PRESERVICE SCIENCE TEACHERS' INFORMAL REASONING REGARDING SOCIOSCIENTIFIC ISSUES AND THE FACTORS INFLUENCING THEIR INFORMAL REASONING

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MUSTAFA SAMİ TOPÇU

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_____

Prof. Dr. Sencer AYATA
Director

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

_____

Prof. Dr. Hamide ERTEPINAR
Head of Department

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

Assist. Prof. Dr. Troy D. SADLER	Assist. Prof. Dr. Özgül YILMAZ-TÜZÜN
Co-Supervisor	Supervisor

Examining Committee Members

Prof. Dr. M. Yaşar ÖZDEN	(METU,CEIT)	_____
Assist. Prof. Dr. Özgül YILMAZ-TÜZÜN	(METU,ELE)	_____
Assist Prof. Dr. Troy Dow SADLER	(UF,STL)	_____
Assist. Prof. Dr. Ceren TEKKAYA	(METU,ELE)	_____
Assist Prof. Dr. Gaye TUNCER-TEKSÖZ	(METU,ELE)	_____

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Name, Last name : Mustafa Sami TOPÇU

Signature :

ABSTRACT

PRESERVICE SCIENCE TEACHERS' INFORMAL REASONING REGARDING SOCIOSCIENTIFIC ISSUES AND THE FACTORS INFLUENCING THEIR INFORMAL REASONING

Topçu, Mustafa Sami

Ph.D., Department of Elementary Education

Supervisor : Assist. Prof. Dr. Özgül Yılmaz-Tüzün

Co-Supervisor : Assist. Prof. Dr. Troy D. Sadler

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The main purpose of this study was to explore Preservice Science Teachers' (PSTs) informal reasoning regarding socioscientific issues (SSI). The study first investigated PSTs' informal reasoning patterns; second, explored the relationship between informal reasoning patterns and quality; third, examined the variation of informal reasoning quality with SSI; at last, focused on the factors influencing PSTs' informal reasoning in the context of SSI.

Totally, 39 PSTs voluntarily participated in the study. Senior elementary PSTs from a public university, in Ankara constituted the sample of this study. Seven SSI were used to explore informal reasoning and influencing factors. Three SSI dealt with gene therapy and, the other three issues dealt with cloning. The last issue dealt with global warming. PSTs'

informal reasoning and the factors influencing the participants' informal reasoning in the context of SSI were analyzed by using constant comparative data analysis method (Glaser & Strauss, 1967). Two interview protocols were used in the present study. Informal Reasoning Interview protocol focused on the investigation of informal reasoning, and Moral Decision-Making Interview protocol was used to identify informal reasoning and the factors influencing informal reasoning.

Emergent informal reasoning patterns from the present study were: rationalistic, emotive, and intuitive informal reasoning patterns. Regarding informal reasoning quality, across each SSI, the participants easily revealed claim with or without justification but they hardly developed counter-position and rebuttal. Emergent frequency of informal reasoning quality types followed the same order across each SSI. Thus, informal reasoning quality was not context-dependent across all SSI. Main factors influencing participants' informal reasoning were accumulated under four main categories; personal experiences, social considerations, moral-ethical considerations, and technological concerns.

Keywords: Informal Reasoning, Socioscientific Issues, Preservice Science Teachers, Factors Influencing Informal Reasoning

ÖZ

FEN ÖĞRETMEN ADAYLARININ SOSYOBİLİMSEL KONULAR HAKKINDAKİ KRİTİK DÜŞÜNME YETENEKLERİ VE BU YETENEKLERİ ETKİLEYEN FAKTÖRLER

Topçu, Mustafa Sami
Doktora, İlköğretim Bölümü
Tez Yöneticisi : Yrd. Doç. Dr. Özgül Yılmaz-Tüzün
Ortak Tez Yöneticisi : Yrd. Doç. Dr. Troy D. Sadler

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Bu çalışmanın ana amacı, sosyobilimsel konular hakkında fen öğretmen adaylarının kritik düşünme (informal reasoning) yeteneklerini araştırmaktır. Çalışmada ilk olarak fen öğretmen adaylarının kritik düşünme örüntüleri incelendi. İkinci olarak fen öğretmen adaylarının kritik düşünme örüntüleri ve bunların niteliği arasındaki ilişki sorgulandı. Üçüncü olarak fen öğretmen adaylarının kritik düşünme niteliğinin sosyobilimsel konuların içeriğine göre nasıl değiştiği incelendi. Son olarak da farklı sosyobilimsel konularla ilgili olarak öğretmen adaylarının kritik düşünme yeteneklerini etkileyen faktörlere odaklanıldı.

Çalışmaya Ankarada'ki bir devlet üniversitesinden toplam 39 fen öğretmen adayı gönüllü olarak katıldı. Kritik düşünme yetenekleri ve bu yetenekleri etkileyen faktörleri belirlemek için yedi sosyobilimsel konu kullanıldı. Bu konulardan üç tanesi gen terapisi ile ilgili iken üç tanesi de

klonlama ile ilgiliydi. Son konuda küresel ısınma ile ilgiliydi. Öğretmen adaylarının kritik düşünme yetenekleri ve bu yetenekleri etkileyen faktörler nitel bir veri analiz yöntemi olan sürekli kıyaslama (constant-comparative) analiz metoduyla belirlendi. Bu çalışmada iki tane görüşme protokolu kullanıldı. Kritik düşünme görüşme protokolu katılımcıların kritik düşünme yeteneklerini incelemek için kullanıldı. Ahlaki-karar verme görüşme protokolu ise katılımcıların kritik düşünme yeteneklerini ve bu yetenekleri etkiyen faktörleri belirlemek için kullanıldı.

Analizlerin sonucunda üç çeşit kritik düşünme örüntüsü ortaya çıkmıştır: akılcı (rationalistic), duygusal (emotive) ve sezgisel (intuitive) düşünme örüntüleri. Kritik düşünme yeteneklerinin niteliği hakkında ise, tüm sosyobilimsel konular için öğretmen adayları kolaylıkla iddialarını ve bu iddialarını destekleyen argümanlarını belirtmişlerdir. Fakat katılımcılar az sayıda kendi iddialarına karşıt iddialar ve bu iddiaları destekleyen argümanlar geliştirmişlerdir. Aynı zamanda, katılımcıların kritik düşünme niteliği tüm sosyobilimsel konular boyunca aynı eğilimi göstermiştir. Böylelikle, fen öğretmen adaylarının kritik düşünme niteliklerinin, sosyobilimsel konuların içeriğinden bağımsız olduğu bulunmuştur. Katılımcıların kritik düşünme yeteneklerini etkileyen faktörler ise dört ana kategoride toplanmıştır. Bunlar; kişisel deneyimler, sosyal faktörler, ahlaki-etik konular, ve teknolojiden duyulan endişelerdir.

Anahtar Kelimeler: Kritik Düşünme (Informal Reasoning), Sosyobilimsel Konular, Fen Öğretmen Adayları, Kritik Düşünmeyi Etkileyen Faktörler.

I dedicate this study to the five most important people in my life.

To my mother, Zeynep TOPÇU: You always encourage me to achieve everything.
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To my brother, İbrahim TOPÇU: You are the best friend in my life.
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ABBREVATIONS

SSI : Socioscientific Issues

STS: Science-Technology-Society

STSE : Science-Technology-Society-Environment

NOS : Nature of Science Conceptualization

TAP : Toulmin's Argumentation Pattern

IRI : Informal Reasoning Interview

MDMI : Moral-Decision Making Interview

RQ : Research Question

cGPA : Cumulative Grade Point Average

PSTs : Preservice Science Teachers

HD : Huntington's Disease gene therapy scenario

NS : Nearsightedness gene therapy scenario

IN : Intelligence gene therapy scenario

RC : Reproductive Cloning scenario

AC : Accident Cloning scenario

TC : Therapeutic Cloning scenario

GW : Global Warming scenario

EU : European Union

US : United States of America

CHAPTER 1

INTRODUCTION

Scientific knowledge is developing and renewing itself by the day considering the needs of the society. At the same time, social norms are acquiring a shape by being influenced from the scientific studies (Sadler & Zeidler, 2005b). It is clear that there is a close link between science and society.

1.1. Socioscientific Issues (SSI) and Informal Reasoning

Today's societal norms are confronting with recent scientific developments (Kolstø, 2006). The scientific developments regarding genetic engineering (gene therapy, cloning, and stem cells) and ecology (global warming) are some examples wherein science and society closely interact with each other. For example, advances in the field of industry parallel to scientific developments are causing several concerns in society about global warming. On the one hand, industrial field is developing and changing rapidly based on scientific developments. For example, plenty of new factories are opened, and many workers are working in the factories. When a factory is closed, these workers will lose their jobs. Human life depends on the factories because products produced by the factories may ease human life condition. In other words, people need these products to live better. Moreover, people need the factories due to their potential in providing jobs

to them. On the other hand, environment goes from bad to worse because the factories release several dangerous gases. Some of them such as carbon dioxide can cause global warming. When the factories continue to release these damaging gases, effects of global warming will be strengthened. In this example issue, some people may support the idea that the factories should be opened because of providing job opportunities and improving life standards. Another group of people may not support this idea because of having global warming. When we just focus on only global warming, this can also create opposing ideas in a society. For example, a group of people may consider global warming as a threatening event, others may consider as routine fluctuations of the world's seasons. Thus, scientific issues can create contradictory ideas in a society. These contradictory scientific issues may be named as dilemma. These dilemmas have been termed as socioscientific issues (SSI) because these issues include both social and scientific factors (Sadler, 2004). In other words, these issues represent social dilemmas associated with science (Fleming, 1986a; 1986b; Kolstø, 2001a, Patronis, Potari, & Spiliotopoulou, 1999; Sadler & Zeidler, 2005a; Zeidler, Walker, Ackett, & Simmons, 2002). Today, rapid developments in biotechnological area (e.g., cloning, gene therapy) and challenges in environmental area (e.g., global warming, land-use decisions) have created many dilemmas in society. Thus, these emergent dilemmas in society have taken many researchers' attention as appropriate context in order to study SSI. Recently many researchers conducted SSI research in genetic engineering (Ekborg, 2008; Jimenez-Aleixandre, Rodriguez, & Duschl, 2000; Walker & Zeidler, 2007; Zohar & Nemet, 2002), environmental issues (Kortland, 1996; Osborne, Erduran, & Simon, 2004; Patronis et al., 1999; Wu & Tsai, 2007), and other areas such as childhood leukemia, banning of smoking, and the effects of mobile phone use on health (Albe, 2008; Kolstø, 2006; Lee, 2007).

When people are confronted with the SSI, they try to develop opinions about these issues. To address these issues, people try to understand and suggest possible solutions to these issues. In other words, people try to resolve them. When they try to resolve these issues, they discuss and develop claims about the issues. In other words, they negotiate with the issue. Thus, it may be claimed that when people confronted with the SSI, they resolve and negotiate with the SSI. When people resolve and negotiate with these SSI, they use their cognitive processes characterized by informal reasoning (Sadler & Zeidler, 2004). In formal reasoning, premises are fixed and unchanging and conclusions are necessary derivates. In other words, assumptions or arguments or consequences about one issue are not flexible and straightforward. In informal reasoning, premises can changeable and conclusions are self-evident (Perkins, Farady, & Bushey, 1991). In other words, assumptions or claims or consequences about one issue is flexible and straightforward. Moreover, Evans (2002) summarized differences between formal and informal reasoning. In formal reasoning, premises and conclusions about one issue are explicitly stated; however, in informal reasoning, they are not clearly stated. Furthermore, formal reasoning is generally deductive while informal reasoning tends not to involve deductive reasoning. Last distinctive difference was that, in formal reasoning, reason supports conclusion; however, in informal reasoning, reason supports or against to conclusion. For example, regarding Huntington Disease illness, if parents use a gene therapy in order to overcome this illness before the child is not born, the child will not have this disease (Huntington Disease) in future. In formal reasoning, people think that if the parents use this therapy, the child will not have this disease. This example shows that premise is fixed, and conclusion is necessary derivation. However, in informal reasoning, people consider advantages and disadvantages of this gene therapy. In addition to rational thinking, they

may consider several conditions such as moral-ethical issues and emotions. In informal reasoning, on the one hand, people may claim that this therapy should be used because it is necessary to overcome this illness. On the other hand, they may claim that this therapy should not be used because it is not true with respect to morality. As seen in the example, each person may develop different premises, and their conclusion may depend on their self-evaluation. To sum up, "It [informal reasoning] underlies attitudes and opinions, involves ill-structured problems that have no definite solution, and often involves inductive (rather than deductive) reasoning problems" (Zohar & Nemet, 2002, p. 38).

Informal reasoning and SSI research have gained big momentum in recent years. In 1980s, Science-Technology-Society (STS) education was popular research area, and this approach was integrated into science curricula and textbooks. STS education aimed that students should conceptualize the relationship among science, technology, and society. However, in 2000s, in addition to this relationship, SSI approach has involved morality, personal experiences, and nature of science conceptualization (NOS) (Zeidler, Sadler, Simmons, & Howes, 2005). In other words, this approach have presented more comprehensive framework in order to educate scientifically literate students. Scientific literacy involves not only the understanding of scientific knowledge, but also make informed decision making regarding SSI (Sadler & Zeidler, 2005a). Moreover, important science education organizations (American Association for the Advancement of Science, 1990; National Research Council, 1996; Queensland School Curriculum Council, 2001) stated that students should have the ability to discuss, analyze, and make decisions about SSI. These abilities privately making decisions regarding these issues were named as socioscientific decision making in SSI literature. Since the improvement of

scientific literacy is one of the main goals of science education and socioscientific decision making is an important part of scientific literacy, it is necessary to explore how students develop their decisions regarding SSI.

At this point, exploring Preservice Teachers' especially Preservice Science Teachers' (PSTs) informal reasoning gained special importance because they were ideal candidates to teach SSI to students and to integrate SSI into science curricula. Ekborg (2005) claimed that during their undergraduate education, Preservice Science and Mathematics Teachers did not develop sufficient conceptual understanding to be able to resolve and negotiate with one SSI including environment. The author had also suspects whether these teachers would be able to improve their students' conceptual understanding or not. In addition to improving students' conceptual understanding, improvement of students' informed decision-making regarding SSI is necessity to educate scientifically literate students. Although Ekborg (2005) claimed that Preservice Teachers have not had sufficient content knowledge, in the present study, PSTs' content knowledge was assumed in adequate level, and as a next step, PSTs informal reasoning was explored. In the process of investigation of PSTs' informal reasoning, their argumentation skills were also explored.

If science education aims to promote students' argumentation skills, science classrooms are ideal contexts to achieve this aim. However, Duschl and Osborne's (2002) and Sadler's (2006) studies concluded that general trend in science classrooms, where the teacher talks and the students' talk is not supported, must be changed. "A reasonable place to advocate and promote this kind of change is science teacher preparotary programs" (Sadler, 2006, p. 324). Before the promotion of argumentation, it is necessary to investigate PSTs' argumentation skills to understand the

current condition of PSTs with respect to their argumentation skills. Therefore, in the present study, PSTs' argumentation skills as expression of informal reasoning was investigated to shed light upon socioscientific research to promote these skills.

1.2. Assessment of Informal Reasoning in the Context of SSI

In socioscientific literature, there were several assessment types of informal reasoning. In other words, different frameworks were developed to understand the representation of informal reasoning. While some of the researchers assessed informal reasoning as pattern (Sadler & Zeidler, 2005a), other researchers assessed informal reasoning as mode (Patronis et al., 1999; Yang & Anderson, 2003). For example, Sadler and Zeidler (2005b) studied with undergraduate students in the context of genetic engineering issues and stated three informal reasoning patterns: rational, emotional, and intuitive informal reasoning. Rationalistic informal reasoning included reason-based thinking; emotive informal reasoning included empathy and sympathy; and intuitive informal reasoning pattern reflected gut-level reactions to the SSI. Yang and Anderson (2003) studied with senior high school students in the context of nuclear energy usage and claimed three reasoning modes: scientifically oriented, socially oriented, and equally disposed reasoning modes. While scientifically oriented students made their decision depending on scientific information, socially oriented students made decision depending on social factors. The equally disposed students' reason depended on both on scientific information and social factors together (Yang & Anderson, 2003). Patronis et al. (1999) studied with 14-year-old students in the context of road construction issue and described four modes of informal reasoning: social, ecological, economical, and practical modes. The students developed reasoning based

on social, ecological, economic or practical aspects of the situation. Furthermore, regarding this issue, the students had several dilemmas between development versus conservation of natural environment, society versus nature, money versus human values, and personal happiness versus benefit for all. As observed in the socioscientific literature, many frameworks were developed in order to assess informal reasoning. In the present study, all frameworks were considered by the researcher.

Sadler and Zeidler (2005b) claimed that "assessments of informal reasoning can focus on at least two unique features: quality and patterns" (p. 73). They claimed that in addition to informal reasoning patterns, informal reasoning quality is another important characteristic of informal reasoning. Thus, in addition to informal reasoning modes or patterns, informal reasoning quality was explored in the present study.

In science education area, there is plenty of research assessing informal reasoning quality with argumentation theory and research. In general, these studies used Toulmin's (1958) or Kuhn's (1991) model of argumentation as a philosophical exploration of argumentation. Kuhn's (1991) argumentation theory was mainly affected by the Toulmin's (1958) Argument Pattern (TAP), which provides a framework to analyze argument structure consisting of claims, data, backings, warrants, and rebuttals. Van Eemeren (1995) defined the argumentation as "argumentation is a social, intellectual, verbal activity serving to justify or refute an opinion, consisting of statements directed towards obtaining the approbation of an audience" (p. 146). Erduran, Simon, and Osborne (2004) explained argumentation components (claims, data, backings, warrants, and rebuttal) and relationships among these concepts as: "TAP illustrates the structure of an argument in terms of an interconnected set of a claim; data that supports that

claim; warrants that provide a link between the data and the claim; backings that strengthen the warrants; and finally, rebuttals which point to the circumstances under which the claim would not hold true" (p. 918). It may be claimed that argumentation is an approach investigating how people make and support their claims regarding one issue.

Although TAP was used by several science education researchers (e.g., Jimenez-Aleixandre et al., 2000; Osborne et al., 2004; Zohar & Nemet, 2002), this theory has several limitations (Erduran et al., 2004; Sadler & Fowler, 2006). Sadler and Fowler (2006) claimed that TAP can be only applied to group discussions to identify what counts as data, warrants, and backings. In other words, this condition can be problematic for individual discussions regarding SSI. Kelly, Druker, and Chen (1998) had difficulty in the clarification of what counts as claim, data, warrant, and backings in their studies. In other words, they had conceptual difficulty to differentiate them from each other. Even tough the several critiques about TAP have been raised, in this study, the rubric in order to assess argumentation was developed based on TAP. This rubric included some components of TAP such as claim, rebuttal. Moreover, it involved theory of TAP. The developed rubric consisted of claim, justification, counter-position, and rebuttal which were able to separate from each other. In other words, it was easy to differentiate them conceptually from each other. In addition, the participants' argumentation skills were able to explore individually with this rubric.

Starting from the 1990s, TAP theory and research have gained importance and popularity as a theme and approach for science education research. Several science education researchers investigated argumentation skills in the context of different SSI (e.g., Albe, 2008; Ekborg, 2008;

Jimenez –Aleixandre et al., 2000; Kortland, 1996; Lee, 2007; Patronis et al., 1999; Zohar & Nemet, 2002). While some researchers (Kortland, 1996; Walker & Zeidler, 2007; Zohar & Nemet, 2002) conducted the intervention studies to improve argumentation skills, some researchers (Jimenez–Aleixandre et al., 2000; Lee, 2007; Patronis et al., 1999) directly explored argumentation skills in the context of different SSI. For example, Kortland (1996) conducted intervention study in order to investigate middle school students' argumentation patterns about environmental issues including waste management. Patronis et al. (1999) assessed middle school students' argumentation skills using environmental issues. Both Kortland (1996) and Patronis et al. (1999) studied with middle school students in the context of environmental issues. However, they reached different results. Kortland (1996) found that students had difficulty in developing well-substantiated arguments although explicit instruction regarding argumentation and SSI was conducted in the study. On the contrary, Patronis et al. (1999) found that students were able to develop well-substantiated arguments about environment issues. In the present study, while sophisticated argumentation skills refer to well-substantiated argumentation skills, naïve argumentation skills refer to not well-developed argumentation skills.

In addition to environmental issues, some researchers (Ekborg, 2008; Jimenez–Aleixandre et al., 2000; Walker & Zeidler, 2007; Zohar & Nemet, 2002) explored argumentation skills with genetics engineering issues. For example, Jimenez -Aleixandre et al. (2000) studied with the ninth-grade students to investigate their argumentation skills regarding a genetics issue. Zohar and Nemet (2002) conducted intervention study with ninth-grade students in order to explore their argumentation skills in the context of genetics issues. Jimenez –Aleixandre et al. (2000) reported that the students did not develop well-substantiated argumentation skills regarding this issue.

However, Zohar and Nemet (2002) explored that the students showed sophisticated argumentation skills. In this study, intervention might have been effective in development of students' argumentation skills.

According to the research mentioned so far, some researchers studying in the context of environment issues explored either sophisticated (well-substantiated) argumentation skills (Patronis et al., 1999) or naïve (not well-substantiated) argumentation skills (Kortland, 1996). Some researchers studying in the context of genetics issues also explored both sophisticated argumentation skills (Zohar & Nemet, 2002) and naïve argumentation skills (Jimenez–Aleixandre et. al., 2000). In addition to environment and genetics issues, some researchers used other SSI (e.g., the effects of mobile phone use on health, banning of smoking) in order to explore students' argumentation skills (Albe, 2008; Kolstø, 2006; Lee, 2007). For example, Kolstø (2006) studied 22 students' argumentation skills in the context of power transmission lines and childhood leukemia issues. In response to power transmission lines and childhood leukemia issues, participants developed five different types of main arguments which are identified as: the relative risk argument, the precautionary argument, the uncertainty argument, the small risk argument, and the pros and cons argument. Socioscientific literature showed that there has not been any consistent pattern of people's argumentation skills as the indication of informal reasoning quality with respect to different SSI and methodological approaches (e.g., experimental study, survey study). Thus, how participants' informal reasoning quality varies with different SSI was one gap in the current socioscientific literature. In line with this argument, in the present study, seven SSI were used in order to investigate informal reasoning. When six SSI were related to genetic engineering, one SSI was related to global warming. In this study, the main aim was to investigate PSTs' informal

reasoning in the context of genetic engineering issues. However, considering the inconsistency about the changing of argumentation skills with different SSI, one environmental issue was added to the present study in order to explore the variation of informal reasoning quality with different SSI. However, one environment issue was used in this study because it was hard to compensate the frequency of SSI, and the researcher would need extra much time and effort in order to study with too much SSI.

1.3. Factors Related to Informal Reasoning

According to the socioscientific literature, it may be claimed that there are mainly four variables influencing informal reasoning; personal experience (Albe, 2008; Bell & Lederman, 2003; Sadler & Zeidler, 2004; Sadler et al., 2004), understanding of NOS (Bell & Lederman, 2003; Sadler, Chambers, & Zeidler, 2004; Walker & Zeidler, 2007; Zeidler et al., 2002), moral perspective (Bell & Lederman, 2003; Fleming,1986a, 1986b; Pedretti, 1999; Sadler & Zeidler, 2004; Zeidler & Schafer, 1984), and content knowledge (Albe, 2008; Fleming, 1986b; Hogan, 2002; Sadler, 2003; Zeidler & Schafer, 1984). For example, Sadler (2003) focused on the role of content knowledge and morality in informal reasoning. He found that while morality was related to participants' informal reasoning pattern, content knowledge was not related to informal reasoning pattern. In the same study, Sadler (2003) found that content knowledge was related to informal reasoning quality. Bell and Lederman (2003) studied with the 21 university (across the USA) professors, and categorized their decision making factors by considering their responses to SSI. The researchers divided the university professors' into two groups based on their divergent views of NOS. According to this research, it was concluded that NOS affected neither group's decision making regarding four SSI (fetal tissue implantation;

global warming and green house gas emissions; diet, exercise, and cancer; cigarette smoking and cancer). In two groups, participants' decisions about these issues were influenced by their personal values, moral perspective, and social concerns. In spite of the fact that previous research revealed the variables related to informal reasoning, there is not any specific research on determining factors influencing people's informal reasoning in the framework of this study. The research about the factors influencing people's informal reasoning gains special importance in order to make valuable contribution to socioscientific literature. Hence, the other concern of this study was to investigate the factors influencing people's informal reasoning regarding SSI.

1.4. Research Questions

Research Question 1 (RQ1): What kind of informal reasoning patterns (i.e., rationalistic, emotive, and/or intuitive) do PSTs use as they negotiate multiple SSI?

Research Question 2 (RQ2): How does the quality of informal reasoning demonstrated by PSTs, as they negotiate SSI, vary as a function of informal reasoning patterns?

Research Question 3 (RQ3): How does the quality of informal reasoning vary as PSTs negotiate with different SSI?

Research Question 4 (RQ4): What factors influence PSTs' informal reasoning as they negotiate with multiple SSI?

1.5. Significance of the Study

There are mainly three reasons to conduct the present study;

1. In this study, two representation types of informal reasoning (informal reasoning pattern and informal reasoning quality) were explored regarding seven SSI. While informal reasoning pattern is related to rationalistic, emotional, and intuitive responses to SSI, informal reasoning quality is related to how people can develop argumentation skills about these issues. Informal reasoning pattern investigates types of informal reasoning (rationalistic, emotive, and intuitive), but informal reasoning quality investigates the quality of arguments, claims, and conclusions. Thus, investigating the relationship between these two important constructs leads a better understanding about informal reasoning, because these constructs are two different assessment types of informal reasoning. When informal reasoning is better understood, science educators and researchers may conduct further research about improvement of informal reasoning. Furthermore, science curriculum developers may integrate SSI in science curriculum considering informal reasoning. Thus, the more informal reasoning is understood, the more future research and curricular advances will be achieved to improve informal reasoning in educational contexts.

2. In general, research on informal reasoning and informal reasoning quality has been conducted in Western countries (Albe, 2008; Ekborg, 2008; Jimenez-Aleixandre et al., 2000; Kolstø, 2001b; Kortland, 1996; Patronis et al., 1999; Tytler, Duggan, & Gott, 2001) and USA (Bell & Lederman, 2003; Hogan, 2002; Sadler et al., 2004; Zeidler & Schafer, 1984; Zeidler et al., 2002). Culture may be effective in shaping people's informal reasoning. People in different cultures may develop different informal reasoning patterns in response to different SSI. In other words, different cultures (West

and East culture) may have different social norms affecting people's decision making about SSI. Turkey may be called as a bridging country between east and west. It carries both east and west social norms. Hence, to investigate Turkish participants' informal reasoning contributes to socioscientific literature by bridging about a cultural perspective.

3. The present study's sampling carries special importance to make contribution to socioscientific literature. This study's sampling consists of PSTs who are ideal candidates to teach SSI, and to advance students' informal reasoning in science classrooms. Since SSI include society related science contents, science classrooms are appropriate environments to teach SSI. Because of these reasons, PSTs' informal reasoning gains special importance. When PSTs are aware of their own informal reasoning and importance of teaching SSI, they may improve their students' informal reasoning, and they may teach SSI more consciously. As a result, during teacher education programs, PSTs' informal reasoning should be explored.

CHAPTER 2

REVIEW OF LITERATURE

The main purpose of this study was to investigate PSTs' informal reasoning in the context of SSI. In addition to the main focus, the factors influencing PSTs' informal reasoning and changing of informal reasoning quality with multiple SSI and informal reasoning patterns were explored in this study. In this section, first, theoretical framework of this study was introduced, and science-related social issues and its relation to informal reasoning were discussed. Second, two main characteristics of informal reasoning (informal reasoning pattern and quality) were introduced. Last, in light of the literature, factors influencing informal reasoning were examined in detail.

Figure 2.1 represents the theoretical framework of this study. In this framework, informal reasoning was the main issue to be focused and investigated. Informal reasoning had two main characteristics (Sadler & Zeidler, 2005b) which were informal reasoning patterns and informal reasoning quality. In line this framework, these two main characteristics were investigated. Informal reasoning patterns were related to rationalistic, emotive, and intuitive thinking. Informal reasoning quality (argumentation) was related to expression of informal reasoning. Since informal reasoning was expressed through argumentation, the relationship between informal reasoning and argumentation was established in the framework of this study.

Thus, the assessment of informal reasoning was provided with the informal reasoning patterns and argumentation. The factors influencing informal reasoning were also part of the framework of this study. Socioscientific literature showed that there are several variables (e.g., moral consideration, personal experience, social consideration) related to informal reasoning (Bell & Lederman, 2003; Sadler & Zeidler, 2005a). These researchers explored the factors related to informal reasoning when they investigated informal reasoning in the context of different SSI. However, exploration of the factors influencing informal reasoning in the border of this framework provided uniqueness for the present study. Moreover, exploration of these factors in detail provided better understanding about informal reasoning because people's informal reasoning was influenced by these factors.

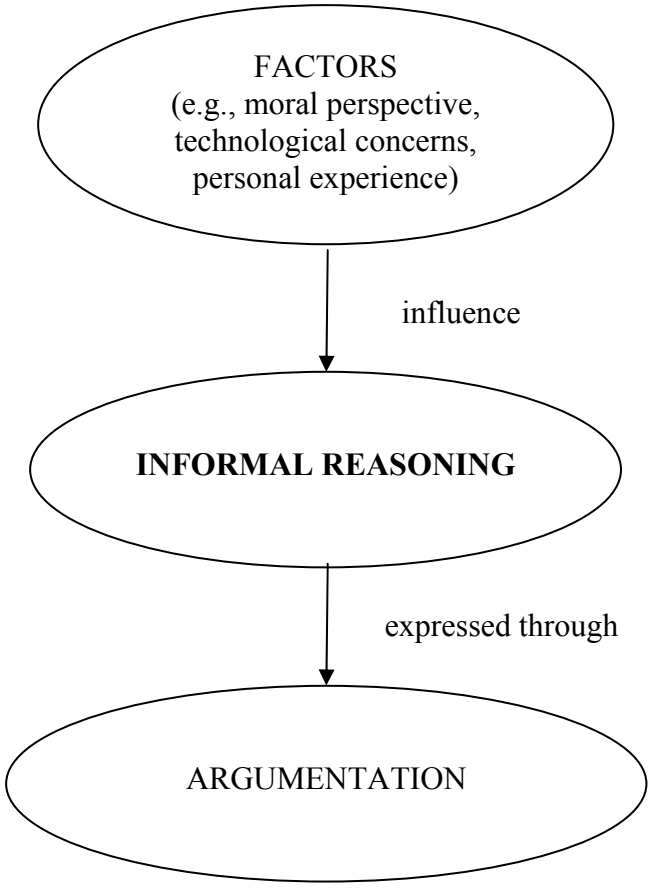

Figure 2.1: Theoretical Framework of the Study

2.1. New Approach to Study Science-Related Social Issues

In the last period of 20th century, researchers in science education have reached the consensus that science can be better understood with the consideration of the society. Thus, it is claimed that there is a considerable relation between science and society. In addition to society, science is also related to technology and environment. Several approaches have been developed in order to reveal the relationship among science, technology, society, and environment.

Zeidler et al. (2005) summarized the science-related social issues in the historical development. In the 1970s, many science education researchers had reached the consensus that there were combined influences among science, technology, and society. They also accepted that science would be more meaningful if the students understood the science in the context of technology and society. They named this approach as science-technology-society education (STS). In 1980s, STS education had become diffuse over the science course and textbooks. In STS approach, science-society interconnections were emphasized and science-related social issues were focused (Kolstø, 2001a). Furthermore, in this approach, connection of science and technology in students' social world were focused to supply for collateral learning (Zeidler & Keefer, 2003). However, STS approach was not exciting or relevant to the students because this approach did not consider students' everyday personal experiences regarding science-related issues (e.g., genetic cloning, nuclear power) (Shamos, 1995). Following the STS approach, some science educators (Hodson, 1994; Pedretti, 1999) supported the science-technology-society-environment (STSE) education that it was a more developed condition of STS education. This approach investigated science in a larger social, cultural, and political context (Zeidler

& Keefer, 2003). Despite the fact that this approach focused on the ethical dilemmas such as the moral concerns in genetics engineering issues or controversies such as contradictory opinions in gene cloning issues, it did not give enough importance to pedagogical power of discourse, reasoned argumentation, explicit nature of science (NOS), emotive and cultural development of students.

Since the study of SSI was conceptually related to STS education, a brief historical development of STS education had been given in above paragraph. As understood from the Zeidler et al.'s (2005) summary above, there were several critiques regarding the STS and STSE approaches. Thus, science educators needed to develop a new approach named as SSI (see Figure 2.2).

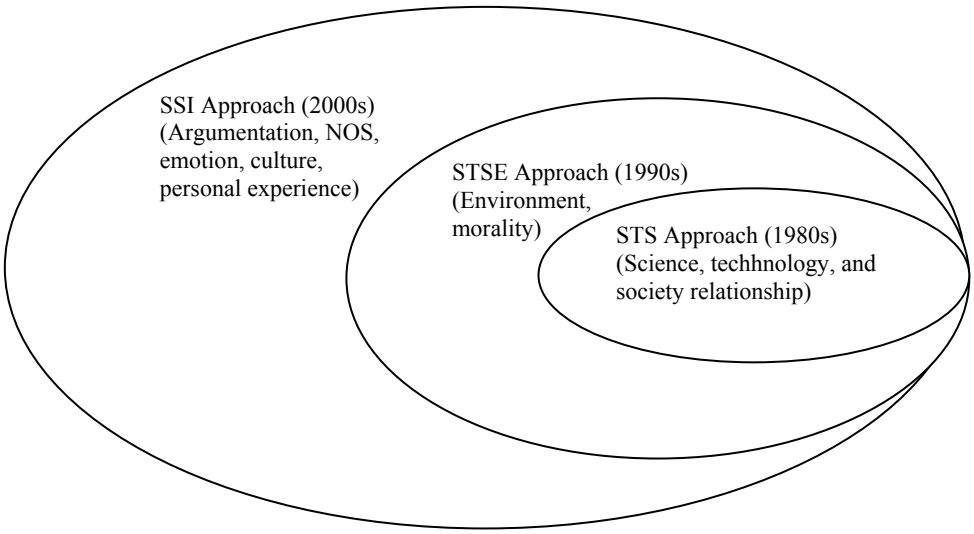

Figure 2.2: Historical and Conceptual Relationships among Science-Related Social Approaches

Social issues related to science have taken an important place in the recent developing science education research area. Cloning, stem cells, genome projects, global warming, and alternative fuels have become important issues considered with respect to interaction between science and society. Because of the role of both social and scientific factors in these issues, they have been termed as SSI (Sadler, 2004). On the one hand, these issues included scientific claims and arguments in addition to political, personal, and ethical perspective (Kolstø et al., 2006). On the other hand, they combined societal interest, effect, and consequences (Sadler, 2004) in addition to the scientific aspect of SSI. Moreover, these issues were generally controversial in their own nature and they were the typical issues reported in media (Kolstø, 2001a). These controversial issues were likely to be confronted with people's daily life and these issues frequently included disagreements or dilemmas related to science- related claims (Kolstø, 2001a).

SSI approach characterized a reconceptualization of STS approach, and it focused on not only social dimension of science and technology but also on students' personal experiences and belief systems (Zeidler et al., 2005). Although STS focused on the impact of science and technology on society, it did not investigate the moral and ethical issues and emotional aspects of learning science (Sadler & Zeidler, 2005a; Zeidler et al., 2005). The biggest critique regarding STS and STSE approach was that they had a limited theoretical framework (Hodson, 2003; Jenkins, 2002; Shamos, 1995, Zeidler et al., 2005). The SSI movement developed the theoretical framework that integrated moral and epistemological orientations and considered the role of emotions and characters in science education context (Sadler, 2004; Zeidler & Keefer, 2003). In summary, SSI provided the individuals with cognitive, emotional, and social development in the context

of their decision-making. In addition, decision making on these issues had important role in the promoting of scientific literacy (Bingle & Gaskell, 1994; Zeidler & Keefer, 2003). Thus, scientific literacy was defined by SSI researchers as developing students' ability to discuss and interpret evidence and draw conclusions in the context of SSI (Sadler & Zeidler, 2005a). It was accepted that scientifically literate persons should have made thoughtful decisions regarding SSI (Kolstø et al., 2006). Since the promoting of scientific literacy was the basic goal of science education and socioscientific decision making was an integral component of this goal, it was necessary to understand how people negotiated and resolved SSI (Sadler & Zeidler, 2005a). To achieve this, in socioscientific decision making process, students needed to develop their discussion, interpretation, and drawing conclusion abilities regarding SSI. When students confronted with controversial dilemmas in science lessons, they would use processes and patterns about these dilemmas. In other words, while students negotiated for these dilemmas, they would use some cognitive or emotional processes such as rational, emotional, or intuitive. Thus, negotiation and resolution of SSI might be effective in promoting individuals' multiple development (rational, emotive, social, content knowledge, nature of science conceptualization etc.) by educating scientifically literate students.

2.2. Informal Reasoning and Its Relation to SSI

Evans (2002) defined the reasoning as the process of constructing and evaluating arguments. When we consider reasoning, we generally think about logic. In other words, we think about accepting consequences, and rejecting previous knowledge about an issue (Perkins, et al., 1991). Moreover, in the historical development of science, reasoning was generally examined in the context of logic and mathematics and equaled to formal

reasoning (Sadler, 2004). T. S. Kuhn (1962) challenged the significance of formal reasoning in science and also stated that although formal reasoning might contribute to scientific discovery, it was not enough for producing progress about one issue. Moreover, Tweney (1991) stated that while science results were presented in formal reasoning language with heavy reliance on logic, these results themselves stemmed from informal reasoning. To understand informal reasoning more clearly, Perkins (1985) summarized three differences between formal reasoning and informal reasoning in technical language. (1) Whereas, in formal reasoning, premises (assumptions or preconditions) were given and they are certain, in informal reasoning, one might add or subtract from the premises and one might think critically. (2) In formal reasoning, well-formed arguments were used and arguments were deductive in nature. However, in informal reasoning, arguments could be constructed on both side of the scenarios and each one might be probabilistic and they were inductive in nature. (3) In formal reasoning, since steps were deductive, arguments were frequently "long chain" character, as in many mathematical proofs. In informal reasoning, arguments were like a bush with many short branches not with single and long branches.

In education literature, informal reasoning has been defined as a concept by several researchers. Sadler (2004) stated that informal reasoning included a person's ability to generate and evaluate the complex issues without presenting clear-cut solutions. Moreover, Zohar and Nemet (2002) described the concept: "Informal reasoning involves reasoning about causes and consequences and about advantages and disadvantages, or pros and cons, of particular propositions or decision alternatives. It underlies attitudes and opinions, involves ill-structured problems that no definite solution, and often involves inductive reasoning problems" (p. 38). Means and Voss

(1996) stated that informal reasoning gained importance when the problems were more discussable, complex, ill-structured, and open-ended. Since SSI were ill-structured, debatable, and open-ended in their own nature, these issues were the perfect selection for the application of informal reasoning (D. Kuhn, 1993). In addition, SSI were generally difficult to interpret for individuals (Sadler & Zeidler, 2005b). As a result, the resolution and negotiation of such complex problems could be characterized generally by the process of informal reasoning.

2.3. Informal Reasoning Characteristics (Informal Reasoning Patterns and Quality)

The main aim of this study was to investigate PSTs' informal reasoning in the context of SSI. Assessment of informal reasoning could focus on two unique characteristics (Sadler & Zeidler, 2005b). These were informal reasoning patterns and informal reasoning quality. The term "informal reasoning patterns" stemmed from Sadler and Zeidler's (2005a) study when they explored people's informal reasoning in the context of SSI. In these studies, participants developed three distinctive patterns of informal reasoning: rationalistic, emotive, and intuitive (Sadler & Zeidler, 2005a; 2005b). Rationalistic informal reasoning included reason-based thinking. This thinking subsumed utilitarian principles, cost-benefit issues, and rational assessment of technology. Emotive informal reasoning included implementation of emotions such as empathy and sympathy. This type of informal reasoning focused on the human elements of the issues. However, this mode of informal reasoning should have not been considered as irrational. In other words, it might reflect rational thinking processes. Intuitive informal reasoning pattern reflected the unexplainable immediate reactions to the socioscientific contexts (Sadler & Zeidler, 2005a). While

rationalistic informal reasoning could be assessed as rational pattern, emotive and intuitive informal reasoning patterns could be assessed as affective patterns.

In addition to "informal reasoning patterns" framework, there were several taxonomies for the analysis of informal reasoning in the socioscientific literature. Table 2.1 shows these different taxonomies.

Table 2.1: Some Taxonomy for the Analysis of Informal Reasoning

The Studies	Informal Reasoning Representation Types
Sadler and Zeidler (2005a, 2005b)	Informal reasoning patterns (rationalistic, emotive, and intuitive)
Yang and Anderson (2003)	Informal reasoning modes (scientific-oriented reasoning and social-oriented reasoning)
Patronis et al. (1999)	Informal reasoning modes (social, ecological ,economic, and practical)

Yang and Anderson (2003) investigated senior high school students' cognitive orientation toward scientific or social information and associated preferential reasoning modes when they engage with an environmental issue concerning nuclear energy usage. The students revealed three reasoning modes: scientifically oriented, socially oriented, and equally disposed reasoning modes. While scientifically oriented students' reason depends on scientific information, socially oriented students' reason depends more on social factors than on scientific evidence. The equally disposed students used diverse sources of information to form their reasons (Yang & Anderson, 2003). In other words, their reason depends both on scientific information and social factors partially. For example, in response to the question which was "what do you think caused the fish to die?", one of the scientifically oriented students answered that "the cause was probably the wastewater because the amount of radiation humans can take might be very different from what the fish can take." (p. 228). One of the socially-oriented

students answered that “I believe it was the plant which caused the death....because I was a member of ‘Debate Society’ club in school, and we had discussed the issue. Besides, we once visited a nuclear power plant and found the plant unsafe...” (p. 228). One of the equally-oriented students answered that “I think the plant had something to do with the death....if farm water is released suddenly, the fish can’t adapt themselves to the temperature and as a result, they might die...” (p. 229). These interview excerpts showed that scientifically-oriented students used scientific information, socially oriented students used personal experiences and beliefs, and equally-oriented students used both of them to make decision about the environmental issue (Yang & Anderson, 2003).

Patronis et al. (1999) described four modes of informal reasoning: social, ecological, economical, and practical modes in response to road construction issue. They considered reasoning as a type of thought based on social, ecological, economic or practical aspects of the situation. “These [reasoning modes] mainly imply values which are sometimes expressed in pairs of contrasting directions: development versus conservation of natural environment, society versus nature, money versus human values, personal happiness versus benefit for all” (p. 748). For example, students proposed the solutions regarding transporting of the road. The road had to pass through the bog and only a few trees would be cut down. Students proposed some arguments; “Should we care about trees or about students?” (p. 748). The value-conflict was revealed among the students regarding the selection of human welfare or respect for nature in this issue.

As observed in the socioscientific literature, the researchers represented informal reasoning with different representation types. Depending on different SSI, the researchers developed different

representation types to explain students' decision making. For example, regarding the road construction issue, students proposed the solutions based on social, ecological, economic or practical aspects of the situation (Yang & Anderson, 2003). On the other hand, regarding genetic engineering issues, students revealed rationalistic, emotive, and intuitive reasoning patterns. When social, ecological, economic or practical aspects formed students' decision making regarding road construction issue, rationalistic, emotive, and intuitive thinking formed students' decision making regarding genetic engineering issues. Therefore, it might be claimed that the researchers developed different informal reasoning frameworks depending on their context of the study.

As previously mentioned, another characteristic of informal reasoning was informal reasoning quality. Kuhn (1991) developed an argumentation model where informal reasoning quality was defined with respect to coherence, internal consistency, and the ability to perceive multiple perspectives. For example, a person may develop sophisticated argumentation skills (informal reasoning quality) when this person develops coherent arguments and analyzes arguments from multiple perspectives (Sadler & Zeidler, 2005b). In addition, Toulmin (1958) developed a framework named as Toulmin's Argumentation Pattern (TAP). To develop appropriate informal reasoning quality rubric for this study, both Kuhn's (1991) and Toulmin's (1958) frameworks about informal reasoning quality (argumentation) was examined. Table 2.2 presents classifications for the analysis of informal reasoning quality in socioscientific literature.

Table 2.2: Classifications for the Analysis of Informal Reasoning Quality

Sadler (2003)	Kuhn (1991)	Toulmin (1958)
Position	Causal theory	Claim
Rationale	Evidence	Data; Warrants
Counter-position	Alternative theories; Counterarguments	Rebuttal
Rebuttal	Rebuttal	

"Informal reasoning quality" was generally presented as "argumentation" in the socioscientific literature. Because of this reason, it is necessary to give information about argumentation and informal reasoning and to address individuals' argumentation skills in the context of different SSI in line with the socioscientific literature. In science education literature, although informal reasoning can be expressed through argumentation (Driver, Newton, & Osborne, 2000; van Eemeren, 1995), Sadler and Zeidler (2005b) stated that informal reasoning and argumentation represent unique constructs. While informal reasoning refers to cognitive and affective processes in the solution of complex issues, argumentation refers to expression of informal reasoning. They also claimed that strong argumentation reveals strong informal reasoning. However, weak argumentation denotes weak informal reasoning.

There have been several research on students' decision making in the context of SSI (e.g., Kolstø, 2006). Most of them showed that science learning did not include only learning scientific contents, but also it included scientific argumentations in classrooms (e.g., Driver et al., 2000; Duschl, 1990; Jimenez-Aleixandre et al., 2000; Kuhn, 1993). Thus, it is necessary to focus on what is argument. In the historical development of science education, the logic and argument have been accepted as close concepts; however, the difference between these concepts should be explained as: "Whereas logic is seen as an academic discipline that presents decontextualized rules for relating premises to conclusions, arguing is a

human practice that is situated in specific social settings" (Driver et al., 2000, p. 290). At this point, argument can be perceived with respect to two ways. In one way, argument may be individual activity that a person thinks and writes and another way, argument may be social activity that person may negotiate with a special group (Driver et al., 2000).

In the education literature, there are two main explanations about the argument. Driver et al. (2000) stated that first definition in Oxford English Dictionary is "advancing a reason for or against a proposition or course of action." Authors also stated that this interpretation of argument was termed as "rhetorical" by Kuhn (1992) or "didactic" by Boulter and Gilbert (1995). In this definition, argument was used to persuade or tell a person about an issue. However, this form of argument was limited because this argument included one-way interaction. The second definition included "constructing an argument involves considering alternative positions" (Driver et al., 2000, p. 291). This type of argument was termed as "diological" or "multivoiced" and in this type of argument, person examined different perspectives (Driver et al., 2000). In addition to these definitions, recently two definitions of argumentation have gained popularity among the science educators. First, van Eemeren et al. (1996) defined argumentation as; "It [argumentation] is a verbal and social activity of reason aiming at increasing (or decreasing) the acceptability of a controversial standpoint for the listener or reader, by putting forward a constellation of propositions intended to justify (or refute) the standpoint before a rational judge" (p. 5). Second, Zohar and Nemet (2002) defined argumentation as a field of research area which is related to how a person asserts and justifies claims, reasons and conclusions. Both definitions were related to how people revealed their opinions and justified or refuted these opinions. In the present study, based on these definitions and TAP (1958), the rubric including claim, justification, counter-position,

and rebuttal was developed in order to explore the partipants' argumentation skills. In other words, how they suggested claim, and justified or refuted these opinions were explored regarding SSI because theoretical framework of this study focused on informal reasoning which was expressed through argumentation.

Argumentation as a field of study was investigated in variety of disciplines, and it was concluded that students in different grades had difficulty in constructing sophisticated (well-substantiated) arguments (e.g., D. Kuhn, 1991; Means & Voss, 1996; Perkins et al., 1991; Perkins & Salomon, 1989). Recently, argumentation skills' investigation gained big momentum in science education area. Several science educators investigated people's argumentation skills in the context of different SSI (e.g., Driver et al., 2000; Jimenez –Aleixandre et al., 2000; Kortland, 1996). For example, when some researchers utilized ecology-based SSI, the other researchers used genetics-based SSI. Table 2.3, Table 2.4, and Table 2.5 present the researchers, sample, SSI, and the main findings of these studies with respect to context of these issues.

Table 2.3: Some Argumentation Studies in the Context of Environmental Issues

Researchers	Sample	SSI	Main Findings
Kortland (1996)	8th grade students' (aged 13-14)	Waste management and recycling issues	There were no improvements in students' argumentation skills.
Patronis et al. (1999)	14-year-old students	The design of a road in their hometown	Students can develop well-organized arguments when they involve a situation.
Osborne et al. (2004)	8th grade students (aged 12–13)	Funding of a new zoo	After the lessons including SSI, students' argumentation quality was improved. However, the change was not significant.
Wu and Tsai (2007)	10th grade high school students	Nuclear energy usage	The students who can generate rebuttals developed significantly more counterarguments than other students, and explicit instruction regarding argumentation may be effective for improving students' argumentation skills.

Table 2.4: Some Argumentation Studies in the Context of Genetics Issues

Researchers	Sample	SSI	Main Findings
Jimenez-Aleixandre et al. (2000)	9th grade high school students (aged 14-15)	Mendelian genetics (e.g., Chicken problem)	Students mostly developed claims instead of justification and warrants. Thus, they did not have sophisticated argumentation.
Zohar and Nemet (2002)	9th grade high school students	Human genetics (e.g., Cystic Fibrosis, Huntington Disease)	Previously designed curriculum (genetics revolution unit) and instruction including argumentation can improve students' argumentation skills.
Walker and Zeidler (2007)	9th –12th grade high school students	Genetically modified foods	Many students had limited experience about engaging in sustained argument or debate.
Ekborg (2008)	Upper secondary school science students	Genetically modified organisms	Students' opinion and argumentation were not relatively affected from the biology teaching.

Table 2.5: Some Argumentation Studies in the Context of other SSI

Researchers	Sample	SSI	Main Findings
Kolstø (2006)	Students was selected from four science classes	Power transmission lines and childhood leukemia	Five different types of arguments were identified; the relative risk argument, the precautionary argument, the uncertainty argument, the small risk argument, and the pros and cons argument.
Lee (2007)	15-16-year old secondary school students	Banning of smoking	Students tended to give different degree of importance to different arguments, which were not absolutely consistent with logical argumentation. Students hardly made informed-decision regarding banning of smoking issue.
Albe (2008)	11th grade science students (aged 16-18)	The effects of mobile phone use on health	When students justified their claims in group discussion, they considered and reflected other students' claims. Thus, they developed collaborative argumentation.

So far, a plenty of research was mentioned about students' argumentation skills as an indicative of informal reasoning quality. It might be concluded students' argumentation skills could change with different SSI. In other words, working with different SSI (e.g., environmental, genetics issues) might be resulted in exploration of different argumentation skills. However, the author did not reach a clear pattern regarding how argumentation skills vary with different SSI according to the tables (Table 3, 4, and 5). For example, regarding genetic engineering issues and environmental issues both sophisticated (Osborne et al., 2004; Patronis et al., 1999; Zohar & Nemet, 2002) and naive (Ekborg, 2008; Jimenez-Aleixandre et al., 2000; Walker & Zeidler, 2007) argumentation skills were observed. In light of these results, in this study, multiple SSI was used. Three SSI was related to gene therapy; three SSI was related to cloning; and one SSI was related to environment. Thus, using multiple SSI, the variation of informal reasoning quality with multiple SSI was explored in the present study to shed light to socioscientific literature in this perspective.

2.4. Informal Reasoning Influencing Factors

In light of the socioscientific literature, the variables related to informal reasoning might be categorized under four main topics: personal experiences, conceptualization of NOS, content knowledge, and moral consideration. In the rest of this part, the researcher introduced the review of the research about the relationship between these variables and informal reasoning.

2.4.1. Personal Experiences & Informal Reasoning

In socioscientific literature, many researchers explored that personal experience was one of the variables related to informal reasoning (Albe, 2008; Bell & Lederman, 2003; Sadler et al., 2004), which is also elaborated in the Table 2.6 introduces research results revealing the relationship between personal experiences and informal reasoning.

Table 2.6: The Characteristics of the Studies Related to Personal Experiences & Informal Reasoning

Researchers	Sample	SSI	Related Findings
Bell and Lederman (2003)	21 professors	Fetal tissue implantation, global warming, diet and cancer, and cigarette smoking and cancer	Most of the participants based their decisions mainly on personal values, morality, and social concerns about SSI.
Sadler et al. (2004)	High school biology students	Global warming	Students' economic interests and personal perspectives affected their decision making regarding global warming.
Sadler and Zeidler (2004)	College students	Genetic engineering issues	Students used their own personal experiences to make decision about genetic engineering issues.
Albe (2008)	11th grade science students	The effects of mobile phone use on health	Students used their general knowledge and personal experience regarding interpretation of scientific controversies.

As seen in Table 2.6, these studies clearly showed that students' personal experience was related to their decision making about different SSI. The researchers revealing this relationship seemed to reach consensus in which personal experience was an important variable shaping students' socioscientific decision making.

2.4.2. Nature of Science (NOS) & Informal Reasoning

Another variable investigated the relationship with informal reasoning was NOS conceptualization. NOS aspects involved understandings that scientific knowledge is: (Bell & Lederman, 2003) "(a) tentative (subject to change), (b) empirically based (derived from observations of the natural world), (c) subjective (theory-laden) to a degree, (d) partially based on human inference, imagination, and creativity, and (e) socially and culturally embedded" (p. 356). Relationship between NOS conceptualization and informal reasoning was studied by several researchers (Bell & Lederman, 2003; Sadler et al., 2004; Walker & Zeidler, 2007; Zeidler et al., 2002) and Table 2.7 introduces related research revealing the relationship between NOS conceptualization and informal reasoning.

Table 2.7: The Characteristics of the Studies Related to NOS & Informal Reasoning

Researchers	Sample	SSI	Related Findings
Zeidler et al. (2002)	9th-12th grade science and physics honor students and upper-level college preservice teachers	Animal rights and using animals in scientific research	Explored the relationship between informal reasoning and 1) socially and culturally embedded nature of scientific knowledge 2) empirical evidence of scientific knowledge 3) the view in which personal knowledge and scientific beliefs should be separated from each other
Bell and Lederman (2003)	21 university professors	Fetal tissue implantation, global warming, the relationship between diet and cigarette smoking with cancer	Participants' views about NOS did not affect their decision-making about SSI.
Sadler et al. (2004)	High school biology students	Global warming	Explored the relationship between informal reasoning and 1) social nature of scientific knowledge 2) the view in which scientific evidence and the information should be separated from each other
Walker and Zeidler (2007)	9th –12th grade high school students	Genetically modified foods	Students' understanding of NOS was not utilized in discussions about genetically modified foods.

As seen in Table 2.7, the research results showed that there was no consensus about the relationship between NOS understanding and decision-making about SSI among the researchers. When Bell and Lederman (2003) and Walker and Zeidler (2007) suggested that students' view about NOS was not considerably related to informal reasoning, Zeidler et al. (2002) and Sadler et al. (2004) claimed that understanding NOS aspects (socially and culturally embedded nature, tentativeness, and empirical evidence of scientific knowledge) were related to informal reasoning. Understanding of NOS and informed decision making about SSI were the two important aims of scientific literacy. Hence, due to the lack of consensus on whether understanding of NOS was related informal reasoning, further research might be necessary related to this relationship.

2.4.3. Content Knowledge & Informal Reasoning

Several research specified that content knowledge might be another factor related to individuals' informal reasoning (Albe, 2008; Fleming, 1986b; Hogan, 2002; Zeidler & Schafer, 1984). This is also shown in Table 2.8 which introduces related research revealing the relationship between content knowledge and informal reasoning.

Table 2.8: The Characteristics of the Studies Related to Content Knowledge & Informal Reasoning

Researchers	Sample	SSI	Related Findings
Zeidler and Schafer (1984)	Undergraduate students	Environmental issues	Conceptual understanding about ecology-based issues influenced students' informal reasoning.
Fleming (1986b)	Adolescents, who had successfully completed the introductory courses of chemistry and physics	Nuclear power plants and genetics engineering	Lack of conceptual understanding limited informal reasoning about SSI. In other words, informal reasoning is associated with the understanding of scientific knowledge.
Hogan (2002)	8th grade students	Invasive exotic species	Conceptual understanding was related to students' informal reasoning about this ecology-based scenario.
Sadler (2003)	Undergraduate students	Gene therapy and cloning scenarios	When conceptual understanding is related to informal reasoning quality, however, it is not related to informal reasoning patterns.
Albe (2008)	11th grade science students (aged 16-18)	The effects of mobile phone use on health	Students used their technological and scientific knowledge rarely in their decision making about this SSI. However, this study revealed importance of general knowledge utilized by students in decision making.

As seen in Table 2.8, the studies investigating the relationship between conceptual understanding and informal reasoning reported that there was considerable relationship between conceptual understanding and informal reasoning. Considering the reviewed socioscientific literature, it

might be claimed that content knowledge was an important factor which was related to informal reasoning in educational contexts.

2.4.4. Moral Perspective & Informal Reasoning

Socioscientific literature reported that moral perspective was another important factor related to individuals' informal reasoning (Bell & Lederman, 2003; Fleming, 1986a, 1986b; Pedretti, 1999; Zeidler & Schafer, 1984) and Table 2.9 introduces related research revealing the relationship between moral perspective and informal reasoning.

Table 2.9: The Characteristics of the Studies Related to Moral Perspective & Informal Reasoning

Researchers	Sample	SSI	Related Findings
Zeidler and Schafer (1984)	College students	Environmental issues	The participants integrated morality in their decision-making.
Fleming (1986a, 1986b)	High school students	Nuclear power and genetic engineering issues	Morality is effective in the high school students' decision making. 70% of the participants used moral reasoning domains in response to these SSI.
Pedretti (1999)	Fifth and sixth grade students	An environmental issue	Following the intervention, over half of the students dealt with the moral contexts (In pre-intervention study, 22% of the students considered morality)
Bell and Lederman (2003)	21 university professors	Fetal tissue implantation, global warming, the relationship between diet and cigarette smoking with cancer	Moral perspective is important variable in order to understand people's decision making process regarding SSI.
Sadler and Zeidler (2004)	College students	Genetic engineering issues	Moral perspective significantly influenced students' decision-making, and genetic engineering issues were seen as moral problems by students.

In addition to moral consideration and other factors mentioned so far, a variety of the factors (religion, family bias, economics, socio-political issues, background knowledge, and popular culture) appeared as influencing socioscientific decision-making (Bell & Lederman, 2003; Fleming 1986a,

1986b; Sadler & Zeidler, 2004; Sadler & Zeidler, 2005a; Zeidler & Schafer, 1984). The emergence of these factors might depend on the context or sampling of a study. The factors influencing informal reasoning were part of the framework of this study. Socioscientific literature showed that there were several variables (e.g., conceptualization of NOS, personal experience, content knowledge) related to informal reasoning (Albe, 2008; Bell & Lederman, 2003; Hogan, 2002; Sadler et al., 2004). The researchers explored several factors related to informal reasoning when they investigate informal reasoning in the context of different SSI. However, exploration of the factors influencing informal reasoning was the one of the important aim of this study. Investigation of these factors in the theoretical framework of this study might provide more comprehensive understanding about informal reasoning.

CHAPTER 3

METHOD

The main focus of this study was to investigate PSTs' informal reasoning across genetics and ecology based SSI. Since SSI were complex, discussable, and open-ended in their own nature, the negotiation and resolution of these issues included informal reasoning. In this study, genetics and ecology-based issues were used that they were complex, open-ended, and debatable SSI. When PSTs negotiated and resolved these issues, they developed and supported a position by using their informal reasoning. In the present study, both genetics and ecology based SSI were ideal topics for investigating informal reasoning.

The study first investigated PSTs' informal reasoning patterns in the context of multiple SSI; second, explored the relationship between informal reasoning patterns and quality; third, investigated the variation of informal reasoning quality with SSI; at last, focused on the factors influencing PSTs' informal reasoning. The researcher used basic interpretive qualitative research approach for the present study (Merriam & Associates, 2002). In this approach, a researcher may use concepts, models, and theories to frame the study, and data are collected with interviews and observations, and data analysis involves identifying recurrent patterns (categories, factors, themes), and overall interpretation of this study depends a researcher's understanding (Merriam & Associates, 2002).

The rest of this chapter introduced the research questions, research design including the selected SSI and data collection process, sampling, and data analysis.

3.1. Research Questions and Their Rationales

3.1.1. RQ1 and Its Rationale

RQ1. What kind of informal reasoning patterns (i.e., rationalistic, emotive, and/or intuitive) do PSTs use as they negotiate multiple SSI?

RQ1 focused on the PSTs' informal reasoning patterns (i.e., rationalistic, emotive, and/or intuitive) in the context of SSI. Socioscientific literature asserted that the different age and educational level groups can develop different informal reasoning patterns in response to SSI (Sadler & Zeidler, 2005a). For this RQ1, the most appropriate informal reasoning framework developed by Sadler and Zeidler (2005a; 2005b) was benefited to investigate PSTs' informal reasoning patterns. Investigation of this research question has a potential in providing a better and more comprehensive understanding for PSTs' informal reasoning.

3.1.2. RQ2 and Its Rationale

RQ2. How does the quality of informal reasoning demonstrated by PSTs, as they negotiate SSI, vary as a function of informal reasoning patterns?

RQ2 explored the relationship between informal reasoning patterns

and informal reasoning quality. Basically, both were different representations of informal reasoning. Informal reasoning patterns were related to rationalistic, emotive, or intuitive patterns. The other representation of informal reasoning was informal reasoning quality which could change in the range between naïve argumentation skills and sophisticated argumentation skills. In socioscientific literature, there has not been any research about the relationship between informal reasoning patterns and informal reasoning quality. Investigating this relationship between these two important characteristics of informal reasoning provided better understanding for informal reasoning and made valuable contribution to socioscientific literature.

3.1.3. RQ3 and Its Rationale

RQ3. How does the quality of informal reasoning vary as PSTs negotiate with different SSI?

RQ3 investigated the variation of PSTs' informal reasoning quality with the seven SSI. Socioscientific argumentation skills have been studied by several science educators with different socioscientific contexts (e.g., Kortland, 1996; Zohar & Nemet, 2002). For example, while some researchers used genetics-based SSI, other researchers used ecology-based SSI in order to explore participants' argumentation skills. When the results of these studies compared, there has not been any consensus about how and why argumentation skills vary within contexts (SSI). Thus, with this study, the other gap of socioscientific literature was tried to be filled out focusing on the variations of informal reasoning quality with multiple SSI.

3.1.4. RQ4 and Its Rationale

RQ4. What factors influence PSTs' informal reasoning as they negotiate with multiple SSI?

RQ4 explored the factors influencing PSTs' informal reasoning in the context of multiple SSI. According to the socioscientific literature, there were several variables related to informal reasoning. For example, personal experiences, social concerns, moral perspective, content knowledge, and nature of science were found as variables related to informal reasoning regarding SSI (Bell & Lederman, 2003; Fleming 1986a, 1986b; Sadler & Zeidler, 2004; Sadler & Zeidler, 2005a; Zeidler & Schafer, 1984). Although above studies mentioned the factors related to socioscientific decision making, there was no specific research focusing only on the factors influencing informal reasoning in the socioscientific literature.

3.2. Research Design

3.2.1. The Selection of the SSI

In this study, participants were given several SSI. With these SSI, participants' informal reasoning patterns and informal reasoning quality were explored because these issues were suitable for investigation of informal reasoning patterns (rationalistic, emotive, and intuitive) and informal reasoning quality (naïve argumentation skills through sophisticated argumentation skills). Moreover, these issues were appropriate for investigation of expected factors (e.g., personal experiences, moral-ethical values) influencing informal reasoning. To sum up, used SSI were appropriate for the aim of the study.

Seven SSI were used in this study in order to answer the research questions. Three issues dealt with gene therapy and the other three issues with cloning. The six issues concerning gene therapy and cloning scenarios were adopted from Sadler and Zeidler's (2005a) study. To compare the findings of the present study with Sadler and Zeidler's (2005a) study, these six issues were used in the present study. The last scenario dealt with global warming and it was adopted from Bell and Lederman's (2003) study. To explore the variation of informal reasoning quality with the contents of multiple SSI, this last issue was added into this study.

Gene therapy issues were Huntington's disease, Nearsightedness, and Intelligence. Huntington's disease gene therapy dealt with the therapy of neurological disorder; Near-sightedness gene therapy was used to treat myopia; and Intelligence gene therapy aimed at the improvement of an individual's intelligence. The cloning issues were Reproductive Cloning, Accident Scenario, and Therapeutic Cloning. Reproductive Cloning was developed for the couples who were unable to bear children; Accident scenario dealt with a cloned child; Therapeutic Cloning was the organ transplantation. The last issue was about global warming. This issue was another controversial issue in which some scientists claimed that human-induced global warming was a near certainty and global warming would cause catastrophic ecological results. On the other hand, some scientists claimed that global warming was only a hypothesis and not validated scientifically and reducing gas concentrations would cause serious economical results. All issues used in this study included contradictory opinions about genetic engineering or global warming. As a result, totally seven SSI including controversial opinions were used to investigate the research questions. These SSI were given in Appendix A.

3.2.2 .Data Collection

3.2.2.1. Informal Reasoning Interview (IRI)

All students participated in the IRI. The IRI was a semi-structured interview protocol and focused on the exploration of informal reasoning patterns and quality related to gene therapy, cloning, and global warming issues. The same interview questions were used for six different genetic engineering scenarios. However, only the first question of IRI for global warming scenario was different from the first question of IRI for six genetic cloning scenarios (Appendix A).

Participants read each SSI. Then, the researcher asked IRI questions to collect participants' opinions about particular scenario.

Some IRI questions regarding the Huntington disease scenario were:

- Should gene therapy be used to eliminate HD from sex cells (egg cells or sperm cells) that will be used to create new human offspring? Why or why not?
- How would you convince a friend or acquaintance of your position?
- Can you think of argument that could be made against the position that you have just described? How could someone support that argument (Sadler & Zeidler, 2005a, p. 134)?

After each participant read each scenario, they claimed their position (what is the claim or argument?) about whether they approve of the treatments in gene therapy and cloning contexts or not. Then, participants

were asked to justify their claims about related scenario (what supports claim or argument). Following the justification, questions were asked to reveal their counter-position (what is an opposing claim or argument) about the scenario. Finally, participants were asked questions to reveal their rebuttal (what rejects or refutes the opposing claim or argument). This process was repeated for each scenario. However, in the global warming scenario, instead of appropriateness of therapy, they were asked whether the US should participate or not in the Kyoto Protocol. The rest of the interview process and questions were the same as in the other scenarios.

3.2.2.2. Moral Decision-Making Interview (MDMI)

The MDMI protocol developed by Sadler and Zeidler (2005a; 2005b) was used regarding three SSI (Huntington disease, accident, and global warming scenarios) in order to explore the factors influencing informal reasoning. Despite the fact that some factors influencing informal reasoning were explored in IRI, MDMI was also employed for detailed exploration of the factors influencing informal reasoning. After the IRI was completed, the researcher used MDMI to explore factors influencing PSTs' informal reasoning.

Some examples for MDMI questions regarding Huntington Disease scenario in below:

- What factors were influential in determining your position regarding the Huntington Disease issue?
- Do you think that gene therapy as described as in this scenario is subject to any kind of moral rules and principles? If so, how did this affect your decision making?

- Did you think about who would have access to gene therapy? If so, how did this affect your decision-making (Sadler & Zeidler, 2005a, p. 134)?

In addition, one adaptation was conducted by the researcher in the MDMI protocol. The reason of this change was to investigate the effect of social and cultural factors on socioscientific decision making in Turkish context. In the MDMI, the previous version of the interview question was "Did you think about who would have access to gene therapy? If so, how did this affect your decision-making?" The adapted version of interview question was "Did you think about who would have access to gene therapy and what factors can be effective shaping people's decision making in Turkish cultural context?" During the adaptation process, two experts' opinions about this interview question were taken in order to make a sound and valid adaptation. One of the experts was specialized on informal reasoning. In addition to the experts' opinions, previous research exploring variables related to informal reasoning were also considered (Bell & Lederman, 2003; Sadler, 2003; Sadler & Zeidler, 2005a).

The researcher completed all the interviews individually with each participant. All interviews were conducted in the classrooms or in the private office of the researcher depending on these places' availability. Each individual voluntarily participated in this study. Before each interview process, the researcher explained the aim of the study. During the interviews, when the participants wanted help for further clarification, the researcher provided necessary clarification. However, the researcher was neutral to the opinion of each participant and did not reveal his own personal opinion about scenarios. The participants were neither directed to

any opinion nor affected by it. The researcher shared information on equal level with each participant.

In summary, after each participant read each scenario, IRI was conducted. It took approximately 30 minutes to conduct the IRI for each participant. Following IRI, MDMI was conducted. It took approximately 30 minutes to conduct the MDMI for each participant. Then participants completed a personal information sheet explaining their age, gender, areas of study, and cumulative grade point average (cGPA). It took approximately 5 minutes to conduct the information sheet for each participant. Information sheet was not directly related to the aim of the study. However, it was used for description of the sample profile.

Individuals taking part in this research were interviewed separately. The interviews were audio-recorded and transcribed by the researcher. Since the entire participants' major was science education, and all of them completed biology courses, and some of them (two participants) completed biotechnology courses in their undergraduate education, they thoroughly understood gene therapy and cloning scenarios as well as the global warming scenario because it is a current and popular issue.

3.3. Participants

Several SSI were utilized in order to explore PSTs' informal reasoning in this study. Although these SSI (genetics-based) were appropriate for a variety of educational levels with respect to conceptual understanding (Sadler, 2003), PSTs were chosen because they were ideal candidates to teach these issues and to integrate them into science curricula. All PSTs were in their senior year. The participants of this study were PSTs

who will teach middle school science for 6th through 8th grade students after graduation. They will perceive their degree in the department of elementary science education. Thus, they had completed several must courses like physics, chemistry, and biology. Biology courses involved one genetics course and one ecology course (education and awareness for sustainability), which included genetic engineering issues and global warming issues, respectively. Thus, it was assumed that PSTs had sufficient previous knowledge about global warming and genetics concepts. Assuming that their previous knowledge of these scenarios was adequate level, their content knowledge was not investigated in this study. In addition, in Turkey, The Middle East Technical University is the only university in which the teaching language is completely English. The scenarios adopted from Sadler's (2003) study were directly utilized in this study because participants' education language was English. Considering those reasons, purposive sampling method was used and senior elementary PSTs from a large public university, in Ankara, Turkey were the intended sample for this study. Totally, 39 PSTs participated in the study. While 13 participants were male, 26 participants were female. All participants' major was elementary science education and their minor was elementary mathematics education. Their age range was from 21 to 30. Their cGPA scores varied between 2, 32 and 3, 89 out of 4.

The PSTs voluntarily participated in this study. Before the interviews, each participant was also asked whether they wanted to participate in this study or not. Moreover, background knowledge and the purpose of the study were given to the participants. As a result, of the 45 senior PSTs, 39 PSTs were willing to participate in this study.

3.4. Data Analysis

3.4.1. Analysis of the Research Questions

For RQ1, the researcher investigated PSTs' informal reasoning patterns when they negotiated with SSI. Both IRI and MDMI were employed in order to explore this question. The participants' informal reasoning patterns were explored with the constant comparative method (Glaser & Strauss, 1967).

The first five interview documents (IRI and MDMI) were openly coded by two researchers (the author of this study and the reviewer), while the remaining thirty-four interview documents were openly coded by the researcher. The reviewer was the expert of informal reasoning and SSI. In addition, the reviewer had several publications in top science education journals (Journal of Research in Science Teaching, Science Education, and International Journal of Science Education) about the field of SSI, informal reasoning, and qualitative research. Since the reviewer's main language was English, five transcripts were translated from Turkish into English by the researcher. In addition, the advisor of the present study reviewed these translated interview protocols.

Before the coding, the researchers read all interview documents to explore and understand the content. Then, the researchers analyzed both (IRI and MDMI) transcripts simultaneously and subsequently took notes about the emergent codes of each person. For example, related to each SSI, the researcher determined and coded each participant's informal reasoning benefiting from the both interview transcriptions. In addition, the researcher compared the emergent codes with the previous emergent codes. Depending

on the two transcripts for one person, the researcher made a coding for the participants' informal reasoning about each SSI. During the open coding of the transcripts, plenty of codes (rationalistic thinking, emotive thinking, intuitive thinking, personal experience, moral-ethical issues, social consideration, religious consideration, educational consideration, and economical consideration) emerged regarding the participants' informal reasoning.

In axial coding stage, the researcher tried to develop the categories based on these codes. The researcher organized these codes in four categories, and named these categories as patterns. In light of the data, the researcher decided to benefit from informal reasoning pattern framework (Sadler & Zeidler, 2005a) to categorize the participants' informal reasoning because emergent categories were highly consistent with this framework's categories. Emergent categories from the present study were: rationalistic, emotive, religious, and intuitive informal reasoning patterns.

In selective coding, the author of this study and the reviewer got together to discuss these categories. They debated the categories in light of the data, by reviewing current literature on informal reasoning. After the discussion about informal reasoning pattern framework, the researchers decided three main categories which are; rationalistic, emotive, and intuitive informal reasoning. They decided that religious consideration as a factor influencing informal reasoning but not a type of informal reasoning pattern. Then, the researchers compared their categorizations on these transcripts. For the analyzed five transcripts (each transcript involves seven SSI), the researchers agreed on all categorizations except 4 categorizations out of 35 categorizations. The researchers negotiated the categories until they arrived at a 100% agreement. After the debate, four changes were made. Thus, the

inter-rater consistency was tried to be achieved about categorization of informal reasoning patterns by the investigator triangulation. Furthermore, Creswell (2007) claimed that researchers should have sufficient information to saturate or develop the model; and to achieve this, researchers should conduct 20 to 30 interviews or 50 to 60 interviews. In this perspective, the researcher coded the rest of the transcripts (forty-five interviews) to achieve saturation and development of the theoretical framework of this study because "informal reasoning pattern" was one of the important characteristics of informal reasoning in the theoretical framework of this study.

In selective coding stage, the main purpose was to determine a central phenomenon and systematically connect other categories to this central phenomenon (Strauss & Corbin, 1990). The theoretical framework of this study was re-considered in light of the present data. In the theoretical framework of this study, main phenomenon was informal reasoning, and it had two main characteristics which were informal reasoning patterns and quality. In light of the researchers' categorization, informal reasoning was characterized as; rationalistic, emotive, and intuitive informal reasoning patterns. However, other codes found in open coding (personal experiences, religious consideration, educational consideration, economical consideration, moral-ethical issues) formed the factors influencing informal reasoning in the framework of this study.

For RQ2, the researcher explored the relationship between two characteristics of informal reasoning: informal reasoning patterns and informal reasoning quality. Informal reasoning patterns were explored through the process of RQ1. With RQ2, the participants' informal reasoning

quality was explored, and then the relationship between two unique characteristics of informal reasoning was explored.

In order to assess informal reasoning quality, the development of the rubric was achieved by the researcher with receiving help from an expert of informal reasoning. Informal reasoning quality as another important concept of the present study was operationalized and assessed considering Toulmin's (1958) Argumentation Pattern with minor modifications. Table 3.1 presents the framework of the present study and other studies in order to assess informal reasoning quality.

Table 3.1: Classifications for the Analysis of Informal Reasoning Quality

The present study	Toulmin (1958)	Kuhn (1991)	Sadler (2003)
Claim	Claim	Causal theory	Position
Justification	Data; Warrants	Evidence	Rationale
Counter-position	Rebuttal	Alternative theories; Counterarguments	Counter-position
Rebuttal		Rebuttal	Rebuttal

For each SSI, participants' claims, justifications, counter-positions, and rebuttals were explored. Furthermore, the framework including some criteria and descriptive questions were employed to analyze participants' informal reasoning quality. Table 3.2 introduces criteria and descriptive questions to assess informal reasoning quality.

Table 3.2. Criteria and Descriptive Questions Evaluating Informal Reasoning Quality

Criterion	**Descriptive Questions**
Claim	Can a participant develop claim(s) about the issue?
Justifications	Can a participant develop justification(s) in addition to claim(s)?
Counter-position	Can a participant develop counter-position in addition to claim(s) and justification(s)?
Rebuttal	Can a participant develop rebuttal in addition to claim(s), justification(s), and counter-position?

Claim refers to whether the participant only developed claim about any scenario or not. If the participant developed only claim but not justification, this criterion may be named as claim without justification. For example, although the participants claimed that "one therapy (in genetic engineering issues) should be done or not", they did not develop any justifications related to their claim. Justification refers to arguments supporting the participants' claims. In this criterion, participants developed claim and subsequently supported their claims with several arguments. For example, they claimed that "this therapy should be done because human health is important." Counter-position is a criterion that it is related to whether participants may develop counter-positions considering their previous positions or not. Moreover, rebuttal is related to arguments supporting their previous arguments considering counter-position arguments.

The exploration of the informal reasoning quality was made by the similar procedures as the analysis of RQ1. The IRI was utilized in order to explore informal reasoning quality. The participants' informal reasoning quality was explored with the constant comparative method (Glaser & Strauss, 1967).

The first five interview documents (IRI) were openly coded by two researchers (the author of this study and the reviewer), while the remaining thirty-four interview documents were openly coded by the researcher. The researchers analyzed IRI transcripts and subsequently took notes about the emergent codes of each person. For example, related to each SSI, the researcher determined and coded each participant's informal reasoning quality utilizing from the interview transcriptions. In addition, the researcher compared the emergent codes with the previous emergent codes. Depending

on the IRI transcripts for each person, the researcher made a coding for the participants' informal reasoning quality about each SSI. During the open coding of the transcripts, several codes (claim, justification, counter-position, and rebuttal) emerged regarding the participants' informal reasoning quality.

In axial coding stage, the researcher tried to develop the categories based on these codes. The researcher organized these codes in four categories, and named these categories as types of informal reasoning quality. In light of the data, the informal reasoning quality types were categorized that they were type 1, type 2, type 3, and type 4. Informal reasoning quality type 1 included only claim; type 2 included claim and its justification; type 3 included claim, its justification, and counter-position; type 4 included claim, its justification, counter-position, and rebuttal.

In selective coding, the researchers got together to discuss these categories. They debated the categories in light of the data, by reviewing current literature on informal reasoning. After the discussion about informal reasoning quality, the reviewer approved the informal reasoning quality types. For the analyzed five transcripts (each transcript involves seven SSI), the researchers agreed on all categorizations except 4 categorizations out of 35 categorizations. The researchers negotiated the categories until they arrived at a 100% agreement. After the debate, four changes were made. Thus, the inter-rater consistency was tried to be achieved about categorization of informal reasoning quality by the investigator triangulation. Similar to RQ1 process, the researcher coded the rest of the transcripts (forty-five interviews) to achieve saturation and development of the theoretical framework of this study. Furthermore, in this stage, the theoretical framework of this study was re-considered in light of the present

data. In addition, informal reasoning quality as expression of informal reasoning was related to the main phenomenon of this study, and placed in the theoretical framework of this study.

In research question 3, the researcher investigated how the quality of informal reasoning does vary as PSTs negotiate with different SSI. To explore this research question, participants' informal reasoning quality types were utilized. The researcher reported the variation of informal reasoning quality with the SSI by presenting frequencies of participants' informal reasoning quality types regarding each SSI.

In research question 4, the researcher investigated the factors influencing PSTs' informal reasoning as they negotiate for multiple SSI. Both IRI and MDMI were employed to explore this research question. The factors influencing participants' informal reasoning were explored with the constant comparative method (Glaser & Strauss, 1967). The thirty-nine interview documents were openly coded by the researcher. The researcher coded all transcripts to achieve saturation and development of the theoretical framework of this study because one part of theoretical framework of this study consisted of the factors influencing informal reasoning.

The researcher analyzed both (IRI and MDMI) transcripts simultaneously and subsequently took notes about potential factors influencing informal reasoning. The researcher compared the emergent codes with the previous emergent codes. Depending on the two transcripts for one person, the researcher made a coding for the factors influencing informal reasoning about each SSI. During the open coding of the transcripts, plenty of codes (cultural consideration, psychological

consideration, emotive consideration, religious consideration, personal experience, moral-ethical issues, social consideration, religious consideration, political issues, educational consideration, and economical consideration) emerged regarding the factors influencing informal reasoning.

In axial coding stage, the researcher tried to develop the categories based on these codes. The researcher organized these codes in six categories. In light of the data, the researcher finalized the categories influencing informal reasoning as; social consideration, educational consideration, economical consideration, religious consideration, emotive consideration, moral-ethical issues, technological concerns, and personal experience.

In selective coding stage, the researchers got together to discuss these categories. They debated the categories in light of the data. The researchers negotiated the categories until they arrived at a 100% agreement. After the debate, two changes were made. The first revision was that three factors which are educational, economical and religious considerations were accumulated under the category of social consideration. The second revision was that emotive consideration was assessed as a type of informal reasoning patterns not a factor influencing informal reasoning. After the discussion about factors influencing informal reasoning, the researchers decided four main categories influencing informal reasoning; personal experiences, moral-ethical issues, social considerations, and technological concerns.

3.4.2. Presentation of the Interview Excerpts

All excerpts presented in the present study were reported by an alpha-numeric code which represented the quoted participant. The first number, which can range from 1 to 39, identified a specific participant. This number was followed by either an "R" or an "M". When "R" indicated that the quotation was taken from the informal reasoning interview, "M" indicated that the quotation was taken from the moral decision-making interview. The last two letters of the code were presented parenthetically and represented one of the seven scenarios. "HD" represented the Huntington's disease gene therapy scenario; "NS" represented the nearsightedness gene therapy scenario; "IN" represented the intelligence gene therapy scenario; "RC" represented the reproductive cloning scenario; "AC" represented the accident cloning scenario; "TC" represented the therapeutic cloning scenario; "GW" represented the global warming scenario. For example, 6R(HD) refers to excerpt was taken from participant 6 regarding Huntington Disease issue using Informal Reasoning Interview Protocol.

3.5. Trustworthiness of the Study

The trustworthiness of qualitative studies was an important issue to make valid and reliable inferences. Lincoln and Guba (1985) defined the term "trustworthiness" with the question: "How can an inquirer persuade his or her audiences (including self) that the findings of inquiry are worth paying attention to, worth taking account of? What arguments can be mounted, what criteria invoked, what questions asked, that would be persuasive on this issue? (p. 290)". In other words, what extent the researcher persuades the readers of the study about the findings of the study are reliable and valid.

In the quantitative research approach, the value of the study is determined by its validity, reliability, and objectivity. However, in the qualitative research approach, these concepts remain the same although their names change. In this section, these concepts were employed together to enable trustworthiness to be better understood.

To provide trustworthiness of this qualitative study; credibility (internal validity), applicability (external validity), dependability (reliability), and confirmability (objectivity) issues (Sadler, 2003) were considered by the researcher during the study.

3.5.1. Credibility (Internal Validity)

In quantitative approach, internal validity refers to how research results match reality (Merriam, 1998). In qualitative approach, credibility has similar meaning with the internal validity, and it refers to truth value (Lincoln & Guba, 1985). To confirm internal validity, some strategies were followed by the researcher for the present study;

3.5.1.1. Triangulation

This strategy refers to the utilization of multiple investigators or multiple sources of data (Denzin, 1970). Both data collection triangulation and data analysis triangulation were used in this study. Triangulation of this study was provided with using both IRI and the MDMI at the same time to explore participants' informal reasoning. Two interviews were utilized to provide multiple sources of data about informal reasoning. In addition to multiple sources, multiple investigators were employed in this study. IRI and MDMI transcripts were reviewed by two investigators. Two

investigators analyzed five interview transcripts independently from each other. According to both analyses, at least 89 % inter-rater consistency was determined about the rating of five transcripts.

3.5.1.2. Member Checking

This strategy refers to "taking data and tentative interpretations back to the people from whom they were derived and asking them if the results are plausible" (Merriam, 1998, p. 204). After participants completed IRI, they completed the MDMI. Similar to the IRI, participants reflected similar results in the MDMI. For example, participants reported similar factors influencing their informal reasoning in both IRI and MDMI about one SSI. Thus, participants confirmed the researcher's interpretation related to the factors influencing informal reasoning.

3.5.2. Applicability (External Validity)

In quantitative approach, external validity is related to findings of one study can be applied to other situations (Merriam, 1998). In qualitative approach, applicability is used as a term and it refers to transferability (Lincoln & Guba, 1985). In order to confirm external validity of this study, the participants' rich and thick description (participants' major and minor undergraduate area, graduate condition, gender, university, cGPA, and country), data collection procedures (how this procedure is followed throughout the data collection process and which tools are used), qualitative analysis method (constant-comparative method), informal reasoning quality and informal reasoning patterns were clearly presented in the present study.

3.5.3. Dependability (Reliability)

In quantitative approach, reliability is used as a term and it refers to consistency of the findings. In other words, it is related to "which research findings can be replicated" (Merriam, 1998, p.205). In qualitative approach, dependability is used as a term and it refers to consistency (Lilcoln & Guba, 1985). Moreover, reliability is an important prerequisite of validity (Frankel & Wallen, 2003). Reliability of this study was confirmed with two ways. First one is with inter-rater reliability, both the researcher and the reviewer coded the informal reasoning pattern and informal reasoning quality of five participants, and second one is using preliminary interview results to help shape some questions of IRI and MDMI.

3.5.4 .Confirmability (Objectivity)

In quantitative and qualitative approach, objectivity is used as a term, and it refers to "the degree to which qualitative data and their interpretations can be authenticated" (Sadler, 2003, p. 105). Credibility strategies are also valid for confirmability (Sadler, 2003). Thus, the confirmability of this study was verified using the credibility strategies (triangulation and member checking).

CHAPTER 4

RESULTS

In light of the conducted interview protocols with the participants, this chapter presented results and explanations of these results. These results and explanations were given after the related research question throughout this chapter. Moreover, experts taken from interview data were also presented in order to provide basis for inferences.

4.1. Exploration of PSTs' Informal Reasoning Patterns

RQ1: What kind of informal reasoning patterns (i.e., rationalistic, emotive, and/or intuitive) PSTs follow as they negotiate for multiple SSI?

To answer RQ1, first, PSTs' informal reasoning patterns were determined. Then how these patterns show variation across each SSI were determined.

In response to each SSI, the participants developed different informal reasoning patterns. Similar to Sadler's (2003) study, the data in the present study reported a process including rationalistic, emotive, and intuitive reasoning patterns. These patterns were presented by the participants when they resolve and negotiate with these SSI. Thus, the assessment of informal reasoning was framed with respect to rationalistic,

emotive, and intuitive thinking patterns. A rationalistic thinking pattern included thought and argument depending on the reason. Emotive informal reasoning included moral emotions (empathy and sympathy) and, intuitive informal reasoning included immediate feelings and reactions in response to SSI.

4.1.1. Rationalistic Informal Reasoning

In this process, individuals utilized rational patterns of thought. Rationalistic patterns were used for addressing patient rights, parental responsibilities, side effects, and future applications.

Throughout the present study, all participants used rationalistic informal reasoning pattern at least one in order to resolve one SSI. For HD, 32 participants; for NS, 31 participants; for IN, 32 participants; for RC, 14 participants; for AC, 12 participants; for TC, 16 participants; for GW, 27 participants displayed rationalistic informal reasoning pattern. Below, some excerpts including rationalistic thoughts were reported. For example, regarding the HD issue, participant 6 displayed rationalistic implications taking into consideration the importance of human health and bad effects of illness in the future. Participant 12 showed a series of the rationalistic concerns regarding global warming effects on the world such as climate change, ice melting and the development of healthy generations in the future. The last quote, provided by participant 15 in response to nearsightedness issue, stated that there were already alternative treatment methods (e.g., glasses) involving less risk and side effects in order to treat nearsightedness gene. Basically, this participant claimed the argument in which this gene therapy should not be used for this disease.

- 6R(HD): In my opinion, it (Huntington disease gene) should be eliminated because by eliminating this gene, we can get rid of this illness. The effects of this illness will be observed in the future. These effects will be harmful for the individual. Human life is important. Since people continue to live by this gene therapy, this therapy should be used. In addition, interferences to the natural cycle may cause harmful effects for the future of the world. In spite of this, as the people's health is important this therapy should be used.
- 12R(GW): I think, all countries in the world should have participated in Kyoto protocol because this problem is global, not specific to any country. Thus, all countries in the world should give sufficient importance to global warming. We are efficiently observing the effects of global warming on our world day by day. For example, climate equilibrium is changing fast all over the world, and ices are melting in the poles. People should take responsibility to do something about global warming because global warming is important issue for healthy next generations.
- 15R(NS): In my opinion, this therapy is useless because there has already been several alternative treatment methods such as lens or glasses or surgical methods to overcome this illness. Meanwhile, I do not think this treatment method (NS) is not necessarily related to human life as others (e.g., HD). In other words, a human's life is not issue in hear. Finally, alternative treatment methods (such as lenses or glasses) are easier and cheaper than gene therapy method. Moreover, gene therapy treatment may include more risk factors and side effects than other treatment methods. As a result, gene therapy method should not be used for this illness which can be overcome easily.

4.1.2. Emotive Informal Reasoning

In this informal reasoning pattern, empathy and concern were important concepts that the participants frequently employed their empathy and concern in their decision-making regarding SSI. For HD, 20 participants; for NS, 6 participants; for IN, 7 participants; for RC, 8 participants; for AC, 17 participants; for TC, 18 participants; for GW, 1 participants displayed emotive informal reasoning pattern. Below excerpts clearly displayed that when several participants tried to resolve SSI, they employed their emotions and empathy. In response to the reproductive cloning issue, participant 10 considered the child's and the family's feelings, and this participant used the empathy to resolve the issue. Participant 16 also utilized empathy to negotiate with the Huntington's disease issue. Participant 25 used the emotions and empathy to resolve the issue. As a result, all participants developed empathy in response to the Huntington disease issue.

- 10R(RC): I think cloning is a horrible thing. This scenario resembles to science-fiction films. If this therapy is used, this condition will cause bad effects on the child in the future. I believe that cloning will be unfair for the child's future because the child will be physically as the same as his/her mother or father. The child may not want to be as same as his/her father or mother. They may want to be a different person like other not cloned children in the future. Moreover, this cloning will be a terrible thing for either the mother or the father because it will be very boring for them to see and re-live their own childhood.
- 16M(HD): When I am putting myself into the child, I strongly want this therapy because this therapy will affect my health and my

future. To live better life in the future without HD illnesses, I need to use this therapy. Because of these reasons, this therapy should be used.

- 25M(HD): My emotions are dominant in my decision-making regarding this scenario. In here, I put myself into my family and I think that this scenario is directly related to a person's life. The other things such as morality and ethics are not so important in this scenario. As a result, this therapy should be used.

4.1.3. Intuitive Informal Reasoning

Emotive and intuitive informal reasoning patterns represent qualitatively different methods in order to resolve SSI (Sadler, 2003). When emotive reasoning includes emotion and reason, intuitive reasoning involves immediate reactions to any particular SSI. Furthermore, intuitive informal reasoning may not be rational (Sadler, 2003). However, since it is a type of resolution of one SSI, it may be considered as a type of informal reasoning.

For HD, 5 participants; for NS, 2 participants; for IN, 2 participants; for RC, 18 participants; for AC, 13 participants; for TC, 7 participants; for GW, 18 participants displayed intuitive informal reasoning pattern. Below excerpts clearly displayed that some participants had immediate reactions to the several SSI. When some participants (participant 28 and 30) displayed negative reactions to the reproduction and therapeutic cloning issues, another (participant 30) participant showed positive response to the accident issue. However, these participants' reaction was intuitive instead of rational. As a result, their unthinking responses were affective reactions in response to these issues. In other words, their unintended reaction to these issues may be classified as "gut-level" responses (Sadler, 2003).

- 28R(RC): I am absolutely against the things such as cloning a child. Since my religious beliefs form a barrier to cloning, I think cloning is nonsense.
- 30R(AC): I think this therapy is needless. We do not have to use this therapy. As a result, it should not be used.
- 34R(TC): This therapy absolutely should be used. This scenario is not related to both ethics and religion.

4.1.4. Overlapping Informal Reasoning Patterns

The participants' informal reasoning patterns were not observed as independent or separate regarding plenty of SSI. In other words, the participants displayed multiple informal reasoning patterns in response to each SSI except for intelligence issue. For example, in response to HD issue, 18 out of 39 participants demonstrated rationalistic and emotive informal reasoning patterns together. In other words, they exhibited their empathy and rational concerns in order to resolve HD issue at the same time. Throughout the study, three paired combinations of informal reasoning patterns, which are rationalistic-emotive (frequency=26), rationalistic-intuitive (frequency=6), and emotive-intuitive (frequency=1), were observed. Table 4.1 clearly displayed overlapping informal reasoning patterns regarding SSI.

Table 4.1. The Participants' Combined Patterns of Informal Reasoning.

Combined Patterns	Excerpts*
Rationalistic-Emotive	1R(TC): Yes, this therapy should be used because when the patient confronted with this illness, the patient would have much responsibilities towards the life. For example, the patient will have a family whom the patient is responsible for. The patient should take care of his/her family. When I confronted with this illness, I could use this cloning method. *However, we are destabilizing the natural cycle in the world. We are interfering with the natural selection using this cloning method. As animals are confronted with the viruses and gyms, humans are also confronted with the illnesses such as HD in order to supply for natural selection. As animals are confronting with the natural selection, humans should also confront with the natural selection.*
Rationalistic-Intuitive	4R(GW): **I think US should have participated in this protocol. US considered only its own benefits.** *Since dangerous gases emissions affect the entire world, all countries should have been participated in this protocol. For healthy next generations and in order to be preventing from global warming, we should take some precautions.*
Emotive-Intuitive	26M(AC): Emotive factors were effective in my decision-making about this (Accident Cloning) issue. I only put myself into the woman. I did not consider the risk stemming from the cloning…**According to my religious beliefs, I would not use this therapy. Meanwhile, considering the religious beliefs which affect the decision-making of Turkish society, 70-80% of Turkish people do not use this cloning method.**

*Rationalistic evidence was displayed as italic character; emotive evidence was displayed as underline character; and intuitive evidence was displayed as bold character.

As a summary, it was found that the participants hold not only rationalistic, emotive, and intuitive informal reasoning separately but also combination of them. Table 4.2 presents emergent informal reasoning patterns and all combinations of informal reasoning patterns.

Table 4.2. Emergent Informal Reasoning Patterns and Overlapping Conditions in response to SSI

SSI	Informal Reasoning Patterns*						Total
	R	E	I	R - E	R - I	E - I	
HD	14	2	5	18			39
NS	31	6	2				39
IN	30	5	2	2			39
RC	13	7	18	1			39
AC	10	14	12	2		1	39
TC	14	16	7	2			39
GW	20		12	1	6		39

*R = Rationalistic; E = Emotive; I = Intuitive; HD = Huntington's disease gene therapy; NS = Nearsightedness gene therapy; IN = Intelligence gene therapy; RC = Reproductive cloning; AC = Accident cloning; TC = Therapeutic cloning; GW = Global warming

According to Table 4.2, the most observed combination of informal reasoning was R-E (Rationalistic-Emotive). In response to all issues except for NS issue, at least one participant developed rationalistic and emotive informal reasoning patterns together. Specifically about the HD case, 18 participants presented combination of R-E. The emergence of the high frequency of R-E among the other overlapping conditions may be resulted from the reason that when rationalistic and emotive informal reasoning patterns may include reasons about one SSI, intuitive informal reasoning may include immediate reactions not reasons regarding one SSI. The other emergent combination of informal reasoning pattern was R-I (Rationalistic-Intuitive). The participants presented this combination regarding only global warming issue. They gave immediate reactions about the participation of USA into Kyoto Protocol because during the data collection time a majority of participants had prejudices against USA politically and sociologically. However, in addition to intuitive informal reasoning, the participants also developed rationalistic informal reasoning pattern. For example, the most participants claimed that Kyoto Protocol was related to the entire world, and the world was warming and ice melting rapidly. Thus, all countries should give enough importance to global warming and they should have

participated in this protocol. Because of these reasons, 6 participants may have developed rationalistic and intuitive informal reasoning patterns together. The other emergent overlapping informal reasoning pattern was E-I (Emotive-Intuitive). Regarding Accident case, 1 participant presented this combination. General trend about cloning cases showed that the participants mostly developed emotive and intuitive informal reasoning patterns. As seen in Table 4.2; 14, 12, and 10 participants exhibited emotive, intuitive, and rationalistic informal reasoning patterns, respectively. Thus, this combination (E-I) may be presented by the participant because of the context of this issue (cloning issue).

Plenty of emergent informal reasoning patterns were consistent with the Sadler and Zeidler's (2005a) findings. Figure 4.1 presents the schematic representations of three informal reasoning patterns of Sadler and Zeidler' study (2005a) and the present study. According to Figure 4.1, Sadler and Zeidler (2005a) explored the same patterns (rationalistic-emotive, rationalistic-intuitive, and emotive-intuitive) in their study. In addition to these patterns, Sadler and Zeidler (2005a) also reported rationalistic-emotive-intuitive informal reasoning pattern which included all three informal reasoning patterns in response to some SSI. However, in this study, thinking pattern including all three informal reasoning patterns was not found.

Sadler and Zeidler (2005a) The Present Study

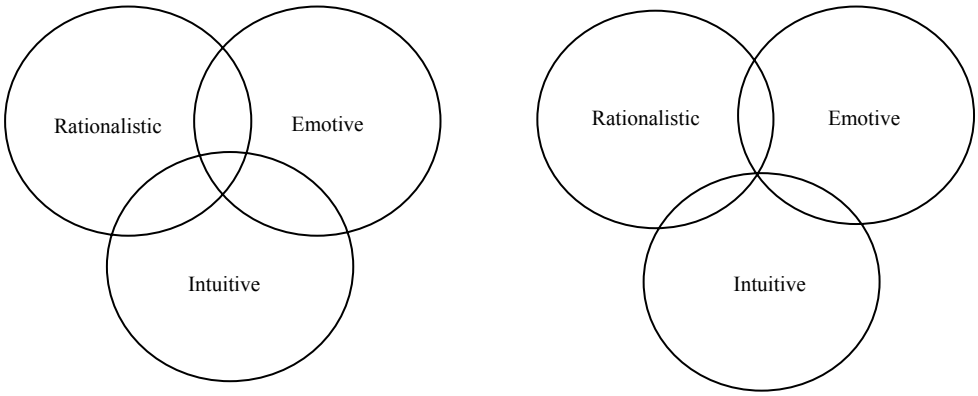

Figure 4.1. Emergent Informal Reasoning Patterns and Overlapping Conditions of Sadler and Zeidler's (2005a) Study and the Present Study

4.1.5. The Variation of Informal Reasoning Patterns with SSI

When the frequencies of emergent informal reasoning patterns were took into consideration, it was found that there was a considerable variation of informal reasoning patterns with different SSI. Table 4.3. displays the frequency of the participants' emergent informal reasoning patterns across each SSI. However, in this table, each participant may have used more than one informal reasoning pattern in response to one SSI. Thus, the frequency counts of informal reasoning patterns did not represent independent measures of the participants. Furthermore, Table 4.3. was used only for the aim of description.

Table 4.3. Informal Reasoning Patterns in response to SSI

Informal Reasoning Patterns	SSI*							
	HD	**NS**	**IN**	**RC**	**AC**	**TC**	**GW**	**Total**
Rationalistic	32	31	32	14	12	16	27	164
	(82%)	(79%)	(82%)	(36%)	(31%)	(41%)	(69%)	(60%)
Emotive	20	6	7	8	17	18	1	77
	(51%)	(15%)	(18%)	(21%)	(44%)	(46%)	(3%)	(28%)
Intuitive	5	2	2	18	13	7	18	65
	(13%)	(5%)	(5%)	(46%)	(33%)	(18%)	(46%)	(24%)

*HD = Huntington's disease gene therapy; NS = nearsightedness gene therapy; IN = intelligence gene therapy; RC = reproductive cloning; AC = accident cloning; TC = therapeutic cloning; GW = global warming

According to Table 4.3, it may be asserted that all three informal reasoning patterns were mostly context dependent. However, rationalistic informal reasoning was the least context dependent. During the resolution of Huntington's disease (82%), nearsightedness (79%), intelligence (82%), and global warming (69%) issues, the participants mostly used rationalistic informal reasoning. Similar to Sadler and Zeidler's (2005a) study, the present study supported that rationalism was the least context dependent among all informal reasoning patterns regarding the different SSI.

According to Table 4.3, it was also suggested that context dependence was more for emotive informal reasoning. The emergence of emotive informal reasoning remained relatively high across much of the cloning issues instead of much of the gene therapy issues. These result suggested that cloning issues (RC, AC, and TC) were more effective than the most of the gene therapy (NS, and IN) issues in revealing the participants' emotive informal reasoning pattern. Sadler (2003) reported similar findings about incidence of emotive reasoning. Both studies showed that the incidence of emotive informal reasoning was more distinctive about

cloning issues because the participants' empathy and sympathy were distinctively revealed regarding these issues. Sadler (2003) interpreted the findings in which when emotive informal reasoning followed undecided pattern among gene therapy issues, its using stayed approximately high regarding all cloning issues. Thus, consistent trend was explored in both studies about the emergence of emotive informal reasoning.

In addition to emotive informal reasoning, Table 4.3 exhibited context dependence for intuitive informal reasoning. Although intuitive informal reasoning pattern was distinctive pattern in reproductive cloning issue, the role of this reasoning took attention in other issues such as gene therapy and global warming issues. Similar to the present study, Sadler's (2003) study demonstrated that intuitive informal reasoning was one of the emergent patterns for the resolution of several SSI such as intelligence, reproductive, and cloning issues. As a result, both studies showed that intuitive informal reasoning was another significant pattern for the resolution of some SSI.

4.2. Variation of Informal Reasoning Quality with Informal Reasoning Patterns across SSI

RQ2: How does the quality of informal reasoning demonstrated by PSTs negotiating SSI vary as a function of informal reasoning patterns?

The main concern of this research question was the exploration of the variation of informal reasoning quality with informal reasoning patterns across SSI. Participants' informal reasoning patterns were reported in the research question 1. In addition to exploration of informal reasoning patterns, informal reasoning quality was assessed in the present research

question by the criteria and descriptive questions. Table 4.4 displays criteria and descriptive questions in order to explore participants' informal reasoning quality.

Table 4.4. Criteria and Descriptive Questions Assessing Informal Reasoning Quality

Criterion	**Descriptive Questions**
Claim	Can a participant develop claim(s) about a issue?
Justifications	Can a participant develop justification(s) in addition to claim(s)?
Counter-position	Can a participant develop counter-position in addition to claim(s) and justification(s)?
Rebuttal	Can a participant develop rebuttal in addition to claim(s), justification(s), and counter-position?

Utilized criteria for the informal reasoning quality were consistent with argumentation theory developed by Toulmin (1958) and Kuhn (1991). In the present study, to assess informal reasoning quality, the criteria stated above were developed by the researcher. Table 4.5 shows the informal reasoning quality types and criteria to assess informal reasoning quality. Furthermore, it displays excerpts taken from the interviews.

Table 4.5. The Assessment Criteria of the Informal Reasoning Quality and Interview Excerpts

Informal Reasoning Quality Types	Criterion	Excerpt
1	Claim without justification	30R(HD): I think it (gene therapy) may be used. No problem.
2	Claim with justification	39R(NS): I think this therapy should not be used because I have myopia. I am using glasses, and myopia does not affect my daily and work life. There are several alternative treatments such as glasses, lens, and laser to overcome this illness. Since there are already several alternative methods without risks, this gene therapy is needless and should not be used.
3	Claim with justification and counter-position	19R(HD): This therapy may be used. Of course, parents do not want their child to be ill in the future. They prefer using this therapy method. Otherwise, their children will confront with big difficulties in the future. However, the parents need to consider negative results stemming from this therapy..... Genetic engineering may cause problems by influencing the natural equilibrium. With the genetic engineering, we are interfering with the natural equilibrium. Thus, we can cause the new problems in nature. Deaths are inseparable part of the natural equilibrium. If we interfere with the natural equilibrium, and gene therapies are used for each illness, this condition may cause new problems in nature. In addition, due to side effects of the gene therapy, there is a possibility that the child may have different illnesses in the future.
4	Claim with justification, counter-position, and rebuttal	7R(IN): This therapy should not be used because I think using this therapy includes high risk. With this therapy, you may confront with exaggerated (excessive) conditions. For example, this therapy may cause other intelligence problems such as idiot. Moreover, if the society has too many clever people, this condition may be result with the chaos and unsolved problems in the society because this condition directly affects the job distribution. At this point, the question "Who will have which job?" should be answered. When you try to raise more intelligent people, you may confront with these unexpected problems. However, if the society has intelligent people, this will enable them to have strong society. The next generations in this society will have more success and happiness. In addition, I think intelligence is not only related to genetics, but also related to environment, family, and school. When environment, family, and school affect the development of person's intelligence in positive way, the person's intelligence may develop in expected way. As a result, instead of improving the people's intelligence genetically, we can arrange environmental conditions in order to improve people's intelligence.

During the remaining part of the present study, informal reasoning quality types were presented with numbers, ranging from 1 to 4; small numbers were less sophisticated than the large numbers. Informal reasoning quality type 1 included only a claim; informal reasoning quality type 2 consisted of a claim and its justification; informal reasoning quality type 3 included a claim, its justification, and counter-position. Informal reasoning quality type 4 comprised of a claim, its justification, counter-position, and rebuttal. In other words, informal reasoning quality type 1 and 2 represented less sophisticated informal reasoning qualities because they consisted of a claim or a claim with its justification. Furthermore, informal reasoning quality type 3 and type 4 expressed more sophisticated informal reasoning quality since they consisted of a claim with its justification and counter-position or a claim with its justification, counter-position, and rebuttal.

The relationship between informal reasoning quality and informal reasoning patterns were explored across each SSI because the participants developed different informal reasoning patterns (e. g., rationalistic, emotive, and intuitive) or combinations of these patterns (e. g., rationalistic-emotive; emotive-intuitive; rationalistic-intuitive). For example, related to HD issue, some participants developed rationalistic and emotive informal reasoning patterns at the same time.

4.2.1. The Relationship between Informal Reasoning Patterns and Quality regarding HD

Regarding HD issue, all types of informal reasoning patterns (rationalistic, emotive, and intuitive) were observed separately. In addition, one combination of informal reasoning patterns (rationalistic and emotive) was explored about this issue.

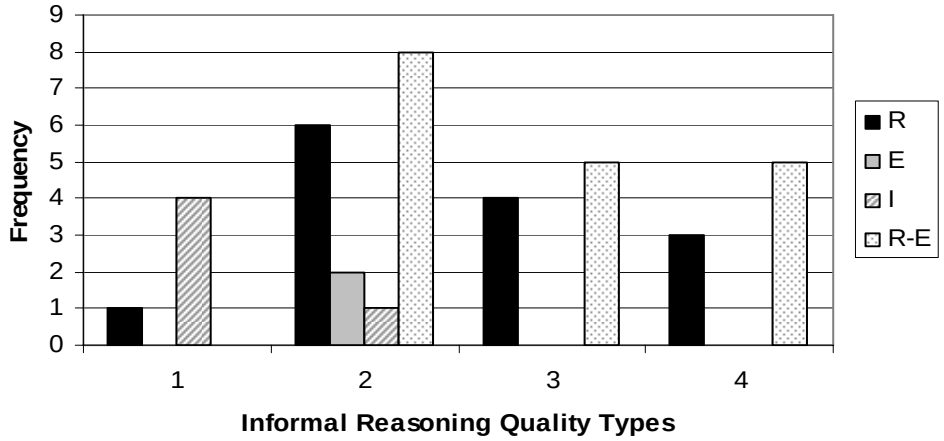

Figure 4.2. Distribution of Informal Reasoning Quality Types by Informal Reasoning Patterns for HD. *Note.* R = Rationalistic Informal Reasoning; E = Emotive Informal Reasoning; I = Intuitive Informal Reasoning; R-E = Rationalistic and Emotive Informal Reasoning; R-I = Rationalistic and Intuitive Informal Reasoning; E-I = Emotive and Intuitive Informal Reasoning.

As observed in Figure 4.2, intuitive informal reasoning pattern was mostly observed for the participants having informal reasoning quality 1 and 2. Moreover, rationalistic-emotive informal reasoning patterns were mostly observed in the participants having informal reasoning quality types 2, 3 and 4. In other words, the participants having more sophisticated informal reasoning quality generally had rationalistic-emotive informal reasoning patterns. Moreover, the participants who had sophisticated informal reasoning quality (type 3 and 4) did not develop intuitive informal reasoning patterns. As a result, when the participants' informal reasoning quality moved from less sophisticated to more sophisticated, their informal

reasoning patterns were better represented by rationalistic informal reasoning patterns rather than intuitive reasoning.

4.2.2. The Relationship between Informal Reasoning Patterns and Quality regarding NS

Regarding NS issue, all types of informal reasoning patterns (rationalistic, emotive, and intuitive) were observed separately.

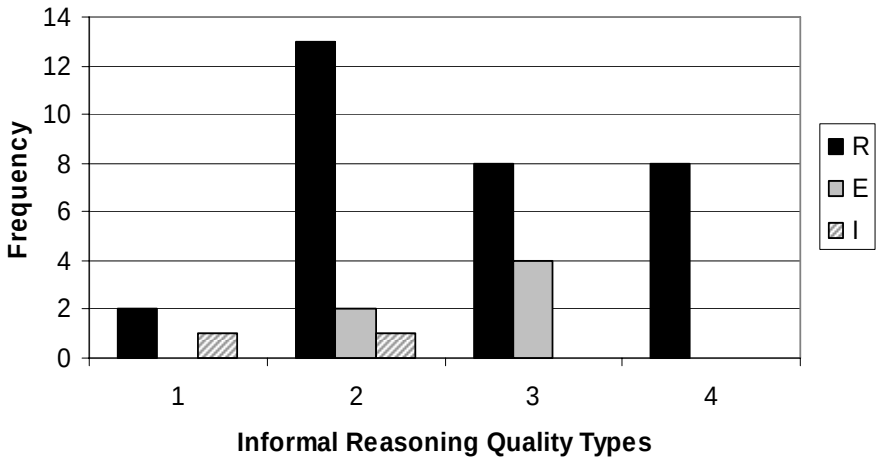

Figure 4.3. Distribution of Informal Reasoning Quality Types by Informal Reasoning Patterns for NS

As observed in Figure 4.3, similar to HD issue, intuitive informal reasoning pattern was mostly determined for the participants having informal reasoning quality 1 and 2. That is to say, this pattern was revealed by the participant who had less sophisticated informal reasoning quality. In addition, emotive reasoning pattern was mostly observed by the participant

having informal reasoning quality type 2 and 3. Furthermore, similar to HD issue, rationalistic reasoning pattern were mostly seen in the participants having informal reasoning quality type 2, 3 and 4. Regarding this SSI, rationalistic informal reasoning pattern was dominant throughout all the informal reasoning quality types. However, it may be claimed that the participants having more sophisticated informal reasoning quality mostly displayed rationalistic informal reasoning. Moreover, the participants having sophisticated informal reasoning quality (type 3 and 4) did not develop intuitive informal reasoning. Consistent with the HD, in this SSI, when the participants' informal reasoning quality changed from less sophisticated to more sophisticated, their informal reasoning pattern changed from intuitive reasoning to rationalistic informal reasoning pattern.

4.2.3. The Relationship between Informal Reasoning Patterns and Quality regarding IN

Regarding IN issue, all types of informal reasoning patterns (rationalistic, emotive, and intuitive) were observed separately. Moreover, one combination of informal reasoning patterns (rationalistic and emotive) was determined about this issue.

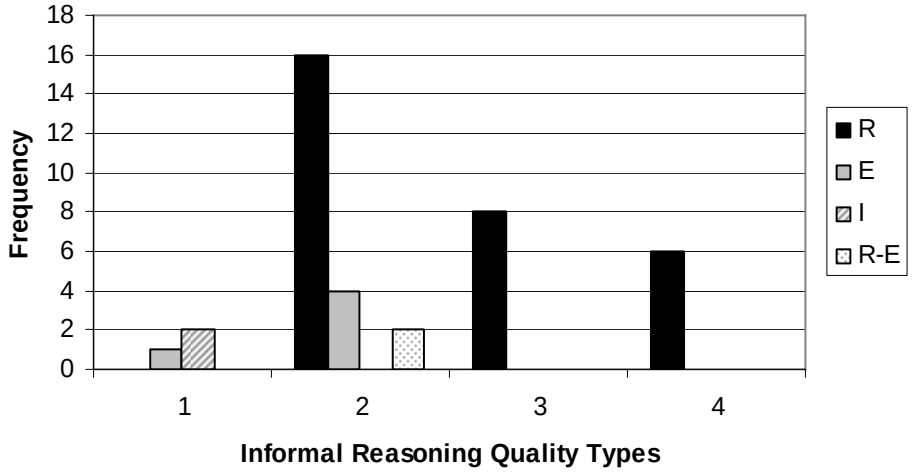

Figure 4.4. Distribution of Informal Reasoning Quality Types by Informal Reasoning Patterns for IN

As observed in Figure 4.4, similar to previous two SSI (HD and NS), only the participants having informal reasoning quality type 1 displayed intuitive informal reasoning pattern about this issue. Furthermore, only the participants having informal reasoning quality type 1 and type 2 displayed emotive informal reasoning patterns. Similar to HD, most participants having informal reasoning quality type 2, 3 and 4 displayed rationalistic informal reasoning pattern. Parallel to previous SSI, the participants having more sophisticated informal reasoning quality exhibited rationalistic informal reasoning, and they did not develop intuitive informal reasoning about this issue. Moreover, consistent with the previous SSI, when the participants' informal reasoning quality changed from less sophisticated to more sophisticated (type 1 through type 4), their informal reasoning pattern changed from intuitive or emotive reasoning pattern to rationalistic informal reasoning.

4.2.4. The Relationship between Informal Reasoning Patterns and Quality regarding RC

For RC, all types of informal reasoning patterns (rationalistic, emotive, and intuitive) were determined separately. Furthermore, one combination of informal reasoning pattern (rationalistic and emotive) was observed about this issue.

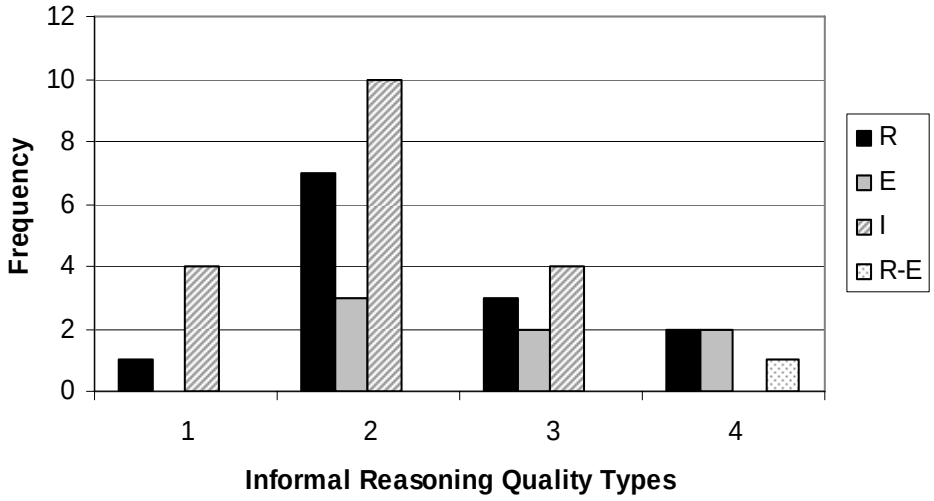

Figure 4.5. Distribution of Informal Reasoning Quality Types by Informal Reasoning Patterns for RC

As observed in figure 4.5, different from the previous gene therapy issues (HD, NS, and IN), intuitive informal reasoning pattern was determined in approximately all reasoning quality types (type 1, 2, and 3). For this issue, context might be effective on students' decision making because previous issues were about the gene therapy. However, in this issue, context changed as a cloning issue. Thus, the most participants having less or more sophisticated informal reasoning quality developed intuitive or

emotive informal reasoning patterns regarding this issue. Emotive reasoning pattern was observed in the participants having informal reasoning quality type 2, 3, and 4. In the same time, rationalistic informal reasoning pattern was observed in all informal reasoning quality types. Different from other previous SSI, for this issue, rationalistic informal reasoning pattern was not determining factor across each type of informal reasoning quality because it was observed throughout all the informal reasoning quality types.

4.2.5. The Relationship between Informal Reasoning Patterns and Quality regarding AC

For AC, all types of informal reasoning patterns (rationalistic, emotive, and intuitive) were determined separately. In addition, two combinations of informal reasoning patterns (rationalistic-emotive; emotive-intuitive) were observed about this issue.

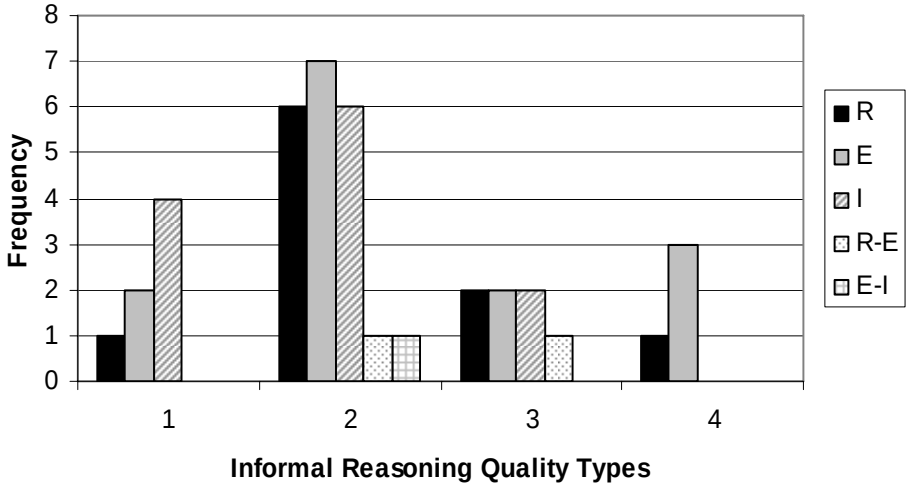

Figure 4.6. Distribution of Informal Reasoning Quality Types by Informal Reasoning Patterns for AC

As observed in figure 4.6, similar to another cloning issue (RC), emotive and intuitive informal reasoning patterns were seen in approximately all reasoning quality types (type 1, 2, and 3). In addition, for this issue, context might be effective on students' decision making because intuitive especially emotive informal reasoning pattern were observed for each type of informal reasoning quality. Since this issue was related to the cloning, emotive and intuitive informal reasoning patterns were observed much. Participants might be sensitive to cloning issues because most participants claimed that when gene therapy is needed treatment for human health, however, cloning is not necessary. For informal reasoning quality type 4, as if emotive informal reasoning pattern was observed, intuitive informal reasoning was not explored for these participants. In addition, rationalistic informal reasoning pattern was observed in all informal reasoning quality types. This finding supported the previous finding that the participants having sophisticated informal reasoning quality such as type 4 did not develop intuitive informal reasoning. Consistent with another cloning issue (reproduction issue), rationalistic informal reasoning pattern was not determining factor across all type of informal reasoning quality because this pattern was observed throughout all the informal reasoning quality types.

4.2.6. The Relationship between Informal Reasoning Patterns and Quality regarding TC

For TC, all types of informal reasoning patterns (rationalistic, emotive, and intuitive) were determined separately. Moreover, one combination of informal reasoning pattern (rationalistic-emotive) was observed about this issue.

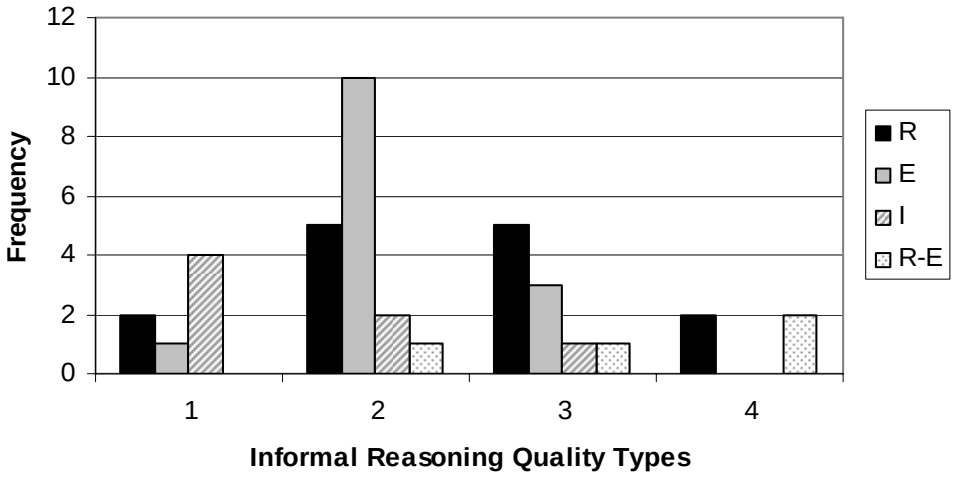

Figure 4.7. Distribution of Informal Reasoning Quality Types by Informal Reasoning Patterns for TC

As seen in figure 4.7, in this issue, rationalistic and emotive informal reasoning patterns were observed in all informal reasoning quality types. Consistent with the other cloning issues (RC and AC), rationalistic and emotive informal reasoning pattern were not determining factor across all type of informal reasoning quality, and also emotive informal reasoning pattern was not determining factor because both patterns were observed throughout all the informal reasoning quality types. Furthermore, similar to another cloning issue (RC) and different from the previous gene therapy issues (HD, NS, and IN), emotive and intuitive informal reasoning patterns were seen much in all reasoning quality types. Since this issue was related to the cloning, emotive and intuitive informal reasoning patterns were observed much. Students utilized emotions or they showed immediate reactions when they resolve and negotiate with this SSI. Finally, the other important finding about this issue was that when informal reasoning quality changed from less sophisticated to more sophisticated, intuitive informal reasoning pattern became less and lost in informal reasoning quality 4. This finding supported the claims regarding gene therapy issues.

4.2.7. The Relationship between Informal Reasoning Patterns and Quality regarding GW

Regarding GW, all types of informal reasoning patterns (rationalistic, emotive, and intuitive) were determined separately. Furthermore, two combination of informal reasoning pattern (rationalistic-emotive; rationalistic-intuitive) were observed about this issue.

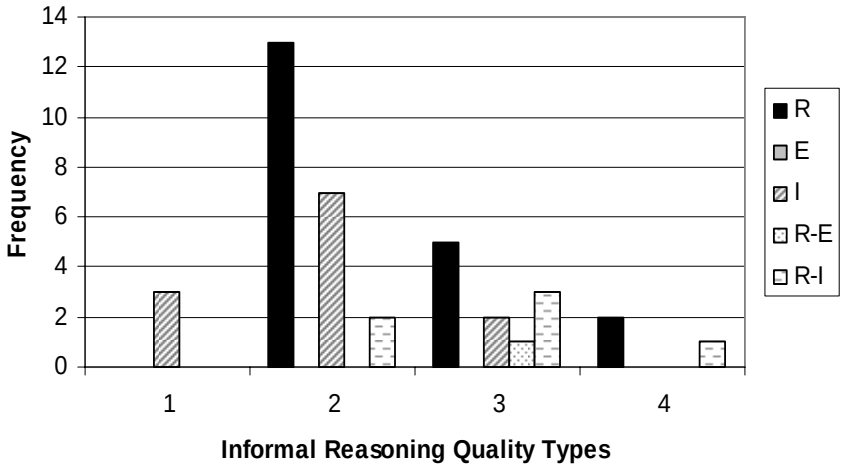

Figure 4.8. Distribution of Informal Reasoning Quality Types by Informal Reasoning Patterns for GW

As seen in figure 4.8, intuitive informal reasoning pattern was observed in all informal reasoning quality types in this issue. The context of GW was effective for this issue similar to several previous issues. This issue was related to the whether US should participate or not the Kyoto Protocol about global warming. Since the most participants had negative prejudice

against US sociologically and politically, they displayed intuitive informal reasoning pattern and they gave immediate reactions to this issue. Intuitive informal reasoning pattern took attention for this issue because intuitive informal reasoning was seen in all informal reasoning types. The other finding related to this issue was that the frequency of rationalistic informal reasoning pattern became less when informal reasoning quality changed from less sophisticated to more sophisticated. This finding was unexpected because it was expected that when the informal reasoning quality changed from less sophisticated to more sophisticated, the frequency of rationalistic informal reasoning pattern should become more. However, since the context may be effective in participants' informal reasoning, this result may be found for this issue. Different from all the previous issues, emotive informal reasoning pattern was not observed except one participant for this issue. As a result, because of the context of the issue, participants generally displayed rational or intuitive informal reasoning instead of emotive informal reasoning.

4.3. Variation of Informal Reasoning Quality with SSI

How does the quality of informal reasoning vary as PSTs negotiate with different SSI?

The aim of this research question was to investigate the variation of informal reasoning quality with SSI. For each SSI, participants' informal reasoning quality was explored in the research question 2. Utilizing from these informal reasoning quality types, the researcher specifically focused on the variation of informal reasoning quality with multiple SSI in this research question.

As stated in research question 2, informal reasoning quality 1 referred to claim without justification; informal reasoning quality 2 referred to claim with justification; informal reasoning quality 3 referred to claim with justification and counter-position; informal reasoning quality 4 referred to claim with justification, counter-position, and rebuttal.

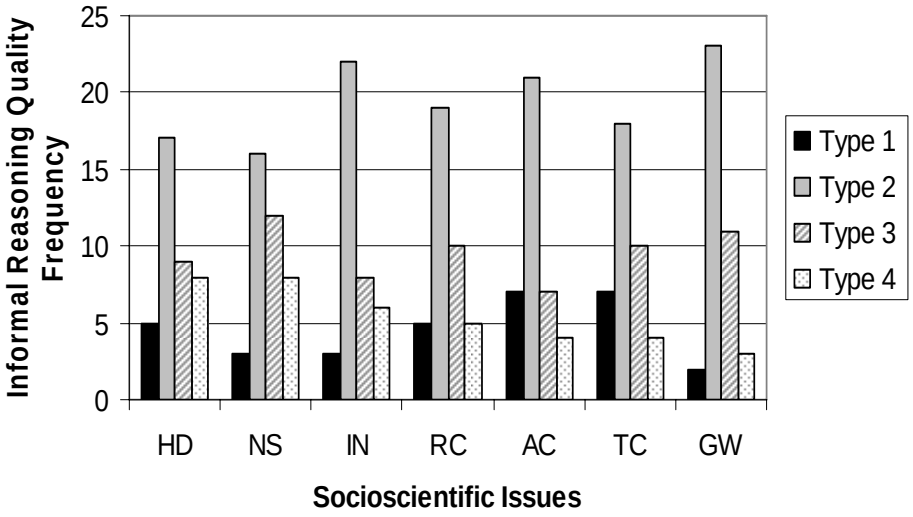

Figure 4.9. Distribution of Informal Reasoning Quality Types by SSI

According to the figure 4.9, among the informal reasoning quality types, the most observed informal reasoning quality was type 2 (claim with justification). Related to this finding, it may be claimed that participants developed sufficient claim with justification but they did not develop sufficient counter-position and rebuttal. In other words, participants generally developed less sophisticated informal reasoning quality instead of sophisticated informal reasoning quality.

Another most notable finding was that a similar pattern among the informal reasoning quality types was observed across each SSI. When the sequence of informal reasoning quality type 1 among all informal reasoning quality types changed depending on the SSI, informal reasoning quality types 2, 3, and 4 followed the same sequence across each SSI. In addition to this, the frequency of three types of informal reasoning quality was sequenced from more to less: type 2; type 3; and type 4 across each SSI. Regarding this finding, context interestingly did not influence the sequence and frequency patterns of informal reasoning quality types. This result suggested that the participants' informal reasoning quality was independent from the context. On the other hand, as stated in research question 1 part, another characteristic of informal reasoning, informal reasoning patterns, was affected from the context. For example, whereas rationalistic informal reasoning pattern was mostly seen in gene therapy issues, emotive and intuitive informal reasoning patterns were observed in cloning issues. Thus, informal reasoning pattern was context-depended; however, informal reasoning quality was independent from the context.

4.4. Factors Influencing Informal Reasoning

RQ4: What factors influence PSTs' informal reasoning as they negotiate with multiple SSI?

The aim of this research question was the exploration and explanation of the factors influencing PSTs' informal reasoning regarding SSI. In the socioscientific literature, there were several studies investigating the variables influencing informal reasoning and socioscientific decision making (Bell & Lederman, 2003; Fleming, 1986b; Hogan, 2002; Sadler et al., 2002; Sadler, 2003; Tytler et al., 2001; Zeidler & Schafer, 1984; Zeidler

et al., 2002). For example, Sadler (2003) investigated the influence of content knowledge and morality on the informal reasoning regarding SSI. Furthermore, Bell and Lederman (2003) explored the influence of NOS conceptualization on socioscientific-decision making. Although there were a few findings in socioscientific literature about the variables influencing people's informal reasoning, there was no specific research directly focusing on the factors influencing informal reasoning. Thus, the other concern of the present study was the focusing on the factors influencing informal reasoning.

When the researcher investigated the PSTs' informal reasoning, he noticed the factors influencing participants' informal reasoning. Then, researcher re-analyzed the transcripts and decided to focus on the factors influencing participants' informal reasoning as another part of the present study because these factors were important in shaping participants' informal reasoning. Thus, new research question was added to this study. This research question was shaped as: "What factors influence PSTs' informal reasoning as they negotiate with multiple SSI?"

In light of the qualitative analyses, main factors influencing participants' informal reasoning were accumulated under four main categories; personal experiences, social considerations, moral-ethical considerations, and technological concerns. Furthermore, the social considerations category consists of three sub-categories; economic, educational, and religious considerations. Table 4.6. displays the factors influencing informal reasoning and the description of these factors. Following the table, each factor was re-explained briefly under these titles. In addition, related to each factor, sample excerpts were presented in the rest of this section.

Table 4.6. Factors Influencing Informal Reasoning and Description of These Factors

Factors Influencing Informal Reasoning	Factor Description
Personal Experiences	Participants use their previous experiences to help interpret dilemmas about issues articulated.
Social Considerations	Participants consider economic, educational, and religious aspects of the society as they resolve SSI.
• Economic Consideration	Participants considered that whether or not the people can use gene therapy or cloning depends on their own economic condition they have. For example, if the people are poor they will not use these therapies. Furthermore, if the people are rich, they will use these therapies. The factor influencing their informal reasoning is economic.
• Educational Consideration	Participants considered that whether or not the people can use gene therapy or cloning depends on their educational level they have. For example, when people's education level increase, they will tend to use these therapies because they are more conscious and intellectual people. Moreover, if the people have the less education level such as elementary or middle school, they will not use these therapies because they are less conscious and intellectual people. The factor influencing their informal reasoning is educational.
• Religious Consideration	Participants argued that decision on usage of gene therapy or cloning depends on their own religious understanding. For example, if the people have are very conservative, they may not use these therapies. Furthermore, if the people are less conservative, they may prefer to use these therapies. The factor influencing their informal reasoning is religious.
Moral-Ethical Considerations	Participants use morality-ethical perspective in the resolution of SSI.
Technological Concerns	Participants state their concerns about technological developments as they engage with SSI.

4.4.1. Personal Experiences

Regarding some SSI, participants utilized their pre-experiences in order to resolve these issues. In the socioscientific literature, several researchers claimed that personal experiences were the guide to resolve and negotiate with socioscientific dilemmas (e.g., Zeidler & Schafer, 1984). In general, researchers concluded that personal domain affects a person's informal reasoning about SSI (Sadler, 2004). In addition, similar to these studies, the present study supported this finding that personal experience

was found as the distinctive factor influencing informal reasoning. For HD, 35 participants; for NS, 16 participants; for IN, 23 participants; for RC, 16 participants; for AC, 23 participants; for TC, 1 participant; for GW, 16 participants used their personal experience to resolve these issues. Below, excerpts taken from the interviews displayed personal experience as a factor:

- 1M(AC): I (Interviewer) - Did you know your position on the issue before you had to consciously reflect on the issue?
  Beforehand, I read several materials about cloning. I do not absolutely agree with using this therapy. I do not have immediate reaction to this scenario.
- 2M(HD): I - Did you think about who would have access to gene therapy? If so, how did this affect your decision-making?
  Turkey is a closed society. In our society, gene therapy is not seen as a good thing. Actually, I do not know the exact reason but this condition may be originated from less educated people in our society.
- 2R(NC): I - How would you convince a friend or acquaintance of your position about nearsightedness scenario?
  I can give some examples from myself. For example, when I use this therapy, I can play several kinds of sport easily. In addition, I would also say living without glasses would be more comfortable.
- 3-1M(HD): I - Did you consider the feelings of a potential child carrying the HD gene? If so, how did this affect your-decision making?
  Related to this illness, I watched TV and read a book. I put myself into child. Even if I have flu, I need to get help from my family. However, this illness is very dangerous. Also, when you have a flu,

you can be healthy with medicines but this illness may be solved by this therapy. As a result, this therapy should be used.

- 3-2M(HD): I - Did you think about who would have access to gene therapy? If so, how did this affect your decision-making?
  In our society, having child is an important thing. Moreover, in our society, child is inseparable part of the family. Because of these reasons, families can use this therapy.
- 5R(IN): I - Can you think of an argument that could be made against the position that you have just described? How could someone support that argument?
  I am giving private lessons to some students. I think these students' intelligence level is low. It is really hard to teach concepts to these students. Some families can see this condition as problematic. Maybe, these families can use this therapy. However, I do not use this therapy for my child.

These excerpts clearly displayed the personal experience as a factor influencing informal reasoning about different SSI. Participant 1 and 3-1 stated that they read a book regarding the gene therapy or cloning. Thus, their previous experiences were effective in shaping their informal reasoning. Participant 2R and 5 used their own life experiences to develop their rationale. Furthermore, participant 2M and 3-2 utilized their pre-experience about Turkish tradition to shape their informal reasoning.

4.4.2. Social Considerations (Economic, Educational, and Religious Considerations)

In socioscientific literature, most of the researchers reached the consensus in which social perspective was an important variable shaping

people's decision making about several SSI (Bell & Lederman, 2003; Sadler et al., 2004; Zeidler et al., 2002). In the present study, concerning some SSI, participants dealt with the economic, educational, and religious aspects of the society in order to resolve these issues. When some participants gave importance to economical considerations, the other participants focused on the educational or religious considerations. Since these considerations were related to society, they were combined under a heading of social consideration.

Below are the excerpts displaying social consideration as a factor influencing informal reasoning in the present study. In addition, economic consideration excerpts presented in following part was displayed as italic character; educational consideration excerpts was displayed as underline character; and religious consideration excerpts was displayed as bold character:

- 14M(HD): I - Did you think about who would have access to gene therapy? If so, how did this affect your decision-making?
  The most important factor is education. Most of the people living in the east part of Turkey are not aware of gene or gene therapy. Most of them do not hear anything about these concepts. **Actually, education level is more dominant than religion in decision making about gene therapy. However, religion and education level are most effective factors influencing their decision making.**
  To sum up, the first factor is education level; second one is religion; and last one is psychological factor shaping in decision making of the Turkish people.
- 2M(HD): I - Did you think about who would have access to gene therapy? If so, how did this affect your decision-making?

At first, rich people may apply for this therapy. **Religion may be effective. In our society, religion is more effective for the proportion of 50 percent in people's decision making about this scenario. I can say that the most important factor influencing our people's decision making is religion.** *The second most important factor may be economic consideration.*

- 4M(AC): I - Did you think about who would have access to gene therapy? If so, how did this affect your decision-making?
  First, rich people will apply for this therapy. **Second, religion may be effective in people's decision making. Religion is important sociological variable in our country. If someone is fundamentalist in our country, the person may evaluate this scenario as destiny. Thus, they may accept this illness as people's destiny.** Educational level is also important. **In our Turkish culture, the most important factor shaping people's decision making is religion. Since people think about the life after the world life, the most important factor is religion in our country.**
- 5M(AC): I - Did you think about who would have access to gene therapy? If so, how did this affect your decision-making?
  Conservative families may not want to use this gene therapy. My family is also conservative. However, under some circumstances, other things are not considered if issue is your family's health. If issue is my or another family's health, I can make a sacrifice with respect to religion. In our society, people's decisions regarding this issue will change according to their interpretation of the religion; As a result, religion may be an important factor in decision making. However, in this scenario, religion is not barrier to use this therapy. *In addition, our country's socioeconomic status is very important. Unfortunately, if this*

therapy is expensive, most people in our country will not use this therapy.

- 8M(HD): I - Did you think about who would have access to gene therapy? If so, how did this affect your decision-making?
  In Turkey context, I think rich people will use this therapy. Also, I think intellectual people will use this therapy. Intellectual people means that people who are not overwhelmed under religion and cultural effects.

These excerpts clearly displayed the social consideration as a factor influencing informal reasoning about SSI. As observed in these excerpts, the participants developed different factors influencing their informal reasoning during the process of their socioscientific decision-making. For example; when participant 14 considered education and religious aspects in order to resolve and negotiate with the HD, participant 8 considered economic and educational factors to resolve this issue. Religious aspect especially took attention in cloning issues such as AC issue. For HD, 7 participants; for NS, 1 participant; for IN, 2 participants; for RC, 2 participants; for AC, 22 participants; for TC, 3 participants; for GW, 1 participant considered religious aspect to make decision regarding these issues. In light of these findings, it may be claimed that different SSI revealed different social factors influencing participants' informal reasoning.

4.4.3. Moral-Ethical Considerations

In light of the socioscientific literature, it may be claimed that moral-ethical perspective was an important variable to resolve and negotiate with socioscientific dilemmas (Evans, 2002; Zeidler & Keefer, 2003). Consistent with the previous studies, this study exhibited moral-ethical consideration as

one of the distinctive factors influencing participants' informal reasoning. About some SSI, participants utilized moral ethical perspectives in order to resolve these issues. Below are the excerpts displaying moral-ethical consideration as a factor influencing informal reasoning:

- 2R(IN): I - Should gene therapy be used to the intelligence of potential offspring? Why or why not?
  In other SSI (HD and NS), human health was an important factor in shaping people's decision making. However, in this issue, morality is more important than human health. I think, this therapy should not be used principally because everyone will not afford to use this therapy. Furthermore, it is not necessary that everyone should be intelligent. I think some differences should be among the people. As a result, this therapy is not necessary.
- 3M(AC): I - Do you think that cloning as described in this scenario is subject to any kind of moral rules or principles? If so, how did this affect your decision-making?
  Of course, this issue is related to morality. In general, Turkish people marry once in their life. Re-marriage is not assessed as a good behavior in the society. However, in this issue, after the accident the mother will dedicate herself to the cloned child and did not make re-marriage. Thus, this condition will not cause moral problem in the society.
- 4R(AC): I - Should this woman be able to produce a clone of her dying baby? Why or why not?
  I think this therapy should not be used because the father is dead. Also, when I think with respect to morality, the child is dead. While deceased child lived in different environments; however, the cloned child will not have the same environment. Moreover, while deceased

child lived with his/her father, the cloned child will not with his/her father. Thus, cloned child will not have as the same rights as deceased child. As a result, having child in this way is unfair. The mother may marry again and may have another child.

- 39M(AC): I - What factors were influential in determining your position regarding the mother who wanted to clone her dying child?
  Morality and religion are effective in my decision-making. I think the cloned child is a copy not a real child. The cloned child may have identity problems, and this child may be unhappy in the future. I think, in this scenario, the mother is egoist. If the mother allows the child's cloning, her behavior will not be true with respect to morality.
- 13R(IC): I - Should gene therapy be used to the intelligence of potential offspring? Why or why not?
  I think this therapy should not be used because if this therapy is used, people will confront with the discrimination. While some people use this therapy, other peoples do not use this therapy. Thus, equality will not be supplied for the people. As a result of not supplying equality among the people, moral-ethical problems may be revealed.

These excerpts clearly displayed the moral-ethical consideration as a factor influencing informal reasoning about SSI. For example; participant 2 did not accept the treatment principally about intelligence issue because this participant considered moral perspective in his/her decision making. Moreover, participant 4 did not accept the treatment emotionally about accident issue because this participant considered moral perspective in order to resolve this issue. Consistent with the socioscientific literature (Bell & Lederman, 2003; Fleming, 1986a; Sadler & Zeidler, 2004), the excerpts

taken from the present study's interviews displayed that participants dealt with the moral-ethical considerations to resolve and negotiate with several SSI. Thus, in the present study, the moral-ethical perspective was found as another important factor influencing informal reasoning regarding SSI.

4.4.4. Technological Concerns

Finally, it was explored that participants had the technological concerns as they negotiated with SSI. In the socioscientific literature, there was almost no research detecting technological concerns as a factor influencing informal reasoning about SSI. However, in this study, technological concern was explored as a distinctive factor influencing participants' informal reasoning during the debate of some SSI.

Below are the excerpts displaying technological concern as a factor influencing informal reasoning:

- 1M(HD) I - Were you concerned with any technological issues associated with gene therapy? If so, what issues did you think about? I actually disappointed with the development of the technology so much. I am scared of these developments. I wish, scientists had not been found this therapy. However, we should accept truth that there is a therapy like this. When I put myself in the family, my opinions are changing.
- 2M(HD) I - Were you concerned with any technological issues associated with gene therapy? If so, what issues did you think about? In general, I do not have any concern about the development of technology. However, technology should be used in right way. If this

technology is not used in right way, some dangerous results may reveal.

- 3M(HD) I - Were you concerned with any technological issues associated with gene therapy? If so, what issues did you think about? Yes, I have several concerns about technological developments. For example, with the developing technology, human's intelligence may be intervened much.
- 5M(AC) I - Were you concerned with any technological issues associated with cloning? If so, what issues did you think about? I have some concerns about technological developments. When people use this technology, several disadvantages may be revealed. Also, the aim of the using this technology is a very important issue. When someone uses technology, the aim of using this technology should be considered.
- 6M(AC) I - Were you concerned with any technological issues associated with cloning? If so, what issues did you think about? Yes, I have some concerns about technological developments. In the past time, when the dolly sheep was cloned, scientists had disappointed with this cloning because cloned sheep were dead. So far, I have not heard any successful gene cloning or therapy operation. Thus, these technological developments may be dangerous.

These excerpts clearly demonstrated technological concern as a factor influencing informal reasoning about SSI. However, participants had technological concerns depending on the context of SSI. For example, when participant 1, 2, and 3 displayed technological concerns about gene therapy; participant 5 and 6 displayed concerns about cloning.

CHAPTER 5

DISCUSSION AND IMPLICATIONS

5.1. Informal Reasoning and SSI

Informal reasoning and SSI have a crucial role in the improvement of scientific literacy (Zeidler & Keefer, 2003). Since the promoting of scientific literacy is the ultimate goal of science education and socioscientific decision making is a crucial part of scientific literacy, it is necessary to investigate how students resolve and negotiate with SSI. In this perspective, PSTs' resolving and negation about SSI has been investigated in the present study.

The present study and reviewed literature (e.g., Sadler and Zeidler, 2005a, 2005b) claimed that there were two unique characteristics of informal reasoning: informal reasoning pattern and informal reasoning quality. In light of the findings of the present study and socioscientific literature, these two characteristics of informal reasoning were discussed successively in this chapter. The factors influencing informal reasoning were also discussed.

5.1.1. Informal Reasoning Patterns and SSI

The phrase "informal reasoning patterns" was originated from the research investigating informal reasoning in the context of SSI (Sadler & Zeidler, 2004; Sadler & Zeidler, 2005a; 2005b). The researchers reported that participants developed three informal reasoning patterns: rationalistic, emotive, and intuitive. Moreover, in the present study, the researcher investigated PSTs' informal reasoning in the context of SSI. In line with the present study, it was concluded that "informal reasoning pattern" framework including rationalistic, emotive, and intuitive patterns was also valid for Turkish context. As a result, the present study showed that this framework had potential to describe PSTs' informal reasoning in Turkish context.

The present study showed that all participants demonstrated at least some evidences of rationalistic informal reasoning in the context of genetic engineering and environmental issues. For gene therapy issues (HD, NS, and IN), cloning issues (RC, AC, and TC), and environmental issue (GW) 32 (82%), 14 (36%), and 27 (69%) participants displayed rationalistic informal reasoning pattern respectively. At this point, different SSI had an important place to reveal PSTs' rationalistic thinking. Regarding gene therapy and global warming issues, most of the participants approached these issues rationally and they suggested rational solutions. Thus, it may be claimed that PSTs' rational thinking formed an important part of their informal reasoning. However, regarding cloning issues, they approached these issues emotionally and intuitively. It was believed that social norms such as religious aspect might have been effective in their decision making. Since a majority of the participants' religious consideration had the barrier to cloning, they might have approached cloning issues emotionally and intuitively.

In addition to rationalistic thinking, the participants frequently used empathy and concern regarding SSI. Similar to Sadler and Zeidler's (2005a) study, the participants in this study exhibited emotive thinking named as emotive informal reasoning pattern in response to SSI. More specifically, for gene therapy issues (HD, NS, and IN), cloning issues (RC, AC, and TC), and environmental issue (GW), 11 (28%), 15 (38%), and 1 (3%) participants displayed emotive informal reasoning pattern respectively. At this point, different SSI played an important role in revealing PSTs' emotive thinking. Regarding cloning issues, most of the participants approached these issues emotionally and they revealed their empathy and concerns. It was believed that moral perspective might have been effective in their decision making. Since a majority of the participants' moral perspective had the barrier to cloning, they might have approached cloning issues emotionally. However, regarding global warming issue, they approached this issue intuitively because social norms such as political aspect might have been effective in their decision making.

In addition to rationalistic and emotive patterns, the participants frequently exhibited gut-level and instantaneous reactions or responses regarding SSI. In other words, they showed intuitive thinking named as intuitive informal reasoning pattern in response to SSI (Sadler & Zeidler, 2005a). When we consider intuitive informal reasoning pattern across SSI, it was found that regarding gene therapy issues (HD, NS, and IN), cloning issues (RC, AC, and TC), and environmental issue (GW), 3 (8%), 13 (33%), and 18 (46%) participants displayed intuitive informal reasoning pattern respectively. At this point, it may be claimed that different SSI had an important place to reveal PSTs' intuitive thinking. Religious and political considerations might have been effective to reveal intuitive thinking especially about cloning and environmental issues. Related to cloning

issues, participants did not assess cloning process as a true action with respect to religious aspect. In addition, related to environmental issue, participants evaluated this issue politically and they claimed all countries should have participated in Kyoto protocol because of political reasons.

These results showed that the context of SSI influenced the participants' informal reasoning pattern. This result was consistent with Sadler and Zeidler's (2005a) and Zeidler and Schafer's (1984) studies in which the significance of context on socioscientific decision making was stated. Specifically, Sadler and Zeidler (2005a) reported that the incidence of emotive and intuitive reasoning was depended on the context of SSI. Similarly, in the present study, the incidence of emotive and intuitive informal reasoning remained relatively high across most of the cloning issues. Intuitive reasoning was also distinctive in global warming issues. Thus, it may be claimed that emotive and intuitive informal reasoning patterns were observed depending on the context of the SSI. Finally, similar to Sadler and Zeidler's (2005a) study, the present study found that rationalistic informal reasoning was the least context dependent among all informal reasoning patterns regarding SSI because the frequency of this pattern remained relatively high for each SSI. As a result, when emotive and intuitive informal reasoning were more context-dependent, rationalistic informal reasoning was less context-dependent in the context of SSI. This claim may be caused from the argument in which several factors were effective in shaping participants' informal reasoning pattern depending on the context of SSI. For example, as mentioned previously, religious factors were effective in shaping most of the participants' informal reasoning pattern as intuitive informal reasoning regarding cloning issues. The factors influencing informal reasoning was discussed in the factors influencing

informal reasoning section in detail in the theoretical framework of this study.

Another distinctive finding of this study was that all participants displayed at least once two informal reasoning patterns together. In other words, different types of informal reasoning patterns (e.g., rationalistic, emotive, and intuitive) were integrated into one person's overall informal reasoning at the same time in response to SSI. The claim of overlapping informal reasoning patterns was supported by the findings of earlier studies (Pedretti, 1999; Sadler & Zeidler, 2005a; Yang & Anderson, 2003). The participants in these studies displayed multiple reasoning patterns in response to SSI. Specifically, Sadler and Zeidler (2005a) developed a model explaining overlapping informal reasoning patterns. This model included all informal reasoning patterns and combination of them. For example; rationalistic, emotive, intuitive, rationalistic-emotive, rationalistic-intuitive, emotive-intuitive, and rationalistic-emotive-intuitive informal reasoning patterns were observed in this model. The present study showed that this overlapping model was partially valid for the PSTs' informal reasoning patterns. When the present study included separate reasoning patterns (rationalistic, emotive, and intuitive), and some overlapping reasoning patterns (rationalistic-emotive, rationalistic-intuitive, emotive-intuitive), there was not any overlapping reasoning condition consisting of all reasoning patterns (rationalistic-emotive-intuitive) together. However, socioscientific literature and the present study showed that the participants tend to show combination of informal reasoning patterns in response to SSI.

The participants in the present study demonstrated multiple informal reasoning patterns in response to all SSI except for NS issue. The overlapping patterns might be caused from the content of the SSI. For

example, regarding HD issue, 18 participants exhibited rationalistic and emotive informal reasoning patterns together. The participants suggested rational solutions such as patient rights in response to HD. In addition, they suggested emotional solutions such as empathy regarding the same issue. However, regarding NS issue, 31 out of 39 participants suggested only rational solutions such as alternative treatment methods (glasses and laser), and only 8 participants showed emotive or intuitive informal reasoning. Actually, this issue may be solved with only rational approach, however, in HD issue, due to content of this issue, both rational and emotional solutions might be necessary for PSTs to response it.

Depending on the findings of the present study, recommendations for PSTs education were twofold. First, since socioscientific decision making is an important aim of science education for future generations dealing with SSI, these issues should be used as a vehicle in order to improve PSTs' informal reasoning during their PSTs education. Although PSTs program currently included STS lesson, it did not involve a lesson including SSI. In general, STS lessons aim to conceptualize the relationship among science, technology, and society. However, this lesson does not include moral-ethical issues, personal experiences, argumentation, and discourse skills. SSI approach is more comprehensive approach that integrates all these variables with science, technology, and society. In addition, Ekborg (2005) studied with Preservice Science and Mathematics Teachers, and the researcher had suspects whether they can make sufficient informed-decision making regarding SSI. Thus, improvement of PSTs' informed-decision making regarding SSI was important during PST education program. In this perspective, SSI approach should be integrated into PST education program to determine and improve PSTs' informal reasoning.

Second, the present study reported that in addition to rationalistic thinking patterns, emotive and intuitive informal reasoning patterns gained importance when the participants resolved and negotiated with the SSI. In traditional classroom learning environments, generally rationalistic thinking was dominant. In other words, teachers or science educators gave importance only on students' intellectual development in traditional learning environments. However, the present showed that PSTs used empathy, care, and immediate reactions in response to SSI. Sadler (2003) stated that if SSI were only evaluated with respect to rationalistic thinking pattern, many students may be excluded from the thinking in classroom environments. Thus, science teachers should consider all informal reasoning patterns because similar to PSTs, students may also develop different informal reasoning patterns in response to SSI. Thus, science teachers need to design lesson plans and educational activities by dealing with the development of different types of informal reasoning patterns in science teaching. To achieve this, first we need to give importance to this issue in teacher education programs. Science educators can address these issues in their courses. For example, in light of this study, if the science educators want to promote PSTs' one type of informal reasoning pattern, they can develop activities or lesson plans including SSI in order to improve PSTs' targeted informal reasoning pattern. For example, if the science educators want to develop PSTs' emotional pattern, they can use cloning issues in their classroom.

5.1.2. Informal Reasoning Patterns and Informal Reasoning Quality

Both informal reasoning patterns and informal reasoning quality were unique characteristics of informal reasoning. In socioscientific literature, there is no specific research investigating the relationship between

informal reasoning patterns and informal reasoning quality. Exploring the relationship between them provided better understanding about informal reasoning.

In gene therapy issues (Huntington disease, nearsightedness, and intelligence issues), two claims were revealed regarding this relationship. The first claim was that when the participants' informal reasoning quality changed from less sophisticated to more sophisticated, their informal reasoning pattern changed from intuitive or emotive reasoning pattern to rationalistic informal reasoning. In general, most participants who developed counter-position and rebuttal in addition to claim and justification generally exhibited rationalistic informal reasoning. Another claim was that, the participants having intuitive informal reasoning pattern did not develop counter-position and rebuttal in addition to claim and justification. They exhibited gut-level reactions instead of using rationalistic thinking patterns in response to gene therapy issues. Based on these claims, it can be inferred that intuitive informal reasoning pattern is related to less sophisticated informal reasoning quality, and rationalistic informal reasoning pattern is related to more sophisticated informal reasoning quality.

In cloning issues (reproductive cloning, accident, and therapeutic cloning issues), a claim was revealed regarding this relationship. Unlike the previous gene therapy issues (HD, NS, and IN), emotive and intuitive informal reasoning patterns were displayed by most of the participants regarding cloning issues. The participants having less or more sophisticated informal reasoning quality approached cloning issues emotionally and intuitively. The context of these issues was related to human cloning. We observed that PSTs' decision making process is influenced to a great extent by their religious beliefs. Most participants established a relationship

between creation and cloning. They claimed that creation is God's act and we should not interfere with this by cloning humans. Thus, they took care creation into consideration and showed gut-level or emotive reactions as they resolved and negotiated with these cloning issues.

In global warming issue, the analyses of the data led me to two conclusions. First, intuitive informal reasoning pattern captured attention in particular. No matter whether the participants had more or less informal reasoning quality, a great majority of them developed intuitive informal reasoning in response to global warming issue. This issue was related to whether US should participate or not in the Kyoto Protocol. Turkish people's bias against some countries such as US may be effective in shaping their decision making in this issue. Since many participants were prejudiced against US, they gave immediate negative reactions to this issue. The second conclusion was related to the rationalistic informal reasoning pattern. When the participants' informal reasoning quality changed from less sophisticated to more sophisticated, the frequency of the participants' rationalistic informal reasoning decreased. This finding was not consistent with the SSI related to genetic engineering issue in which when the participants' informal reasoning quality changed from less sophisticated to more sophisticated, the frequency of rationalistic informal reasoning pattern increased. This interesting finding may have originated from the context of the global warming issue, which was effective in revealing Turkish people's prejudice against some countries.

To sum up, these results related to all SSI showed that the relationship between informal reasoning pattern and informal reasoning quality was context-dependent. For example, regarding gene therapy issues, the participants having more sophisticated informal reasoning quality

generally showed rationalistic informal reasoning pattern; regarding cloning issues, the participants having more or less sophisticated informal reasoning quality generally showed emotive and intuitive informal reasoning. These results showed that the way and the nature of the relationship between these characteristics depended on the context of SSI. These results filled out the gap in socioscientific literature with respect to the relationship between informal reasoning pattern and quality. Moreover, this relationship was explored in PSTs' views.

5.1.3. Informal Reasoning Quality and SSI

In socioscientific literature, similar to the investigation of the relationship between informal reasoning pattern and quality, there has not been any specific research investigating the variation of informal reasoning quality with multiple SSI. Thus, the findings of the present study provided new perspective to socioscientific literature with respect to this relationship. The findings of the present study showed that most observed informal reasoning quality was type 2 (claim with justification) throughout all SSI. Related to this finding, it may be claimed that the participants easily developed claim with or without justification but they hardly developed counter-position and rebuttal across each SSI. This finding was consistent with the Jimenez-Aleixandre et al.'s (2000) finding in which students mostly developed claims instead of justification and warrants. In other words, students developed less sophisticated argumentation skills instead of more sophisticated argumentation skills. Thus, in both studies, participants' informal reasoning quality was not found in adequate level. These results may be caused from not developing PSTs' argumentation skills during their all education life. In Turkish educational system, starting from the elementary level school program to the end of PST program, there is no

course addressing or teaching argumentation. However, Osborne et al. (2004) claimed that "improvement at argumentation is possible if it is explicitly addressed and taught" (p. 1015). Thus, PSTs might not understand counter-position and rebuttal concepts in argumentation because of their lack of education and experiences about use of argumentation. In addition, in classroom learning environments, students did not generally have the opportunity to develop counter-position and, little and not organized opportunities were given to students to make dialogical argumentation (Duschl & Osborne, 2002; Sadler, 2006). Thus, PSTs might not use and develop their argumentation skills during their PST education. As a result of this reflection, PSTs may show lack of sophisticated argumentation skills (counter-position and rebuttal) in the present study.

At this point, it may be suggested that teacher education programs may involve lessons including SSI to determine and develop science teacher candidates' argumentation skills. SSI provide the context in which PSTs are faced with the argumentation. When PSTs confront with the SSI, they try to resolve and negotiate with these issues. In other words, they try to understand and develop argumentation regarding these issues. Thus, one of the important aims of teacher education programs may be achieved by the integration of SSI into PSTs program.

In socioscientific literature, the research including different intervention time periods were resulted with different findings related to the improvement of argumentation skills. Osborne et al. (2004) found positive improvements in elementary students' argumentation skills after 9 months intervention; however, the change was not significant. In contrast to this finding, Zohar and Nemet (2002) found significant improvements in junior high school (grade 7-9) students' argumentation skills after the 12 hours

genetics unit instruction (one week/3 hours). Nevertheless, Osborne et al. (2004) claimed that long time period is necessary to improve students' argumentation skills. At this point, time period gains importance to teach SSI in order to develop students' argumentation skills. There is a lack of attention on argumentation and discourse skills in new Turkish elementary science curriculum. Consistent with the claim of West and US science organizations (e.g., American Association for the Advancement of Science, 1990), curriculum developers in Turkey should also take attention to development of argumentation skills in the context of SSI in elementary and high school levels. In light of the Osborne et al.'s (2004) claims, it may be suggested that students should take lessons including SSI and argumentation in their elementary or high school education. Thus, their argumentation skills may be improved with longitudinal continuum. When these students enter university, they may possess argumentation skills. It was also suggested that similar to informal reasoning pattern, in order to develop PSTs' informal reasoning quality, a course addressing SSI would be beneficial. Moreover, due to importance of prolong exposure to these skills, addressing argumentation in other offered courses may also necessary.

Another interesting finding was that the emergent frequency of informal reasoning quality types followed the same pattern across each SSI. They were ordered from more to less: type2, type 3, and type 4 across all SSI. Although frequency of informal reasoning quality type 1 changed across each SSI, the frequency order of other informal quality types was not changed. Thus, it may be claimed that informal reasoning quality was not context-dependent in the present study. In other words, the order of emergent frequency of informal reasoning quality types except for type 1 was independent from the SSI. When informal reasoning quality type 1 referred to claim without justification; informal reasoning quality type 2

referred to claim with justification. In general, when the participants proposed the claim, they also justified their claim in the present study. The condition of informal reasoning quality type 1 was negligible because when the most observed type was type 2, type 1 was developed by few participants. Thus, the condition of type 1 frequency did not change the researcher's claim in which informal reasoning quality was not content-dependent across SSI. Informal reasoning patterns related to rational, emotional, and intuitive thinking, and informal reasoning quality related to how the participants developed claim and justified this claim. Thus, the participants' informal reasoning patterns were depended on the context of SSI. For example, regarding GW issue, a majority of the participants showed intuitive informal reasoning because they had prejudice against US. However, the participants' informal reasoning quality was independent from the content of SSI because content of SSI did not influence the participants' argumentation skills regarding SSI.

5.1.4. Factors Influencing Informal Reasoning

Socioscientific literature showed that there were several variables influencing informal reasoning (e.g., Albe, 2008; Bell & Lederman, 2003; Sadler et al., 2004). In light of the present research, the researcher categorized the variables influencing informal reasoning under four main topics: personal experiences, social considerations, moral-ethical perspective, and technological concerns. Furthermore, the social consideration category consisted of three sub-categories: economic, educational, and religious considerations.

First factor influencing informal reasoning was personal experiences. Several science education researchers (Albe, 2008; Bell & Lederman, 2003;

Sadler et al., 2004; Sadler & Zeidler, 2004) gave notable attention to the central role of the personal experiences in socioscientific decision making. In general, the researchers concluded that personal domain influenced a person's informal reasoning about SSI. Albe (2008) claimed that students used their personal experience and cultural views to make decision regarding human carcinogenesis and doping effects. In addition, Bell and Lederman (2003) explored that personal experiences influenced participants' decision making about science related technological issues. Consistent with the socioscientific literature, the present study displayed that personal experience was one of the distinctive factors in participants' decision making about SSI. At least 16 participants used their personal experience to make decision regarding all SSI except for TC. Only 1 participant used their personal experience to make decision regarding TC. The data analysis showed that although most of the participants had pre-knowledge and pre-experience regarding genetic engineering and global warming issues, they had lack of pre-knowledge and pre-experience regarding therapeutic cloning issue. It may be caused from the content of this issue because this issue included several technical terms such as spinal cord injury and immunological rejection. In addition, this issue represented more complicated genetic engineering process than other SSI. According to these results, it may be claimed that PSTs' personal experience was depended on the content of the SSI.

Second factor influencing informal reasoning was social consideration. This category consisted of three sub-categories; economic, educational, and religious considerations. Socioscientific literature demonstrated that economic interests (e.g., Sadler et al., 2004), social and cultural factors (e.g., Bell & Lederman, 2003; Zeidler et al., 2002,), and religious consideration (Sadler & Donnelly, 2006) influenced people's

decision making regarding SSI. Bell and Lederman (2003) explored that most of the participants based their decisions on social concerns. Consisted with the existing literature, in this study, social consideration (economic, educational, and religious consideration) was explored as another factor influencing people's informal reasoning.

Similar to Sadler and Donnelly's (2006) study, religious aspect was found as a factor influencing informal reasoning in the present study. It may be caused from the profile of the religion in Turkey. Most of the citizens in Turkey (99 percent) are Muslim and this religion profile affected their decision making regarding some SSI. For example, a majority of the participants (22 out of 39) considered religious aspect to make decision regarding AC issue. This issue was related to cloning of a child, so the participants' religious consideration formed the barrier to use this cloning method. They approached this issue negatively because of their religious consideration.

Sadler et al. (2004) reported that students' economic interests influenced their decision making regarding global warming. Consistent with the Sadler et al.'s (2004) study, the present study found economic consideration as a factor influencing informal reasoning. According to the World Bank Turkey Report (2006), Turkey is a middle income country which has a dynamic emerging-market economy strategically located between Europe and Asia. This report also declared that extreme poverty is low (about 1 percent), however, poverty affects over 20 percent of Turkey's population. The participants claimed that a majority of the Turkish people would not afford these genetic engineering methods because these methods were considerably expensive. Thus, Turkey's social and economical condition was effective in shaping PSTs' decision making regarding SSI.

Educational consideration was found as another social factor influencing informal reasoning. Turkey is also one of the developing countries in the world with respect to education. According to World Bank's Turkey Education Sector Study (2005), in Turkey, "only 27 percent of the adult population has a complete secondary school education, compared with 65 percent in the EU, 74 percent in Korea, 82 percent in Poland, and 87 percent in the US" (p. V). Especially, in the east part of Turkey, people considerably had lack of education opportunities. In the present study, a majority of the participants claimed that most of the people in Turkey are not educated sufficiently. Thus, since a majority of Turkish citizens do not understand genetic engineering concepts and methods because of lack of education opportunities, they would not accept genetic engineering methods. Thus, the educational consideration was found an important factor influencing the participants' informal reasoning in Turkey context.

As mentioned in the significance of the present study part, culture may be effective in shaping people's informal reasoning. Different cultures (West and East culture) may have different social norms influencing people's decision making about SSI. Parallel with the claims in the significance of the study part, the present study showed that social and cultural dynamics such as economical, educational, and religious considerations in Turkey were effective in shaping decision making of PSTs regarding SSI. The studies including the factors related to informal reasoning were generally conducted in Western and US countries. The present study sheds light the factors influencing informal reasoning in the context of a bridging country (Turkey) between East and West. The further research especially in the context of East countries may provide better

understanding about the place of social and cultural norms in the participants' informal reasoning.

Third factor influencing informal reasoning was moral-ethical consideration. In general, socioscientific literature reported that moral-ethical perspective was a crucial variable to resolve and negotiate with SSI. Researchers claimed that SSI included moral perspective (e.g., Bell & Lederman, 2003; Fleming, 1986a, 1986b; Pedretti, 1999; Sadler & Zeidler, 2004; Zeidler & Schafer, 1984) that influenced people's decision making about these issues. Pedretti (1999) studied with the fifth and sixth grade students to explore their decision making regarding an environmental issue and found that following the intervention, many students dealt with the moral perspective in their decision making about this issue. Moreover, Bell and Lederman (2003) studied with college professors to understand the effect of views of NOS and other expected factors on their decision making regarding several science related social issues and reported that moral consideration had an important role in participants' decision making about these issues. Parallel with the existed literature, the present study confirmed that moral-ethical perspective had important role to make informed decision making about SSI. Especially dealt with the cloning issues, the participants exhibited their moral-ethical concerns in order to resolve and negotiate with these issues. At this point, it may be claimed that the participants' moral-ethical consideration depended on the content of SSI. For example, they claimed that when gene therapy was necessary for human health and did not include moral-ethical issues, cloning was also necessary but it included moral-ethical concerns. In addition, a majority of the participants had big religious concerns regarding cloning issues. Because of the content of the cloning issues which included organ or human cloning, they assessed these cloning as not true decision with respect to moral-ethical and religious

aspects. Their religious aspects provoked their moral-ethical values. These combined effect led the participants reject these cloning issues. In light of the socioscientific literature and the present study, it may be claimed that SSI involve moral perspective by their own nature because SSI include social dilemmas that were mostly originated from the people's moral-ethical concerns.

Fourth factor influencing informal reasoning was technological concern. Although few research mentioned the concerns such as social concerns in decision making regarding science related social issues (Bell & Lederman, 2003), there was not any specific research detecting technological concern as a factor influencing decision making in the socioscientific literature. However, the participants generally claimed that technological developments in genetic engineering area can reach to dangerous and uncontrollable levels, so, technological developments related to gene therapy and cloning may lead the society to chaos. If the government does not control genetic engineering, this technology may be used in bad faith. For example, without the authority in the country, the black markets in organ transplantation may increase. This condition may be harmful for the society. As a result, technological concern was explored as another distinctive factor influencing participants' informal reasoning about SSI.

In light of the previous studies and the present study, exploration of the factors influencing informal reasoning may provide the opportunities in order to improve informal reasoning during the PST education. When science educators are aware of these factors, they may improve PSTs' informal reasoning. For example, when science educators are aware of the lack of PSTs' moral development, they may give importance to PSTs' moral

development that is the factor influencing informal reasoning. In addition to moral development, science educators may consider and develop PSTs' personal experience related to SSI. To achieve this, science educators may lead the PSTs to several sources such as books and technological sources related to genetic engineering. Similar to moral consideration and personal experience factors, all factors influencing informal reasoning should be developed by in or out school activities. As a result, that science educators develop student's informal reasoning may depend on the awareness and the development of these factors.

5.2. The Study's Limitations and Future Research

5.2.1. Limitation of the Study

SSI selection may be a limitation of the present study. To investigate the variation of informal reasoning quality with SSI, the different contexts (genetics-based and ecology-based) were utilized by the researcher. Six SSI were about genetic engineering issues. One SSI was about global warming issue. However, there was not equality with respect to number of the issues between genetics-based and ecology-based issues. When there were six genetics-based SSI, there was only one ecology-based SSI in this study because it was hard to control the frequency of SSI. If the present study involved five additional environmental issues, the researcher would need extra much time and effort in order to conduct this study.

Another limitation of the present study may be about global warming. This issue was adopted from Bell and Lederman's (2003) study. However, this issue included the information about participation in the Kyoto protocol of some countries. After the participants read this issue, one

of the informal reasoning interview questions was: “whether US should participate or not Kyoto Protocol”. During the data collection time, it was observed that the participants had a prejudice against the politics of the US, their bias against US might have affected their decision making about global warming issue. Accordingly, many participants gave immediate responses to this issue and they exhibited negative reactions about the participation of US in Kyoto protocol.

At last, the findings of the present study are limited to 39 PSTs graduated from Middle East Technical University in 2006-2007 academic year.

5.2.2. Future Research

According to the results of the present study, some recommendations were provided for future research in this section. In this study, PSTs’ informal reasoning pattern and informal reasoning quality as two unique characteristics of informal reasoning were explored and introduced. However, how PSTs’ informal reasoning can be improved was not investigated in this study. Thus, the research about improvement of informal reasoning will contribute valuable findings to socioscientific literature. In these research, some teaching methods or activities can be used in order to promote informal reasoning. Then, the effect of teaching methods and activities on the informal reasoning can be investigated. Especially experimental studies may be effective to explore the effects of teaching methods and activities on PSTs’ informal reasoning.

The focus of this study was the exploration of informal reasoning across multiple SSI. In this study, the variation of informal reasoning

patterns and informal reasoning quality with some demographic variables such as race, religion affiliation, and gender were not explored. However, demographic variables of the participants may be effective on their informal reasoning. Thus, in future research, the relationships among informal reasoning patterns, informal reasoning quality, and demographic variables may be investigated because these variables may create variation in peoples' informal reasoning. Exploring the effect of religion, race, and gender on informal reasoning may provide distinctive contributions to socioscientific literature in further research.

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APPENDICES

APPENDIX A

INFORMAL REASONING INTERVIEW

Gene Therapy Description

Germ-line gene therapy is a potential genetic technology. (It has not yet been used in humans.) This type of gene therapy would involve altering a gene in an individual's sex cells (egg or sperm cells) or in a newly conceived embryo (just after fertilization). The intent of gene therapy would be to remove an undesirable gene and replace it with a preferred gene. The sex cell or embryo, resulting from gene therapy, would possess the ''new'' gene and would be missing the ''old'' gene.

Interview Questions

1. Do you have any questions regarding gene therapy?
2. Are you unsure about any of the information presented in the handout?

Huntington's Disease Gene Therapy Prompt

Huntington's disease (HD) is a neurological disorder caused by a single gene. Its symptoms usually start between the ages of 35 and 45. The

first symptoms include uncontrollable body spasms and cognitive impairment. As the disease progresses, patients become physically incapacitated, suffer from emotional instability, and eventually lose mental faculties. HD usually runs its course over a period of 15–20 years and always results in death. No conventional treatments are known to work against HD. Because Huntington's disease is controlled by one gene, it could be a candidate for gene therapy.

Interview Questions

1. Should gene therapy be used to eliminate HD from sex cells (egg cells or sperm cells) that will be used to create new human offspring? Why or why not?
2. How would you convince a friend or acquaintance of your position?
3. (If necessary) Is there anything else you might say to prove your point?
4. Can you think of an argument that could be made against the position that you have just described? How could someone support that argument?
5. If someone confronted you with that argument, what could you say in response? How would you defend your position against that argument?
6. (If no counter-position is articulated) If someone said_____, how could you respond? How would you defend your position against his/her argument?
7. (If necessary) Is there anything else you might say to prove that you are right?

Near-sightedness Gene Therapy Prompt

Near-sightedness is a condition that affects millions of people worldwide. Near-sightedness, also known as myopia, manifests in blurred distance vision. Interventions such as eyeglasses, contacts, and corrective surgery are frequently used to treat this condition.

Interview Questions

1. If science found a single gene that produced near-sightedness, should gene therapy be used to eliminate near-sightedness gene from sex cells (egg cells or sperm cells) that will be used to create new human offspring? Why or why not?
2. How would you convince a friend or acquaintance of your position?
3. (If necessary) Is there anything else you might say to prove your point?
4. Can you think of an argument that could be made against the position that you have just described? How could someone support that argument?
5. If someone confronted you with that argument, what could you say in response? How would you defend your position against that argument?
6. (If no counter-position is articulated) If someone said_____, how could you respond? How would you defend your position against his/her argument?
7. (If necessary) Is there anything else you might say to prove that you are right?

Intelligence Gene Therapy Prompt

We know that a person's intelligence is controlled by a variety of factors including both environmental and genetic influences. It is likely that several genes contribute to a person's intelligence. No single factor, whether

genetic or environmental, could completely determine an individual's intelligence; however, it is conceivable that scientists could find a single gene that at least contributes to an individual's intelligence.

Interview Questions

1. If science were able to isolate a gene that significantly contributed to a person's intelligence, should that gene be used for gene therapy to increase the intelligence of potential offspring? Why or why not?
2. How would you convince a friend or acquaintance of your position?
3. (If necessary) Is there anything else you might say to prove your point?
4. Can you think of an argument that could be made against the position that you have just described? How could someone support that argument?
5. If someone confronted you with that argument, what could you say in response? How would you defend your position against that argument?
6. (If no counter-position is articulated) If someone said_____, how could you respond? How would you defend your position against his/her argument?
7. (If necessary) Is there anything else you might say to prove that you are right?

Cloning Description

The process of cloning is designed to produce an organism genetically identical to another organism. In the normal process of mammalian reproduction, genetic material from an egg cell and a sperm cell combine during fertilization to produce a new genetic combination. The new

genetic makeup of the offspring is distinct from both parents. The fertilized egg cell will eventually develop into a new offspring. In cloning, the genetic material of an unfertilized egg cell is removed, and a complete set of genetic material (from a donor) is inserted into the egg cell. The donor genetic material can be relatively easily obtained from most body cells (e.g., skin cells). The egg cell that carries them donor's genetic material can be stimulated to grow as if it were a fertilized egg. The cloned offspring would be genetically identical to the donor organism.

Interview Questions

1. Do you have any questions regarding gene therapy?
2. Are you unsure about any of the information presented in the handout?

Reproductive Cloning Prompt

Many otherwise healthy couples are unable to bear children. Modern reproductive technologies like fertility drugs and in vitro fertilization have enabled some of these individuals to have their own children. However, some couples remain infertile and unable to have a baby. For these individuals, cloning could be used as another reproductive technology. In this case, one of the parents would serve as the genetic donor. The donor's genetic material would be inserted into an egg cell, and then the embryo (the egg carrying a complete set of the donor's genetic material) would be implanted into the woman. The embryo would develop into a fetus and eventually be born as a baby.

Interview Questions

1. Should individuals who want to carry and have their own children be able to choose cloning as a reproductive option?
2. How would you convince a friend or acquaintance of your position?
3. (If necessary) Is there anything else you might say to prove your point?
4. Can you think of an argument that could be made against the position that you have just described? How could someone support that argument?
5. If someone confronted you with that argument, what could you say in response? How would you defend your position against that argument?
6. (If no counter-position is articulated) If someone said_____, how could you respond? How would you defend your position against his/her argument?
7. (If necessary) Is there anything else you might say to prove that you are right?

Deceased Child Cloning Prompt

A couple and their newborn child (their only child) are involved in a terrible automobile accident. The father dies at the scene of the accident, and the baby is severely injured. The mother sustains only minor cuts and bruises. At the hospital, doctors inform the mother that her baby will undoubtedly die within a matter of days. The woman wants to raise a child that is the product of her now deceased husband and herself. She would like to take cell samples from her dying child so that she can carry and give birth to a genetic clone of the child.

Interview Questions

1. Should this woman be able to produce a clone of her dying baby?
2. How would you convince a friend or acquaintance of your position?
3. (If necessary) Is there anything else you might say to prove your point?
4. Can you think of an argument that could be made against the position that you have just described? How could someone support that argument?
5. If someone confronted you with that argument, what could you say in response? How would you defend your position against that argument?
6. (If no counter-position is articulated) If someone said_____, how could you respond? How would you defend your position against his/her argument?
7. (If necessary) Is there anything else you might say to prove that you are right?

Therapeutic Cloning Prompt

Thus far, you have read about and discussed reproductive cloning. Although the technology and initial procedures involved in therapeutic and reproductive cloning are similar, the end products and applications are different. In therapeutic cloning, a cloned embryo is created and stimulated so that it begins growing. (Just like reproductive cloning, this involves inserting the genetic material of a donor into an egg cell so that the resulting embryo is genetically identical to the donor.) The embryo would continue to develop until it has formed stem cells. (This ordinarily occurs within 3 weeks of the time the embryo starts growing.) At this point, the stem cells

would be removed from the embryo. Stem cells are unique because they can be stimulated to develop into many different types of body tissues. For example, they can produce kidney tissue that could be transplanted into individuals with kidney disease or nerve cells that could be used for individuals suffering from spinal cord injuries or Parkinson's disease. Two major problems are associated with organ transplantation: a lack of available organs, and immunological rejection. There are far more patients waiting for transplants than there are donated organs. In addition, the immune systems of patients who actually receive transplants often reject the transplanted organ because the body recognizes it as a foreign substance. Organs and tissues produced by means of therapeutic cloning would solve both of these problems. Patients awaiting transplants could donate their own genetic material for the production of the cloned embryo. Because the resulting tissue or organ would carry the same genetic material as the patient, the immune system would not reject it.

Interview Questions

1. Should therapeutic cloning be used to develop tissues for patients who need transplants such as individuals suffering from fatal kidney disease?
2. How would you convince a friend or acquaintance of your position?
3. (If necessary) Is there anything else you might say to prove your point?
4. Can you think of an argument that could be made against the position that you have just described? How could someone support that argument?
5. If someone confronted you with that argument, what could you say in response? How would you defend your position against that argument?

6. (If no counter-position is articulated) If someone said_____, how could you respond? How would you defend your position against his/her argument?
7. (If necessary) Is there anything else you might say to prove that you are right?

Global Warming Prompt

Today, global climate change is a major environmental issue facing the United States and the international community. According to one side, the prospect of human-induced global warming is a near certainty, and failure to address the problem will have catastrophic ecological consequences. According to the other side, global warming is a hypothesis lacking scientific validation, and reducing greenhouse gas emissions will have serious negative economic consequences.

In 1992, the United States, along with roughly 150 other nations, signed the United Nations Framework Convention on Climate Change (FCCC) at the Earth Summit in Rio de Janeiro. The FCCC was ratified by the US Senate in 1992 and has now been ratified by a total of 166 nations. The ultimate objective of this treaty is to "achieve . . . stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system." In line with this objective, the most industrialized nations, including the United States, agreed to the voluntarily aim of returning their greenhouse gas emissions back to 1990 levels by the year 2000. However, the United States and most other industrialized nations are not on course to meet this target. In fact, emissions in the United States are projected to be 13% higher in the year 2000 than they were in 1990. Because these voluntary targets have proven inadequate in curbing emissions growth, there is now widespread agreement that legally-binding measures are necessary. The upcoming

climate conference in Kyoto, Japan, is based on the premise that the participating nations should agree, for the first time, upon a legally-binding limit on emissions.

Interview Questions

1. Should the United States and other industrialized nations agree to legally-binding limits on greenhouse gas emissions? Why or why not?
2. How would you convince a friend or acquaintance of your position?
3. (If necessary) Is there anything else you might say to prove your point?
4. Can you think of an argument that could be made against the position that you have just described? How could someone support that argument?
5. If someone confronted you with that argument, what could you say in response? How would you defend your position against that argument?
6. (If no counter-position is articulated) If someone said_____, how could you respond? How would you defend your position against his/her argument?
7. (If necessary) Is there anything else you might say to prove that you are right?

APPENDIX B

MORAL DECISION MAKING INTERVIEW

The questions listed refer to the Huntington's disease scenario. Similar questions (modified according to content) were asked regarding the deceased child cloning and global warming prompts.

Interview Questions

1. What factors were influential in determining your position regarding the Huntington's disease issue?
2. Did you immediately feel that gene therapy was the right/wrong course of action in this context? Did you know your position on the issue before you had to consciously reflect on the issue?
3. In arriving at you decision, did you consider the perspective or feelings of anyone involved in the scenario?
   (a) Did you consider the position or feelings of a parent faced with giving birth to a child that has HD? If so, how did this affect your decision making?
   (b) Did you consider the feelings of a potential child carrying the HD gene? If so, how did this affect your decision making?
4. Did you try to put yourself in the place of either a potential parent or child? If so, how did this affect your decision making?
5. Do you think that gene therapy as described in this case is subject to any kind of moral rules or principles? If so, how did this affect your decision making?
6. Did you consider the responsibility of parents? If so, what are the responsibilities of the parents in this scenario?

7. Did you consider whether or not a parent has the right to alter the child's genes? If so, how did this affect your decision making?
8. Did you consider the rights of the future child? If so, how did this affect your decision making?
9. Did you think about the roles and responsibilities of the doctors who would perform the gene therapy? If so, how did this affect your decision making?
10. Did you consider the child's future with and without gene therapy? What aspects of the child's future did you think about, and how did it shape your position?
11. Did you consider possible side effects for either the mother or the potential child? If so, how did this affect your decision making?
12. Were you concerned with any technological issues associated with gene therapy? If so, what issues did you think about?
13. Did you think about who would have access to gene therapy? If so, how did this affect your decision making?
14. Is there anything else that I might know about your thinking process or decision making as you considered this gene therapy issue?

APPENDIX C

PARTICIPANT INFORMATION SHEET

Name:_____

Age:_____

Gender:_____

Race:_____

Religious Affilation:_____

Major and Minor Departments:_____

_____

cGPA:_____

APPENDIX D

TRANSLATED INTERVIEW EXCERPTS

1. Excerpts taken from rationalistic informal reasoning part

6R(HD): In my opinion, it (Huntington disease gene) should be eliminated because by eliminating this gene, we can get rid of this illness. The effects of this illness will be observed in the future. These effects will be harmful for the individual. Human life is important. Since people continue to live by this gene therapy, this therapy should be used. In addition, interferences to the natural cycle may cause harmful effects for the future of the world. In spite of this, as the people's health is important this therapy should be used.	Bence bu hastalık geni elimine edilmelidir çünkü bu genin elimine edilmesiyle bu hastalıktan kurtulabiliriz. Bu hastalığın etkileri gelecekte gözlenecektir. Hastalığın bu etkileri kişi için zararlı olacaktır. İnsan yaşamı önemlidir. İnsanlar gen terapisi metoduyla hayatlarını sürdürebilecekleri için bu terapi kullanılmalıdır. Ayrıca, doğal döngüye yapılan müdaheleler dünyanın geleceği için zararlı etkilere yol açabilir. Buna rağmen insanların sağlığı önemli olduğu için bu terapinin kullanılması gerekmektedir.
12R(GW): I think, all countries in the world should have participated in Kyoto protocol because this problem is global, not specific to any country. Thus, all countries in the world should give sufficient importance to global warming. We are efficiently observing the effects of global warming on our world day by day. For example, climate equilibrium is changing fast all over the world, and ices are melting in the poles. People should take responsibility to do something about global warming because global warming is important issue for healthy next generations.	Bence dünyadaki tüm ülkeler Kyoto protokoluna katılmalıydılar. Çünkü bu problem global olup, herhangi bir ülkeye özgü değildir. Dünyadaki tüm ülkeler global ısınmaya gereken önemi vermelidir. Bizler her geçen gün etkili bir biçimde global ısınmanın dünyamız üzerindeki etkisini gözlemliyoruz. Örneğin, iklim dengesi tüm dünya üzerinde hızlı bir şekilde değişiyor ve kutuplardaki buzlar eriyor. İnsanlar global ısınma konusunda birşeyler yapabilmek için sorumluluk almalıdırlar çünkü global ısınma gelecek sağlıklı nesiller için önemlidir.
15R(NS): In my opinion, this therapy is useless because there has already been several alternative treatment methods such as lens or glasses or surgical methods to overcome this illness. Meanwhile, I do not think this treatment method (NS) is not necessarily related to human life as others (e.g., HD). In other words, a human's life is not issue in hear. Finally, alternative treatment methods (such as lenses or glasses) are easier and cheaper than gene therapy method. Moreover, gene therapy treatment may include more risk factors and side effects than other treatment methods. As a result, gene therapy method should not be used for this illness which can be overcome easily.	Bence bu terapiyi kullanmak gereksiz çünkü zaten bu hastalığın üstesinden gelmek için birçok alternatif tedavi yöntemleri var. Örneğin bu hastalıkla mücadele etmek için lens veya gözlük takma veya cerrahi müdaheleler yapılabilir. Aynı zamanda ben bu gen terapisinin (NS) diğer senaryodaki (HD) gibi insanların hayatlarıyla ilgili olduğunu düşünmüyorum. Diğer bir deyişle, burda söz konusu olan bir insanın hayatı değildir. Son olarak alternatif tedavi metodlarının (lens veya gözlük gibi) kullanımı gen terapisine göre daha kolay ve daha ucuzdur. Bununla birlikte gen terapisi diğer terapi yöntemlerine göre daha çok risk faktörü taşıyıp daha çok yan etkiyi içerebilir. Sonuç olarak, gen terapi metodu kolaylıkla üstesinden gelinebilecek bu hastalık için kullanılmamalıdır.

2. Excerpts taken from emotive informal reasoning part

10R(RC): I think cloning is a horrible thing. This scenario resembles to science-fiction films. If this therapy is used, this condition will cause bad effects on the child in the future. I believe that cloning will be unfair for the child's future because the child will be physically as the same as his/her mother or father. The child may not want to be as same as his/her father or mother. They may want to be a different person like other not cloned children in the future. Moreover, this cloning will be a terrible thing for either the mother or the father because it will be very boring for them to see and re-live their own childhood.	Bence klonlama korkunç bir şeydir. Bu senaryo bilim-kurgu filmlerine benzemektedir. Eğer bu terapi kullanılırsa bu durum çocuklar üzerinde gelecekte kötü etkilere neden olacaktır. İnanıyorum ki klonlama çocuğun geleceği için haksızlık olacaktır. Çünkü çocuk gelecekte annesiyle ya da babasıyla fiziksel olarak aynı olacaktır. Çocuk annesine ya da babasının tam aynısı olmak istemeyebilir. Bu çocuklar gelecekte diğer klonlanmamış çocuklar gibi farklı bir kişi olmak isteyebilir. Dahası bu klonlama olayı anne ya da baba için de kötü bir olay olacaktır. Çünkü onlar için çocukluklarını tekrardan yaşamak çok sıkıcı olacaktır.
16M(HD): When I am putting myself into the child, I strongly want this therapy because this therapy will affect my health and my future. To live better life in the future without HD illnesses, I need to use this therapy. Because of these reasons, this therapy should be used.	Ben kendimi çocuğun yerini koyduğumda bu terapiyi kesinlikle isterim. Çünkü bu terapi benim sağlığımı ve geleceğimi etkileyecektir. HD hastalığına sahip olmadan gelecekte daha iyi yaşamak için benim bu terapiyi kullanmaya ihtiyacım var. Bu nedenlerden dolayı bu terapi kullanılmalıdır.
25M(HD): My emotions are dominant in my decision-making regarding this scenario. In here, I put myself into my family and I think that this scenario is directly related to a person's life. The other things such as morality and ethics are not so important in this scenario. As a result, this therapy should be used.	Benim bu senaryo hakkında karar vermemde duygularım etkilidir. Bu durumda, ben kendimi ailenin yerine koydum ve ben bu senaryonun direk olarak kişinin yaşamı ile ilgili olduğunu düşünüyorum. Diğer şeylerin örneğin ahlakın ve etiğin bu senaryoda o kadar önemli olmadığını düşünüyorum. Sonuç olarak bu terapi yöntemi kullanılmalıdır.

3. Excerpts taken from intuitive informal reasoning part

28R(RC): I am absolutely against the things such as cloning a child. Since my religious beliefs form a barrier to cloning, I think cloning is nonsense.	Çocuk klonlama gibi şeylere ben tamamen karşıyım. Benim dini inançlarım klonlamaya karşı bir engel oluşturduğu için ben klonlamanın saçma bir şey olduğunu düşünüyorum.
30R(AC): I think this therapy is needless. We do not have to use this therapy. As a result, it should not be used.	Bence bu terapi gereksiz. Bu terapiyi kullanmaya mecbur değiliz. Sonuç olarak bu terapi kullanılmamalıdır.
34R(TC): This therapy absolutely should be used. This scenario is not related to both ethics and religion.	Bu terapi kesinlikle kullanılmalıdır. Bu senaryo etikle ve dinle ilgili değildir.

4. Excerpts taken from participants' combined patterns of informal reasoning part.

Rationalistic-Emotive	1R(TC): Yes, this therapy should be used because when the patient confronted with this illness, the patient would have much responsibilities towards the life. For example, the patient will have a family whom the patient is responsible for. The patient should take care of his/her family. When I confronted with this illness, I could use this cloning method. *However, we are destabilizing the natural cycle in the world. We are interfering with the natural selection using this cloning method. As animals are confronted with the viruses and gyms, humans are also confronted with the illnesses such as HD in order to supply for natural selection. As animals are confronting with the natural selection, humans should also confront with the natural selection.*	Evet bu terapi kullanılmalıdır. Çünkü hasta bu hastalıkla karşılaştığı zaman hayata karşı birçok sorumluluğa sahip olacaktır. Örneğin hastanın sorumlu olduğu bir ailesi olacaktır. Hastanın ailesine bakması gerekir. Ben böyle bir rahatsızlıkla karşılaşsam bu klonlama metodunu kullanırdım. *Bununla birlikte bizler dünyanın doğal dengesini bozuyoruz. Bizler klonlama metodunu kullanarak doğal seçilime müdahele ediyoruz. Hayvanların virüslerle ve mikroplarla karşılaştığı gibi, insanlarda doğal seçilimin sağlanması için hastalıklarla (HD) karşılaşırlar. Hayvanların doğal seçilimle karşılaştığı gibi, insanlarında doğal seçilimle karşılaşması gerekir.*
Rationalistic-Intuitive	4R(GW): **I think US should have participated in this protocol. US considered only its own benefits.** *Since dangerous gases emissions affect the entire world, all countries should have been participated in this protocol. For healthy next generations and in order to be preventing from global warming, we should take some precautions.*	**Bence US bu protokole katılmalıydı. US sadece kendi menfaatlerini göz önüne almıştır.** *Tehlikeli gaz emisyonları tüm dünyayı etkilediği için, tüm ülkeler bu protokole katılmalıydı. Sağlıklı gelecek nesiller için ve global ısınmadan korunmak için bizler bazı önlemler almamız gerekmektedir.*
Emotive-Intuitive	26M(AC): Emotive factors were effective in my decision-making about this (Accident Cloning) issue. I only put myself into the woman. I did not consider the risk stemming from the cloning…**According to my religious beliefs, I would not use this therapy. Meanwhile, considering the religious beliefs which affect the decision-making of Turkish society, 70-80% of Turkish people do not use this cloning method.**	Duygusal faktörler benim bu konu hakkında karar vermemde etkiliydi. Ben kendimi kadının yerine koydum ve ben klonlamadan kaynaklanan riskleri göz önüne almadım..... **Benim kendi dini inançlarıma göre bu terapiyi kullanmazdım. Aynı zamanda dini inançların Türk toplumunun karar vermelerindeki etkisini de göz önüne alarak, Türk insanlarının %70-80'inin bu klonlama metodunu kullanmaz.**

5. Excerpts related to the assessment criteria of the informal reasoning quality

1	Claim without justification	30R(HD): I think it (gene therapy) may be used. No problem.	Bence bu gen terapisi kullanılabilir. Herhangi bir problem yok.
2	Claim with justification	39R(NS): I think this therapy should not be used because I have myopia. I am using glasses, and myopia does not affect my daily and work life. There are several alternative treatments such as glasses, lens, and laser to overcome this illness. Since there are already several alternative methods without risks, this gene therapy is needless and should not be used.	Bence bu terapi kullanılmaması gerekir. Çünkü ben miyopum. Ben gözlük kullanıyorum ve miyop benim günlük yaşamımı ve iş hayatımı etkilemez. Bu rahatsızlığın giderilmesi için birçok alternatif tedavi yöntemleri var. Örneğin, gözlük, lens, ve laser kullanımı bu hastalıklar için. Zaten risksiz alternatif tedavi yöntemleri olduğu için bu gen terapisi gereksizdir ve kullanılmasına gerek yoktur.
3	Claim with justification and counter-position	19R(HD): This therapy may be used. Of course, parents do not want their child to be ill in the future. They prefer using this therapy method. Otherwise, their children will confront with big difficulties in the future. However, the parents need to consider negative results stemming from this therapy..... Genetic engineering may cause problems by influencing the natural equilibrium. With the genetic engineering, we are interfering with the natural equilibrium. Thus, we can cause the new problems in nature. Deaths are inseparable part of the natural equilibrium. If we interfere with the natural equilibrium, and gene therapies are used for each illness, this condition may cause new problems in nature. In addition, due to side effects of the gene therapy, there is a possibility that the child may have different illnesses in the future.	Bu terapi kullanılabilir. Tabiki aileler çocuklarınının gelecekte rahatsız olmalarını istemezler. Onlar bu tedavi yöntemini kullanmayı tercih ederler. Yoksa çocukları gelecekte büyük zorluklarla karşılaşacaklardır. Bununla birlikte aileler bu terapiden ortaya çıkacak negatif sonuçları göz önüne almalılar.....Genetik mühendisliği doğada dengeyi etkileyerek problemler meydana getirebilir. Genetik mühendisliğiyle doğanın dengesine müdahele ediyoruz ve böylece doğada yeni problemlere neden olabiliriz. Ölümler doğanın dengesinin vazgeçilmez parçasıdır. Eğer biz doğanın dengesine müdahele edersek ve gen terapisi her hastalık için kullanılırsa bu durum doğada yeni problemler ortaya çıkarabilir. Ayrıca, gen terapisinin yan etkilerinin yüzünden gelecekte çocuğun farklı hastalıklara sahip olma olasılığı da vardır.

4	Claim with justification, counter-position, and rebuttal	7R(IN): This therapy should not be used because I think using this therapy includes high risk. With this therapy, you may confront with exaggerated (excessive) conditions. For example, this therapy may cause other intelligence problems such as idiot. Moreover, if the society has too many clever people, this condition may be result with the chaos and unsolved problems in the society because this condition directly affects the job distribution. At this point, the question "Who will have which job?" should be answered. When you try to raise more intelligent people, you may confront with these unexpected problems. However, if the society has intelligent people, this will enable them to have strong society. The next generations in this society will have more success and happiness. In addition, I think intelligence is not only related to genetics, but also related to environment, family, and school. When environment, family, and school affect the development of person's intelligence in positive way, the person's intelligence may develop in expected way. As a result, instead of improving the people's intelligence genetically, we can arrange environmental conditions in order to improve people's intelligence.	Bu terapinin kullanılmaması gerekir. Çünkü bence bu terapiyi kullanmak yüksek risk içerir. Bu terapiyle siz ekstrem durumlarla karşılaşabilirsiniz. Örneğin, bu terapi diğer zeka problemlerine neden olabilir. Örneğin zeka geriliği gibi. Ayrıca, eğer toplum çok fazla zeki insana sahipse, bu durum toplumda kaosla ve çözülmemiş problemlerle sonuçlanabilir. Çünkü bu durum direk olarak iş dağılımını etkiler. Bu noktada, "Kim hangi işe sahip olacak" sorusunu cevaplanması gerekmektedir. Siz daha zeki insanlar yetiştirdiğinizde, beklenmeyen bu tip problemlerle karşılaşabilirsiniz. Bununla birlikte, eğer toplum zeki insanlara sahipse bu güçlü bir toplum oluşmasını sağlayacaktır. Bu toplum içinde gelecek nesiller daha çok başarıya ve mutluluğa sahip olacaklardır. Ayrıca, ben zekanın sadece genetikle ilişkili olduğunu düşünmüyorum aynı zamanda çevreyle, aileyle ve okulla da ilgili olduğunu düşünüyorum. Çevre, aile ve okul bir kişinin zekasını pozitif yönde etkilediğinde kişinin zekası beklenen yönde gelişir. Sonuç olarak, insanların zekasını genetik yönde ilerletmek yerine, biz insanların zekasını geliştirmek için çevresel durumları düzenleyebiliriz.

6. Excerpts taken from personal experiences part

1M(AC): I (Interviewer) - Did you know your position on the issue before you had to consciously reflect on the issue? Beforehand, I read several materials about cloning. I do not absolutely agree with using this therapy. I do not have immediate reaction to this scenario.	Önceden, klonlama hakkında birçok materyal okudum. Ben bu terapinin kullanılmasına tamamen karşıyım. Bu senaryoya karşı ani bir reaksiyona sahip değilim.
2M(HD): I - Did you think about who would have access to gene therapy? If so, how did this affect your decision-making? Turkey is a closed society. In our society, gene therapy is not seen as a good thing. Actually, I do not know the exact reason but this condition may be originated from less educated people in our society.	Türkiye kapalı bir toplumdur. Bizim toplumumuzda gen terapisi iyi birşey olarak görülmez. Neden böyle olduğunu aslında ben de tam olarak bilmiyorum fakat bu durum toplumumuzdaki daha az eğitimli insanlardan kaynaklanmış olabilir.

2R(NC): I - How would you convince a friend or acquaintance of your position about nearsightedness scenario? I can give some examples from myself. For example, when I use this therapy, I can play several kinds of sport easily. In addition, I would also say living without glasses would be more comfortable.	Ben kendimden bazı örnekler verebilirim. Örneğin, ben bu terapiyi kullandığımda birçok sporu rahat birşekilde yapabilirim. Ayrıca gözlüksüz daha konforlu olacağımı söylerdim.
3-1M(HD): I - Did you consider the feelings of a potential child carrying the HD gene? If so, how did this affect your-decision making? Related to this illness, I watched TV and read a book. I put myself into child. Even if I have flu, I need to get help from my family. However, this illness is very dangerous. Also, when you have flu, you can be healthy with medicines but this illness may be solved by this therapy. As a result, this therapy should be used.	Bu hastalıkla ilgili olarak ben televizyon izledim ve kitap okudum. Ben kendimi çocuğun yerine koydum. Grip bile olsam anneme ihtiyacım olmaktadır. Bununla birlikte, bu hastalık çok tehlikelidir. Ayrıca, grip olduğunuzda siz ilaçlarla iyileşebilirsiniz. Fakat bu hastalık bu terapiyle çözülebilir. Sonuç olarak bu terapi kullanılmalıdır.
3-2M(HD): I - Did you think about who would have access to gene therapy? If so, how did this affect your decision-making? In our society, having child is an important thing. Moreover, in our society, child is inseparable part of the family. Because of these reasons, families can use this therapy.	Bizim toplumumuzda, çocuk sahibi olmak önemli bir konudur. Dahası bizim toplumumuzda çocuk ailenin ayrılmaz bir parçasıdır. Bu sebeplerden dolayı aileler bu terapiyi kullanabilirler.
5R(IN): I - Can you think of an argument that could be made against the position that you have just described? How could someone support that argument? I am giving private lessons to some students. I think these students' intelligence level is low. It is really hard to teach concepts to these students. Some families can see this condition as problematic. Maybe, these families can use this therapy. However, I do not use this therapy for my child.	Ben bazı öğrencilerime özel dersler veriyorum. Bence bu öğrencilerin zeka seviyeleri düşük. Bu öğrencilere kavramları öğretmek gerçekten zor. Bazı aileler bu durumu problematik görebilir. Belki de bu aileler bu terapiyi kullanabilir. Bununla birlikte, ben çocuğum için bu terapiyi kullanmam.

7. Excerpts taken from social considerations (economic, educational, and religious considerations) part

14M(HD): I - Did you think about who would have access to gene therapy? If so, how did this affect your decision-making? The most important factor is education. Most of the people living in the east part of Turkey are not aware of gene or gene therapy. Most of them do not hear anything about these concepts. **Actually, education level is more dominant than religion in decision making about gene therapy. However, religion and education level are most effective factors influencing their decision making.** To sum up, the first factor is education level; second one is religion; and last one is psychological factor shaping in decision making of the Turkish people.	En önemli faktör eğitimdir. Türkiyenin doğusunda yaşayan çoğu insan genin ve gen terapisinin farkında değildir. Onların çoğu bu kavramlar hakkında herhangi birşey duymazlar. **Gerçekten de insanların gen terapisi konusunda karar vermesinde eğitim seviyesi dini inançlardan daha baskındır. Bununla birlikte din ve eğitim insanların karar vermesinde en etkili faktörlerdir.** Özetle, Türk insanların karar vermesinde etkili olan ilk faktör eğitim seviyesidir. İkinci faktör dindir ve son faktörde psikolojik faktördür.
2M(HD): I - Did you think about who would have access to gene therapy? If so, how did this affect your decision-making? *At first, rich people may apply for this therapy.* **Religion may be effective. In our society, religion is more effective for the proportion of 50 percent in people's decision making about this scenario. I can say that the most important factor influencing our people's decision making is religion.** *The second most important factor may be economic consideration.*	*İlk olarak zengin insanlar bu terapi için başvurabilirler.* **Din etkili olabilir. Bizim toplumumuzun %50'sinden daha fazlası için bu senaryo hakkında karar vermesinde din daha fazla etkilidir. Şunu söyleyebilirim ki bizim insanlarımızın karar vermesini etkileyen en önemli faktör dindir.** *İkinci en önemli faktör ekonomi olabilir.*
4M(AC): I - Did you think about who would have access to gene therapy? If so, how did this affect your decision-making? *First, rich people will apply for this therapy.* **Second, religion may be effective in people's decision making. Religion is important sociological variable in our country. If someone is fundamentalist in our country, the person may evaluate this scenario as destiny. Thus, they may accept this illness as people's destiny.** Educational level is also important. **In our Turkish culture, the most important factor shaping people's decision making is religion. Since people think about the life after the world life, the most important factor is religion in our country.**	*İlk olarak zengin insanlar bu terapi için başvuracaklardır.* **İkinci olarak din insanların karar vermesinde etkili olabilir. Din bizim ülkemizde önemli bir sosyolojik değişkendir. Eğer bizim ülkemizde bir insan fundemantalist ise, bu kişi bu senaryoyu kader olarak değerlendirebilirler. Sonuç olarak, bu insanlar bu hastalığı insanların kaderi olarak değerlendirebilirler.** Eğitim seviyesi de önemlidir. **Türk kültüründe, insanların karar vermesini etkileyen en önemli faktör dindir. İnsanlar yaşam sonrası hayatı göz önüne aldıkları için, bizim ülkemizdeki en önemli faktör dindir.**
5M(AC): I - Did you think about who would have access to gene therapy? If so, how did this affect your decision-making? **Conservative families may not want to use this gene therapy. My family is also conservative. However, under some circumstances, other things are not considered if issue is your family's health. If issue is my or another family's health, I can**	**Muhafazakar aileler bu gen terapisini kullanmak istemeyebilirler. Benim ailemde muhafazakar. Bununla birlikte, bazı durumlarda, eğer konu ailenin sağlıysa diğer şeyler göz önüne alınmaz. Eğer konu benim veya diğer bir ailenin sağlığıysa ben dini bazı inançlarım konusunda fedakarlıklar yapabilirim. Bizim toplumumuzda insanların bu konu hakkındaki kararları onların dini**

make a sacrifice with respect to religion. In our society, people's decisions regarding this issue will change according to their interpretation of the religion; As a result, religion may be an important factor in decision making. However, in this scenario, religion is not barrier to use this therapy. *In addition, our country's socioeconomic status is very important. Unfortunately, if this therapy is expensive, most people in our country will not use this therapy.*	**yorumlayışlarına göre değişecektir. Sonuç olarak, din karar vermede önemli bir faktör olabilir. Bununla birlikte, bu senaryoda, din bu terapinin kullanılmasında bir engel oluşturmamaktadır.** *Ayrıca, bizim ülkemizin sosyoekonomik statüsü de çok önemlidir. Maalesef, eğer bu terapi çok pahalı olursa bizim ülkemizdeki çoğu insan bu terapiyi kullanmayacaktır.*
8M(HD): I - Did you think about who would have access to gene therapy? If so, how did this affect your decision-making? *In Turkey context, I think rich people will use this therapy.* Also, I think intellectual people will use this therapy. Intellectual people means that people who are not overwhelmed under religion and cultural effects.	*Türkiye konteksinde zengin insanların bu terapiyi kullanacağını düşünüyorum.* Aynı zamanda entelektüel insanlar bu terapiyi kullanacaktır. Entellektüel insan din ve kültürel etkilerin altında ezilmeyen insandır.

8. Excerpts taken from moral-ethical considerations part

2R(IN): I - Should gene therapy be used to the intelligence of potential offspring? Why or why not? In other SSI (HD and NS), human health was an important factor in shaping people's decision making. However, in this issue, morality is more important than human health. I think, this therapy should not be used principally because everyone will not afford to use this therapy. Furthermore, it is not necessary that everyone should be intelligent. I think some differences should be among the people. As a result, this therapy is not necessary.	Diğer sosyobilimsel konularda (HD ve NS) insan sağlığı insanların karar vermelerinde önemli bir faktördü. Bununla birlikte bu konuda ahlak insan sağlığından daha önemlidir. Bence prensip olarak bu terapi kullanılmamalı çünkü herkesin bu terapiyi kullanmaya gücü yetmeyecektir. Ayrıca herkesin zeki olmasına gerek yoktur. Bence insanlar arasında bazı farklılıklar olması gerekir. Sonuç olarak, bu terapiye gerek yoktur.
3M(AC): I - Do you think that cloning as described in this scenario is subject to any kind of moral rules or principles? If so, how did this affect your decision-making? Of course, this issue is related to morality. In general, Turkish people marry once in their life. Re-marriage is not assessed as a good behavior in the society. However, in this issue, after the accident the mother will dedicate herself to the cloned child and did not make re-marriage. Thus, this condition will not cause moral problem in the society.	Tabiki bu konu ahlakla ilgilidir. Genellikle Türk insanları yaşamlarında bir kez evlenir. Tekrar evlenmek toplumda iyi bir davranış olarak değerlendirilmez. Fakat bu konuda, kazadan sonra anne kendisini çocuğuna adayacaktır ve tekrar evlenmeyecektir. Böylece bu durum ahlaki açıdan toplumda bir probleme neden olmayacaktır.
4R(AC): 1 - Should this woman be able to produce a clone of her dying baby? Why or why not? I think this therapy should not be used because the father is dead. Also, when I think with respect to morality, the child is dead. While	Bence bu terapinin kullanılmaması gerekir çünkü baba ölüdür. Ben ahlaki açıdan düşündüğümde çocuk da ölüdür. Ölü çocuk farklı çevrelerde yaşamışken, klonlanmış çocuk aynı çevreye sahip olmayacaktır. Ayrıca, ölen çocuk babasıyla yaşamışken, klonlanmış çocuk

deceased child lived in different environments; however, the cloned child will not have the same environment. Moreover, while deceased child lived with his/her father, the cloned child will not with his/her father. Thus, cloned child will not have as the same rights as deceased child. As a result, having child in this way is unfair. The mother may marry again and may have another child.	babasına sahip olmayacaktır. Böylece klonlanmış çocuk ölü çocukla aynı haklara sahip olmayacaktır. Sonuç olarak, bu şekilde çocuğa sahip olmak adil değildir. Anne tekrar evlenebilir ve başka bir çocuk sahibi olabilir.
39M(AC): I - What factors were influential in determining your position regarding the mother who wanted to clone her dying child? Morality and religion are effective in my decision-making. I think the cloned child is a copy not a real child. The cloned child may have identity problems, and this child may be unhappy in the future. I think, in this scenario, the mother is egoist. If the mother allows the child's cloning, her behavior will not be true with respect to morality.	Ahlak ve din karar vermemde etkilidir. Bence klonlanmış çocuk kopyadır gerçek değildir. Klonlanmış çocuk kimlik problemlerine sahip olabilir ve bu çocuk gelecekte mutsuz olabilir. Bence bu senaryoda anne egoisttir. Eğer anne klonlamaya izin verirse, onun davranışı ahlaki açıdan doğru olmayacaktır.
13R(IC): I - Should gene therapy be used to the intelligence of potential offspring? Why or why not? I think this therapy should not be used because if this therapy is used, people will confront with the discrimination. While some people use this therapy, other peoples do not use this therapy. Thus, equality will not be supplied for the people. As a result of not supplying equality among the people, moral-ethical problems may be revealed.	Bence bu terapi kullanılmamalıdır. Eğer bu terapi kullanılırsa insanlar ayrımcılıkla karşılaşacaklardır. Bazı insanlar bu terapiyi kullanırken bazı insanlar ise kullanmayacaktır. Böylece, insanlar için eşitlik sağlanamayacaktır. İnsanlar arasında eşitliliğin sağlanamaması sonucunda, ahlaki ve etik problemler ortaya çıkacaktır.

9. Excerpts taken from technological concerns part

1M(HD) I - Were you concerned with any technological issues associated with gene therapy? If so, what issues did you think about? I actually disappointed with the development of the technology so much. I am scared of these developments. I wish, scientists had not been found this therapy. However, we should accept truth that there is a therapy like this. When I put myself in the family, my opinions are changing.	Ben gerçekten teknolojinin bu denli gelişmesinden rahatsızım. Bu gelişmelerden korkuyorum. Keşke bilim insanları bu terapiyi bulmamış olsalardı. Bununla birlikte, böyle bir terapinin var olduğu gerçeğini kabul etmeliyiz. Ben kendimi burdaki ailenin yerine koyduğumda, fikirlerim değişiyor.
2M(HD) I - Were you concerned with any technological issues associated with gene therapy? If so, what issues did you think about? In general, I do not have any concern about the development of technology. However, technology should be used in right way. If this technology is not used in right way, some dangerous results may reveal.	Genel olarak teknolojinin gelişmesinden rahatsızlık duymuyorum. Bununla birlikte teknolojinin doğru yönde kullanılması gerekmektedir. Eğer bu teknoloji doğru yönde kullanılmazsa tehlikeli sonuçlar ortaya çıkabilir.

3M(HD) I - Were you concerned with any technological issues associated with gene therapy? If so, what issues did you think about? Yes, I have several concerns about technological developments. For example, with the developing technology, human's intelligence may be intervened much.	Evet, teknolojik gelişmeler hakkında birçok endişelerim var. Örneğin, bu teknolojik gelişmelerle insan zekasına daha çok müdahele edilebilir.
5M(AC) I - Were you concerned with any technological issues associated with cloning? If so, what issues did you think about? I have some concerns about technological developments. When people use this technology, several disadvantages may be revealed. Also, the aim of the using this technology is a very important issue. When someone uses technology, the aim of using this technology should be considered.	Teknolojik gelişmeler hakkında bazı endişelerim var. İnsanlar teknolojiyi kullandığında birçok dezavantajlar ortaya çıkabilir. Ayrıca teknolojinin kullanım amacıda ayrı bir önem taşımaktadır. Birileri teknolojiyi kullanırken teknolojinin kullanım amacını da göz önünde bulundurmalıdır.
6M(AC) I - Were you concerned with any technological issues associated with cloning? If so, what issues did you think about? Yes, I have some concerns about technological developments. In the past time, when the dolly sheep was cloned, scientists had disappointed with this cloning because cloned sheep were dead. So far, I have not heard any successful gene cloning or therapy operation. Thus, these technological developments may be dangerous.	Evet teknolojik gelişmeler konusunda bazı endişelerim var. Geçmiş zamanlarda dolly koyunu kopyalandığında bilim adamları hayal kırıklılığına uğradı. Çünkü dolly koyunu öldü. Bugüne kadar gen klonlanmasında ve terapisinde herhangi bir başarıya ulaşıldığını duymadım. Böylece, bu teknolojik gelişmeler tehlikeli olabilir.

APPENDIX E

EXTENDED TURKISH ABSTRACT
(GENİŞLETİLMİŞ TÜRKÇE ÖZET)

FEN ÖĞRETMEN ADAYLARININ SOSYOBİLİMSEL KONULAR HAKKINDAKİ KRİTİK DÜŞÜNME YETENEKLERİ VE BU YETENEKLERİ ETKİLEYEN FAKTÖRLER

Bilim her geçen gün toplumunda ihtiyaçlarını göz önüne alarak gelişmektedir. Aynı zamanda sosyal normlarda bilimsel gelişmelerden etkilenerek yeni bir şekil kazanmaktadır (Sadler & Zeidler, 2005b). Böylece bilim ve toplum arasında açık bir ilişki olduğundan söz edebiliriz.

1. Sosyobilimsel Konular ve Kritik Düşünme (Informal Reasoning)

Bugünün toplumu gelişen teknolojiyle sürekli olarak yüz yüze gelmektedir (Kolstø, 2006). Genetik mühendisliği ve ekoloji alanındaki bilimsel gelişmeler fen ve toplumun birbiri içersinde nasıl etkileşim olduğuna dair çok iyi örnekler sunar. Örneğin bilimsel gelişmelere paralel olarak endüstriyel alandaki gelişmeler küresel ısınma konusunda toplumda bir çok endişeye neden olmaktadır. Bir taraftan bilimsel gelişmelere bağlı olarak endüstriyel alan hızla değişmekte ve gelişmektedir. Örneğin birçok yeni fabrikalar açılmaktadır ve birçok işçi bu fabrikalarda çalışmaktadır. Bu fabrikalarda üretilen ürünler insan yaşamını kolaylaştırdığı için birçok insanın yaşamı bu fabrikalara bağlıdır. Diğer bir deyişle insanların daha iyi bir hayat yaşamaları için bu fabrikalara ihtiyaçları vardır. Diğer bir taraftan

da fabrikalar birçok zehirli gaz açığa çıkardıkları için çevrenin durumu daha kötüye gitmektedir. Açığa çıkan bu gazların bir kısmı örneğin karbondioksit küresel ısınmaya neden olmaktadır. Eğer fabrikalar bu tehlikeli gazları salmaya devam ederlerse küresel ısınma daha güçlü bir şekilde hissedilecektir. Bu örnekten anlaşıldığı üzere açılan fabrikalar bazı insanlara iş imkanı sağladığı için ve yaşam standartlarını yükselttiği için bu fabrikaların açık kalması fikri savunulabilir. Diğer bir grup insansa küresel ısınmaya yol açtığı için bu fikri desteklemeyebilir. Sadece küresel ısınmaya yoğunlaştığımızda da bu durumun toplumda karşıt fikirlerin ortaya çıkmasına yol açabileceğini fark edebiliriz. Örneğin bir grup insan küresel ısınmayı doğayı tehdit edici bir olay olarak görürken diğerleri bunu dünyadaki iklimlerin rutin bir ilerleyişi olarak değerlendirebilir. Böylelikle bilimsel konular toplum içerisinde karşıt fikirlere yol açabilir. Bu konular hakkındaki karşıt fikirler ikilem olarak adlandırılabilir. Bu ikilemler sosyobilimsel konular içersinde çok rahat bir şekilde gözlemlenebilir. Bu konular hem bilimsel hem de sosyal konuları aynı anda içermektedir (Sadler, 2004). Diğer bir deyişle bu konular bilimselliği içeren sosyal ikilemleri temsil eder (Fleming, 1986a; 1986b; Kolstø, 2001a, Patronis, Potari, & Spiliotopoulou, 1999; Sadler & Zeidler, 2005a; Zeidler, Walker, Ackett, & Simmons, 2002). Bugünlerde biyoteknoloji alanındaki hızlı gelişmeler ve çevre alanındaki yaşanan sorunlar toplum içersinde birçok ikilemi meydana getirmiştir. Toplum içersinde ortaya çıkan bu ikilemleri içermesi dolayısıyla sosyobilimsel konuları uygun bir içerik olarak çalışmak bir çok bilim insanının dikkatini çekmiştir. Son zamanlarda bir çok araşırmacı sosyobilimsel bir konu olan genetik mühendisliği hakkında birçok araştırma yapmıştır (Ekborg, 2008; Jimenez-Aleixandre, Rodriguez, & Duschl, 2000; Walker & Zeidler, 2007; Zohar & Nemet, 2002). Bir çok araştırmacı da ekoloji konuların da çalışmalarını gerçekleştirmiştir (Kortland, 1996; Osborne, Erduran, & Simon, 2004; Patronis et al., 1999;

Wu & Tsai, 2007). Aynı zamanda mobil telefonların etkisi ve sigara içmenin yasaklanması gibi diğer sosyobilimsel konular üzerinde de çalışan birçok bilim insanı vardır (Albe, 2008; Kolstø, 2006; Lee, 2007).

İnsanlar sosyobilimsel konularla karşılaştıklarında bu konular hakında fikirler geliştirmeye çalışırlar. Bu konuları açıklığa kavuşturmak için insanlar bu konularu anlamaya çalışıp çeşitli öneriler getirmeye çalışırlar. Diğer bir deyişle bu konuyu çözmeye çalışırlar. İnsanlar bu konuları çözmeye çalışırken bu konuyu tartışırlar ve bu konu hakkında iddialar geliştirirler. Diğer bir deyişle bu konuyu derinlemesine tartışırlar. Yani insanlar sosyobilimsel konularla karşılaştıklarında bu konuları çözerler ve derinlemesine tartışırlar. İnsanlar bu konuları çözerlerken ve derinlemesine tartışırlarken kritik düşünme (informal reasoning) diye kavramsallaştırılan süreçlerini kullanırlar (Sadler & Zeidler, 2004). Mantıksal düşünme (formal reasoning) sürecinde sosyobilimsel bir konu hakkındaki öncüller sabit ve değişmezken ortaya çıkabilecek sonuçlar bunlara bağlı olarak ortaya çıkan sonuçlardır. Diğer bir deyişle bir konu hakkındaki varsayımlar, argümanlar ve sonuçlar değişken değildir. Kritik düşünme (informal reasoning) sürecinde ise öncüller değişebilir ve ortaya çıkan sonuçlar kendi içersinde değerlendirilir (Perkins, Farady, & Bushey, 1991). Evans (2002) formal düşünme yeteneğiyle kritik düşünme yeteneği arasındaki farkları şu şekilde özetlemiştir: Mantıksal düşünme sürecinde bir konu hakkındaki öncüller ve sonuçlar açıkça belirtilerken kritik düşünme sürecinde öncüller ve sonuçlar açıkça belirtilmemiştir. Aynı zamanda mantıksal düşünme süreci genellikle tümdengelimci bir yaklaşım izlerken kritik düşünme süreci genellikle tümdengelimci bir yaklaşım içermemektedir. Bu iki kavram arasındaki son fark ise mantıksal düşünme sürecinde neden sonucu desteklerken kritik düşünme sürecinde neden sonucu destekleyedebilir veya desteklemeyedebilir. Bunu bir örnekle ifade

etmek gerekirse, Huntington hastalığında eğer çocuk doğmadan önce anne karnında gen tedavisi uygulanırsa çocuk gelecekte bu hastalığı yaşamayacaktır. Mantıksal düşünme sürecini kullanan bir insan şöyle düşünür; Eğer aile bu terapiyi kullanırsa çocuklarının bu hastalığa sahip olmayacaktır. Bu örnek şunu gösterir ki mantıksal düşünme sürecinde öncül tektir ve değişmezdir. Sonuçta öncüle bağlı olarak geliştirilmiştir. Kritik düşünme sürecinde ise insanlar gen terapisinin avantajlarını ve dezavantajlarını göz önüne alır. Aynı zaman da akılcı çözümlerin yanısıra ahlaki-etik çözümleri ve duygusal çözümleri de göz önüne alabilir. Kritik düşünme sürecinde bir grup insan gen tedavisinin kullanılması gerektiğini, çünkü bu tedavinin bu hastalığın üstesinden geleceğini savunurken diğer bir grup insansa bu tedavi yönteminin etik açıdan uygun olmadığını düşünerek yapılmaması gerektiğini savunabilir. Örnekten de anlaşıldığı üzere kritik düşünme sürecinde her insan farklı öncüller geliştirebilir ve onların ortaya sürdükleri sonuçlar da kendi öz değerlendirmelerine bağlı olabilir. Zohar ve Nemet (2002) tarafından kritik düşünmenin (informal reasoning) genel bir tanımı yapılmıştır. Kritik düşünme (informal reasoning), tutumları ve fikirleri içerir aynı zamanda ikilemleri içeren konuları inceler ve genellikle tümevarımcı bir yaklaşımı içerir.

Kritik düşünme (informal reasoning) ve sosyobilimsel konular hakkında yapılan araştırmalar son yıllarda büyük bir ivme kazanmıştır. 1980'li yıllarda fen-teknoloji-toplum yaklaşımı popüler bir araştırma alanıydı. Popüler olmasının yanısıra bu yaklaşım fen müfredatlarına ve ders kitaplarına da entegre edildi. Fen-teknoloji-toplum yaklaşımındaki en önemli amaç kişilerin fen, teknoloji ve toplum arasındaki ilişkiyi anlamasını sağlamaktı. Bununla birlikte 2000'li yıllarda sosyobilimsel konular yaklaşımı bu ilişkinin yanısıra ahlaki konuları, kişisel deneyimleri ve bilimin doğasını da içerdi (Zeidler, Sadler, Simmons, & Howes, 2005). Bu

yaklaşım fen-teknoloji-toplum yaklaşımına göre daha kapsamlı bir teorik çatıya sahipti. Diğer bir deyişle bu yaklaşım fen okuryazarı öğrenciler yetiştirmek için daha kapsamlı bir yaklaşımdı. Fen okur yazarlığı sadece bilimsel bilgiyi anlamayı içermeyip sosyobilimsel konularda bilgiye dayalı karar vermeyi de amaçlamaktadır. Aynı zamanda dünyadaki önemli fen eğitim organizasyonları (American Association for the Advancement of Science, 1990; National Research Council, 1996; Queensland School Curriculum Council, 2001) öğrencilerin sosyobilimsel konuları tartışabilmeleri, analiz edebilmeleri, ve bilgiye dayalı kararlar verebilmeleri konusunda yetenekleri olması gerektiğine vurgu yapmaktadır. Fen okuryazarlığının geliştirilmesi fen eğitiminin en önemli amaçlarından biri olduğu için ve sosyobilimsel konularda bilgiye dayalı karar verme de fen okuryazarlığının önemli bir parçası olduğu için, öğrencilerin sosyobilimsel konular hakkında karar geliştirme süreçlerinin incelenmesi gerekmektedir.

Bu noktada fen öğretmen adaylarının kritik düşünme (informal reasoning) yeteneklerini incelemek önem kazanmaktadır. Çünkü fen öğretmen adayları hem sosyobilimsel konuları öğrencilere öğretmek bakımından hem de sosyobilimsel konuları fen müfredatlarına entegre etmek açısından ideal örneklem grubunu oluşturmaktadır.

2. Sosyobilimsel Konular Hakkındaki Kritik Düşünmenin (Informal Reasoning) Değerlendirilmesi

Sosyobilimsel literatürde, kritik düşünme (informal reasoning) birçok şekilde değerlendirilmiştir. Bazı araştırmacılar kritik düşünmeyi örüntü (Sadler & Zeidler, 2005a) olarak değerlendirirken diğer araştırmacılar mod (Patronis et al., 1999; Yang & Anderson, 2003) olarak değerlendirmişlerdir. Örneğin, Sadler and Zeidler (2005b) genetik mühendisliği konusu hakkında üniversite öğrencilerinin kritik

düşünmelerini araştırmak için bir çalışma yaptı. Çalışması sonucunda üç çeşit kritik düşünme örüntüsü ortaya çıktı; akılcı, duygusal, ve sezgisel düşünme örüntüleri. Akılcı düşünme örüntüsü akılcı temelli düşünmeye dayalı iken, duygusal düşünme empati ve sempatiyi içerdi, sezgisel düşünme örüntüsü ise ani-düşünmeden verilen reaksiyonları içerdi. Yang ve Anderson (2003) nükleer enerji konusunda lise son sınıf öğrencilerinin kritik düşünmelerini araştırmak için bir çalışma yaptı. Çalışma sonucunda üç çeşit kritik düşünme modu ortaya çıktı; bilimsel eğilimli, toplumsal eğilimli ve hem bilimsel hem de sosyal eğilimli düşünme modları. Bilimsel eğilimli öğrenciler sosyobilimsel konular hakkındaki kararlarını alırlarken bilimsel bilgiye dayandılar. Sosyal eğilimli öğrenciler ise karar alırken sosyal faktörleri göz önüne aldılar. Son olarak hem toplumsal hemde bilimsel eğilimli çocuklar ise karar alırken hem bilimsel bilgiyi hem de sosyal faktörleri aynı anda göz önüne aldılar.

Sadler ve Zeidler (2005b) kritik düşünmeyi değerlendirirken kritik düşünmenin en önemli iki özelliğinin olduğunu belirtmiştir. Bunlar kritik düşünme niteliği ve kritik düşünme örüntüsüdür (Sadler & Zeidler, 2005a). Bu çalışma da kritik düşünmenin daha iyi anlaşılmasını sağlamak için kritik düşünme moduna ve örüntüsüne ek olarak kritik düşünme niteliği de incelenmiştir.

Fen eğitim alanında kritik düşünme niteliğini argüman geliştirme (argumentation) teorisiyle değerlendiren birçok araştırma bulunmaktadır. Genellikle bu çalışmalarda Toulmin'in (1958) veya Kuhn'ın (1991) argüman geliştime modelleri kullanılmıştır. Kuhn's (1991) argüman geliştirme teorisi çoğunlukla Toulmin'in (1958) argüman geliştime örüntüsü modelinden etkilenmiştir. Toulmin'in (1958) argüman geliştirme modeli; iddia (claim), bu iddiayı destekleyen ya da reddeden argümanlar

(justification), iddiaya zıt iddia geliştirme (counter-position), ve zıt iddiayı göz önüne alarak önceki iddayı desteklemeden (rebuttal) oluşmaktadır. Van Eemeren (1995) argüman geliştirmeyi şu şekilde tanımlamıştır; Argüman geliştirme sosyal entellektüel ve söze dayalı bir aktivetedir. Aynı zamanda bir fikri desteklemeyi ya da reddetmeyi içerir.

1990'lardan başlayarak Toulmin'in (1958) argüman geliştirme modeli fen eğitim alanında önemli bir yaklaşım olarak popularite kazanmıştır. Bir çok fen eğitimi araştırmacısı argüman geliştirme yeteneklerini farklı sosyobilimsel içerikler içinde incelemiştir. (e.g., Albe, 2008; Ekborg, 2008; Jimenez –Aleixandre et al., 2000; Kortland, 1996; Lee, 2007; Patronis et al., 1999; Zohar & Nemet, 2002). Bazı araştırmacılar (Kortland, 1996; Walker & Zeidler, 2007; Zohar & Nemet, 2002) argüman geliştirme yeteneklerini geliştirmek için deneysel çalışmalar, bir kısım araştırmacı da (Jimenez–Aleixandre et al., 2000; Lee, 2007; Patronis et al., 1999) argüman geliştirme hakkıda sadece durum tespit çalışmaları yapmıştır (Patronis et al., 1999). Örneğin, Kortland (1996) atık maddelerin yönetimi hakkında orta okul öğrencileriyle deneysel bir çalışma yapmıştır. Patronis et al. (1999) çevre hakkında yine orta okul öğrencilerinin argüman geliştirme yeteneklerini incelemiştir. Çalışmaları sonucunda, Kortland (1996) ve Patronis et al. (1999) farklı sonuçlara ulaşmışlardır. Kortland (1996) öğrencilerin ilerlemiş düzeyde argüman geliştiremediklerini tespit ederken Patronis et al. (1999) öğrencilerin iyi bir düzeyde argüman geliştirdiklerini tespit etmiştir.

3. Kritik Düşünmeyi (Informal Reasoning) Etkileyen Faktörler

Sosyobilimsel literatüre bakıldığı zaman kritik düşünmeyi etkileyen dört değişkenden bahsedebiliriz. Bunlar; kişisel deneyimler (Albe, 2008;

Bell & Lederman, 2003; Sadler & Zeidler, 2004; Sadler et al., 2004), bilimin doğasını anlama (Bell & Lederman, 2003; Sadler, Chambers, & Zeidler, 2004; Walker & Zeidler, 2007; Zeidler et al., 2002), ahlaki perspektif (Bell & Lederman, 2003; Fleming,1986a, 1986b; Pedretti, 1999; Sadler & Zeidler, 2004; Zeidler & Schafer, 1984), ve alan bilgisidir (Albe, 2008; Fleming, 1986b; Hogan, 2002; Sadler, 2003; Zeidler & Schafer, 1984). Örneğin, Sadler (2003) çalışmasında alan bilgisinin ve ahlaki perspektifin kritik düşünmedeki yerini sorgulamıştır. Ahlaki perspektifin kritik düşünme örüntüsü ile ilişkili olduğunu tespit ederken; alan bilgisinin kritik düşünme örüntüsüyle ilgili olmadığını tespit etmiştir. Aynı çalışmada, Sadler (2003) alan bilgisinin kritik düşünme niteliğiyle ilgili olmadığını tespit etmiştir. Bell ve Lederman (2003), 21 üniversite profesörüyle kritik düşünme ve bilimin doğası arasındaki ilişkiyi sorgulamak için bir çalışma yapmıştır. Sonuç olarak bilimin doğasının katılımcıların karar vermelerini etkilemezken; kişisel değerlerin, ahlaki perspektifin ve sosyal endişelerin katılımcıların karar vermesinde etkili olduğunu tespit etmiştir.

4. Araştırma Soruları

1. Fen öğretmen adayları sosyobilimsel konularla karşılaştıklarında ne tür kritik düşünme örüntüleri ortaya koymuşlardır?

2. Fen öğretmen adaylarının kritik düşünme örüntüleri ve niteliği arasında sosyobilimsel konular boyunca nasıl bir ilişki gözlemlenmektedir?

3. Fen öğretmen adaylarının kritik düşünme niteliği sosyobilimsel konular boyunca nasıl bir değişim göstermektedir?

4. Fen öğretmen adaylarının sosyobilimsel konular hakkında kritik düşünme süreçlerinde hangi faktörler etkili olmuştur?

Araştırma sorularından da anlaşılacağı üzere bu çalışmanın ana amacı, sosyobilimsel konular hakkında fen öğretmen adaylarının kritik düşünme (informal reasoning) yeteneklerini araştırmaktır. Çalışmada ilk olarak fen öğretmen adaylarının kritik düşünme örüntüleri incelendi. İkinci olarak fen öğretmen adaylarının kritik düşünme örüntüleri ve bunların niteliği arasındaki ilişki sorgulandı. Üçüncü olarak fen öğretmen adaylarının kritik düşünme niteliğinin sosyobilimsel konuların içeriğine göre nasıl değiştiği incelendi. Son olarak da farklı sosyobilimsel konularla ilgili olarak öğretmen adaylarının kritik düşünme yeteneklerini etkileyen faktörlere odaklanıldı. Tüm bu araştırma sorularını cevaplamak için, araştırmacı yorumsal nitel araştırma yaklaşımını (basic interpretive qualitative research approach) benimsedi (Merriam & Associates, 2002). Bu yaklaşımda araştırmacı çalışmasına bir şekil vermek için kavramlar, modeller ve teoriler kullanır; bilgi, görüşmelerle ve gözlemlerle toplanır; ve çalışmanın genel yorumu araştırmacının çalışmadan ne anladığına bağlıdır (Merriam & Associates, 2002). Aynı zamanda, öğretmen adaylarının kritik düşünme yetenekleri ve bu yetenekleri etkileyen faktörler nitel bir veri analiz yöntemi olan sürekli kıyaslama (constant-comparative) analiz metoduyla belirlendi.

Kritik düşünme yetenekleri ve bu yetenekleri etkileyen faktörleri belirlemek için yedi sosyobilimsel konu kullanıldı. Bu konulardan üç tanesi gen terapisi ile ilgili iken üç tanesi de klonlama ile ilgiliydi. Son konuda global ısınma ile ilgiliydi. Konu içeriği olarak bu çalışmada kullanılan sosyobilimsel konular birçok eğitim seviyesi için uygun olsa da özellikle fen öğretmen adayları için daha uygun olduğu düşünüldü. Çünkü onlar bu konuları öğretmek için en ideal adaylardı. Bu çalışmanın katılımcılarının

hepsi eğitimlerinin son yıllarındaydılar. Katılımcılar eğitimleri boyunca birçok biyoloji ve ekoloji dersi aldılar. Böylelikle onların alan bilgisi yeterli düzeyde varsayılarak bu çalışmada alan bilgileri sorgulanmadı. Çalışmaya Ankarada'ki bir devlet üniversitesinden toplam 39 fen öğretmen adayı gönüllü olarak katıldı. Katılımcıların 13'ü erkek iken, 26'sı bayandı.

Bu çalışma hakkında bilgi toplamak için toplam iki tane görüşme protokolu kullanıldı. Kritik düşünme görüşme protokolu katılımcıların kritik düşünme yeteneklerini incelemek için kullanıldı. Ahlaki-karar verme görüşme protokolu ise katılımcıların kritik düşünme yeteneklerini ve bu yetenekleri etkiyen faktörleri belirlemek için kullanıldı.

Çalışmanın ne kadar doğru bir şekilde yapıldığını belirtmek için iç geçerlik, dış geçerlik, objektiflik ve güvenirlik konularına çalışma boyunca dikkat edildi.

5. Kritik Düşünme Örüntüleri (Informal Reasoning Patterns)

Analizlerin sonucunda üç çeşit kritik düşünme örüntüsü ortaya çıkmıştır: akılcı (rationalistic), duygusal (emotive) ve sezgisel (intuitive) düşünme örüntüleri. Akılcı düşünme örüntülerine örnek olarak aşağıdaki görüşme alıntılarına bakılabilir:

- 6R(HD): Bence bu hastalık geni elimine edilmelidir çünkü bu genin elimine edilmesiyle bu hastalıktan kurtulabiliriz. Bu hastalığın etkileri gelecekte gözlenecektir. Hastalığın bu etkileri kişi için zararlı olacaktır. İnsan yaşamı önemlidir. İnsanlar gen terapisi metoduyla hayatlarını sürdürebilecekleri için bu terapi kullanılmalıdır. Ayrıca, doğal döngüye yapılan müdaheleler dünyanın geleceği için zararlı etkilere yol açabilir. Buna rağmen insanların sağlığı önemli olduğu için bu terapinin kullanılması gerekmektedir.

- 12R(GW): Bence dünyadaki tüm ülkeler Kyoto protokoluna katılmalıydılar. Çünkü bu problem global olup, herhangi bir ülkeye özgü değildir. Dünyadaki tüm ülkeler global ısınmaya gereken önemi vermelidir. Bizler her geçen gün etkili bir biçimde global ısınmanın dünyamız üzerindeki etkisini gözlemliyoruz. Örneğin, iklim dengesi tüm dünya üzerinde hızlı bir şekilde değişiyor ve kutuplardaki buzlar eriyor. İnsanlar global ısınma konusunda birşeyler yapabilmek için sorumluluk almalıdırlar çünkü global ısınma gelecek sağlıklı nesiller için önemlidir.
- 15R(NS): Bence bu terapiyi kullanmak gereksiz çünkü zaten bu hastalığın üstesinden gelmek için birçok alternatif tedavi yöntemleri var. Örneğin bu hastalıkla mücadele etmek için lens veya gözlük takma veya cerrahi müdaheleler yapılabilir. Aynı zamanda ben bu gen terapisinin (NS) diğer senaryodaki (HD) gibi insanların hayatlarıyla ilgili olduğunu düşünmüyorum. Diğer bir deyişle, burda söz konusu olan bir insanın hayatı değildir. Son olarak alternatif tedavi metodlarının (lens veya gözlük gibi) kullanımı gen terapisine göre daha kolay ve daha ucuzdur. Bununla birlikte gen terapisi diğer terapi yöntemlerine göre daha çok risk faktörü taşıyıp daha çok yan etkiyi içerebilir. Sonuç olarak, gen terapi metodu kolaylıkla üstesinden gelinebilecek bu hastalık için kullanılmamalıdır.

Görüşme protokollerinden anlaşıldığı üzere 6 numaralı katılımcı Huntington hastalığıyla ilgili sosyobilimsel konuya karşı, 12 numaralı katılımcı küresel ısınma konusuna karşı, 15 numaralı katılımcı ise uzağı net görememe konusuna karşı akılcı düşünme örüntüsünü geliştirmişlerdir.

Akılcı düşünme örüntüsünün yanısıra duygusal düşünme örüntülerine örnek olarak aşağıdaki görüşme alıntılarına bakılabilir:

- 10R(RC): Bence klonlama korkunç bir şeydir. Bu senaryo bilim-kurgu filmlerine benzemektedir. Eğer bu terapi kullanılırsa bu durum çocuklar üzerinde gelecekte kötü etkilere neden olacaktır. İnanıyorum ki klonlama çocuğun geleceği için haksızlık olacaktır. Çünkü çocuk gelecekte annesiyle ya da babasıyla fiziksel olarak aynı olacaktır. Çocuk annesine ya da babasının tam aynısı olmak istemeyebilir. Bu çocuklar gelecekte diğer klonlanmamış çocuklar gibi farklı bir kişi olmak isteyebilir. Dahası bu klonlama olayı anne

ya da baba için de kötü bir olay olacaktır. Çünkü onlar için çocukluklarını tekrardan yaşamak çok sıkıcı olacaktır.

- 16M(HD): Ben kendimi çocuğun yerini koyduğumda bu terapiyi kesinlikle isterim. Çünkü bu terapi benim sağlığımı ve geleceğimi etkileyecektir. HD hastalığına sahip olmadan gelecekte daha iyi yaşamak için benim bu terapiyi kullanmaya ihtiyacım var. Bu nedenlerden dolayı bu terapi kullanılmalıdır.
- 25M(HD): Benim bu senaryo hakkında karar vermemde duygularım etkilidir. Bu durumda, ben kendimi ailenin yerine koydum ve ben bu senaryonun direk olarak kişinin yaşamı ile ilgili olduğunu düşünüyorum. Diğer şeylerin örneğin ahlakın ve etiğin bu senaryoda o kadar önemli olmadığını düşünüyorum. Sonuç olarak bu terapi yöntemi kullanılmalıdır.

Görüşme protokollerinden anlaşıldığı üzere 10 numaralı katılımcı klonlamayla ilgili sosyobilimsel konuya karşı, 16 ve 25 numaralı katılımcılar ise Huntington hastalığıyla ilgili konuya karşı duygusal düşünme örüntüsü geliştirmişlerdir.

Akılcı ve duygusal düşünme örüntüsünün yanısıra sezgisel düşünme örüntülerine örnek olarak aşağıdaki görüşme alıntılarına bakılabilir:

- 28R(RC): Çocuk klonlama gibi şeylere ben tamamen karşıyım. Benim dini inançlarım klonlamaya karşı bir engel oluşturduğu için ben klonlamanın saçma bir şey olduğunu düşünüyorum.
- 30R(AC): Bence bu terapi gereksiz. Bu terapiyi kullanmaya mecbur değiliz. Sonuç olarak bu terapi kullanılmamalıdır.
- 34R(TC): Bu terapi kesinlikle kullanılmalıdır. Bu senaryo etikle ve dinle ilgili değildir.

Görüşme protokollerinden alınan alıntılardan anlaşıldığı üzere, 28 numaralı katılımcı klonlama ile ilgili sosyobilimsel konuya karşı, 30 numaralı katılımcı yine insan klonlama ile ilgili konuya karşı, 34 numaralı katılımcı yine organ klonlama konusuna karşı sezgisel düşünme örüntüsü geliştirmişlerdir.

Geliştirilen bu informal düşünme örüntülerine ek olarak çalışma sırasında tek bir sosyobilimsel konuya karşı ikili düşünme örüntüleride tespit edilmiştir. Örneğin 4 numaralı katılımcı küresel ısınma konusunda hem sezgisel hem de akılcı düşünme örüntüleri geliştirmiştir. (Koyu olan kısımlar sezgisel düşünme örüntüsünü, italik olan kısımlar akılcı düşünme örüntüsünü, altı çizili olan kısımlar ise duygusal düşünme örüntüsünü belirtmektedir.)

- 4R(GW): **Bence US bu protokole katılmalıydı. US sadece kendi menfaatlerini göz önüne almıştır.** *Tehlikeli gaz emisyonları tüm dünyayı etkilediği için, tüm ülkeler bu protokole katılmalıydı. Sağlıklı gelecek nesiller için ve global ısınmadan korunmak için bizler bazı önlemler almamız gerekmektedir.*
- 1R(TC): Evet bu terapi kullanılmalıdır. Çünkü hasta bu hastalıkla karşılaştığı zaman hayata karşı birçok sorumluluğa sahip olacaktır. Örneğin hastanın sorumlu olduğu bir ailesi olacaktır. Hastanın ailesine bakması gerekir. Ben böyle bir rahatsızlıkla karşılaşsam bu klonlama metodunu kullanırdım. *Bununla birlikte bizler dünyanın doğal dengesini bozuyoruz. Bizler klonlama metodunu kullanarak doğal seçilime müdahele ediyoruz. Hayvanların virüslerle ve mikroplarla karşılaştığı gibi, insanlarda doğal seçilimin sağlanması için hastalıklarla (HD) karşılaşırlar. Hayvanların doğal seçilimle karşılaştığı gibi, insanlarında doğal seçilimle karşılaşması gerekir*
- 26M(AC): Duygusal faktörler benim bu konu hakkında karar vermemde etkiliydi. Ben kendimi kadının yerine koydum ve ben klonlamadan kaynaklanan riskleri göz önüne almadım..... **Benim kendi dini inançlarıma göre bu terapiyi kullanmazdım. Aynı zamanda dini inançların Türk toplumunun karar vermelerindeki etkisini de göz önüne alarak, Türk insanlarının %70-80'inin bu klonlama metodunu kullanmaz.**

Görüşmelerden yapılan alıntılardan da görülmektedir ki katılımcılar bir sosyobilimsel konuya karşı birden fazla kritik düşünme geliştirebilmektedirler.

6. Kritik Düşünme Niteliği (Informal Reasoning Quality)

Daha öncede bahsedildiği üzere sosyobilimsel konulara karşı kritik düşünceyi daha iyi anlayabilmek için bu çalışmada kritik düşünme örüntülerinini yanısıra kritik düşünme niteliği de incelenmiştir. Kritik düşünme niteliğini belirlemek için bir ölçek geliştirilmiştir. Aşağıdaki tablo geliştirilen ölçeği göstermektedir. Toplam dört çeşit kritik düşünme niteliği tipi belirlenmişdir.

Kritik Düşünme Niteliği Tipleri	Kriter	Alıntı
1	Sadece iddia	30R(HD): Bence bu gen terapisi kullanılabilir. Herhangi bir problem yok.
2	İddia ve iddiayı destekleme	39R(NS): Bence bu terapi kullanılmaması gerekir. Çünkü ben miyopum. Ben gözlük kullanıyorum ve miyop benim günlük yaşamımı ve iş hayatımı etkilemez. Bu rahatsızlığın giderilmesi için birçok alternatif tedavi yöntemleri var. Örneğin, gözlük, lens, ve laser kullanımı bu hastalıklar için. Zaten risksiz alternatif tedavi yöntemleri olduğu için bu gen terapisi gereksizdir ve kullanılmasına gerek yoktur.
3	İddia, iddiayı destekleme, ve karşı iddia geliştirme	19R(HD): Bu terapi kullanılabilir. Tabiki aileler çocuklarınının gelecekte rahatsız olmalarını istemezler. Onlar bu tedavi yöntemini kullanmayı tercih ederler. Yoksa çocukları gelecekte büyük zorluklarla karşılaşacaklardır. Bununla birlikte aileler bu terapiden ortaya çıkacak negatif sonuçları göz önüne almalılar.....Genetik mühendisliği doğada dengeyi etkileyerek problemler meydana getirebilir. Genetik mühendisliğiyle doğanın dengesine müdahele ediyoruz ve böylece doğada yeni problemlere neden olabiliriz. Ölümler doğanın dengesinin vazgeçilmez parçasıdır. Eğer biz doğanın dengesine müdahele edersek ve gen terapisi her hastalık için kullanılırsa bu durum doğada yeni problemler ortaya çıkarabilir. Ayrıca, gen terapisinin yan etkilerinin yüzünden gelecekte çocuğun farklı hastalıklara sahip olma olasılığı da vardır.

4	İddia, iddiayı destekleme, karşı iddia geliştirme, ve karşı iddiaya karşı iddiayı destekleme	7R(IN): Bu terapinin kullanılmaması gerekir. Çünkü bence bu terapiyi kullanmak yüksek risk içerir. Bu terapiyle siz ekstrem durumlarla karşılaşabilirsiniz. Örneğin, bu terapi diğer zeka problemlerine neden olabilir. Örneğin zeka geriliği gibi. Ayrıca, eğer toplum çok fazla zeki insana sahipse, bu durum toplumda kaosla ve çözülmemiş problemlerle sonuçlanabilir. Çünkü bu durum direk olarak iş dağılımını etkiler. Bu noktada, "Kim hangi işe sahip olacak" sorusunu cevaplanması gerekmektedir. Siz daha zeki insanlar yetiştirdiğinizde, beklenmeyen bu tip problemlerle karşılaşabilirsiniz. Bununla birlikte, eğer toplum zeki insanlara sahipse bu güçlü bir toplum oluşmasını sağlayacaktır. Bu toplum içinde gelecek nesiller daha çok başarıya ve mutluluğa sahip olacaklardır. Ayrıca, ben zekanın sadece genetikle ilişkili olduğunu düşünmüyorum aynı zamanda çevreyle, aileyle ve okulla da ilgili olduğunu düşünüyorum. Çevre, aile ve okul bir kişinin zekasını pozitif yönde etkilediğinde kişinin zekası beklenen yönde gelişir. Sonuç olarak, insanların zekasını genetik yönde ilerletmek yerine, biz insanların zekasını geliştirmek için çevresel durumları düzenleyebiliriz.

Tablodan da anlaşıldığı üzere birinci tipten dördüncü tip kritik düşünme niteliğine doğru gidildikçe katılımcılardan daha iyi nitelikte kritik düşünme beklenmektedir. Fakat çalışma sonucu göstermiştir ki öğretmen adayları kolaylıkla iddialarını ve bu iddialarını destekleyen argümanlarını belirtmişlerdir. Katılımcıların az sayıda kendi iddialarına karşıt iddialar ve bu iddiaları destekleyen argümanlar geliştirdiği tespit edilmiştir.

Aynı zamanda, katılımcıların kritik düşünme niteliği tüm sosyobilimsel konular boyunca aynı eğilimi göstermiştir. Böylelikle, fen öğretmen adaylarının kritik düşünme niteliklerinin, sosyobilimsel konuların içeriğinden bağımsız olduğu bulunmuştur. Çalışma sonuçlarına göre katılımcıların kritik düşünme yeteneklerini etkileyen faktörler ise dört ana grupta toplanmıştır. Bunlar; kişisel deneyimler, sosyal faktörler, ahlaki-etik konular, ve teknolojiden duyulan endişelerdir.

7. Kritik Düşünmeyi Etkileyen Faktörler

Kişisel deneyimle ilgili alıntılar aşağıda belirtilmiştir:

- 1M(AC): Önceden, klonlama hakkında birçok materyal okudum. Ben bu terapinin kullanılmasına tamamen karşıyım. Bu senaryoya karşı ani bir reaksiyona sahip değilim.
- 2M(HD): Türkiye kapalı bir toplumdur. Bizim toplumumuzda gen terapisi iyi birşey olarak görülmez. Neden böyle olduğunu aslında ben de tam olarak bilmiyorum fakat bu durum toplumumuzdaki daha az eğitimli insanlardan kaynaklanmış olabilir.
- 2R(NC): Ben kendimden bazı örnekler verebilirim. Örneğin, ben bu terapiyi kullandığımda birçok sporu rahat birşekilde yapabilirim. Ayrıca gözlüksüz daha konforlu olacağımı söylerdim.
- 3-1M(HD): Bu hastalıkla ilgili olarak ben televizyon izledim ve kitap okudum. Ben kendimi çocuğun yerine koydum. Grip bile olsam anneme ihtiyacım olmaktadır. Bununla birlikte, bu hastalık çok tehlikelidir. Ayrıca, grip olduğunuzda siz ilaçlarla iyileşebilirsiniz. Fakat bu hastalık bu terapiyle çözülebilir. Sonuç olarak bu terapi kullanılmalıdır.
- 3-2M(HD): Bizim toplumumuzda, çocuk sahibi olmak önemli bir konudur. Dahası bizim toplumumuzda çocuk ailenin ayrılmaz bir parçasıdır. Bu sebeplerden dolayı aileler bu terapiyi kullanabilirler.
- 5R(IN): Ben bazı öğrencilerime özel dersler veriyorum. Bence bu öğrencilerin zeka seviyeleri düşük. Bu öğrencilere kavramları öğretmek gerçekten zor. Bazı aileler bu durumu problematik görebilir. Belki de bu aileler bu terapiyi kullanabilir. Bununla birlikte, ben çocuğum için bu terapiyi kullanmam.

Alıntılar göstermiştir ki hemen hemen tüm sosyobilimsel konular boyunca katılımcıların kişisel deneyimleri karar vermelerinde önemli bir yere sahiptir.

Kişisel deneyimlerin yanısıra sosyal faktörlerlerinde katılımcıların karar vermelerinde önemli bir yere sahip olduğu tespit edilmiştir. Bu faktörle ilgili alıntılar aşağıda belirtilmiştir (Koyu olan kısımlar din faktörünü, altı çizili olan kısımlar eğitim faktörünü, italik olan kısımlar ekonomi faktörünü göstermektedir).

- 14M(HD): En önemli faktör eğitimdir. Türkiyenin doğusunda yaşayan çoğu insan genin ve gen terapisinin farkında değildir. Onların çoğu bu kavramlar hakkında herhangi birşey duymazlar. **Gerçekten de insanların gen terapisi konusunda karar vermesinde eğitim seviyesi dini inançlardan daha baskındır. Bununla birlikte din ve eğitim insanların karar vermesinde en etkili faktörlerdir.** Özetle, Türk insanların karar vermesinde etkili olan ilk faktör eğitim seviyesidir. İkinci faktör dindir ve son faktörde psikolojik faktördür.
- 2M(HD): *İlk olarak zengin insanlar bu terapi için başvurabilirler.* **Din etkili olabilir. Bizim toplumumuzun %50'sinden daha fazlası için bu senaryo hakkında karar vermesinde din daha fazla etkilidir. Şunu söyleyebilirim ki bizim insanlarımızın karar vermesini etkileyen en önemli faktör dindir.** *İkinci en önemli faktör ekonomi olabilir.*
- 4M(AC): *İlk olarak zengin insanlar bu terapi için başvuracaklardır.* **İkinci olarak din insanların karar vermesinde etkili olabilir. Din bizim ülkemizde önemli bir sosyolojik değişkendir. Eğer bizim ülkemizde bir insan fundemantalist ise, bu kişi bu senaryoyu kader olarak değerlendirebilirler. Sonuç olarak, bu insanlar bu hastalığı insanların kaderi olarak değerlendirebilirler.** Eğitim seviyesi de önemlidir. **Türk kültüründe, insanların karar vermesini etkileyen en önemli faktör dindir. İnsanlar yaşam sonrası hayatı göz önüne aldıkları için, bizim ülkemizdeki en önemli faktör dindir.**
- 5M(AC): **Muhafazakar aileler bu gen terapisini kullanmak istemeyebilirler. Benim ailemde muhafazakar. Bununla birlikte, bazı durumlarda, eğer konu ailenin sağlıysa diğer şeyler göz önüne alınmaz. Eğer konu benim veya diğer bir ailenin sağlığıysa ben dini bazı inançlarım konusunda fedakarlıklar yapabilirim. Bizim toplumumuzda insanların bu konu hakkındaki kararları onların dini yorumlayışlarına göre değişecektir. Sonuç olarak, din karar vermede önemli bir faktör olabilir. Bununla birlikte, bu senaryoda, din bu terapinin kullanılmasında bir engel oluşturmamaktadır.** *Ayrıca, bizim ülkemizin sosyoekonomik statüsü de çok önemlidir. Maalesef, eğer bu terapi çok pahalı olursa bizim ülkemizdeki çoğu insan bu terapiyi kullanmayacaktır.*
- 8M(HD): *Türkiye konteksinde zengin insanların bu terapiyi kullanacağını düşünüyorum.* Aynı zamanda entelektüel insanlar bu

terapiyi kullanacaktır. Entellektüel insan din ve kültürel etkilerin altında ezilmeyen insandır.

Alıntılar göstermiştir ki hemen hemen tüm sosyobilimsel konular boyunca katılımcıların sahip olmuş oldukları sosyal faktörler karar vermelerinde önemli bir yere sahiptir.

Kişisel deneyimlerin ve sosyal faktörlerin yanısıra ahlaki perspektifinde katılımcıların karar vermelerinde önemli bir yere sahip olduğu tespit edilmiştir. Bu iddiayla ilgili alıntılar aşağıda belirtilmiştir:

- 2R(IN): Diğer sosyobilimsel konularda (HD ve NS) insan sağlığı insanların karar vermelerinde önemli bir faktördü. Bununla birlikte bu konuda ahlak insan sağlığından daha önemlidir. Bence prensip olarak bu terapi kullanılmamalı çünkü herkesin bu terapiyi kullanmaya gücü yetmeyecektir. Ayrıca herkesin zeki olmasına gerek yoktur. Bence insanlar arasında bazı farklılıklar olması gerekir. Sonuç olarak, bu terapiye gerek yoktur.
- 3M(AC): Tabiki bu konu ahlakla ilgilidir. Genellikle Türk insanları yaşamlarında bir kez evlenir. Tekrar evlenmek toplumda iyi bir davranış olarak değerlendirilmez. Fakat bu konuda, kazadan sonra anne kendisini çocuğuna adayacaktır ve tekrar evlenmeyecektir. Böylece bu durum ahlaki açıdan toplumda bir probleme neden olmayacaktır.
- 4R(AC): Bence bu terapinin kullanılmaması gerekir çünkü baba ölüdür. Ben ahlaki açıdan düşündüğümde çocuk da ölüdür. Ölü çocuk farklı çevrelerde yaşamışken, klonlanmış çocuk aynı çevreye sahip olmayacaktır. Ayrıca, ölen çocuk babasıyla yaşamışken, klonlanmış çocuk babasına sahip olmayacaktır. Böylece klonlanmış çocuk ölü çocukla aynı haklara sahip olmayacaktır. Sonuç olarak, bu şekilde çocuğa sahip olmak adil değildir. Anne tekrar evlenebilir ve başka bir çocuk sahibi olabilir.
- 39M(AC): Ahlak ve din karar vermemde etkilidir. Bence klonlanmış çocuk kopyadır gerçek değildir. Klonlanmış çocuk kimlik problemlerine sahip olabilir ve bu çocuk gelecekte mutsuz olabilir. Bence bu senaryoda anne egoisttir. Eğer anne klonlamaya izin verirse, onun davranışı ahlaki açıdan doğru olmayacaktır.
- 13R(IC): Bence bu terapi kullanılmamalıdır. Eğer bu terapi kullanılırsa insanlar ayrımcılıkla karşılaşacaklardır. Bazı insanlar bu

terapiyi kullanırken bazı insanlar ise kullanmayacaktır. Böylece, insanlar için eşitlik sağlanamayacaktır. İnsanlar arasında eşitliliğin sağlanamaması sonucunda, ahlaki ve etik problemler ortaya çıkacaktır.

Alıntılar göstermiştir ki hemen hemen tüm sosyobilimsel konular boyunca katılımcıların sahip olmuş oldukları ahlaki perspektif karar vermelerinde önemli bir yere sahiptir.

Kişisel deneyimlerin, sosyal faktörlerin ve ahlaki perspektifin yanısıra teknolojik endişelerin de katılımcıların karar vermelerinde önemli bir yere sahip olduğu aşağıdaki alıntılardan anlaşılmaktadır.

- 1M(HD): Ben gerçekten teknolojinin bu denli gelişmesinden rahatsızım. Bu gelişmelerden korkuyorum. Keşke bilim insanları bu terapiyi bulmamış olsalardı. Bununla birlikte, böyle bir terapinin var olduğu gerçeğini kabul etmeliyiz. Ben kendimi burdaki ailenin yerine koyduğumda, fikirlerim değişiyor.
- 2M(HD): Genel olarak teknolojinin gelişmesinden rahatsızlık duymuyorum. Bununla birlikte teknolojinin doğru yönde kullanılması gerekmektedir. Eğer bu teknoloji doğru yönde kullanılmazsa tehlikeli sonuçlar ortaya çıkabilir.
- 3M(HD): Evet, teknolojik gelişmeler hakkında birçok endişelerim var. Örneğin, bu teknolojik gelişmelerle insan zekasına daha çok müdahele edilebilir.
- 5M(AC): Teknolojik gelişmeler hakkında bazı endişelerim var. İnsanlar teknolojiyi kullandığında birçok dezavantajlar ortaya çıkabilir. Ayrıca teknolojinin kullanım amacıda ayrı bir önem taşımaktadır. Birileri teknolojiyi kullanırken teknolojinin kullanım amacını da göz önünde bulundurmalıdır.
- 6M(AC): Evet teknolojik gelişmeler konusunda bazı endişelerim var. Geçmiş zamanlarda dolly koyunu kopyalandığında bilim adamları hayal kırıklılığına uğradı. Çünkü dolly koyunu öldü. Bugüne kadar gen klonlanmasında ve terapisinde herhangi bir başarıya ulaşıldığını duymadım. Böylece, bu teknolojik gelişmeler tehlikeli olabilir.

Alıntılar göstermiştir ki hemen hemen tüm sosyobilimsel konular boyunca katılımcıların sahip olmuş oldukları teknolojik endişeler karar vermelerinde önemli bir yere sahiptir.

8. Tartışma ve Öneriler

Çalışmanın bulgularına dayanılarak fen öğretmen eğitimi adına iki öneri yapılabilir. Birincisi, sosyobilimsel konular hakkında karar verme fen eğitiminin önemli bir amacı olduğu için, fen öğretmen adaylarının kritik düşünmelerinin geliştirilmesi için sosyobilimsel konular bir araç olarak kullanılmalıdır. Şu anki fen öğretim programı her ne kadar fen-teknoloji-toplum derslerini içerse de sosyobilimsel konularla ilgili bir ders içermemektedir. Genellikle fen-teknoloji-toplum dersleri bu kavramlar arasındaki ilişkinin anlaşılmasını sağlamak için yapılan derslerdir. Bununla birlikte bu dersler ahlaki-etik değerleri, kişisel deneyimleri, argüman geliştirmeyi içermez. Sosyobilimsel yaklaşım daha kapsamlı bir yaklaşım olup tüm bu değişkenleri fen-teknoloji-toplumla entegre eder. Ekborg (2005) fen ve matemetik öğretmen adaylarıyla yaptığı çalışmasında adayların eksik olan alan bilgisinin yanısıra sosyobilimsel konular hakkında iyi bir şekilde kritik düşünme gerçekleştiremeyecekleri tahmininde bulunmuştur. Sonuç olarak, fen öğretmen adaylarının kritik düşünme yeteneklerinin geliştirilmesi öğretmen eğitimleri sırasında olması gereken önemli bir gereklilik halini almıştır. Bu nedenle sosyobilimsel konular fen öğretmen eğitimi programlarına entegre edilmelidir.

İkinci öneri ise kritik düşünme örüntüleri ile ilgilidir. Yapılan bu çalışma göstermiştir ki sosyobilimsel konulara karşı akılcı düşünme örüntüsünün yanısıra duygusal ve sezgisel düşünme örüntüleri de tespit edilmiştir. Geleneksel öğrenme ortamlarında genellikle akılcı düşünmenin

ön planda olduğu bir gerçektir. Fakat, Sadler'ın (2003) görüşüne göre eğer öğrenciler sadece akılcı düşünme örüntüleri bakımından değerlendirilirlerse birçok öğrenci sınıf ortamında düşünme bakımından yalıtılmış olur. Sonuç olarak, fen eğitimcileri ve öğretmenleri öğretim ortamı içinde tüm kritik düşünme örüntülerini göz önüne almalıdır. Aynı zamanda fen eğitimcileri ve öğretmenleri tüm kritik düşünme örüntülerini göz önüne alarak ders planları ve eğitsel aktiviteler hazırlamalıdır.

Bu iki öneriden sonra bu çalışmanın diğer bir amacı olan kritik düşünme niteliği ve örüntüsü arasındaki ilişkinin belirlenmesi hakkında bilgi vermek yararlı olacaktır. Gen terapisi konularına karşı kritik düşünme örüntüsü ve niteliği arasındaki ilişki bakımında iki tane önemli bulgudan söz edilebilir. Birincisi, katılımcıların kritik düşünme niteliği daha az gelişmişten daha çok gelişmişe doğru değişirken katılımcıların kritik düşünme örüntüsü sezgisel veya duygusal örüntüden akılcı örüntüye doğru bir değişim göstermiştir. İkincisi, sezgisel kritik düşünmeye sahip olan katılımcılar genellikle gelişmiş düzeyde kritik düşünme niteliği gösterememişlerdir. Bu bulguları göz önüne alarak, sezgisel kritik düşünme örüntüsünün az gelişmiş kritik düşünme niteliğiyle ilişkili olduğunu söyleyebiliriz. Bunun yanında akılcı kritik düşünme örüntüsününde iyi gelişmiş kritik düşünme niteliğiyle ilişkili olduğunu söyleyebiliriz.

Klonlama ile ilgili sosyobilimsel konularda ise sadece bir tane bulgu ortaya çıkmıştır. Gen terapisi konularından farklı olarak klonlama konularında katılımcıların çoğu sezgisel ve duygusal kritik düşünme örüntüleri geliştirmişlerdir. Gelişmiş ya da az gelişmiş kritik düşünme niteliğine sahip olan tüm katılımcılar klonlama konularına sezgisel ve duygusal bir şekilde yaklaşmışlardır. Bu durumun ortaya çıkması klonlamayla ilgili sosyobilimsel konuların içeriğinden kaynaklanmış

olabilir. Bu sosyobilimsel konularda içerik genellikle insan klonlanmasıyla ilgiliydi. İnsan klonlanması çoğu katılımcı için dini inançlar açısından bir engel oluşturmuş olabilir. Dolayısıyla çoğu katılımcı bu nedenden dolayı insan klonlanmasına olumsuz bir şekilde yaklaşmış olabilir.

Küresel ısınma konusunda araştırmacı iki sonuca ulaşmıştır. Birincisi sezgisel kritik düşünme yeteneğiyle ilgilidir. Katılımcılar az ya da çok gelişmiş kritik düşünme niteliğine sahip olsalar da küresel ısınma konusuna sezgisel bir şekilde yaklaşmışlardır. Bu konu genel olarak Amerika'nın Kyoto Protokoluna katılıp katılmaması ile ilgiliydi. Bu çalışma için öğrencilerden bilgi toplanıldığı sırada değişik politik nedenlerden dolayı Türkiyede ki çoğu kişi Amerikaya karşı olumsuz bir önyargıya sahipti. Bu önyargı katılımcıları da etkilediği için çoğu katılımcı bu konuya sezgisel bir şekilde yaklaşmış olabilir.

Sonuç olarak kritik düşünme niteliğiyle örüntüsü arasındaki ilişkinin sosyobilimsel konunun içeriğine göre değişebileceği tespit edilmiştir. Bu sonuçlar kritik düşünme örüntüsü ile niteliği arasındaki ilişkinin doğasının ve yönünün sosyobilimsel konunun içeriğine bağlı olduğunu göstermiştir. Aynı zamanda bu sonuç sosyobilimsel literatürde bu açıdan önemli bir boşluğu doldurmuştur.

Bu çalışma içerisinde diğer bir önemli bulguda kritik düşünme nitelikleri arasında en çok gözlemlenen niteliğin ikinci tip nitelik olmasıdır. Bu tip nitelik iddia ve bu iddiayı destekleyen argümanlardan oluşmaktadır. Aynı zamanda yine çalışma sonuçlarına göre katılımcıları istenilen düzeyde karşıt iddia ve bunun yanısıra karşıt iddia karşısında kendi iddialarını savunamadıkları tespit edilmiştir. Diğer bir deyişle gelişmiş düzeyde kritik düşünme niteliği gözlenememiştir. Bu sonuç fen öğretmen adaylarının kritik

düşünme niteliklerini üniversite eğitimleri boyunca geliştirememiş olmalarından kaynaklanabilir. Türk eğitim sisteminde ilköğretimden başlayarak üniversite yaşamının sonuna kadar öğrenciler argüman geliştirmeyi içeren bir dersle karşılaşmamaktadırlar. Bunun yanısıra Osborne et al. (2004) eğer argüman geliştirmenin açık bir şekilde öğretilmesi sağlanırsa ancak o zaman argüman geliştirmede bir ilerlemenin sağlanacağını iddia etmiştir. Bu noktada sosyobilimsel konuların kritik düşünmeyi ilerletmek için fen eğitim programlarına entegre edilmesi önerilebilir. Sosyobilimsel konular öğrencilerin argüman geliştirmeyle karşılaşacağı bir ortam hazırlar. Öğrenciler sosyobilimsel konularla karşılaştıklarında argümanlar geliştirirler. Böylece fen eğitiminin en büyük amaçlarından biri olan sosyobilimsel konular hakkında gelişmiş düzeyde argümanlar geliştirme başarıyla gerçekleştirilebilir.

APPENDIX F

CURRICULUM VITAE

PERSONAL INFORMATION

Surname, Name: Topçu, Mustafa Sami
Nationality: Turkish (TC)
Date and Place of Birth: 6 November 1981 , Sivas
Marital Status: Married
Phone: +90 312 210 40 59
email: mstopcu@metu.edu.tr

EDUCATION

Degree	Institution	Year of Graduation
PhD	METU, Ankara	2008
MS	9 Eylül University, İzmir	2004
BS	19 Mayıs University, Amasya	2002

WORK EXPERIENCE

Year	Place	Enrollment
2005- Present	METU Department of Elementary Education	Research Assistant
2002-2004	Kaynaklar Elementary School , İzmir	Science Teacher

FOREIGN LANGUAGES

Advanced English

PUBLICATIONS

1. Yılmaz-Tuzun, Ö., & Topcu, M. S. (2008). Relationships Among Preservice Science Teachers' Epistemological Beliefs, Epistemological World Wiews, and Self-Efficacy Beliefs, *International Journal of Science Education, 30*(1), 65-85.

HOBBIES

TableTennis, Computer Technologies, Movies, Reading