırılmış Karar Vermenin Fraktal Modeli üzerinden yapılan analizde görülmüştür ki, katılımcılar yapay et için ortaya koydukları 'alternatifler'i önce yapay etin ne olduğunu anlamada, karar verme ilerledikçe ise yapay etin etkinliğinin karşılaştırılmasında kullanmıştır. Bu durum Piaget'in kişi yeni bir bilgiyle karşılaştığında bu yeni bilgiyi varolan şemasına uydurmaya çalışır ve bu kişinin varolan şemasının gelişimine katsı sağlar ve yeni şemalar oluştur (Erden & Akman, 1995) teorisine uymaktadır. Anlaşılmıştır ki karar anında yapay et katılımcılar için artık kendine özgü bir besin ürünüdür.

Zeidler, Walker, Ackett, ve Simmons, (2002), Walker ve Zeidler (2003), Sadler, Chambers ve Zeidler (2004) bulugularıyla aynı doğrultuda olarak, bu çalışmada karar verme sürecinde NOS1 ve NOS7 mercek kullanımlarına dair doğrudan bulgulara rastlanmamıştır. Bununla birlikte özellikle Grup U'nun önyargı merceğini sıklıkla kullanmasında ve Grup S'in 'karar' düşünme alanında sağlılklılık kriterine ve risk faktör merceğine neredeyse hiç yer vermemesi üzerinden katılımcıların NOS1 anlayışlarının karar verme sürecini şekillendirebildiği kanısına varılmıştır. Bunun yanında, alanyazında bahsi geçen altı öncül çalışmanın bulgularından farklı olarak NOS3 ve NOS5 merceklerinin kullanımına dair güçlü bulgulara ulaşılmıştır. Bununla birlikte tüm katılımcıların karar verme sürecinde NOS4 merceği çok etkinken NOS2 merceğinin kullanımının sadece 'amaçlar' düşünme alanında etkin olduğu anlaşılmıştır. Ayrıca görülmüştür ki, tüm karar verme süreci boyunca Grup S üyeleri genellikle bilimin doğası anlayışlarına uygun olacak şekilde gelişmiş NOS mercekleri kullanmıştır. Fakat Grup U üyeleri bazı durumlarda kendi anlayışlarının aksi doğrultusunda NOS mercek kullanımı yapmıştır. Çalışmanın bulgularından yola çıkarak, bilimin doğasındaki hali kişinin hazırdaki alyaşından farklı şekilde NOS merceği kullanma sebeplerinin: (i) Grup U üyelerinin bilimin doğasının bazı boyutlarında gelişmiş anlayışlara da sahip olmaları, (ii) bazı bilimin doğası boyutlarındaki anlayışların karar verme sürecinde başka boyutlardaki NOS merceklerinin kullanımını etkilemesi, (iii) karar verme sürecinin ta kendisinin bilimin doğasına dair mercek kullanımını etkilemesi ve (iv) karar verilen konunun özelliklerinin NOS merceği kullanımını etkilemesi olabileceğine kanaat getirilmiştir. Bununla birlikte, tüm katılımcıların 'karar' düşünme alanında bilimin doğasına dair sadece NOS3 ve NOS4 mercekleri etkin olmuştur.

Sosyobilimsel konu olarak yapay etin ele alındığı bu çalışmadaki karar verme sürecinde bilimin doğası dışındaki kullanılan diğer merceklerden önyargı, öncelik ve ders deneyimi gibi bazıları ilk kez bu çalışma ile tanımlanmıştır. Doğanın dengesi, din, teknoloji'nin de içinde olduğu merceklerin büyük çoğunluğu ise alanyazınla pararleldir (Lederman & Bell, 2003; Sadler & Zeidler, 2004a; Halverson vd., 2009; Lee & Grace, 2012; Cebesoy 2014). Ayrıca Kortland (1996), Hogan (2002) ve Liu vd. (2010) çalışmalarından farklı ama Halverson vd. (2009), Lee ve Grace (2012) ve Cebesoy (2014) çalışmalarıyla benzer olarak karılımcıların karar verme sürecinde her düşünme alanında dair çoklu mercek kullnımı yaptıkları anlaşılmıştır. Bununla birlikte karar vermede en etkin merceklerin Bell ve Lederman (2003), Sadler ve Zeidler (2004a), Khishfe (2012), ve Cebesoy (2014) çalışmalarında belirtildiği gibi sosyalve ahlaki değerlendirmer içerenler oldukları tespit edilmiştir.

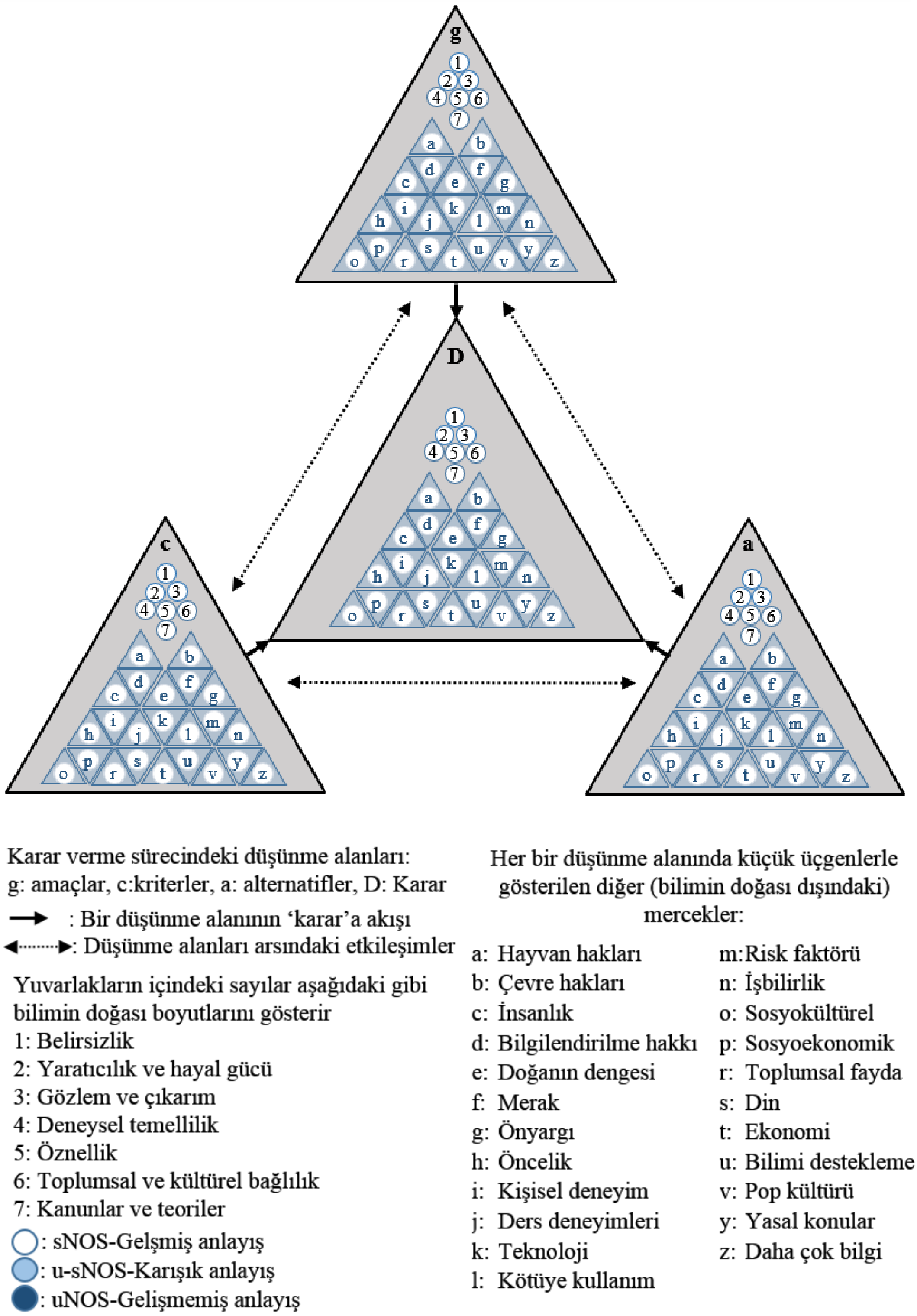
Katılımcıların büyük çoğunluğu yapay ete ilişkin referandumu EVET oyu vererek tamamlamıştır. Buyüzden aynı Lederman ve Bell (2003) ve Khishfe (2012) belirttiği gibi ilk bakışta Grup U ile Grup S arasında verdikleri oy bakımından bir fark olduğu söylenemez. Bu çalışma ile daha derinlemesine bakılarak EVET oyu veren Grup U üyelerinin tamamının rasyonel ritülaizm, Grup S üyelerinin neredeyse tamamının tam gaz ileri yaklaşımını karar verme stratejisi olarak kullandıkları anlaşılmıştır. Etzioni'ye (1989) göre bu iki strateji iyi bir karar vermek için çok kötü seçeneklerdir ve aslında yapılması gereken karma tarama stratejini işletmektir. Katılımcılardan karma tarama stratejisini işletenlerin tamamı referandumu HAYIR oyu vererek tamamlamıştır ve sadece bu kişiler 'karar'da gelişmiş bir NOS4 merceği kullanımı yapmışlardır ve bu katılımcılar varoldukları grubun bilimin doğası özelliklerini en az yansıtanlardan U5, U6 ve S5'tir. Diğerbir değişle bu katılımcıların bilimin doğasına dair genel görşleri birbirine yakındır ve üç grup oluşturlması halinde orta gelişmiş anlayışa sahip üyelerinden oluşan bir gruba dahil edilebilir. Bu durum bilimin doğasına dair gelişmişlik bakımından hibrit anlayışlara sahip kişilerin daha iyi kararlar verebilieceği ihtimaline ışık tutumuştur.

Katılımcıların neredeyse tamamı sosyobilimsel konularda referendum yerine bir komitenin karar vermesi gerektiğini belirtmiştir. Grup U'nun bilim insanlarına aşırı güven duymasının anlaşılması ile her ne kadar ‘karar’ düşünme bölgesinde bir etkiliği saptanamasa da anslında Grup U nun gelişmemiş NOS5 mercekleri ile tüm karar vereme sürecini geçirdiği kanaatine varılmışıtr.

Bu çalışmanın bulguları üzerinden gidilerek fen öğretmen adaylarının eğitiminde hem bilimin doğası hem de diğer epistemolojilerle ilgili bilgilendirmelerin yer aldığı (ki böylelikle öğrenciler daha bilinçli bir şekilde karar verme sürecinde control sahibi olacaklar ve bildgilendirmenin kaynağını anlayabilecekleri için karar vermede bilgileri yeniden düzenle becerisini kazanacaklar), ağırlıklı olarak internette araştırma içeren (ki böylelikle kendi doğal haber ortamları olan araştırma yapma becerilerini geliştirecekler), gerçek karar verme durumunu yansıtabilen bir karar vereme modeli üzerinden yürütülen (ki böylelikle öğrenciler karar vermenin bir süreç olduğunu idrak edip bu süreci en iyi şekilde yönetmeye dair beceriler geliştirecekler), özellikle odak grup görüşmeleri gibi teknikler ile derlenen öğrencilerin sosyobilimsel konulara ilşkin ilgilerinin gözönünde bulundurulduğu (ki böylelikle öğrencilerin dersteki katılımı artacak) karar verme derslerinine doğrudan yer verilmesi önerilmektedir.

Sosyobilimsel konularda bilinçli karar vermeyle ilgili kazanımların doğal ortamı fen programlarıdır çünkü böylesi karaların özü hayati bir şekilde bilimin doğası anlayışlarına bağlıdır. Bununla birlikte sosyobilimsel konularda karar verme pek çok merceği bir arada kullanmayı gerektirdiği için Türçe, İngilizce gibi dil dersleri, sosyal biligiler dersleri ve bilgi teknolohileridersleri gibi farklı disiplinleriden gelecek destek ayrıca çok öenmlidir. Buyüzden program geliştiricileri K-12 öğrencilerinin programlarında sosyobilimsel konulara ilişkin disiplinlerarası bağlantılar kurmalıdır. Öğrencilerin sosyobilimsel konulara ilişkin ilgilerini arttırmak için Türkiye ve dünya genelinden örneklerin yer aldığı ve ayrıca en azından her şehirden bir örnek olmak üzere yerel durumların da yer aldığı sosyobllimsel konulara dair etkinlikler içiren kitapçıklar hazırlanmalıdır. Bu etkinliklerden karar verme üzerine olanlar gerçek karar verme durumunu yansıtabilen karar verme modeli üzerinden yürütülmelidir. Yapay et sosoyobilimsel bir konu olarak ilk kez bu çalışmada ele alınmıştır ve yapay et ile ilgili sınıflarda yapılacak etkinliklerde Figür 5.1’de yer alan Karar Vermenin Fraktal Modeli denetim listesi kullanılabilir. Sınıflarda yürütülen etkinliğin gidişatına göre bu denetleme listesine yeni mercekler eklenebilir bazı mercekler çıkarılabilir. Karar Vermenin Fraktal Modeli'nin sınıflarda uygulanmasına ilişkin çalışmalar devam edecektir.

Derinlemesine veriler üzerinden keşifler yaparak öğrencilerin bilinçli karar vericiler olamasına daha yüksek bir katkı sağlamak için sosyobilimsel konularla ilgli eğitim alanında gelecekte yapılacak çalışmalarda 'karar verme' kendi doğasını yansıtacak şekilde süreç olarak ele alınmalıdır ve gerçek karar verme durumunu yansıtan bir model üzerinden yürütülmelidir.



Figür 5.1 Karar Vermenin Fraktal Modeli için bir denetleme listesi örneği.

APPENDIX I: TEZ İZİN FORMU

TEZ İZİN FORMU / THESIS PERMISSION FORM

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<u>**YAZARIN /** AUTHOR</u>

Soyadı / Surname : ADAL
Adı / Name : ELİF ECE
Bölümü / Department : İLKÖĞRETİM

<u>**TEZİN ADI /** TITLE OF THE THESIS</u> (**İngilizce** / English) : INVESTIGATION OF PRESERVICE SCIENCE TEACHERS' NATURE OF SCIENCE UNDERSTANDING AND DECISION MAKING ON SOCIOSCIENTIFIC ISSUE THROUGH THE FRACTAL MODEL

<u>**TEZİN TÜRÜ**</u> **/** <u>DEGREE</u>**:** **Yüksek Lisans** / Master **Doktora** / PhD

1. **Tezin tamamı dünya çapında erişime açılacaktır. /** Release the entire work immediately for access worldwide.
2. **Tez <u>iki yıl</u> süreyle erişime kapalı olacaktır.** / Secure the entire work for patent and/or proprietary purposes for a period of **<u>two years</u>. ***
3. **Tez <u>altı ay</u> süreyle erişime kapalı olacaktır.** / Secure the entire work for period of **<u>six months</u>**. *****

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