PRESERVICE SCIENCE TEACHERS' SSI TEACHING SELF-EFFICACY BELIEFS AND THEIR RELATIONS TO KNOWLEDGE, RISK AND BENEFIT PERCEPTIONS, AND PERSONAL EPISTEMOLOGICAL BELIEFS

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ABSTRACT

PRESERVICE SCIENCE TEACHERS' SSI TEACHING SELF-EFFICACY BELIEFS AND THEIR RELATIONS TO KNOWLEDGE, RISK AND BENEFIT PERCEPTIONS, AND PERSONAL EPISTEMOLOGICAL BELIEFS

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This study aimed to examine the nature of preservice science teachers' (PSTs) SSI teaching self-efficacy beliefs and their relation to personal epistemological beliefs, GM foods risk-benefit perceptions, and GM foods knowledge. To this end, this study proposed and tested a path model. In this mixed-design research study, first, the variables were assessed through four main quantitative instruments. The proposed model involving the four variables was tested by utilizing path analysis. Then, to gain deeper understandings about GM foods teaching self-efficacy beliefs and the observed paths between GM foods teaching self-efficacy beliefs and each of the other three variables in the model, qualitative data was collected through an interview protocol.

The quantitative results revealed that the PSTs have moderately high GM foods teaching self-efficacy beliefs, moderately sophisticated personal epistemological beliefs, moderately high GM foods risk perception, and the level of their GM foods benefit perception and GM foods knowledge was in the mid-range. The path analysis showed that PSTs' personal epistemological beliefs, GM foods risk perception, and GM foods knowledge were related to their GM foods teaching self-efficacy beliefs. In addition, it was found that GM Foods risk and benefit perceptions were correlated to GM Foods knowledge and personal epistemological beliefs, and GM Foods knowledge was correlated to personal epistemological beliefs. The qualitative findings supported the quantitative results and were very helpful to explain the observed relationships in the model. Besides, the qualitative findings revealed detailed information regarding PSTs' GM foods teaching self-efficacy beliefs. It was revealed, for instance, that although PSTs considered themselves as efficacious to teach SSI, they have many misunderstandings regarding nature of SSI and SSI teaching.

Keywords: Socioscientific Issues, Teaching self-efficacy beliefs, Epistemological Beliefs, GM foods, Risk and benefit perceptions

ÖZ

FEN BİLGİSİ ÖĞRETMEN ADAYLARININ SOSYOBİLİMSEL KONULARIN ÖĞRETİMİ ÖZ-YETERLİK İNANÇLARI VE BU İNANÇLARIN BİLGİ, RİSK VE FAYDA ALGISI VE KİŞİSEL EPİSTEMOLOJİK İNANÇLAR İLE İLİŞKİSİ

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Bu çalışmanın amacı fen bilgisi öğretmen adaylarının sosyobilimsel konuların öğretimine yönelik öz-yeterlik inançlarının doğasını incelemek ve bu inançların kişisel epistemolojik inançlar, GDO'lu gıdalar risk ve fayda algısı ve GDO'lu gıdalar konusundaki bilgi düzeyleri ile olan ilişkisini araştırmaktır. Bu amaçla, bu çalışmada bir yol modeli öne sürülmüş ve test edilmiştir. Karma araştırma deseninin kullanıldığı bu çalışmada, öncelikle değişkenler dört ana ölçme aracı ile ölçülmüştür. Öne sürülen ve dört değişkenden oluşan model yol analizi kullanılarak test edilmiştir. Sonrasında, GDO'lu gıdaların öğretimine yönelik öz-yeterlik inançları ve model analizi sonucu ortaya çıkan GDO'lu gıdaların öğretimine yönelik öz-yeterlik inançları ve diğer üç değişken arasındaki ilişki hakkında daha detaylı bilgiler elde etmek amacıyla görüşme protokolü kullanılarak nitel veri toplanmıştır.

Nicel analiz sonuçlarına göre fen bilgisi öğretmen adaylarının GDO'lu gıdalar konusunun öğretimine yönelik inançlarının kısmen yüksek düzeyde, kişisel epistemolojik inançlarının kısmen sofistike, GDO'lu gıdalar risk algılarının kısmen yüksek ve GDO'lu gıdalar fayda algıları ile GDO'lu gıdalar bilgi düzeyinin orta düzeyde olduğu ortaya çıkmıştır. Yol analizi sonuçlarına göre ise, fen bilgisi öğretmen adaylarının kişisel epistemolojik inançları, GDO'lu gıdalar risk algıları ve GDO'lu gıdalar bilgi düzeyleri onların GDO'lu gıdalar konusunun öğretimine yönelik inançları ile ilişkilidir. Ayrıca, GDO'lu gıdalar risk ve fayda algısının GDO'lu gıdalar bilgi düzeyi ve kişisel epistemolojik inançlar ile ilişkili olduğu; GDO'lu gıdalar bilgi düzeyinin ise kişisel epistemolojik inançlar ile ilişkili olduğu ortaya çıkmıştır. Nitel analiz sonuçları nicel analiz sonuçlarını desteklemiştir ve öne sürülen modelde ortaya çıkan ilişkileri açıklamada yardımcı olmuştur. Bunun yanı sıra, nitel analiz sonuçları fen bilgisi öğretmen adaylarının GDO'lu gıdalar konusunun öğretimine yönelik inançlarının doğasına yönelik detaylı bilgiler ortaya çıkarmıştır. Örneğin nitel analiz sonuçları ortaya çıkarmıştır ki fen bilgisi öğretmen adayları sosyobilimsel konuları öğretmek konusunda yüksek bir inanca sahip olduklarını düşünmelerine rağmen sosyobilimsel konuların doğası ve öğretimine yönelik birçok yanlış ve eksik bilgiye sahiptirler.

Anahtar kelimeler: Sosyobilimsel Konular, Öğretim öz-yeterlik inancı, Epistemolojik İnançlar, GDO'lu gıdalar, Risk ve fayda algısı

To Women

all over the world,

who has no access to education

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AAAS	American Association for the Advancement of Science
AGFI	Adjusted Goodness of Fit
AMOS	Analysis of Moment Structures
ARG	Fostering Argumentation and Decision Making on GM Foods
BEN	Benefit Perception
CFA	Confirmatory Factor Analysis
CFI	Comparative Fit Index
EBI	Epistemological Beliefs Inventory
EFA	Exploratory Factor Analysis
GFI	Goodness of Fit
GIS	General Instructional Strategies of GM Foods Teaching,
GM	Genetically Modified
GMO	Genetically Modified Organisms
IA	Innate Ability
KNOW	Knowledge
MoNE	Ministry of National Education
NOS	Nature of Science
NSTA	National Science Teachers Association
OE	GM Foods Teaching Outcome Expectancy

OECD	Organization for Economic Cooperation and Development
PST	Preservice Science Teacher
QLCK	Quick Learning and Certain Knowledge
RISK	Risk Perception
RMR	Root Mean Square Residuals
RMSEA	Root Mean Square Error of Approximation
SEM	Structural Equation Modeling
SEQ	Schommer's Epistemological Questionnaire
SK	Simple Knowledge
SRMR	Standardized Root Mean Square Residuals
STEBI	Science Teaching Efficacy Belief Instrument
SSI	Socioscientific issues
STS	Science, Technology and Society
STSE	Science, Technology, Society and Environment

CHAPTER I

INTRODUCTION

Social issues that are related to science and technology have been increasingly appealing public interest, thereby the idea of incorporating science-related social issues in school curricula has been considered as a vital need for science education (Christensen & Fensham, 2012). For this purpose, there have been several curriculum movements in the past that aimed to embed social issues into scientific contexts (Sadler & Dawson, 2012). Science-Technology-Society (STS) curriculum-based education is the most known of these movements which has been started to be implemented by the late 1970s. STS movement aimed to focus on students' understanding of the interaction among science, technology, and society (Bybee, 1985; Yager, 1996; Zeidler, Sadler, Simmons, & Howes, 2005) and use of decision making skills to make decisions about society-related issues including science and technology aspects (Yang & Anderson, 2003). However, due to the absence of an emphasis on learners' psychological and epistemological growth and their moral and ethical development, STS has been criticized (e.g. Zeidler et al., 2005). STS movement, then, evolved into a more issues-driven curriculum which is named science-technology-society-environment education (STSE) (Hodson, 1994; Pedretti, 1997). Although STSE curriculum represented an improvement over STS curriculum, it still gave little attention to moral and ethical development of students. Besides, it was also criticized for neglecting the discourse, argumentation, NOS considerations, and epistemological connections within the issues themselves and lack of a well-developed theoretical basis.

In contrast to previous efforts for the contextualization of science content through the exploration of socially relevant issues, socioscientific issues (SSI) movement has emerged as a new framework. SSI movement seeks to enable students to discuss moral ethical issues including scientific and social point of views which may sometimes conflict students' own beliefs (Zeidler, Sadler, Applebaum, & Callahan, 2009). In addition to encompassing moral, ethical and epistemological aspects of science, another distinctive feature of SSI movement is that, it is based upon a theoretical framework derived from developmental psychology, sociology, and philosophy such as sociocultural theories and situated learning perspectives (Sadler & Dawson, 2012).

SSI are those that are 'based on scientific concepts or problems, controversial in nature, discussed in public outlets and frequently subject to political and social influences (Sadler & Zeidler, 2005, p. 113). These science-related social issues are ill-structured and open-ended problems which do not possess clear-cut solutions (Sadler, 2004; Sadler & Zeidler, 2005); and individuals may easily confront these issues in their daily lives such as genetic engineering, environmental issues, nuclear power usage, and effects of mobile phone usage. Researchers have argued that SSI should be a part of science instructions for several reasons. First, there has been reported that majority of the learners perceive science and science education as irrelevant for both themselves and for the society they live in (Dillon, 2009; Gilbert, 2006; Holbrook, 2008), therefore, there is a need to make science education more relevant to students' lives. To this end, SSI based education, which encourages students to construct scientific knowledge as a result of social interaction and discourse, will help to promote relevance of science education with society (Zeidler et al., 2005). Also, engaging with controversial societal issues has been considered to foster citizenship education (Sadler, Barab, & Scott, 2007) and promote public understanding of science (Kolsto, 2001). That is, since dealing with SSI in science classrooms helps students to bridge science and their lived experiences (Zeidler et al., 2005), SSI-based science education would prepare students for active participation in modern democracies (Sadler et al., 2007). Besides, integrating SSI in science education provide students with the understanding of how science and technology interacts with each other and the way ethical and moral aspects are embedded in scientific issues (Zeidler et al., 2005). Given that citizens of societies will need to be knowledgeable about the ways in which science and technology are impacted by, and impacted upon, the physical and sociopolitical environment (Hodson, 2003), educating students through SSI-based science education is vital to improve public understanding of science. In addition to these, learner practices in the context of socioscientific controversy are considered to increase students' interest and motivation to science learning (Dori, Tal, & Tsaushu, 2003; Lee & Erdogan, 2007; Yager, Lim, & Yager, 2006). Moreover, research have revealed that SSI based education may enhance students understanding of NOS (Khishfe & Lederman, 2006; Walker & Zeidler, 2007), promote the development of sophisticated scientific ideas (Venville & Dawson, 2010), and support students to develop argumentation skills as they discuss complexity of an issue from multiple perspectives, and generate claims and ideas (Grace, 2009; Pedretti, 1999; Zohar & Nemet, 2002). SSI advocates proposed that all these potential gainings of SSI-based science education improve future generations' informed decision making skills, which, in turn, develop their scientific literacy (Sadler, Amirshokoohi, Kazempour, & Allspaw, 2006; Zeidler et al. 2005).

Science teachers, nonetheless, are far from implementing these controversial issues on a regular basis (Lee, Abd-El-Khalick, & Choi, 2006; Sadler et al. 2006). Although they embrace the idea of incorporating SSI into science education (Bryce & Gray, 2004; Cross & Price, 1996), implementing controversial issues is still rare in science classrooms (Zeidler & Keefer, 2003). A number of factors may impede science teachers' use of SSI. The mostly reported factors were; the problems in dealing with controversial SSI, that is, the inconsistency between the idea of discussing value-laden controversial issues and traditional value-free science education (Cross & Price, 1996); the fact that science teachers still possess a traditional view of science (Hansen & Olson, 1996); insufficient content and pedagogical knowledge (Kilinc et al., 2013); being under the pressure of high stakes examinations and families (Kilinc et al., 2013), lack of teaching materials (Lee et al., 2006); and science teachers' teaching self-efficacy beliefs (Lee et al., 2006).

It has been argued that successful implementation of reform efforts such as the integration of SSI in science education depends largely on teacher beliefs and intentions (Bybee, 1993; Lumpe, Haney, & Czerniak, 2000). Evidence suggests that in most cases, teacher beliefs may impede implementation of reform-based curricula (Beck, Czerniak, & Lumpe, 2000; Kazempour, 2009). According to Ramey-Gassert and Shroyer (1992), enhancing science teachers' self-efficacy beliefs may be helpful for them to use new topics, including SSI, in their classrooms. Similarly, Tobin, Tippins, and Gallard (1994) asserted that:

> Future research should seek to enhance our understanding of the relationship between beliefs and science education reform. Many of the reform attempts of the past have ignored the role teacher beliefs play in sustaining the status quo. The studies reviewed suggest that teacher beliefs are a critical ingredient in the factors that determine what happens in schools, (p. 64).

Teachers' self-efficacy beliefs have been considered as one of the most influential factors for the implementation of effective teaching (Knoblauch & Woolfolk-Hoy, 2008) and it was apparent from several studies that teachers' self-efficacy beliefs to teach science influence the way they teach (e.g. Ramey-Gassert & Shroyer, 1992) such as the desire to use different materials and approaches, their willingness to improve their teaching, and implementation of various teaching methods (Weiner, 2003). Having its roots in the social learning theory developed by Bandura (1977), self-efficacy, which is a situation-specific construct, is "people's judgements of their capabilities to organize and execute courses of action required to attain designed types of performances" (Bandura, 1986, p. 391). Bandura asserted that behavior is based upon individuals' believes in their ability to perform this specific behavior (self-efficacy) and their expectancy of certain behaviors to produce desirable outcomes (outcome expectancy) (1977). Accordingly, teacher efficacy is defined as "teachers' belief in his or her own capability to organize and execute courses of action required to successfully accomplish a specific teaching task in a particular context" (Tschannen-Moran, Woolfolk-Hoy & Hoy, 1998, p. 233). If the two components of self-efficacy are defined in terms of teachers, self-efficacy has generally referred to the belief that one's teaching ability is related to positive changes in students' learning and behavior, and outcome expectancy is the belief that student learning can be influenced by effective teaching (Riggs & Enochs, 1990).

Given the fact that SSI teaching should be enhanced in science classrooms and teacher self-efficacy beliefs play a major role to accomplish this goal, in the present study the nature of preservice science teachers' (PSTs) SSI teaching self-efficacy beliefs was investigated. In light of an extensive literature review, it was assumed that personal epistemological beliefs, knowledge and risk-benefit perceptions might be related to SSI teaching self-efficacy beliefs. It was also assumed that personal epistemological beliefs, knowledge and risk-benefit perceptions could be related to each other in that personal epistemological beliefs might be related to risk-benefit perceptions and knowledge; and knowledge might be related to risk-benefit perceptions. Based on all these assumed relationships a model was proposed to be tested. To further analyze and gain deeper understandings about the observed paths in the model, qualitative data was used. To this end, the participants were asked detailed questions about their GM foods teaching self-efficacy beliefs and the related variables. To make the study more feasible, in the qualitative part of the study, the researcher focused only on the relationships among GM foods teaching self-efficacy beliefs and its relations to the variables personal epistemological beliefs, GM foods knowledge, and GM foods risk-benefit perceptions.

In the present study, the issue of genetically modified (GM) foods was chosen as SSI context. The reason of choosing GM foods is twofold: First, GM foods and other genetic engineering issues are among the most debatable issues in both Turkey and in the world. There has been an ongoing debate on GM foods about its consequences for the nature, human beings and global economy; and whether it should be used or not. In Turkey, a recent legislation has been recently accepted about the use of genetically modified corns and soybeans for animal livestock (Bostan & Gün, 2013; Haspolat, 2012). These kinds of society-related scientific issues are believed to be integrated in science education programs so that future generations have the ability to make informed decision making. Therefore, GM foods, which is still a hot issue in Turkey was considered as a suitable SSI context for the present study. Second, in 2013, Turkish national science curriculum has undergone several revisions and one of them was the efforts to integrate SSI into science education (Ministry of National Education

[MoNE], 2013). As part of these revisions, science textbooks also started to be refined gradually for each grade level. So far, 5th, 6th and 7th grade science textbooks have been refined. Some socioscientific issues such as the use of food additives or the use of naphthalene as a moth repellent at home were utilized as contexts for student discussion. Parallel to these changes, SSI has started to be included in science teacher education courses such as STS (science-technology-society), methods of science teaching, and science teaching practicum in universities. This being the case, preservice science teachers have been becoming familiar with SSI, especially the ones presented in recent middle school science textbooks, such as GM foods. Therefore, the issue of GM foods was considered to be a suitable and relevant context for participants to discuss about. More specifically, the participants' teaching self-efficacy beliefs, risk-benefit perceptions, and knowledge were explored in the context of GM foods through quantitative and qualitative instruments. In addition, the proposed model involved personal epistemological beliefs variable. In the GM foods teaching self-efficacy beliefs instrument, PSTs' efficacy beliefs considering GM foods teaching were investigated. In addition, GM foods risk-benefit perceptions scale comprised of items related to potential risks and benefits of GM foods for human health, environment, economy, and society in general. Finally, the participants' knowledge about GM foods was explored by GM foods knowledge scale.

1.1 Purpose of the Study and Research Questions

In the present study relationships among PSTs' GM foods teaching self efficacy beliefs, personal epistemological beliefs, GM foods risk-benefit perceptions, and GM foods knowledge were investigated. Specifically, the study addresses the following research questions:

1. What are preservice science teachers' GM foods teaching self efficacy beliefs, personal epistemological beliefs, GM foods knowledge and GM foods risk-benefit perceptions?

2. What is the direct relationship among PSTs' GM foods teaching self efficacy beliefs, and their personal epistemological beliefs, GM foods risk-benefit perception, and GM foods knowledge respectively?

3. What is the direct relationship between PSTs' personal epistemological beliefs, GM foods risk-benefit perceptions, and GM foods knowledge?

4. What factors explain the observed relationships among GM foods teaching self-efficacy beliefs and each of the variables in the path model obtained in quantitative part of the study?

1.2 Overview of the Proposed Model

The model contains four main variables, namely, GM foods teaching self-efficacy beliefs, personal epistemological beliefs, GM foods risk-benefit perceptions, and GM foods knowledge. Teaching self-efficacy beliefs and personal epistemological beliefs are represented by a number of subcomponents in the model. GM foods teaching self-efficacy beliefs have three dimensions; general instructional strategies of GM foods teaching, GM foods teaching outcome expectancy, and fostering argumentation and decision making on GM foods. On the other hand, personal epistemological beliefs have five dimensions; quick learning, innate ability, simple knowledge, certain knowledge, and omniscient authority.

The present model specifically proposed that dimensions of personal epistemological beliefs (quick learning, innate ability, simple knowledge, certain knowledge, and omniscient authority), GM foods risk-benefit perceptions, and GM foods knowledge are directly linked to PSTs' teaching self-efficacy beliefs about general instructional strategies of GM foods teaching, GM foods teaching outcome expectancy, and fostering argumentation and decision making on GM foods (see Figure 1.2).

Besides, it was proposed that dimensions of personal epistemological beliefs (quick learning, innate ability, simple knowledge, certain knowledge, and omniscient authority) are directly linked to PSTs' GM foods knowledge, and GM foods risk-benefit perceptions. Finally, PSTs' GM foods knowledge was directly linked to their GM foods risk-benefit perceptions (see Figure 1.3).

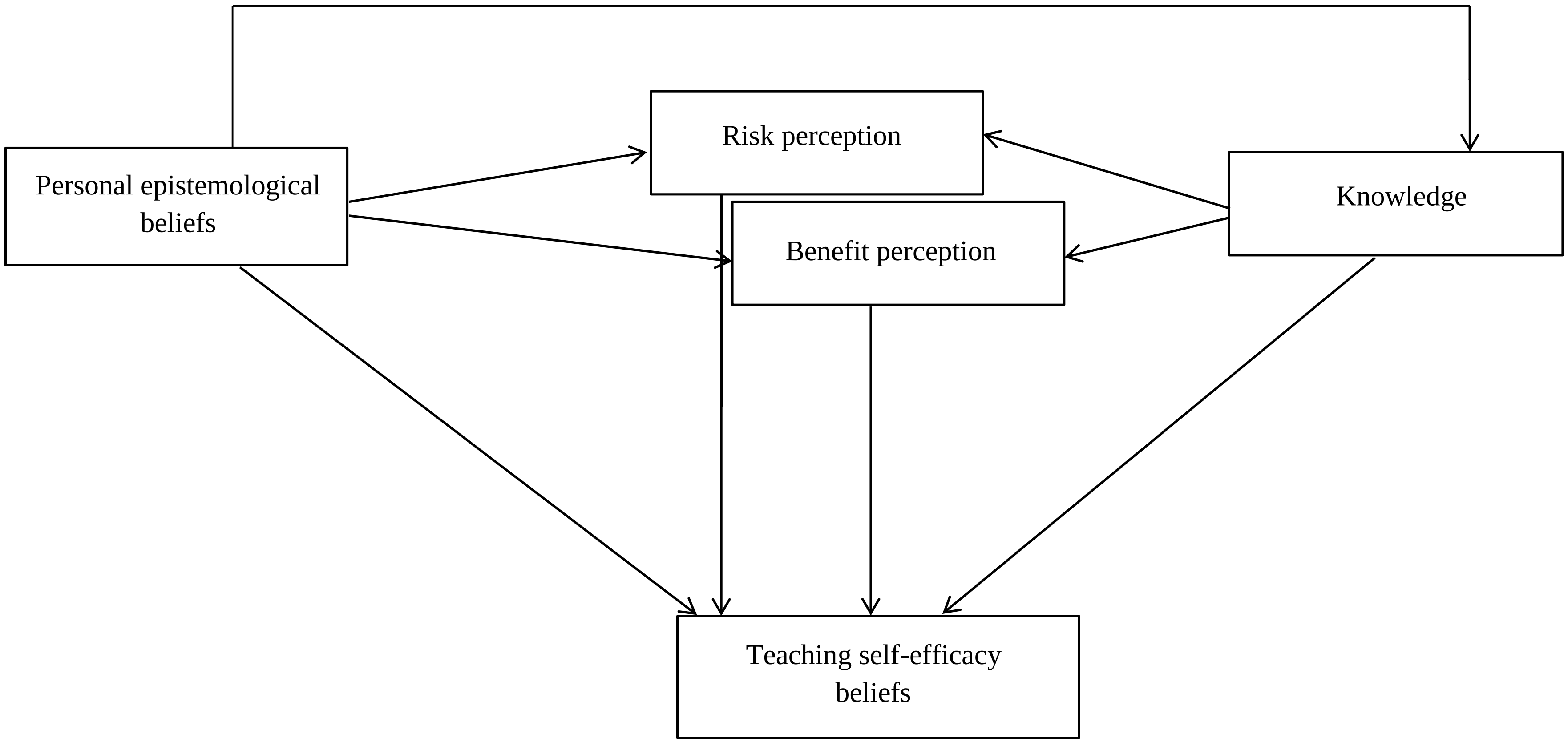

Figure 1.1 Model of the proposed relationships between the variables

1.3 Rationale for the Proposed Relations in the Model

1.3.1. GM foods teaching self-efficacy beliefs and related factors

Evidence suggested that teachers' self-efficacy beliefs are influenced by some internal (e.g. personal philosophy of teaching, confidence about science content and pedagogical knowledge) and external variables (e.g. the school workplace environment) (Ramey-Gassert, 1993). Similar to this idea, Kagan (1992) argued that teacher beliefs about educational content influence their beliefs about pedagogy of this content. For instance, teachers' content knowledge is considered as one of the most influential source of their teaching self-efficacy beliefs (Palmer, 2006). Similarly, epistemological beliefs affect teachers' orientation toward science teaching (Tsai, 2002). Some other variables have also been reported in the literature to be related to the content and considered to affect teaching of this content. Kilinc et al. (2013) described this by asserting that teachers extend their personal beliefs about content (personal identity) to their beliefs about the pedagogy of this content (professional identity). In light of these assertions, the present study proposes a model involving variables that might be related to teachers' GM foods teaching self-efficacy beliefs. Firstly, it was proposed in the model that PSTs' GM foods teaching self-efficacy beliefs are positively related to their personal epistemological beliefs, GM foods knowledge, and GM foods risk-benefit perceptions.

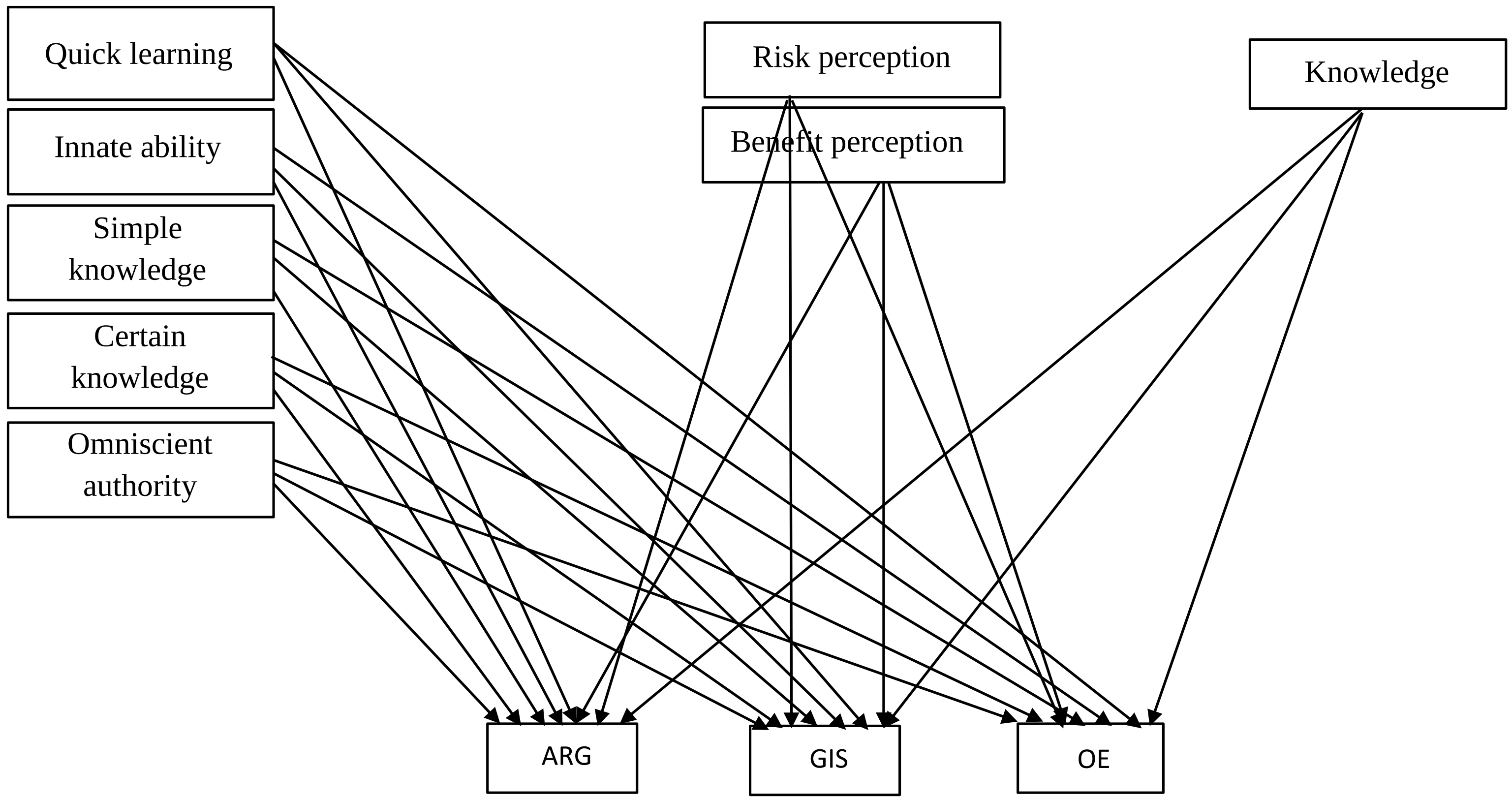

Figure 1.2 Model of the proposed relationships among GM foods teaching self-efficacy beliefs dimensions and personal epistemological beliefs dimensions, risk-benefit perceptions, and knowledge

Personal epistemological beliefs which refer to individuals' beliefs about knowledge and ways of knowing (Hofer & Pintrich, 1997) has been considered as an influential factor to teachers' instructional orientations and teaching competencies (Brownlee, 2003; Chan & Elliott, 2004; Cheng, Chan, Tang, & Cheng, 2009; Hashweh, 1996; Olafson & Shraw, 2006; Sosu & Gray, 2012). To illustrate, Tanase and Wang (2010) suggested that epistemological beliefs had significant impact on teaching competence. The researchers argued that changes in preservice teachers' beliefs resulted in corresponding changes in their teaching practices (Tanase & Wang, 2010). Similarly, according to Hashweh (1996), teachers with sophisticated epistemological beliefs are more opening up to students' alternative conceptions, use teaching strategies that are better integrated and placing more emphasis on student discussion, interaction and problem solving than those holding naive perspectives. Although related literature revealed interrelationships among personal epistemological beliefs and teaching self-efficacy beliefs, there are a few studies exploring the relationships between personal epistemological beliefs and teaching self-efficacy beliefs in the context of SSI. The present study asserts that teachers' personal epistemological beliefs might be related to their SSI teaching self-efficacy beliefs.

Given that personal epistemological beliefs are the beliefs about nature of knowledge and learning, teachers' beliefs about what constitutes the knowledge and how individuals learn are likely in relation to the ways they feel efficacious to teach scientific topics. Advocating this idea, Yilmaz-Tuzun and Topcu (2008) found that PSTs' epistemological beliefs, epistemological worldviews and self-efficacy beliefs to teach science were related. The authors reported that the innate ability dimension of epistemological beliefs was significantly contributed to PSTs self-efficacy beliefs to teach science. The relation between personal epistemological beliefs and teaching efficacy beliefs becomes more apparent when considered in the context of SSI teaching. SSI teaching requires classroom environments unlike to traditional classroom environments. For instance, SSI teaching necessitates using student-centered teaching that gives priority to students' needs and interactions, utilizing argumentation practices that give students chance to share their multiple perspectives, and implementing socially based daily life issues to make science more relevant to students' lives. It is therefore, reasonable to propose that having strong SSI teaching self-efficacy beliefs requires sophisticated epistemological beliefs. For example, we believe that, if a teacher holds less sophisticated epistemological beliefs on certainty of knowledge, s/he has low self-efficacy to teach SSI because by its nature, SSI are subject to ongoing inquiry (Sadler, et al., 2007). Therefore, to feel efficacious to teach SSI, teachers should advocate the idea that scientific knowledge is not certain but subject to change in time. Similarly, if a teacher believes that knowledge is handed down by authority rather than derived from reasons, s/he likely to has low SSI teaching self-efficacy; because solving SSI includes investigating multiple ideas, perspectives, and interest rather than only accepting what is dictated by the authority. It is also important to note here that the present study assumes personal epistemological beliefs to be domain-general. That is, epistemological beliefs are considered to be similar across domains (Schommer & Walker, 1995). In contrast to this view, researchers advocating domain-specificity of epistemological beliefs propose that individuals may hold differing beliefs regarding certain domains of knowledge (e.g. Buehl, Alexander, & Murphy, 2002; Stathopoulou & Vosniadou, 2007). Although the literature on personal epistemological beliefs has not come to a concensus on whether epistemological beliefs are domain-specific or domain-general, there are research studies which revealed that personal epistemological beliefs can be both domain-general and domain-specific concurrently (e.g. Buehl & Alexander, 2001; Kienhues, Bromme, & Stahl, 2008; Schommer-Aikins, 2002). Besides, in the present study, rather than examining the participants' beliefs on a specific domain, the aim was to measure general beliefs of epistemology. Considering all these, in this study, while assessing PSTs' epistemological beliefs, instead of using an epistemological beliefs scale which developed specifically on GM foods we preferred to utilize an instrument that measures general personal epistemological beliefs.

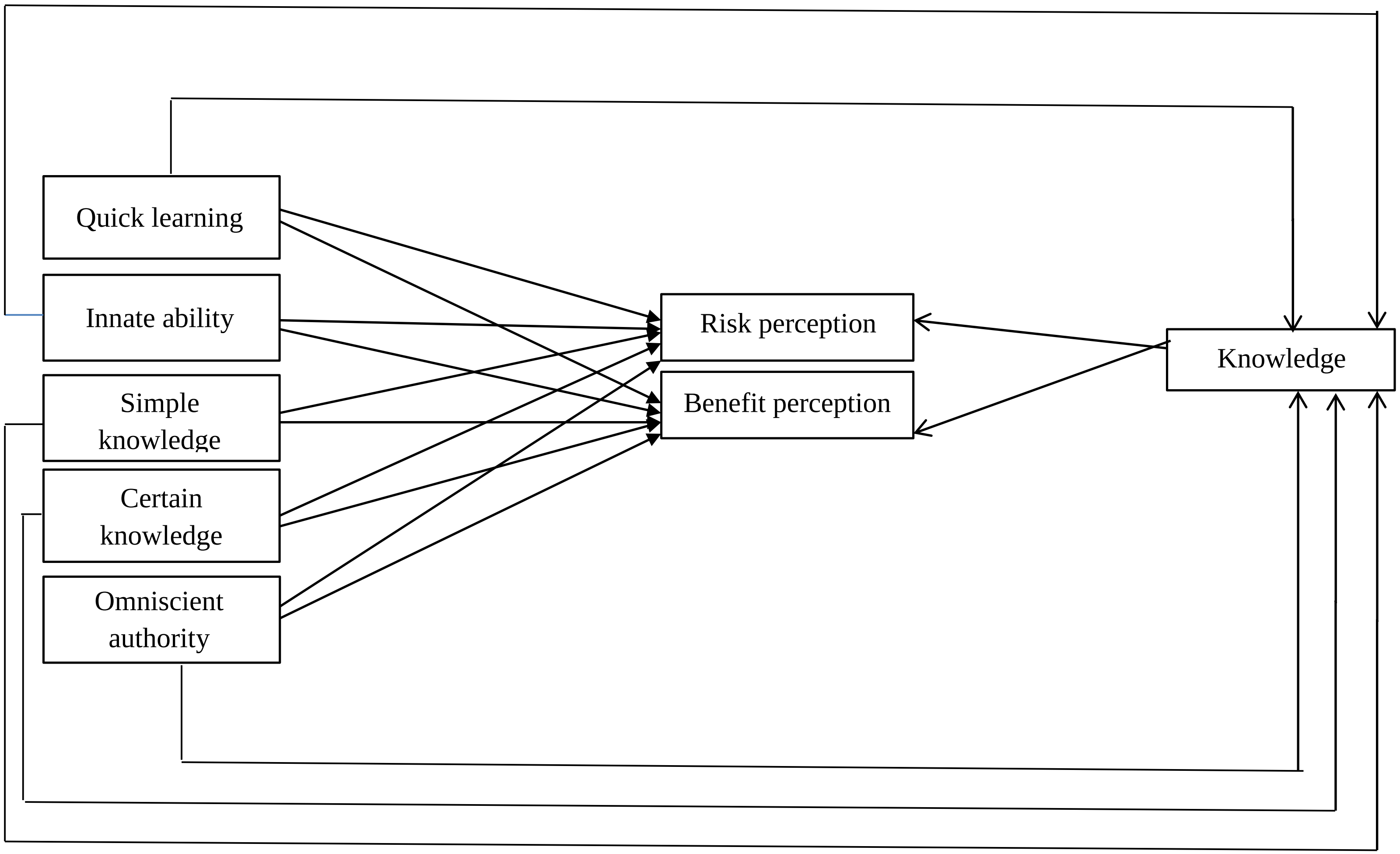

Figure 1.3 Model of the proposed relationships among personal epistemological beliefs dimensions, GM foods risk-benefit perceptions, and GM foods knowledge

Knowledge about the content is the other variable that is proposed to be in relation to PSTs' GM foods teaching self-efficacy beliefs. In this study, knowledge refers to PSTs' knowledge about GM foods. More specifically, this variable indicates PSTs' knowledge about gene technology applications, potential consequences of GM food production, and legislative regulations about GM foods usage and production (Frewer, Howard, & Shepherd, 1997; Verdurme & Viaene, 2003). Literature has provided evidence that content knowledge is one of the crucial sources of teachers' self-efficacy beliefs to teach (Bleicher & Lindgren, 2005; Schoon & Boone, 1998; Swars & Dooley, 2010; Palmer, 2006; Swackhamer, Koellner, Basile, & Kimbrough, 2009). For instance, Palmer (2006) explored the sources of teaching efficacy beliefs in a science methods course and argued that content mastery is one of the sources of efficacy beliefs in addition to enactive mastery experiences, vicarious experiences, verbal persuasion, and physiological/affective states proposed by Bandura (1997). Similarly, Swachamer et al. (2009) investigated whether teachers' teaching self-efficacy beliefs increase with having better content knowledge in a 5-year long research study. Results of the study revealed that as the number of content courses taken by teachers had increased, their outcome expectancy beliefs also increased. However, taking more content courses was not related to increased personal science teaching self-efficacy beliefs. In light of the previous research about the relationships between teacher knowledge and teaching self-efficacy beliefs, we believe that it is fruitful to explore whether knowledge about GM foods influences GM foods teaching self-efficacy beliefs. Given that SSI are complex and embrace multiple perspectives, teachers need to develop thorough understandings about content to implement these controversial issues in the classroom (Day & Bryce, 2011). To illustrate, being knowledgeable about gene technology applications, risky and beneficial aspects of GM foods, and the policies taken to regulate GM foods production and usage may provide teachers with the ability to lead discussions better, which in turn may encourage science teachers to feel more efficacious about teaching GM foods. Parallel to this idea, the model in this study proposes that as PSTs have increased GM foods knowledge they will likely to have stronger GM foods teaching self-efficacy beliefs.

The final variable that is proposed to be in relation to PSTs' GM foods teaching self-efficacy beliefs was GM foods risk-benefit perceptions. While there has not been a common definition for the term risk in the literature, in most contexts, it refers to "the possibility of unwanted events" (Rohrmann & Renn, 2000, p. 14). Perceived risks, which is a phrase used most of the time interchangeably with the phrase risk, refer to people's "judgments and evaluations of hazards they (or their facilities, or the environment) are or might be exposed to (Rohrmann & Renn, 2000, p. 14)".

Given the nature of controversial issues, risk perceptions are crucial to understand SSI (Christensen, 2009; Kilinc, Boyes, & Stanisstreet, 2013). Although very limited research has been conducted on the relationship between teaching self-efficacy and risk perception, it was revealed that like teacher beliefs, risk perceptions about an issue are very likely to reflect on teachers' choices and pedagogical practices (Kagan, 1992; Gardner & Jones, 2011). According to Kilinc et al. (2013), teachers' beliefs about the risks of GM foods which they called risk perceptions about GM foods, affect their GM foods teaching efficacy beliefs. They asserted that as teachers' GM foods risk perceptions increases, they would have stronger teaching efficacy beliefs to teach this topic. Parallel to these ideas, we believe that risk perceptions might be related to teachers' self-efficacy beliefs to teach controversial SSI. Supporting this assertion, Cross and Price (1996) argued that, teachers have the desire to teach controversial issues to promote social justice and raise students with the capability of informed decision making. Therefore, it can be considered that teachers with higher risk perceptions about an issue may possess stronger beliefs to teach this issue due to having such a desire to shape next generations. In this study, we propose that teachers' risk perceptions about SSI can be related to their teaching practices such as their willingness to teach SSI, the methods they choose, and the time they spend to teach controversial issues. That is, as teachers' GM foods risk perception increases, their GM foods teaching self-efficacy beliefs become stronger. Conversely, teachers holding lower levels of risk perception would be less likely to have such a desire to raise students with the awareness of risk factors inherent in GM foods therefore possess lower teaching self-efficacy beliefs regarding this issue.

On the other hand, in line with the idea that teacher perceptions have a profound effect on pedagogical choices and practices of teachers, the present study also aimed to investigate in what ways PSTs' GM foods benefit perception influences their GM foods teaching self-efficacy. Although there are many studies focused on the interrelationships among teacher perceptions (how teachers perceive the topic they teach and the perception about teaching about a specific topic) and teacher behaviour (e.g. the way they teach, teaching methods they choose, practices they implement in the classroom), there is very limited number of studies investigating how benefit perception on a controversial SSI can be related to teachers' self-efficacy beliefs to teach these issues. We believe that, like risk perception, increased benefit perception about SSI, may increase teacher self-efficacy to teach controversial SSI. The reasons might be that, teachers with high benefit perceptions about a specific SSI might feel herself/himself more comfortable to teach it. For instance, if a teacher believes that nuclear power plants are necessary since it provides us with large amount of energy, then, this teacher might feel herself more efficacious to teach nuclear energy to raise her students' as knowledgeable about this issue. This teacher is more likely to insist on teaching the benefits of nuclear power plants and try to spend more time to help students understand the benefits of the issue. Because, unlike the teacher with risk perception, such a teacher wants to raise students as aware citizens about the beneficial aspects of a certain issue. Therefore, as for the risk perception, in this study it was assumed that, benefit perception may also have a positive relationship with teachers' self-efficacy beliefs to teach SSI. Advocating this idea, Lee and Witz (2009) argued that teachers' personal moral and ethical values influence their orientations to teach SSI. According to them, teachers' experiences, values, and priorities could make them become more enthusiastic to teach SSI. This assertation was in line with the present study that, science teachers' benefit perceptions regarding SSI might promote their confidence to teach those controversial issues in their science classrooms.

It is important to note that, there has been an ongoing debate among researchers about whether perception and beliefs are the same or similar. Smith (2001) argued that the relation between perception and belief is more than merely contingent. In a study from educational context, Kilinc et al. (2013) used the term risk perceptions of GM foods as a synonym for teachers' beliefs about the risks of GM foods. Keeping in mind that beliefs and perception are not exactly the same entities, in the present study, we used the term perception as a variable in very close relation to individuals' beliefs.

1.3.2. Personal epistemological beliefs and its relation to GM foods knowledge and GM foods risk-benefit perceptions

Research has revealed so far that personal epistemological beliefs affect individuals' learning (e.g. Hofer & Pintrich, 1997). It also has been articulated that personal epistemological beliefs are related to conceptual learning (May & Etkina, 2002), academic achievement (Schommer, 1993), argumentation skills (Mason & Scirica, 2006), reasoning (Bendixen, Schraw, & Dunkle, 1998) and performance on complex educational tasks such as problem solving (King & Kitchener, 1994). For instance, Kardash and Scholes (1996) investigated the relationships between students' interpretation of controversial issues and their personal epistemological beliefs. They explored the influence of personal epistemological beliefs on participants' interpretation of controversial issues. Their study revealed that participants who had sophisticated epistemological beliefs about the certainty of knowledge (who believes that knowledge is tentative) were more likely to conclude that the mixed evidences they provided about the controversial issue is inconclusive while participants with naïve epistemological beliefs (who believes that knowledge is certain) claimed that this mixed evidence was conclusive in one direction or another. This study clearly showed that individuals' treatment of controversial issues is in relation to their personal epistemological beliefs.

In the present study, one of the aims was to explore the relationship between PSTs' personal epistemological beliefs and their knowledge about a specific SSI, GM foods. It was proposed in the model that as PSTs' personal epistemological beliefs become sophisticated, their knowledge about GM foods would increase. We believe that knowledge about and awareness of controversial issues might require holding sophisticated epistemological beliefs. Namely, as individuals' sophistication levels about the nature of knowledge and knowing increases, their understanding about a controversial issue such as GM foods would also increase. For instance, as PSTs believe that knowledge is changing and evolving but not certain would have the disposition to understand the nature and characteristics of controversial issues.

Research studies have revealed that individuals' personal epistemological beliefs may affect understanding about potentially controversial issues. For example, Sinatra, Southerland, McConaughy, and Demastes (2003), in their study investigating the relationship between participants' epistemological beliefs, thinking dispositions, and understanding and accepting of evolution argued that epistemological beliefs are likely candidates for affecting learning about evolution, which is controversial in nature. In that study, personal epistemological beliefs were measured by Schommer's epistemological questionnaire but only involving the subdimensions seek single answers (simple knowledge), do not criticize authority and dependence on authority (omniscient authority), and ambiguous information and knowledge is certain (certain knowledge). Their findings revealed that, one of the personal epistemological beliefs subscales, ambiguous information, significantly related to knowledge of evolution. It was articulated that participants who reported a dislike for ambiguity had less knowledge of biological evolution. Ambiguity refers to the belief that knowledge is certain and there are simple answers. In addition, individuals holding this belief are unlikely to question authority. Therefore, the finding suggested that individuals holding less sophisticated ambiguity beliefs and believing that knowledge is certain possessed less knowledge about biological evolution.

In this study, another variable that was hypothesized to be in relation to PSTs' personal epistemological beliefs was their risk-benefit perceptions. Despite the fact that there is a very limited number of research studies investigating personal epistemological beliefs and risk-benefit perceptions, there is an agreement in the literature that beliefs are interrelated and people's certain beliefs in the belief system might affect another type of beliefs considering an issue (Abelson, 1979; Rokeach, 1968). Given the fact that risk-benefit perceptions are closely related to individuals' belief systems, personal epistemological beliefs might be associated with these perceptions considering the controversial issue of GM foods. As the literature suggested some variables such as interest in science, environmental attitude, and personal and cultural values have already been supported to be important indicators of risk-benefit perceptions or of general attitudes toward controversial issues (Earle & Cvetkovich, 1997; Retzbach, Marschall, Rahnke, Otto, & Maier, 2011). Retzbach et al. (2011), in their study investigating the possible predictors of people's perceptions of nanotechnology, which is an emerging technology with some uncertainties, revealed that the three scientific epistemological beliefs dimensions, certainty, development, and justification were positively correlated to benefit perceptions, and negatively correlated to risk perceptions.

As previously mentioned personal epistemological beliefs deal with the nature of knowledge and knowing. Individuals' understanding of scientific evidence, for instance, how empirical data is obtained and used for supporting or refuting scientific claims is another aspect that personal epistemology try to seek for (Gott & Duggan, 1998). From the epistemological perspective, an individual might consider scientific evidence as certain (stable and objective) or uncertain (tentative and interpretive). As Retzbach et al. (2011) suggested this aspect of epistemological beliefs is especially important for the evaluation of emerging technologies, such as GM foods. The reason is that, the evidence for the issue of GM foods is quite uncertain and even scientists have varying opinions about whether GM foods will cause hazardous health or environmental consequences (Deckers, 2005). Given the fact that individuals with sophisticated epistemological beliefs are more likely to interpret issues from multiple perspectives and try to understand both the negative and positive sides of an issue, it might be proposed that as personal epistemological beliefs become sophisticated, risks and benefit perceptions of GM foods would increase.

1.3.3. GM foods knowledge and GM foods risk-benefit perceptions

The final proposed relationship in the model was among the variables knowledge and risk-benefit perceptions. Research studies conducted so far have revealed that knowledge about GM foods may determine individuals' risk and benefit perceptions of this issue. Literature revealed some contradictory results about risk perception and knowledge relationship in the context of GM foods. To illustrate, Chen and Li (2007) stated in their study that, although individuals' knowledge about GM foods has increased, they are still less optimistic about GM foods, which means that they do not consider GM foods as totally harmless. Chen and Li (2007) argued about two possible reasons. First, as knowledge increases about GM foods, individuals become more critical about the issue and ask more questions about it (Sandoe, 2001). Second, according to Grunert et al. (2000) prior negative attitudes will not become mitigate, rather they become stronger as the new information provided. That means, presence of new information is more likely to activate existing attitudes rather than changing them (Fazio, 1990; Frewer, Scholderer, Downs, & Bredahl, 2000). On the other hand, Zhang and Liu (2015) and Chen and Li (2007) reported that as individuals' knowledge about GM foods increases, their risk perception becomes lower. Aside from these, there are a few studies revealed that knowledge is not related to people's risk and benefit perceptions regarding controversial issues (e.g. Retzbach et al. 2011).

Majority of the studies about knowledge and benefit perception reported that as individuals' knowledge about GM foods increases, their benefit perception of this issue will also increase. For instance, Zhang and Liu (2015) argued that if people have more knowledge about GM foods, then they will perceive more benefits from GM foods. Similarly, Sjöberg (2008), in his study investigating public and gene technology experts' perceptions and attitudes toward GM foods, stated that experts differ from public significantly in terms of benefit perception of GM foods.

It is reasonable to assert that as individuals become more knowledgeable about the issue of GM foods, they would recognize both the benefits and risks regarding this issue. Therefore, in our model we propose that, both risk and benefit perceptions of GM foods are associated positively with PSTs' GM foods knowledge. That is, we propose that as PSTs' knowledge about GM foods increases, their risk and benefit perceptions of the issue will become stronger.

1.4. Significance of the Study

There are mainly three reasons to conduct the present study:

1. SSI, as a way to improve scientific literacy and informed decision making of students, has been incorporated into science teaching programs in many countries such as Australia, USA, UK, and Turkey. Despite the growing importance given to SSI inclusion in science education, teachers usually mention that they have several challenges to implement these controversial issues in their science teaching (Lee et al. 2006). As a new framework differing from the traditional science teaching, SSI teaching requires science teachers to develop new pedagogies (Christensen & Fensham, 2012). It is evident in the literature that teaching self-efficacy influences the way teachers practice in the classroom and react to new reform efforts such as SSI in science education (Lumpe, Haney, & Czerniak, 2000; Ramey-Gassert & Shroyer, 1992). In addition, it has been argued that as teachers' self-efficacy beliefs become stronger, they are more competent and eager to include SSI into their science teaching (Zeidler & Nichols, 2009). Therefore, it is crucial to investigate the nature of SSI teaching self-efficacy. Exploring the nature of teacher self-efficacy regarding SSI would be insightful for both pre-service and in-service teacher education programs to raise and support teachers for such unfamiliar and controversial topics.

2. This study has potential to make a unique contribution to SSI teaching literature since it examines the relationships among the mentioned variables by proposing a structural model and further supports the proposed model with interview data. Aiming to investigate mainly PSTs' SSI teaching self-efficacy beliefs, this study also explores whether knowledge, risk-benefit perceptions, and personal epistemological beliefs are associated with PSTs' SSI teaching self-efficacy beliefs. Besides, the study explores the relationships among each independent variables; knowledge, risk-benefit perception, and personal epistemological beliefs. In SSI literature, there is very limited number of studies investigating teacher self-efficacy beliefs regarding SSI (e.g. Kilinc, et al., 2013; Lee, et al., 2006). For instance, Lee et al. (2006) investigated Korean secondary science teachers' perceptions and teaching self-efficacy beliefs regarding SSI however Lee et al. (2006) were aimed only to reveal out the existing science teacher self-efficacy beliefs rather than proposing relationships among science teachers' self efficacy beliefs and any other variables. Also, Kilinc et al. (2013) investigated PSTs' teaching self-efficacy beliefs and its relation to their moral beliefs, religious beliefs, content knowledge, and risk perceptions. When especially considering the fact that Turkish national science curriculum has undergone several recent revisions in 2013 to integrate SSI (MoNE, 2013), teacher education programs, in parallel, need to be revised to raise future teachers who are ready for implementing SSI practices in science classrooms. To this end, the present study, investigating PSTs' SSI teaching self-efficacy beliefs and its relationships with the proposed variables by utilizing both qualitative and quantitative methods will shed light on how we can improve teacher efficacy beliefs regarding SSI.

3. The present study is crucial in a way that the participants are preservice teachers. Since SSI is quite a new concept for Turkish curriculum, there is a need to investigate the nature and the influencing factors of SSI teaching self-efficacy beliefs starting with pre-service years. Also, as the studies revealed, once teaching self-efficacy beliefs are established, they tend to be resistant to change (Hoy & Spero, 2005). Therefore, it would be crucial to investigate and develop preservice teacher beliefs before they start to professional teaching career. Finally, it would be important to note that majority of

the SSI research studies has been conducted in western countries (e.g. Lewis & Leach, 2006; Rose & Barton, 2012; Sadler et al. 2006). It has been revealed that culture has an influencing factor on teacher self-efficacy beliefs (Cakiroglu, Cakiroglu, & Boone, 2005). We believe that, given the nature of SSI as controversial involving ethical and moral aspects, SSI teaching self-efficacy beliefs and the associated factors such as risk-benefit perceptions would be highly influenced by teachers' cultural backgrounds. Therefore, conducting such a study in Turkey, which has been influenced by both eastern and western cultures, would reveal interesting findings for the related literature.

CHAPTER II

LITERATURE REVIEW

2.1 Socioscientific Issues and Their Importance in Science Education

Prioritizing the social significance of science has been one of the aims of science education policies especially after the emergence of STS movement in the 1970s. In 1982, the National Science Teachers Association (NSTA) published a paper describing the characteristics of a scientifically literate person as one who understand the interconnections among science, technology, and society (NSTA, 1982). However, due to some criticisms such as not including ethical issues and not focusing on moral or character development of students, STS education has become marginalized (Pedretti & Hodson, 1995; Zeidler, Sadler, Simmons, & Howes, 2005). After then, STSE education was proposed by some science educators (Hodson, 1994, 2003; Pedretti, 1997). Although STSE was a more issues-driven curriculum, it was also failed to become a widely used framework in science education due to similar reasons such as lack of a theoretical basis, an emphasis on moral and ethical development of students, discourse and argumentation practices, and emotive, cultural, developmental or epistemological connections inherent in issues (Zeidler et al., 2005). In the late 1990s, a new framework, which is named SSI, has emerged for science education and science education research. Aside from being a context for science education, SSI also refers to a pedagogical strategy that focuses specifically on promoting students' informed decision making about socially relevant scientific issues by considering ethics and construction of moral development (Driver, Leach, Millar, & Scott, 1996; Driver, Newton, & Osborne, 2000; Sadler, 2004). While involving what STS curriculum offers, SSI framework also considers ethical, moral, and emotional development of students (Zeidler, Walker, Ackett, & Simmons, 2002). Another feature that SSI movement marks advancement over STS curriculum was that it has been based on theory (Sadler & Dawson, 2012; Zeidler et al., 2005). More specifically, SSI research has grounded in theory derived from cognitive and developmental psychology, sociocultural theories, and situated learning perspectives (Sadler, 2009).

Much of the research on SSI has focused on informal reasoning and argumentation practices within the context of controversial issues. The main focus of these studies would be gathered under four themes: socioscientific argumentation (e.g. Jimenez-Aleixandre, Rodriguez, & Duschl, 2000; Kortland, 1996; Patronis, Potari, & Spiliotopoulou, 1999; Zohar & Nemet, 2002) relationships between NOS conceptualizations and socioscientific decision making (e.g. Bell & Lederman, 2003; Sadler, Chambers, & Zeidler, 2004; Zeidler, Walker, Ackett, & Simmons, 2002), the evaluation of information pertaining to SSI (e.g. Kolsto, 2001; Korpan, Bisanz, Bisanz, & Henderson, 1997; Tytler, Duggan, & Gott, 2001; Sadler et al., 2004), and the influence of conceptual understanding on informal reasoning (e.g. Fleming, 1986; Hogan, 2002, Tytler et al., 2001; Zeidler & Schafer, 1984). These studies have shed light on how students negotiate and resolve SSI; however, they have not addressed how SSI would be used as fruitful context for science learning and teaching. Since the focus of this part of the review was to present studies associated with the use of SSI as contexts for science teaching and learning, studies on informal reasoning were not reviewed in detail.

In recent years, research studies in SSI literature have asserted the idea that SSI can be used as contexts for teaching and learning of science. According to these studies, teaching science content through socially relevant issues provide basis for student development of argumentation practices and scientific literacy, understandings of science and NOS, and interest and motivation for learning science. In the following parts, related literature regarding each of these student gaining obtained as a result of SSI teaching were presented.

Scientific literacy, which is a phrase representing what students are supposed to know and do in consequence of their science learning practices, is accepted as one of the major goals of science education (Sadler & Zeidler, 2009). Since it has been considered as one of the major aims of science education, science education organizations and researchers have put effort into making science teaching that fosters students' scientific literacy for many years (e.g. American Association for the Advancement of Science [AAAS], 1993; Holbrook & Rannikmae, 2009; Hurd, 1958; Millar, 1997; National Academy of Sciences, 1996; Organization for Economic Cooperation and Development [OECD], 2006, 2009; Roberts, 2007; Roth & Barton, 2004; Sadler & Zeidler, 2009; Shamos, 1995). In those years, the definition of scientific literacy has been changed many times since it was first used by Hurd (1958).

In the Handbook of Research on Science Education, Roberts (2007) reviewed the research studies on scientific literacy in two different visions: Vision I and Vision II and defined these two visions as the following:

> Vision I gives meaning to scientific literacy by looking inward at the canon of orthodox natural science, that is, the products and processes of science itself. At the extreme, this approach envisions literacy (or, perhaps, thorough knowledgeability) within science. Vision II derives its meaning from the character of situations with a scientific component, situations that students are likely to encounter as citizens. At the extreme, this vision can be called literacy (thorough knowledgeability) about science-related situations in which considerations other than science have an important place at the table (p. 730).

According to Vision I, the aim of science education is to transfer scientific concepts that helps students to understand scientific products and processes. On the other hand, Vision II involves personal decision making about real life situations which are influenced by social, political, economical, and ethical perspectives. Hence, according to Vision I, being scientifically literate requires knowledge about the discipline "science". However, Vision II highlights the importance of the ability to utilize scientific ideas, processes, and reasoning.

In a similar vein, OECD Programme for International Student Assessment (PISA) (1998) defined scientific literacy as "the capacity to use scientific knowledge, to identify questions and to draw evidence-based conclusions in order to understand and help make decisions about the natural world and the changes made to it through human activity" (p. 60).

As can be understood, much of the earlier definitions of scientific literacy focused on student learning of science content. However, in time, the definition of scientific literacy has been replaced by possessing the ability for being active citizens in society, developing reasoning, and using decision-making skills regarding socioscientific issues (Holbrook & Rannikmae, 2009). To illustrate, a scientifically literate individual was defined by OECD in 2009 as,

- Use scientific knowledge to identify questions, acquire new knowledge, explain scientific phenomena and draw evidence-based conclusions about science-related issues;
- Understand the characteristic features of science as a form of human knowledge and enquiry;
- Be aware of how science and technology shape our material, intellectual and cultural environments;
- Be willing to engage in science-related issues, and with the ideas of science, as a reflective citizen (p. 3).

Moreover, Holbrook and Rannikmae (2009) defined scientific literacy as:

> Developing an ability, to creatively utilize appropriate evidence-based scientific knowledge and skills, particularly with relevance for everyday life and a career, in solving personally challenging yet meaningful scientific problems as well as making, responsible socio-scientific decisions, collective interaction skills, personal development and suitable communication approaches as well as the need to exhibit sound and persuasive reasoning in putting forward socio-scientific arguments (p. 286).

Similarly, Santos (2009) suggested a humanistic perspective for scientific literacy, which in included three phases: to encourage students to identify social issues for discussion by observing reality; to engage students in the debates and discussions of social issues through a dialogical process; and to transform their understanding into sociopolitical actions.

As evident in recent definitions of scientific literacy, aside from raising knowledgeable students about science content, science education should also encourage students to resolve societal problems, to take sociopolitical actions in the resolution of global concerns and issues, to be reflective and responsible citizens who are aware of how science and technology shape our material, intellectual and cultural environments. Keeping all these goals in mind, research on SSI has asserted that in order to achieve these and raise students as scientifically literate, SSI can be used as a fruitful context in science education (e.g. Lee, et al., 2013; Sadler & Zeidler, 2009).

In addition to promoting scientific literacy, SSI are considered as suitable contexts for developing students' argumentation practices. Research studies conducted to investigate the use of SSI for fostering student argumentation generally implemented an SSI intervention. Zohar and Nemet (2002) investigated teaching of argumentation skills in the context of human genetics dilemmas. More specifically, their study focused on student learning of human genetics within a unit in which explicit teaching of argumentation skills is embedded in. They used a pre-post argumentation assessment basing on the numbers of justifications provided, argumentation structure, counterarguments, and rebuttals. It was yielded that students in experimental group scored higher on genetics knowledge test comparing to control group. Results of the analysis of students' written tests and transcripts of group discussions revealed that merging argumentation skills into the teaching of SSI such as human genetics developed biological knowledge and argumentation.

Venville and Dawson (2010), in their study investigating the impact of a classroom intervention on 10^{th} grade students' argumentation skills, informal reasoning, and conceptual understanding of science utilized quasi-experimental design with two classrooms for argumentation group and two classrooms for control groups. The teacher of the argumentation group participated in professional learning and used several strategies in classroom such as encouragement of discussions, modeling argument, valuing different positions, prompting for evidence to justify claims and promoting counterarguments. The teacher explicitly taught argumentation skills to the students and encouraged students in the argumentation group to involve in whole-class SSI discussions. Analysis of the pre and post-instruction surveys revealed that the argumentation group enhanced considerably more on the complexity and quality of the arguments. In addition, comparing to control group, argumentation group scored significantly higher on genetics understanding.

Tal and Kedmi (2006) developed a unit named "Treasures in the Sea: Use and Abuse" for implementing it to six classes of 10th and 11th grade students. This study was a pre and post SSI intervention that dealt with using the sea as a resource for agriculture and environmental problems of local coasts and water. Tal and Kedmi (2006) tried to examine students' performances that require higher order thinking skills of argumentation and value judgments in tasks. Namely, their assessment was based on number of justifications used, the extent of use of scientific knowledge, the number of aspects incorporated, and the synthesis of counterarguments and rebuttals. The researchers concluded that, except the synthesis of counterarguments and rebuttals, post intervention groups' performance in SSI discussions was significantly higher than the pre intervention group performances.

Albe (2008) investigated 11th grade students' argumentation by utilizing a micro-ethnographic approach in a French school. In this study, she analyzed student argumentation about health effects related to the use of cell phones during group discussions. Analysis of group discussions (audio recordings and transcripts) revealed that using SSI as contexts for collaborative argumentation can be considered as an efficient way for student engagement in generating arguments. Besides, she argued that epistemological considerations influence the way students generate arguments about controversial issues in that naïve epistemological representations limit student argumentation.

Grace (2009) conducted a research study exploring 15-16 year-old students' decision-making discussions about biological conservation issues. The study utilized a certain framework to assess whether engaging in SSI-intervention results in any change in students' personal reasoning and group discussion. Grace (2009) collected data through pre and post intervention questionnaires and audiotapes of group discussions. Analysis of data articulated that more than half of the participants (67 of 131 students) improved on their argumentation practices while 52 of the participants exhibited the same level of argumentation. Interestingly, seven students dropped one argumentation level. Grace (2009) argued that the intervention study provided students with developed argumentation practices.

Pedretti (1999) studied how formal (school) and non-formal (science center) learning environments provide contexts for student reasoning about a SSI. She used mining as the controversial issue. In the study, 27 fifth and sixth grade students took part in some classroom-based activities and participated in a field trip to a local science center. By utilizing the data sources of field notes and interviews with students and teachers, Pedretti (1999) tried to reveal out how students make informed decisions about a controversial issue as a result of an issues-based approach. The study reported that engaging students in such experiences results in positive improvements in students' decision making with respect to considering multiple perspectives and ethical considerations.

Von Aufschnaiter, Erduran, Osborne, and Simon (2008) investigated the relationship between argumentation and the development of scientific knowledge. In addition, the study explored students' development and use of scientific knowledge. For the assessment of the quality and frequency of students' argumentation, Von Aufschnaiter et al. (2008) used video and audio documents of small group and classroom discussions and analyzed them by using a schema based on the work of Toulmin (1958). Besides, a schema was utilized for determining the content and level of abstraction of students' meaning-making. Results revealed that students draw on their prior experiences and knowledge while engaging in argumentation practices. Moreover, the study suggested that the main indicator of students' construction of qualified arguments is their familiarity and understanding of the content of the task.

Aside from improving scientific literacy and argumentation practices, advocates of SSI have proposed that SSI can be a suitable context for student learning of science content. To this end, a number of research studies have published thus far. For instance, Dori, Tal, and Tsaushu (2003) investigated teaching biotechnology topics through case studies to nonscience majors in 10-12 grades Israeli schools. The main goal of the researchers was to examine nonscience major students' ability to use various thinking skills in analyzing environmental and moral conflicts presented through case studies. Data were collected from pre and post-tests, teachers' interviews and students' feedbacks as reported in portfolios. The instruments were designed to examine knowledge and understanding of concepts, application of previous knowledge to new situations, question posing, argumentation skills, and system thinking. The researchers grouped students by academic ability levels (high, intermediate, and low) for the analyses. Findings revealed that, there was a significant improvement in students' knowledge, understanding levels, and higher order thinking skills at all three academic levels. Low academic level students gained more in the knowledge and understanding of biotechnology concepts comparing to intermediate and high level group students. Moreover, most of the participating students found biotechnology concepts that were studied as interesting and relevant. Dori et al. (2003) concluded that using SSI for teaching science improves scientific and technological literacy and develops higher order thinking skills of nonscience majors.

Yager, Lim, and Yager (2006) aimed to explore the advantages of using an STS approach over a typical textbook approach for teaching science to middle school students. The researchers studied with two teachers. One of these teachers used a local STS issue for teaching, while the other teacher followed the standard science curriculum. The study focused on student concept mastery, general science achievement, concept applications, use of concepts in new situations, and attitudes toward science and the data were collected from pre and post content tests. The findings indicated that although SSI group did not significantly better than the standard group, both groups demonstrated larger gains in terms learning science content.

As aforementioned in detail in the above section, Zohar and Nemet (2002) and Venville and Dawson (2010) conducted SSI-intervention studies to explore science content learning and argumentation practices of students. Both studies revealed that students in SSI teaching group scored significantly higher than the students in the comparison group. In Zohar and Nemet's (2002) research study, students in the SSI group scored higher on a genetics knowledge test than the comparison students. Similarly, in Venville and Dawson's (2010) study, students in the SSI-related intervention performed higher on genetics knowledge test than the comparison students.

Another SSI-intervention study that was conducted by Klosterman and Sadler (2010) explored scientific content knowledge gains as a result of SSI-based instruction. They designed a three-week unit on global warming and measured student knowledge before and after the intervention. The participants of the study were 108 students from grades 9-12 in two different schools. As data sources, Klosterman and Sadler (2010) utilized standards-aligned content knowledge exam (distal assessment) and a curriculum-aligned exam (proximal assessment). Results indicated that students' post-test scores were statistically and significantly different than the pre-test scores. In addition, as a result of the three-week SSI intervention, students expressed more accurate, more detailed, and more sophisticated understandings of global warming, the greenhouse effect, and the controversy and challenges associated with these issues. Klosterman and Sadler (2010) concluded that SSI would be a suitable context for learning and teaching science content.

Rather than using a pre-post design, Bulte, Westbroek, de Jong, and Pilot (2006) utilized design-based research principles to investigate whether a context-based chemistry unit about water quality contributes students’ chemistry understanding or not. In this study, three research cycles took place, each at different schools with five different teachers. Data were collected through videos, field notes, teacher interviews, and student surveys. The analyses revealed that, majority of the students had gains from the water quality unit. More specifically, 80% of the students demonstrated adequate understanding of content knowledge related to water quality unit, 70% of the students showed understanding about parameters for evaluating and interpreting water quality, and 60% of the students related specific parameters to certain water functions, and showed an adequate notion of how experiments could be considered reliable.

Besides developing scientific literacy, argumentation practices, and content knowledge, socially relevant contexts such as SSI has been considered as a beneficial for fostering student interest and motivation. SSI advocates argue that using SSI contexts would increase student interest and motivation to learn science. To illustrate, Dori et al. (2003) explored student interest as a result of a teaching module on biotechnology topics. As a case study, this study aimed to teach genetics to nonscience majors in 10-12 grades Israeli schools. In the module, the controversial and ethical aspects of genetics issue were highlighted. Dori et al. (2003) reported that majority of the students (96% of 200 students) demonstrated interest to biotechnology and found these topics relevant. They provided arguments for personal and social relevance and stated their wish to see the teaching methods that were used in this module more. Therefore, the researchers concluded that using SSI context would be helpful to build student interest in science.

Three different research studies conducted by Bennett, Gräsel, Parchmann, and Waddington (2005), Barber (2001), and Parchmann, et al. (2006) aimed to investigate about context-based chemistry education. In these studies, the researchers implemented and used SSI contexts to teach chemistry. In the first two studies, there were two groups; one implemented context-based chemistry course named Salters

Advanced Chemistry (SAC) and the other was a conventional course. Both studies reported that as a result of using controversial and socially relevant contexts (SAC group), students were more interested in science and expressed their gratitude about their learning experiences. Barber (2001) also reported that majority of the students in SAC group chose chemistry-related courses in their university education. Similarly, Parchmann, et al. (2006), in their study investigating chemistry learning through ChiK (Chemie im Kontext) units over a three-year period in Germany argued that students' motivations to learn chemistry in ChiK group were statistically and significantly higher than student motivation in the comparison group.

In a design-based research study, Bulte et al. (2006) also investigated about context-based chemistry education. They used SSI about water quality in an intervention study. The findings revealed that, comparing to traditional teaching methods, teaching chemistry through SSI contexts increased student interest to learning chemistry and students became more engaged to the lesson. They reported that teaching water quality topics based on discussing about controversial aspects made the scientific concepts more meaningful to students.

NOS have been the final mostly reported science learning outcome that was achieved as a result of SSI teaching. For instance, Khishfe and Lederman (2006) investigated learning about NOS in an SSI context about global warming. In this 6-week intervention study, there were two groups: integrated and nonintegrated. While the integrated' group exposed to a NOS instruction that was related to the science content about global warming, in the nonintegrated group, NOS was taught through a set of activities that specifically addressed NOS issues and were dispersed across the content about global warming. Data were collected from 42 students through an open-ended questionnaire and a semi-structured interview. Analyses of data revealed that students in both groups improved their understanding of NOS (tentative, empirical, creative/imaginative and subjective aspects of NOS). However, Khishfe and Lederman (2006) did not report any difference between the two learning contexts about fostering students' sophisticated NOS understanding.

Similarly, Walker and Zeidler (2007) conducted a case study in which they implemented a SSI curriculum about genetically modified foods. Their aim was to investigate NOS understanding gaining as a result of SSI intervention. They studied with two high school science classrooms and implemented the curriculum through seven 1.5-hour period blocks. NOS themes (tentativeness of science, the role of empirical evidence in science, social and cultural factors in generating scientific knowledge, and creative aspects of science) were highlighted in the curriculum and embedded in the learning activities. As a qualitative research study, data sources comprised of student answers to online and interview questions, and final classroom debates. Analyses of data revealed that the study achieved to improve students' NOS understandings; however, they failed to apply these understanding while they generate decision-making about an issue. The study suggested designing and using SSI approaches that involve NOS aspects. Walker and Zeidler (2007) concluded that these approaches should encourage students to move beyond developing their nature of science conceptions to applying those conceptions within a decision-making context.

The final study that would be reviewed in this part was not specifically designed to investigate nature of science but reflective judgment, a construct that represents epistemological development. Since epistemology deals with the nature of scientific knowledge and the generation of that knowledge, research studies about NOS have been mostly related to epistemology. Zeidler, Sadler, Applebaum, and Callahan, (2009) investigated the influence of an SSI-based intervention on students' reflective judgment. The researchers implemented a one-year long SSI intervention on reflective judgment in four high school anatomy and physiology classrooms (two intervention, two comparison classes). Analyses of interview data revealed that students in the comparison group did not show any differences on reflective judgment. However, students in the intervention group improved significantly on reflective judgment. Zeidler et al. (2009) suggested that implementation of SSI based instructions would foster students' epistemological development.

2.2 Social Cognitive Theory and The Concept of Self Efficacy

Social cognitive theory, developed by Bandura (1986), is founded on a model of causation, which involves a triadic reciprocal determinism, rather than a one-sided determinism for human behavior. In this model of reciprocal causation, as presented in Figure 2.1, behavior, personal factors, and environmental influences all operates bidirectionally as interacting determinants (Bandura, 1989).

The reciprocal relationship between personal factors and behavior suggests that expectations, beliefs, self-perceptions, goals and intentions influence behavior. That is, what people think, believe, and feel effect how they behave (Bandura, 1986). Similarly, the consequences of people's behaviors effect their thought patterns and emotional reactions. The reciprocal relationships between the environment and personal factors is concerned with the interplay among people's expectations, beliefs, and cognitive competencies, such that, these personal factors influenced by their environment influences and also environmental influences are affected by personal factors (Bandura, 1986). Finally, the reciprocal relation between the behavior and environmental influences implies that behavior alters environmental conditions, and environmental influences, in turn, partly determine people's behavior (Bandura, 1986). Because of this reciprocal relationship, Bandura (1989, 2001) suggested that people are both products and producers of their environment.

Social cognitive theory asserts that human agency occurs through intentionality (plan to action), forethought, self-reactiveness (motivation and self-regulation), and self-reflection and it was assumed in social cognitive theory that, people have a number of basic capabilities such as symbolizing, vicarious, forethought, self-regulatory, and self-reflective capabilities (Bandura, 1986, 1989). People have symbolizing capability, which provide them a means of understanding and managing their environment. Bandura (1989) asserts that "people process and transform passing experiences by means of verbal, imaginal, and other symbols into cognitive models of reality that serve as guides for judgment and action" (p. 9). Symbolizing capability in social cognitive theory has a very crucial place that symbols are considered to be the vehicle of human thought.

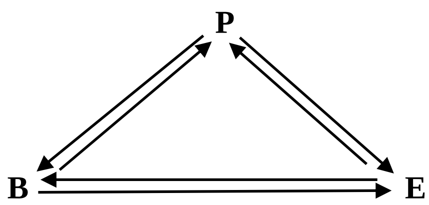

Figure 2.1 Theoretical model of triadic reciprocal determinism in Bandura's social cognitive theory

The other abovementioned capabilities of human agency depend on symbolic capability: vicarious capability provides people with the ability to learn by observing other people's actions and consequences for them; forethought capability refers to people's capability that give chance to plan their actions, set goals, and expect the possible consequences of their actions; self-regulatory capabilities enable people to motivate and regulate their behaviors by themselves; and self-reflective capabilities refer to the capability for reflective self-consciousness, that is, people have the ability to analyze their experiences and think about their own thought processes which provide them to develop an understanding about themselves and the world around them.

According to Bandura (1986), among the types of thoughts that affect action, none is more central than self-efficacy mechanism, which refers to "people's judgments of their capabilities to organize and execute courses of action required to attain designed types of performances" (Bandura, 1986, p. 391). Self efficacy beliefs influence the way people behave, their thought patterns, and the emotional reactions (Bandura, 1989). In their daily lives, people choose their actions based on their beliefs that they can attain them; therefore, people's self-efficacy beliefs determine their persistence in accomplishing an action.

Behavior, as asserted in social learning theory, not only based upon self efficacy but also on outcome expectancies about action-outcome contingencies about life experiences. Outcome expectancy is defined as "a person's estimate that a given behavior will lead to certain outcomes" (Bandura, 1977, p. 79). According to Bandura (1986), the outcomes people expect from a certain situation depend heavily on their judgments of the types of performances they will be able to produce. It was asserted in the theory that, those who have greater efficacy will expect favorable outcomes, while who expect lower efficacy beliefs will possess negative outcomes (Bandura, 1989).

Self efficacy beliefs are based on four principal sources of information which are mastery experiences, vicarious experiences, verbal persuasion, and physiological arousal (Bandura, 1977; 1997). Mastery experiences, which suggested being the most powerful source of efficacy beliefs, are based on authentic experiences. The perception that a task is accomplished successfully increases the sense of efficacy while repeated failures decrease them. Vicarious experiences refer to raising self-perception of efficacy that occurred as a result of seeing or visualizing other similar people's successful performances. People may persuade themselves that if other people can accomplish a task, they may also achieve it. Other than these two sources of information, verbal persuasion was also an important source for teacher efficacy. Verbal persuasion is used to try to talk people into believing that they can accomplish to task they seek to by providing information about the nature of teaching, give encouragement and strategies for overcoming situational obstacles, and providing specific feedbacks about teaching performance. Finally, according to Bandura (1977; 1997), physiological arousal and emotional cues influence people's self-perceptions of teaching competence in that, people possessing feelings of relaxation and positive success are more tend to have self-assurance and expect success.

2.3 Teacher Self-efficacy Beliefs

During the past decade, self efficacy beliefs have received increasing attention in educational research (Pintrich & Schunk, 1995). Teacher efficacy has been defined by Berman, McLaughlin, Bass, Pauly, and Zellman as "the extent to which the teacher believes he or she has the capacity to affect student performance" (1977, p. 137). According to Guskey and Passaro (1994), teacher efficacy refers to "teachers' belief or conviction that they can influence how well students learn, even those who may be difficult or unmotivated" (p. 4).

There are mainly two conceptual strands about teacher efficacy beliefs found in the literature. The first studies of teacher efficacy were conducted by the RAND organization basing on Rotter's (1966) social learning theory. The research studies published by RAND Corporation (Armor et al., 1976) used two items (Item 1: When it comes right down to it, a teacher really can't do much because most of a student's motivation and performance depends on his or her home environment; Item 2: If I really try hard, I can get through to even the most difficult or unmotivated students.) to measure teacher efficacy. A teacher who agrees with the first statement indicates that external factors (environmental factors) are very powerful as compared to teachers' influence on students learning and this belief was labelled as general teaching efficacy (GTE). A teacher who expresses agreement with the second item indicates their own confidence to overcome the difficulties for student learning; therefore, it was labelled as personal teaching efficacy (PTE). In the RAND studies, the sum of the scores obtained from these two items was called teacher efficacy (TE). After the RAND studies, some other measures (e.g. Teacher locus of control developed by Rose and Medway in 1981; Responsibility for student achievement developed by Guskey in 1981; Webb scale developed by Ashton, Olejnik, Crocker, and McAuliffe in 1982), which were longer and comprehensive, were developed and each of these measures were grounded in Rotter's theory.

The second conceptual strand of research was based on Bandura's social cognitive theory and his construct of self efficacy. As aforementioned, self efficacy is a future oriented belief that influences people's thought patterns and emotions about their actions. In addition to self efficacy beliefs, social cognitive theory includes a second kind of expectation, which is called outcome expectancy. While self efficacy beliefs refer to individuals' beliefs about accomplishing a specific task, outcome expectancy beliefs indicate their estimate of the likely consequences of performing that task (Bandura, 1986). When applied to teacher effectiveness, Bandura's theory imply that "teachers who believe student learning can be influenced by effective teaching (outcome expectancy beliefs) and who also have confidence in their own teaching abilities (self-efficacy beliefs) should persist longer, provide a greater academic focus in the classroom, and exhibit different types of feedback than teachers who have lower expectations concerning their ability to influence student learning" (Gibson & Dembo, 1984, p. 570). Several instruments were developed basing on Bandura's social cognitive theory such as, Gibson and Dembo instrument, Bandura's teacher self-efficacy scale and Teachers' Sense of Efficacy Scale.

It is important to mention here about the distinctions between Bandura's self efficacy and Rotter's internal-external locus of control. According to Bandura (1997), perceived self efficacy beliefs are not the same as locus of control. While perceived self efficacy is belief about whether one can accomplish certain actions, locus of control implies beliefs about whether actions affect outcomes. According to Tschannen-Moran, Woolfolk-Hoy and Hoy (1998), perceived self efficacy is a strong predictor of human behavior, however locus of control is a weak predictor. The researchers argue about Rotter's scheme of internal-external locus of control that, "an individual may believe that a particular outcome is internal and controllable, that is, caused by the actions of the individual, but still have little confidence that he or she can accomplish the necessary actions" (p. 211).

In 1990, Riggs and Enochs developed a questionnaire called Science Teaching Efficacy Belief Instrument (STEBI) based on Bandura's social cognitive theory. Right after the development of this in-service teacher scale (STEBI-A), the researchers developed the pre-service version (STEBI-B) of the same scale (Enochs & Riggs, 1990). In this scale, there are two dimensions as parallel to Bandura's theory; personal science teaching efficacy belief and science teaching outcome expectancy, including 25 items in in-service teacher version and 23 items in pre-service teacher version. STEBI was developed in accordance with the assertion that teacher efficacy instruments should be subject specific rather than general. According to Riggs and Enochs (1990), since teacher efficacy beliefs appear to be dependent upon the specific teaching situation, a subject specific instrument would be more informative, that's why they developed the teaching efficacy beliefs scale specifically for science teaching. This idea is consistent with Bandura's definition of self efficacy as a situation specific construct.

Tschannen-Moran, Woolfolk-Hoy and Hoy (1998) proposed an integrated theoretical model of teacher efficacy (Figure 2.2) which suggests new areas for research basing on the conceptual strands discussed above. In this model, similar to Bandura's assertion, the most influential sources of efficacy information are mastery experience, vicarious experience, verbal persuasion, and physiological arousal (Tschannen-Moran, Woolfolk-Hoy & Hoy, 1998). However, as suggested by Tschannen-Moran, Woolfolk-Hoy and Hoy (1998), since teacher efficacy is context specific, teachers do not feel efficacious for all teaching situations and they may feel efficacious to teach a specific content under specific conditions, but feel more or less efficacious under different circumstances. It was suggested in the model that these four sources of efficacy information contribute to analysis of teaching task and assessment of personal teaching competence, but in different ways. The influence of these four sources to teacher efficacy is dependent on cognitive processing, which determines how the sources of information weighted and affect the task analysis and personal teaching competence (Tschannen-Moran, Woolfolk-Hoy & Hoy, 1998). As a result of the interaction between task analysis and personal teaching competence, teacher efficacy is shaped.

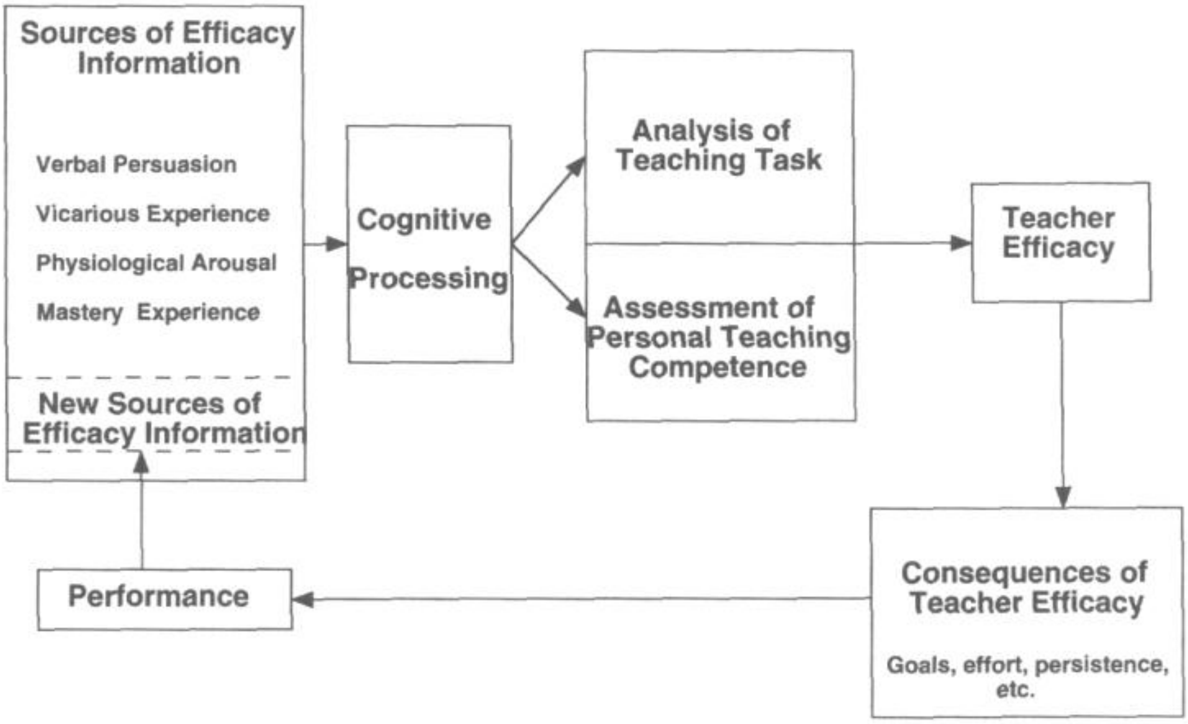

Figure 2.2 The cyclical nature of teacher efficacy

In this model, analysis of task refers to the process in which teachers produce inferences and making judgments about the factors such as difficulty of teaching task, students' abilities and motivation, appropriate instructional strategies, managerial issues, the availability and quality of instructional materials, and the physical conditions of teaching space. The other component of the model, personal teaching competence implies self-perceptions of current teaching functioning. Both analysis of task and personal teaching competence contribute to teacher efficacy and the consequences of it. According to Tschannen-Moran, Woolfolk-Hoy and Hoy, 1998, the most crucial thing that makes teacher efficacy so powerful is its cyclical nature. That is, if a teacher becomes proficient in teaching performance, it would create a new mastery experience, which shapes her future performance. According to this model, greater efficacy beliefs will result in greater effort and persistence leading to better performance, which in turn leads to greater efficacy. Therefore, teachers' teaching performance are considered to influence their sense of efficacy, and when completed, becomes the past and source of future efficacy beliefs. This process is likely to produce a stable set of efficacy beliefs for teachers (Tschannen-Moran, Woolfolk-Hoy & Hoy, 1998).

2.3.1 SSI teaching self-efficacy beliefs

Much of the research on SSI teaching have focused on teachers' beliefs and general opinions about including SSI in their science teaching. These studies have used different terms such as perceptions, critiques, challenges, perspectives and strategies although they mainly investigated teachers' and teacher candidates' beliefs and general opinions about including SSI in their science teaching. However, the number of research on teachers' self-efficacy beliefs about SSI teaching is very limited. In the following parts, first, studies about teacher beliefs and opinions about the inclusion of SSI were presented. Then, the studies on SSI teaching self-efficacy beliefs were reviewed.

Lee, Abd-El-Khalick, and Choi (2006) investigated Korean science teachers' perceptions of the introduction of SSI into the science curriculum. They specifically explored 86 teachers' (65% female) perceptions of the necessity of addressing SSI in science classrooms. Data were collected through a questionnaire involving Likert type and open-ended questions and semi-structured interview. Analyses of the data revealed that teachers perceived a need to address SSI positively. It was also reported that, although teachers articulated the need for SSI inclusion, only a small number of these teachers incorporate SSI in their science teaching. Similarly, Gayford (2002), in his case study for the professional development of science teachers aimed to reveal a small focus group of teachers' opinions about the inclusion of SSI. The study reported that the issue of global climate change offers a valuable context for the application of higher order abilities in science and foster students to develop nature of science understandings.

Barrett and Nieswandt (2010) aimed to explore teacher candidates' beliefs about including SSI, specifically teaching ethics through SSI, in physics and chemistry courses. In this qualitative study, 12 teacher candidates were interviewed at three times (at the beginning of the course, after the first practicum, and after the second practicum) during a 9-month long teacher education program in Canada. The participants' beliefs did not change significantly from the beginning of the study to the end. Similar to Lee et al.'s (2006) research study, most of the teacher candidates (10 of 12) articulated that SSI should be in science education. However, only four of them reported that they would include SSI when teaching. Two of the participants, who also stated that SSI should not be included in science education, mentioned that they would not use SSI in their science teaching. The rest of the participants responded to this question as "maybe" and "unlikely".

Similar to Barrett and Nieswandt's (2010) study, Sadler, Amirshokoohi, Kazempour, and Allspaw (2006) investigated teacher perspectives on the use of SSI and dealing with ethics in science classes. Data were collected through semi-structured interviews from 22 middle and high school science teachers. The study categorized teachers according to their perspectives and strategies related to the place of ethics in science and science education. Besides, how science teachers handle topics with ethical aspects and share their own viewpoints on the issues were the other considerations while categorizing the teachers. Findings revealed that Profile A teachers support the idea of using SSI in science teaching and gave examples of their own SSI experiences in the classroom. Profile B teachers also support SSI teaching however they articulated some constraints that make them hesitate to use SSI in science teaching. Profile C teachers were neutral about the idea of SSI inclusion. Profile D teachers proposed the idea that science and science education should be value-free. Finally, Profile E participants were the teachers who strongly believe that science education should develop students' ethical development. Majority of the teachers mentioned that they avoid sharing their own viewpoints about the issue being discussed. Moreover, according to the participant teachers, it is important to present both sides of an issue in science classrooms.

Cross and Price (1996) explored science teachers' attitude and commitments to teaching about controversial issues in classrooms. More specifically, the study tried to seek out how science teachers perceive the teaching of controversial issues in Scotland and US, and how they deal with expressing their own opinions and values associated with the issue. Cross and Price (1996) collected data through interviews from male and female teachers chosen from varying disciplines such as geology, general science, chemistry, biology, and environmental science. Findings revealed that all of the teachers reported dealing with controversial issues. There were more tendencies among biology teachers to incorporate controversial issues comparing to teachers from other disciplines. Moreover, similar to Sadler et al.'s (2006) study, most of the teachers advocate the idea that teachers should present both sides of the controversial issue. Although some of the teachers argue that teachers should be neutral and avoid sharing their personal positions, other teachers expressed that it is not realistic for teachers to exclude their values while discussing in the classroom. They further mentioned that values, including their own, are necessary aspects of SSI discussions.

Forbes and Davis (2008) investigated preservice teachers' critique and adaptation of SSI-related science curriculum materials and factors that mediate this process. Four preservice elementary teachers participated to the study in the context of an undergraduate method course during one semester. The data sources were interviews, responses to a hypothetical scenario, coursework, journals, and online discussion threads. During the interviews, the participants evaluated an inquiry based lesson plan focused on the effect of pesticides on ecosystems dynamics and trophic interactions. Results indicated that preservice teachers deployed multiple learning goals, and their own subject-matter knowledge, identity, and informal reasoning on SSI, in their critique and adaptation of curriculum materials associated with SSI. The researchers concluded that there is a need for educative curriculum materials in supporting new teachers.

Unlike to aforementioned studies which were generally intervention studies investigating teachers' opinions, perspectives, and perceptions on SSI inclusion, Bryce and Gray (2004), and Ekborg, Ottander, Silfver, and Simon (2013) examined science teachers' real experiences of implementing SSI in their regular teaching and specifically focused on the ways teachers use and the challenges they faced while teaching SSI. The former study investigated biology teachers' implementation of controversial issues by specifically focusing on the challenges they might face while teaching biotechnology issues such as genetic modification, cloning, and etc. after participating to a university summer school (aiming to update these teachers on recent biotechnological advances). 41 biology teachers who were the participants of the summer school completed to a questionnaire and ten of them were chosen to interview with. Besides, 61 students who were taught by these teachers were also interviewed. Findings indicated that both students and teachers find SSI as necessary and valuable. However, many of the teachers lack confidence in leading SSI discussions in the class. Bryce and Gray (2004) suggested that teachers are in need of more guidance and training on the issues; effective ways of handling the discussion of controversial material, techniques and learning strategies to manage conflict resolution in the classroom (especially on the issue of teacher neutrality), purposes and outcomes intended for the discussion of controversial issues, and clarity on the relationship between such discussion and what is formally assessed in the course.

As a more recent research, the latter study worked with 55 teachers by using a mixed-method research design. In the study, teachers were free to choose from the six SSI that the researchers prepared and to organize their lesson. The main goal was to reveal how teachers chose content, organized their work and experienced the students' interest and learning. To this end, teachers were administered a questionnaire and interviewed after the implementation of the issues. Results indicated that the teachers acknowledged the idea of SSI for science teaching however they reported their concerns about the reduced science content. The study also revealed that teachers considered knowledge as a set of facts that should be transmitted to the students and included elements of SSI but mostly to introduce the regular science content. Although the teachers were confident about their SSI teaching and did not feel uncomfortable with small group discussions and argumentation practices, they failed to develop explicit strategies for SSI teaching and they had some difficulties in facilitating the students' search for information, critical examination of arguments and use of media. Ekborg et al. (2013) concluded the paper by remarking on the pressure on teachers to prepare the students for national tests. They argued that this pressure on teachers may hinder the implementation of SSI since it increases the tension between covering the canonical content and developing other skills.

Although most of the SSI research with teachers and teacher candidates has investigated their general opinions about SSI inclusion and some of them investigated their confidence in teaching SSI in science teaching, there has been very limited number of studies exploring teachers' and PSTs' SSI teaching self-efficacy beliefs. For instance, Lee et al. (2006), in their study investigating Korean science teachers' perceptions of the introduction of SSI into science curriculum, aimed to reveal teachers' personal science teaching efficacy beliefs regarding SSI. To this end, the researchers used Likert type items that were adapted from STEBI instrument. One of the items included in the questionnaire was "I am able to use various teaching strategies to deal with socioscientific issues in science classes". Responses given by 86 teachers revealed that science teachers had low personal science teaching efficacy beliefs regarding SSI. According to the participating teachers, time considerations and lack of relevant instructional materials were the main constraints that hinder SSI teaching.

Similarly, Kilinc et al. (2013) aimed to explore the nature of PSTs' teaching efficacy beliefs regarding GM foods. In the study, the researchers asserted that PSTs' beliefs about GM foods, namely their risk perceptions, moral beliefs, religious beliefs, teaching efficacy beliefs and content knowledge compose a belief system. In this mixed design research study, data sources were the quantitative instruments regarding each of the variables and semi-structured interviews. 441 PSTs from eight universities responded to the instruments and a randomly-selected group of eight participants were interviewed individually. The results of the study revealed that participating PSTs had moderately high GM foods teaching efficacy beliefs. The researchers asserted that learning and teaching experiences, communication skills, vicarious experiences, emotional states, and interest in the topic were the sources of participants' GM foods teaching efficacy beliefs. Moreover, it was revealed that among the independent variables in the study, GM foods content knowledge and GM foods risk perception were the predictors of PSTs' teaching efficacy.

Kara (2012) investigated pre-service biology teachers' personal teaching efficacy beliefs related to teaching about SSI, and their perceptions on the necessity of introducing SSI into the classroom and factors that facilitate or impede addressing SSI in the classroom. A hundred and two pre-service biology teachers participated to the study over the course of one semester. The participants were asked to complete a questionnaire comprised of 20 five-point Likert-type items and 3 open-ended questions. The study reported that pre-service biology teachers had moderate personal teaching efficacy beliefs related to teaching about SSI. Besides, the participants perceived that there is a need to address SSI in the classroom. According to participating pre-service biology teachers, the main impediments that hinder SSI teaching were lack of instructional time, lack of readily available materials, difficulties associated with managing classrooms in which small-group discussions, role playing, and similar teaching strategies were employed, and difficulties associated with evaluating student performance, especially in relation to topics with moral and ethical dimensions.

Finally, Yahaya, Zain, and Karpudewan (2015) explored the effects of socioscientific instruction on preservice teachers' sense of efficacy for learning and teaching controversial family health issues. In this study, 251 preservice teachers were randomly assigned to experimental and control groups. The experimental group was taught the contents of the controversial family health issues using socioscientific instruction approach and the control group was taught the same content using a more traditional approach. Data were collected before and after the treatment through a quantitative instrument adapted from Teacher Sense of Efficacy Scale which was developed by Tschannen-Moran & Woolfolk (2001) and qualitative interviews. The findings revealed that the use of socioscientific approach to learning and teaching of controversial family health issues is effective to improve preservice teachers' sense of efficacy. In the study, the participating teacher candidates showed a considerable change from weaker to stronger sense of efficacy.

2.4 Personal Epistemological Beliefs and SSI Teaching Self-efficacy Beliefs

2.4.1 Personal epistemology and epistemological models

Epistemology is a branch of psychology which is concerned with the origins, nature, limits, methods and justification of human knowledge (Hofer, 2002). Epistemology mainly aims to investigate what knowledge is and how it is required, what people know, and how we know what we know (Hofer, 2002).

Personal epistemology concerns with beliefs about knowledge and knowing, the definition of knowledge, how knowledge is constructed and how learning occurs (Hofer, 2001). The study of personal epistemology began with the work of Perry (1968). Since then, different perspectives have been proposed regarding individuals' personal epistemological beliefs. The first line of work is developmental in nature arguing that individuals move through a sequence of development in their beliefs about knowledge and knowing. Within the group advocating this perspective, one group of researchers interested in how individuals interpret their own educational experiences (Baxter Magolda, 1992; Belenky, Clinchy, Goldberg, & Tarule, 1986; Perry, 1968, 1970) while the second group of researchers interested in the way epistemological assumptions affect the thinking and reasoning of individuals, especially focusing on reflective judgement (King & Kitchener, 1994; Kitchener & King, 1981; Kitchener, King, Wood, & Davison, 1989; Kitchener, Lynch, Fischer, & Wood, 1993) and argumentative reasoning (Kuhn, 1991, 1993). In the related literature, five major developmental models have been proposed: Perry scheme (Perry, 1968, 1970), research on "women's ways of knowing" (Belenky et al., 1986), the Epistemological

Reflection Model (Baxter Magolda, 1992, 2004), Reflective Judgment Model (King & Kitchener, 1994), and Kuhn's (1991) work of argumentative reasoning.

Perry (1968, 1970) developed the scheme of intellectual and ethical development basing on a series of open-ended interviews with undergraduate students. Through these interviews, the undergraduate students (31 first-year students including 27 men and 4 women) were asked their experiences during the four year of liberal art undergraduate education. Basing on the initial findings, Perry and his colleagues developed a scheme of intellectual and ethical development. The scheme was then administered to a randomly selected group of 109 first-year students (85 men, 24 women) following their four years of college.

Perry (1968) summarized his findings as:

> Within its own strictest limits, the study demonstrates the possibility of assessing, in developmental terms, abstract structural aspects of knowing and valuing in intelligent late-adolescents. Substantively, the study confirms the validity of one scheme of such development, showing it to be reliably evident as a theme common to all students' reports to be sampled (p. 5).

In this scheme of intellectual and ethical development, there were nine distinct stages, called as "positions", which were divided into four sequential categories: dualism, multiplicity, relativism, and commitment within relativism (Hofer & Pintrich, 1997).

> Dualism: Including Positions 1 and 2, dualisms refers to individuals who view knowledge as either right or wrong and believe that there is a completely unquestioned view of truth with no tolerance for different points of view.

> Multiplicity: Including Position 3 and 4, different from dualism, multiplicity involves the recognition of diversity and uncertainty and refers to individuals who believe that all views are equally valid and each person has a right to his or her own opinion.

Relativism: Including Position 5 and 6, relativism refers to individuals who shifted from a dualistic view of the world to a view of contextual relativism and the major shift is in the perception of self as an active maker of meaning. At this position, individuals perceive knowledge as relative, contingent, and contextual and begin to realize the need to choose and affirm one's own commitments.

Commitment within relativism: Including Position 7 through 9, commitment within relativism reflect a focus on responsibility, engagement, and the forging of commitment within relativism. Individuals in that category make and affirm commitments to values, careers, relationships, and personal identity (Hofer & Pintrich, 1997).

Perry's (1968) scheme, comprising of the dualistic, multiplistic, relativistic point of views, was an important contribution to the epistemology literature. He mainly proposed in this scheme that undergraduate students made meaning of their educational experiences as a reflection of a progressive developmental process (Hofer & Pintrich, 1997). Despite some limitations such as choosing the participants from a group of white, elite, and male undergraduate students at Harvard, his work was an important initiative in the field of personal epistemology.

Research on women's ways of knowing (Belenky et al., 1986) was emerged as a new developmental model of epistemological beliefs after the criticisms about Perry's study in the late 1970s that its generalizability was limited only to a group of elite male college students in Harvard. Belenky et al. (1986) aimed to investigate women's ways of knowing and describe women's perspectives of truth, knowledge, and authority. In their study, 135 women across different ages, class and ethnic backgrounds, and educational histories were interviewed.

The epistemological categories, which are silence, received knowledge (voice of others), subjective knowledge (the inner voice), procedural knowledge (the voice of reason), and constructed knowledge (integrating the voice), proposed by Belenky et al. (1986) organized around the metaphor of voice. Silence refers to “a position in which women experience themselves as mindless and voiceless and subject to the whims of external authority”; received knowledge refers to “a perspective from which women conceive of themselves as capable of receiving, even reproducing, knowledge from the all-knowing external authorities but not capable of creating knowledge on their own”; subjective knowledge refers to “a perspective from which truth and knowledge are conceived of as personal, private, and subjectively known or intuited”; procedural knowledge refers to “a position in which women are invested in learning and applying objective procedures for obtaining and communicating knowledge”; and finally constructed knowledge refers to “a position in which women view all knowledge as contextual, experience themselves as creators of knowledge, and value both subjective and objective strategies for knowing” (Belenky et al., 1986, p. 15).

Although Belenky et al.’s (1986) study was criticized for selecting a single women group, their work revealed important key points about women epistemology, widening the perspectives of Perry (1968). The main distinction between Perry’s work and the study of Belenky et al. was considered as that, Perry’s positions were descriptive of the nature of knowledge and truth while the latter emphasized on the source of knowledge and truth (Hofer & Pintrich, 1997).

As the other developmental model of personal epistemology, Epistemological Reflection Model (Baxter Magolda, 1992) described the stages of epistemological development proposing changes in terms of complexity and reflective thinking. Baxter Magolda initiated a 5-year longitudinal study with 101 undergraduate and graduate students (51 females, 50 males) in 1986. She conducted annual open-ended interviews and administrated Measure of Epistemological Reflection (MER). Different from the earlier work, the group Baxter Magolda studied with was comprised of individuals from both genders.

Epistemological Reflection Model included four different "ways of knowing": absolute, transitional, independent, and contextual. Absolute knowers "view knowledge as certain and believe that authorities have all the answers"; transitional knowers "discover that authorities are not all-knowing and begin to accept the uncertainty of knowledge"; independent knowers question authority as the only source of knowledge and begin to hold their own opinions as equally valid"; contextual knowers "are capable of constructing an individual perspective by judging evidence in context" (Hofer & Pintrich, 1997, p. 98). The developmental patterns for absolute knowing was ranged from receiving (used more often by women) to mastery (used more often by men), for transitional knowing students tend to make a more interpersonal (common among women) or impersonal (common among men) approach, for independent knowing from interindividual (more prevalent among women) to individual (more prevalent among men) and finally gender patterns in the contextual knowing was converged (Buehl, 2003).

The work of Baxter Magolda is important in that, it is a longitudinal study which revealed gender-related patterns of epistemological development by including both males and females in the sample. Other than only investigating how epistemological assumptions influence interpretations of educational experiences, Baxter Magolda's (1992) model included a number of beliefs that were not epistemological such as beliefs about the role of learner, peers, instructors, and beliefs about evaluation (Hofer & Pintrich, 1997).

Reflective Judgment Model, developed by King and Kitchener (1994), derived from the results of a longitudinal study lasted 15 years. While developing the model, King and Kitchener (1994) based on the work of Perry (1970) and Dewey (1933)'s reflective thinking. In this study, they interviewed with individuals varied from high school students to middle-aged adults. Through the interviews, the participants were asked to express and justify their viewpoints and responses to four ill-structured problems. The four ill-structured problems were about how the pyramids were built, the safety of chemical additives in food, the objectivity of news reporting, and the issue of creation and evolution (Hofer & Pintrich, 1997).

Reflective Judgment Model examined individuals' views on knowledge and justification and the relationship between their epistemological assumptions and the way they make reflective judgments about ill-structured problems (King & Kitchener, 1994, 2004). There are seven developmental stages in the model and each step shows different epistemological perspectives (King & Kitchener, 1994, 2004). The seven developmental stages classified into three levels: Pre-reflective thinking (Stages 1-3), quasi-reflective thinking (Stages 4-5), and reflective thinking (Stages 6-7). Pre-reflective judgement means for the view that cannot differentiate between well-defined and ill-defined problems and consider the knowledge as certain and gained by authority. Quasi-reflective judgement refers to the view that can recognize the uncertaintly in the process of knowing and propse different viewpoint on controversial issues. However, individuals from this group still fail to recognize the link among how evidence is gained and a conclusion is made. Finally, reflective thinking refers to the view of being aware of uncertainy, providing evidence to support judgments, and open to reconsider proposed claims and conclusions (King & Kitchener, 1994, 2004).

Similar to Perry's work, Reflective Judgment Model suggest the presence of certain developmental stages starting from the view assuming knowledge is certain and given by authority to the view assuming the knowledge as uncertain and using evidence in their knowledge claims while reasoning on controversial problems. However, Reflective Judgment Model was criticized due to the reasons that the controversial problems used in the study were not based on school knowledge (Buehl, 2003) and the initial aim was not to develop a personal epistemology model (Hofer & Pintrich, 1997).

As the last developmental model of personal epistemology in the literature, Kuhn's (1991) work of argumentative reasoning addressed the epistemological nature of solving ill-structured problems and worked on informal reasoning as an attempt to explore how individuals respond about everyday situations. Unlike the previous studies, Kuhn conducted interviews with a broader sample involving participants from four age groups; teens, 20s, 40s, and 60s. In the interview, Kuhn (1991) asked questions about three current urban social problems which are: “(a) what causes prisoners to return to crime after they’re released?, (b) What causes children to fail in school?, (c) What causes unemployment?” (p. 98). Participants were expected to justify their position as well as propose an opposite view with providing the rebuttal to that position.

In Kuhn’s model, it was suggested that there are three categories of epistemological views; absolutist, multiplist, and evaluative. According to absolutist view, knowledge is certain and absolute and facts and expertise are the basis for knowing. On the contrary, multiplists are doubtful about expertise and do not believe the possibility of expert certainty considering that ones’ view may be as valid as an expert’s view. Similarly, in evaluative view, certainty of knowledge is not accepted. However, according to this view, individuals are not as certain as the experts and viewpoints can be compared and evaluated (Hofer & Pintrich, 1997).

Kuhn’s work did not found a significant gender or age differences but revealed that there is a relation between educational background and epistemological level, such that, as the educational level increases, participants are more likely to be in the evaluative category and less likely to be an absolutist. According to the further research conducted by Kuhn aiming to investigate the relation between epistemologies and argument skills, three argument skills were emerged: generation of genuine evidence, generation of alternative theories, and generation of any form of counterargument (Hofer & Pintrich, 1997). She argued that those holding the evaluative view are more likely to generate counterargument and alternative theory generation which let Kuhn to conclude that “it is primarily the emergence of the evaluative epistemology that is related to argumentative skill development” (Kuhn, 1991, p. 195).

Although Kuhn’s work catch researchers’ attention since it focused on ill-structured problems from daily life and the sample of the study was broad, it was criticized that she offered little information about the validation of the scheme. Also, according to Buehl and Alexander (2001), problems used in the interview were nonacademic and it was related more to the general knowledge beliefs rather than the academic knowledge beliefs. Epistemological development models mentioned so far were displayed in Table 2.1.

Unlike the developmental models of personal epistemology discussed so far, the second line of work suggests that personal epistemology is a system of more-or-less independent beliefs (Schommer, 1989, 1990). As aforementioned, developmental models assert the idea that personal epistemology of individuals is unidimensional. However, in this second approach, which also draws on Perry's work, personal epistemology is multidimensional. Schommer (1989, 1990, 1994) did not organized personal epistemology into positions or stages, but according to this approach, epistemological beliefs are conceptualized as a system of more or less independent beliefs. By system of beliefs, it was meant that "there is more than one belief to consider in personal epistemology" (Schommer-Aikins, 2002, p. 104). By more or less independent beliefs, Schommer meant "it cannot be assumed that beliefs mature in synchrony" (Schommer-Aikins, 2002, p. 104).

Table 2.1

Models of Epistemological Development in Late Adolescents and Adulthood

Intellectual and ethical development (Perry)	Women's ways of knowing (Belenky et al.)	Epistemological reflection (Baxter Magolda)	Reflective judgment (King and Kitchener)	Argumentative reasoning (Kuhn)
Positions	*Epistemological perspectives*	*Ways of knowing*	*Reflective judgment stages*	*Epistemological views*
Dualism	Silence	Absolute knowing	Pre-reflective thinking	Absolutist
	Received knowledge			
Multiplicity	Subjective knowledge	Transitional knowing		Multiplists
Relativism	Procedural knowledge	Independent knowing	Quasi-reflective thinking	Evaluatist
	(a)Connected knowing			
	(b)Separate knowing			
Commitment within relativism	Constructed knowledge	Contextual knowing	Reflective thinking	

Note: Stages and positions are aligned to indicate similarity across the five models. Adapted from "The development of epistemological theories: Beliefs about knowledge and knowing and their relation to learning," by B. K. Hofer and P. R. Pintrich, 1997, *Review of Educational Research, 67*(1), p. 92.

In her research study, Schommer (1990) asserted that epistemological beliefs system is composed of five more or less independent beliefs and included beliefs about; “(a) the stability of knowledge, ranging from tentative to unchanging; (b) the structure of knowledge, ranging from isolated bits to integrated concepts; (c) the source of knowledge, ranging from handed down by authority to gleaned from observation and reason, (d) the speed of knowledge acquisition, ranging from quick-all-or-none learning to gradual learning, and (e) the control of knowledge acquisition, ranging from fixed at birth to life-long improvement” (p. 499). Schommer (1990) developed a quantitative epistemological beliefs questionnaire and administered it to a sample of 117 junior college students and 149 university students, either freshman or sophomores in nearly equal number of men and women. The questionnaire included 63 Likert-type items (28 negative and 35 positive items) ranging from 1 (strongly disagree) to 5 (strongly agree). The 63 items of the questionnaire were grouped into 12 different subsets. The questionnaire was constructed into five hypothesized dimensions: (1) Simple Knowledge, derived from “structure of knowledge”, referring to “knowledge is simple rather than complex”, (2) Omniscient Authority, derived from “source of knowledge” referring to “knowledge is handed down by authority rather than derived from reason”, (3) “Certain Knowledge”, derived from “certainty of knowledge” referring to “knowledge is certain rather than tentative”, (4) Innate Ability, derived from “control of knowledge” referring to “the ability to learn is innate rather than acquired”, (5) Quick Learning, derived from “speed of learning” referring to “learning is quick or not at all” (Schommer, 1990, p. 499). Explanatory factor analysis results revealed four of these five hypothesized beliefs which are Innate Ability, Simple Knowledge, Quick Learning, and Certain Knowledge (Schommer, 1990).

Schommer continued to publish research studies on personal epistemology in the following years. In 1994, she developed a theoretical framework proposing the following assertions:

1) Personal epistemology may be conceptualized as a system of beliefs that is personal epistemology is composed of more than one belief.
2) Beliefs within the system are more or less independent, that is, it cannot be assumed that beliefs will be maturing in synchrony.
3) Epistemological beliefs are better characterized as frequency distributions rather than dichotomies or continuums.
4) Epistemological beliefs have both indirect and direct effects.
5) Whether epistemological beliefs are domain general or domain independent will vary over time for any particular individual.
6) Epistemological belief development and change is influenced by experience. These experiences include engaging in problem solving and learning from family, friends, formal education, and life experiences (Schommer-Aikins, 2002, p. 106).

Schommer's (1990) epistemological questionnaire provided the base for other researchers to both administer the instrument to validate it or develop new personal epistemology instruments in different contexts (e.g. Jehng, Johnson, & Anderson, 1993; Kardash & Scholes, 1996; Schommer, 1993; Schommer, Crouse, & Rhodes, 1992; Schraw, Dunkle, & Bendixen, 1995; Yilmaz-Tuzun & Topcu, 2008). The factor analysis in these studies revealed multidimensionality of personal epistemology. For instance, Yilmaz-Tuzun and Topcu (2008) conducted their study in Turkish context with PSTs in five public universities to explore the relationship between PSTs' epistemological beliefs, epistemological world views, and self efficacy beliefs. The factor analysis of SEQ revealed four factors: Innate Ability, Simple Knowledge, Certain Knowledge, and Omniscient Authority. The emergence of Omniscient Authority factor may due to the cultural difference which may supported the view of multidimensionality of personal epistemology as proposed by Schommer (1990, 1994). Similarly, the epistemological beliefs questionnaire that was developed by Bendixen, Schraw, and Dunkle (1998) revealed multiple factors of epistemological beliefs. In their study, researchers constructed items basing on the criteria for each of the five epistemic factors described by Schommer (1990). In the present study, this epistemological questionnaire was used to collect data about PSTs' epistemological beliefs.

As for the other personal epistemology models, there have been some criticisms about Schommer's proposed model. According to Hofer and Pintrich (1997), construct validity of the two factors in Schommer's questionnaire is problematic. The researchers argued that the two factors fixed ability and quick learning are not epistemological dimensions but more about beliefs about intelligence. In addition, according to them, these two dimensions are not focusing on the nature of knowledge and knowing but more on the nature of learning. Nevertheless, Schommer's work on personal epistemology possesses major importance in personal epistemology literature. Schommer's paper and pencil epistemological beliefs instrument made her the initiator of quantitative research in this area and has given researchers chance to do empirical investigation. In addition, Schommer's work was different from the previous works in that epistemological beliefs were conceptualized as a system that are more or less independent rather than following certain developmental stages. Existing models of epistemological beliefs and their details were displayed in Table 2.2.

Table 2.2

Components from Existing Models of Epistemological Beliefs and Thinking

	Core dimensions of epistemological theories		Peripheral beliefs about learning, instruction, and intelligence	
Researcher(s)	Nature of knowledge	Nature of knowing	Nature of learning and instruction	Nature of intelligence
Perry	Certainty of knowledge: Absolute ↔ Contextual relativism	Source of knowledge: Authorities ↔ Self		
Belenky et al.		Source of knowledge: Received ↔ Constructed Outside the self ↔ Self as maker of meaning		
Baxter Magolda	Certainty of knowledge: Absolute ↔ Contextual	Source of knowledge: Reliance on authority ↔ Self Justification for knowing: Received or mastery ↔ Evidence judged in context	Role of learner Evaluation of learning Role of peers Role of instructor	

Table 2.2 (Continued)

Researcher(s)	Core dimensions of epistemological theories: Nature of knowledge	Core dimensions of epistemological theories: Nature of knowing	Peripheral beliefs about learning, instruction, and intelligence: Nature of learning and instruction	Peripheral beliefs about learning, instruction, and intelligence: Nature of intelligence
King & Kitchener	Certainty of knowledge: Certain, right/wrong ↔ Uncertain, contextual Simplicity of knowledge: Simple ↔ Complex	Justification for knowing: Knowledge requires no justification ↔ Knowledge is constructed, and judgments are critically reevaluated Source of knowledge: Reliance on authority ↔ Knower as constructor of meaning		
Kuhn	Certainty of knowledge: Absolute, right/wrong answers ↔ knowledge evaluated on relative merits	Justification for knowing: Acceptance of facts, unexamined expertise ↔ evaluation of expertise Source of knowledge:Experts ↔ Experts critically evaluated		

Table 2.2 (Continued)

Researcher(s)	Core dimensions of epistemological theories		Peripheral beliefs about learning, instruction, and intelligence	
	Nature of knowledge	Nature of knowing	Nature of learning and instruction	Nature of intelligence
Schommer	Certainty of knowledge: Absolute ↔ Tentative and evolving Simplicity of knowledge: Isolated, unambiguous bits ↔ Interrelated concepts	Source of knowledge: Handed down from authority ↔ Derived from reason	Quick learning	Innate ability

Note: Adapted from "The development of epistemological theories: Beliefs about knowledge and knowing and their relation to learning," by B. K. Hofer and P. R. Pintrich, 1997, *Review of Educational Research, 37*(1), p. 113-115.

2.4.2 Relationships between personal epistemological beliefs and SSI teaching self-efficacy beliefs

Research has shown that teachers' beliefs play a major role in their teaching practices (e.g. Pajares, 1992; Richardson, 1997; Tanase & Wang, 2010). Personal epistemological beliefs, a specific belief construct, have been considered to affect teaching (Olafson & Schraw, 2006; Sinatra & Kardash, 2004). Although there is a need to conduct more research on the relationship between personal epistemological beliefs (beliefs about knowledge and knowing) and teaching, the studies thus far revealed that teachers' personal epistemological beliefs influence instructional orientations and teaching competence (Brownlee, 2003; Chan & Elliott, 2004; Cheng, Chan, Tang, & Cheng, 2009; Hashweh, 1996; Hofer & Pintrich, 1997; Olafson & Schraw, 2006). There are also studies which investigated and reported relationships among scientific epistemological beliefs and teaching self-efficacy beliefs (e.g. Bahcivan, 2014; Kazempour & Sadler, 2015); however, the following section focuses on the research studies that examine the relationships among personal epistemological beliefs and teaching self-efficacy beliefs.

For instance, Sosu and Gray (2012) aimed to investigate the extent to which preservice teacher education fosters epistemic belief change and to which epistemic beliefs influence preservice teachers' instructional preferences and teaching competence in a school context. In this longitudinal study, the participants completed a questionnaire within the first year of their teacher education programme in the year 2005 and at the end of their programme in 2009. Results revealed that there was a change in the participants' epistemic beliefs. That is, participants holding slightly sophisticated views at the beginning were likely to record a significantly higher level of sophisticated belief at the end of the programme. Moreover, the study reported that epistemic beliefs significantly predicted preservice teachers' instructional preferences. Finally, results of the study showed that one of the dimensions of the epistemic beliefs, beliefs about source of knowledge, had an effect on the participants' teaching competence. This finding revealed that preservice teachers who had sophisticated epistemic beliefs in source of knowledge tend to be more competent in teaching comparing to those who had naïve epistemic beliefs.

Similarly, Yilmaz-Tuzun and Topcu (2008) explored the relationships among PSTs' personal epistemological beliefs, epistemological world views, and self-efficacy beliefs. 429 PSTs were administered three main instruments which were; Schommer Epistemological Questionnaire (Schommer, 1990), the Epistemological World Views Scale (Schraw & Olafson, 2002), and the Science Teaching Efficacy Belief Instrument (Riggs & Enochs, 1990). The epistemological beliefs instrument was comprised of four factors; Innate Ability, Simple Knowledge, Certain Knowledge, and Omniscient Authority. In addition, The self-efficacy beliefs instrument involved the dimensions Personal Science Teaching Efficacy Belief Scale (self-efficacy dimension) and Science Teaching Outcome Expectancy Scale (outcome expectancy dimension). In this study, the researchers hypothesized that PSTs' personal epistemological beliefs, epistemological world views, and self-efficacy beliefs to teach science can be related and this relation could be in any direction. Through multiple regression analyses, Yilmaz-Tuzun and Topcu (2008) tried to explore how each of the four factor scores (Innate Ability, Certain Knowledge, Simple Knowledge, Omniscient Authority) generated for PSTs' epistemological beliefs can be predicted from a linear combination of self-efficacy, outcome expectancy, and epistemological world view. The results suggested that for Innate Ability dimension, three of the predictor variables (self efficacy, outcome expectancy, and world view) contributed significantly to the model. For Simple Knowledge, only the predictor variable epistemological world view contributed significantly to the model. For Certain Knowledge, only outcome expectancy variable contributed significantly to the model. Finally, it was revealed that none of the predictor variables significantly contributed to the Omniscient Authority dimension of personal epistemological beliefs.

Unlike to these studies, Fernandez (2009) reported no correlations between epistemological beliefs and teaching efficacy. In this dissertation study, it was sought to determine the extent to which epistemological beliefs in Certain Knowledge and

Omniscient Authority predicted teachers' general teaching efficacy. Fernandez (2009) studied with 107 teachers in a medium-sized school in US and used descriptive and correlational research design. Data were collected through a 22-item quantitative instrument including demographic items (gender and years of experience), 13 items comprising two of the five subscales on the 32-item Epistemic Beliefs Inventory developed by Schraw et al. (1995), and seven items constituting the General Teaching Efficacy subscale of 16-item Teacher Efficacy Scale developed by Gibson and Dembo (1984). The results of the study revealed no significant relationships among epistemological beliefs and teacher efficacy (significance levels were .45 for Certain Knowledge and .07 for Omniscient Authority).

2.5 Risk and Benefit Perception regarding SSI and SSI Teaching Self-efficacy Beliefs

2.5.1 Risk and benefit perception regarding SSI

In the late twentieth and early twenty-first centuries, science and its associated products and technologies increasingly challenged people with new uncertainties and risks (Christensen & Fensham, 2012). The issues incorporating these uncertainties and risks could be exemplified as; global climate change, GM foods, and nuclear power usage, which are commonly referred to as SSI.

Research has revealed that individuals' risk perceptions about new and unfamiliar issues shape their acceptance and behaviors (Beck, 1992; Shaw, 2002). In addition to risk perceptions, whether individuals perceive an issue as beneficial or not could also determine the way they approach to controversial issues and their acceptance as well (Gardner & Jones, 2011; Verdurme & Viaene, 2003).

Although limited in number, there are studies in the literature investigated individuals' risk and benefit perceptions regarding issues such as GM foods, nuclear power plants, nanotechnology or other technology-related issues. Rather than examining students' or teachers' perceptions, the studies generally focused on adult understanding or perceptions of SSI. Besides, comparing to SSI benefit perceptions, SSI risk perceptions were more frequently studied by the researchers.

For instance, Rinkevicius (2000) explored public risk perceptions of a nuclear power plant, Ignalina power plant, in Lithuania. In the study, a series of surveys were administered to adults from different groups in the society. The target groups were inhabitants and public authorities of the county where nuclear power plant is located, experts in the field of energy and environmental policy, and employees of the nuclear power plant. The surveys were basically tried to explore people's attitudes toward risks associated with the nuclear power plant, the degree of psychological discomfort felt, and opinions about the urgency of the need to phase-out the nuclear power plant. It was reported in the study that according to the majority of the participants (73%), the Ignalina nuclear power plant that was dangerous. In addition, nearly %50 of the respondents in Lithuania always or often feels psychological discomfort due to Ignalina. Participants who fully or partially agree that Ignalina nuclear power plant has to be stopped immediately before it is not too late varied from region to region in Lithuania (between 35% and 60%).

Similarly, Shaw (2002) investigated public understandings of SSI (GM foods) in a research study. In the study, data were collected in mainly two phases: Firstly, interviews were conducted with experts from the food and biotechnology industries, government and advisory bodies, food science and technology organizations, academic and research institutes, public interest groups, and the media. Secondly, in order to explore the lay understandings of food risks, interviews were conducted with a range of people in Bristol and the surrounding rural areas. The results revealed that most of the participants possessed risk perception of GM foods. The majority of the older people perceive GM foods especially for younger generations. Besides, female participants articulated that they were opposing to use GM foods in baby food and tried to avoid using GM products for the purpose of feeding their children or grandchildren.

Gaskell et al. (2004) explored Europeans' risk and perception perceptions regarding GM foods. The survey data included the responses of 1000 people in each of 17 European countries. They used data from the Eurobarometer survey on biotechnology and qualitative interviews as well to explore the hypothesis that it is not so much the perceptions of risks as the absence of benefits that is the basis of the widespread rejection of GM foods and crops by the European public. In Eurobarometer survey, respondents were asked whether they thought each of seven biotechnologies was useful for society, risky for society, morally acceptable and whether it should be encouraged. The response alternatives were four-point scales from definitely agree to definitely disagree. The seven applications asked in the survey were; genetic testing, cloning human cells and tissues, cloning animals, environmental remediation, GM medicines, GM crops, and GM foods. The results revealed four groups of respondents in respect to risk and benefit perceptions. Those who possess the perception that GM foods are both useful and risky were categorized under the group "tradeoff" while respondents who had the idea that GM foods are useful but not risky were grouped as "relaxed". On the other hand, those who articulated that GM foods are not useful and risky were called as "skeptical", while the respondents who were saying that GM foods are not useful and not risky were called as "uninterested". The "tradeoff" group was totally 18% of the participants while the "relaxed" group was 14%. Besides, the "skeptical" group constituted 62% of the sample and "uninterested" group constituted 6%. As can be seen from the findings of this study, most of the Europeans (80%) perceive GM foods as risky, while the remaining 20% perceive this issue as beneficial.

Traill (2004) explored adults' GM foods benefit and risk perceptions and their antecedents by collecting data from 372 respondents from US, UK, and France. The researchers used a quantitative scale to collect the data for the study. GM foods risk and benefit perceptions were examined under different categories such as risks to business (farmers, agribusiness, etc.), benefits to business, risks and benefits to the environment, risks and benefits to the developing world, and risks and benefits to self and family. The study also aimed to analyze the extent to which the dimensions of risk-benefit perceptions can be explained by general attitudes widely used to explain food purchase behavior (such as general attitude to the environment, to technology, etc.), as well as by perceived knowledge of GM, level of education, and trust in various sources of information. Findings revealed that, in all the three participating countries, respondent had a moderate level of GM products risk perceptions. In addition, attitude to technology is the most important determinant of GM foods risk perception. That is, respondents' who possessed positive attitude to technology had a positive attitude to GM technology as well. Moreover, level of education to and increased trust to government and food industry were positively correlated to GM food benefit perception. The most important risks revealed in the three locations were perceived self and family risks, and perceived environmental risks.

Unlike to previously mentioned studies, Bonaccorsi et al. (2010) investigated 502 secondary school students' GMO risk perceptions in Italy. They used a quantitative questionnaire which was adapted from Eurobarometer (2005). The study mainly aimed to explore the relationship between the social status and cultural capital of the students' families and their food choices. In the study, it was reported that 63.5% of the participants considered GM foods as a danger to future generations. In addition, 13.5% of the participants articulated that the food they eat would not be a risk for their health. Moreover, according to the findings, students' knowledge about GMOs was confused and rather than the cultural capital and social class of the family, students' answers were more related to the type of school they attended. The authors suggested that schools should promote students' knowledge in order to make informed decisions about controversial issues, such as GMOs.

Another study exploring similarly students' beliefs about risks and benefits of nuclear power was conducted by Kilinc, Boyes, and Stanisstreet (2013). In the study, a questionnaire comprised of four main parts was used. The first part in the questionnaire included 3 items asking students whether they would be willing to pay more for electricity made from nuclear power stations, whether they would pay more if everyone else did, and whether they would be prepared to live near a nuclear power station. The second part of the questionnaire included the main questions which aimed to reveal out students' beliefs about the advantages (benefits) and disadvantages (risks) of nuclear power generation. Finally, the third part contained items related to students' views about the importance of possible characteristics of power generation. In total 2253 students across different grades (Grades 6-10) responded to the questionnaire in three cities in Turkey. The selected cities were chosen on purpose that, they have different prospects of having a nuclear power plant built in their vicinity. The first city, Kirsehir, is a city in central Turkey and there are no current plans for constructing a nuclear power plant at this location. The second city, Sinop, is a city to the north, on the Black Sea coast, and some investigations have been carried out to determine the feasibility of constructing a nuclear power plant near this city. Finally, the third city, Mersin, is a city on the Mediterranean coast, and there have been proposals to site one of Turkey's first nuclear power plants near this location. According to the findings, about half of the participating students believed that nuclear power plants would provide continuous and sufficient electricity, and a few students thought that nuclear power plants may reduce global warming. However, about around three quarters considered that nuclear power plants could give harm to living beings nearby and affect global warming negatively. Finally, it was reported in the study that, students from the cities most likely to have nuclear power plant were more tend to believe negative characteristics of the nuclear power plants.

Sahin and Ekli (2013) also investigated Turkish middle school students' awareness, opinions, and risk perceptions on a controversial issue. In this study, nanotechnology was chosen as the issue being examined. In total, 1396 students across 6^{th}, 7^{th}, and 8^{th} grades responded to a questionnaire which was developed by the researchers. The study reported that almost half of the students (47%) stated that the benefits of nanotechnology outweigh its risks. In addition, it was revealed that, 74 % of the students had some awareness of nanotechnology and 7th and 8th graders were more aware of it than 6th graders. Another interesting finding was that students' grade level, science course achievement, and emotions to nanotechnology significantly influenced their risk perceptions regarding nanotechnology.

2.5.2 Relationships between risk and benefit perception regarding SSI and SSI teaching self-efficacy beliefs

With the inclusion of open-ended SSI into science education, it has been proposed that science teachers need to develop new pedagogies (Christensen & Fensham, 2012). Given the nature of SSI, risk and trust are the two important characteristics of this new paradigm (Christensen & Fensham, 2012). In addition to the need for teachers to be qualified to incorporate risk into students' science learning, it is also of great importance to examine how teachers' risk and benefit perceptions are related to their SSI teaching self-efficacy beliefs. As aforementioned, teachers' beliefs and perceptions regarding controversial issues are the potential factors that might influence their teaching practices, instructional choices and strategies, and teaching self-efficacy beliefs as well (Fischoff, Slovic, & Lichtenstein, 1978; Prokop, Leskova, Kubiatko, & Diran, 2008; Sjöberg, 2002). Keeping in mind that there is very limited number of studies on risk and benefit perceptions in science education, in the following part, studies investigated teacher risk-benefit perceptions and teaching self-efficacy beliefs thus far were reviewed.

Cross and Price (1996), in their study investigating the perceptions of teachers on the teaching of controversial issues, the problem of handling personal value positions in the class, and the tension that exists between traditional value-free science education and the teaching of controversial issues interview with 12 teachers from the fields of environmental science and geography, physics, biology and general science teacher in two different English-speaking countries, Scotland and US. Their study revealed that although it was interpreted as doubtful by the authors, great majority of the participating teachers reported dealing with controversial issues in their classes. Also, Cross and Price (1996) reported variety of responses to the question about teachers' personal value positions in the class. While some of the teachers thought that they should be able to express their own opinions freely, other noted that teachers may not want to share his/her personal opinions. According to Cross and Price (1996), teachers should explain their opinions in terms of evidence and reasoning which informs their opinions. Finally, the teachers were asked about teaching controversial issues in a value-free science and their thoughts about student learning of "real science" by studying controversial issues. Although most of the teachers considered this as very difficult, one of the teachers articulated that it is one of the important responsibilities of her to teach social, political and economic implications of science to teach science. In addition, she was quite willing to raise students as knowledgeable but at the same time socially aware. Cross and Price (1996) concluded that although most of the teachers indicated that they are teaching controversial issues in their classes, this is being done within the context of traditional science teaching. Therefore, teachers should urgently be provided with a framework with which they can produce teaching resources that deal with controversial issues. It was also asserted in the study that teachers possessing concern about controversial issues and the desire to raise future generations as aware of the complex interrelationships among science and society would be more willing to teach these issues in their classes.

Herr, Telljohann, Price, Dake, and Stone (2012) investigated high school health-education teachers' perceptions and practices related to teaching HIV prevention. In total, 400 high school health teachers that were randomly selected in US were administered a questionnaire. The questionnaire was developed by the researchers and aimed to reveal out high school health education teachers' attitudes and perceptions related to HIV prevention education and also their practices. Data analysis was carried out through descriptive analysis and multiple regression analysis. The study reported that 99% of the participating teachers considered HIV prevention instruction as a need. In addition, teachers' preparation, training, and years of experience teaching health education were the significantly related predictors of teacher attitudes and perceptions about teaching HIV prevention. Moreover, teachers in states with a mandate requiring HIV instruction reported higher efficacy expectations and perceived more benefits than those teachers in states without such a mandate. The study concluded that, since teachers who reported the least experience teaching health education had the least supportive attitudes, perceived the most barriers, and had the lowest efficacy and outcome expectations related to teaching about HIV prevention, teacher preparation and training are of great importance to promote teachers about implementing such issues in the classrooms.

In another study, Kilinc et al. (2013), in their study examining PSTs' SSI teaching self-efficacy beliefs, assumed that beliefs about GM foods (content knowledge, risk perceptions, moral beliefs, and religious beliefs) and their teaching efficacy beliefs about this topic constitute a belief system, and these beliefs are interrelated due to core educational beliefs. In order to test their assumption, they administered quantitative instruments for each of these variables to 441 PSTs from eight universities in Turkey. Besides, they interviewed with eight of the participants that they selected randomly. The results revealed the sources of PSTs' SSI teaching self-efficacy beliefs and its predictor factors. The sources of PSTs' efficacy beliefs were learning and teaching experiences, communication skills, vicarious experiences, emotional states, and interest in the topic. In addition, the predictors of SSI (GM foods) teaching self-efficacy beliefs were revealed to be GM foods content knowledge ($r = .34$, $p <0.001$) and GM foods risk perception ($r = .34$, $p <0.001$). Kilinc et al. (2013) concluded that traditional teaching epistemologies and values regarding science teaching teachers possess are the important core beliefs which influence the relationship among the proposed variables and SSI teaching self-efficacy beliefs.

Finally, Gardner and Jones (2011) investigated science instructors' perceptions of the risks of biotechnology and discussed the results in the context of understanding teacher risk perception on science pedagogical practice. To this end, the researchers selected a convenient sample of 91 science educators from four groups; preservice science teachers ($n = 31$), inservice science teachers ($n = 20$), biology graduate teaching assistants ($n = 23$), and university biology professors ($n = 17$). The participants were administered to instruments: Risk Perception Survey and Risk Card Sort Task. The instruments were used to explore participating science educators' structure of risk perception and factors contributing to this structure. The results indicated that while the teacher groups were similar along many aspects of risk perception of biotechnology; they were concerned with the impact of technology and how the benefits for the particular biotechnology application might mediate the risks. Although to a lesser extent, university professors also pointed out the importance of benefits. They tended to make a distinction between biotechnology which was oriented toward solving a previous social concern versus those that were involving the creation of new biological material. In addition to examining risk perception structures, the study revealed the factors contributing to these structures by comparing the means for individuals' worldviews both between and within samples. Within group differences showed that worldviews belonging to the pre-service teachers, graduate teaching assistants, and undergraduate professors tended to be more hierarchical and less fatalist. On the other hand, in the between-group analysis the preservice teachers were significantly more fatalistic than the professors, and the graduate teaching assistants were more egalitarian than the professors. The mostly stated three factors describing what aspects of biotechnology the participants use while making decisions about risk were; the potential frequency and severity of effects to the environment, human health, and society; uncertainty associated with the technology; and their own morals and values. While the preservice teachers much more likely to considered personal morals and values as critical to risk perception formation, inservice teachers claimed personal evaluations. On the other hand, graduate teaching assistants and university professors claimed a more quantitative evaluation of the risks and benefits of biotechnology. Pointing out the importance of the role science teachers play for developing informed views of the complexity of the risks and benefits of the scientific enterprise, Gardner and Jones (2011) concluded that although different group of science instructors had similar frameworks for biotechnology risk evaluation, there were distinctions in how the instructor groups attach importance to these biotechnology risk factors.

2.6 Content Knowledge and SSI Teaching Self-efficacy Beliefs

In this part, research studies on the relationships among teachers' content knowledge and their teaching self-efficacy beliefs were reviewed. The research studies conducted thus far generally utilized the STEBI instrument that was developed by Enochs and Riggs (1990) to measure teaching self-efficacy beliefs. Although most of the studies have reported relationships among content knowledge and the dimensions of teaching self-efficacy beliefs (personal self-efficacy beliefs and outcome expectancy beliefs), there were studies revealed no relationship between those two variables. Moreover, studies seeking out this relationship were majorly focused on general science teaching self-efficacy beliefs rather than examining SSI teaching self-efficacy beliefs. Therefore, the number of studies investigating SSI teaching self-efficacy beliefs was very limited in number. It is also important to note that there was not a uniform terminology for teachers' content knowledge. That is, some of the studies may use the terms conceptual understanding, or understanding of science to refer to content knowledge of participants.

Bleicher and Lindgren (2005) conducted a mixed-method design research study with 49 preservice elementary teachers. They designed a summer course (science methods course) in a large university in South Florida which lasted six weeks. The course was offered in two different campuses of the university by the two different professors (the authors). The quantitative data collection instruments were utilized to explore preservice teachers' science conceptual understanding on the main concepts covered in the course (mass, volume, density, particulate nature of matter, force of dynamic pressure, static pressure, temperature, heat conduction, and convection) and science teaching self-efficacy beliefs (self-efficacy and outcome expectancy beliefs). Qualitative data sources were participants' reflective journals, focus-group discussions, and professors' observations. Analysis of pre and post science conceptual understanding data revealed that the participants had significant gains in the science concepts taught. In addition, preservice teachers had significant gains also in self-efficacy and outcome expectancy beliefs. Moreover, the correlational analysis showed that there was a significant correlation among pre-conceptual understanding and pre-test self-efficacy ($r = .31$) and also between post-test conceptual understanding and post-test self-efficacy ($r = .32$). This indicated that both before and after the participation of the summer course, preservice teachers who had higher conceptual understanding tended to have higher self-efficacy beliefs to teach science. On the other hand, outcome expectancy beliefs were not significantly correlated to conceptual understanding neither for pre nor the post data. Bleicher and Lindgren (2005) concluded the paper by pointing out that increased conceptual understanding would lead to stronger self-efficacy beliefs to teach science and that there is a need for explicitly addressing self-efficacy beliefs in teacher education programs.

Similarly, Newton, Evans, Leonard, and Eastburn (2012) investigated preservice elementary teachers' math content knowledge and teacher efficacy. To this end, they designed a research in mathematics method course with 55 preservice teachers. In this mixed design study, data sources were a mathematics content test, math teaching efficacy beliefs instrument (including two dimensions: personal teaching efficacy beliefs and outcome expectancy beliefs), and written artifacts. Likewise, the study conducted by Bleicher and Lindgren (2005), the study showed that there was a moderate and positive relationship between preservice teachers' content knowledge and personal teaching efficacy beliefs. However, no relationships were found between content knowledge and outcome expectancy. The data obtained through written artifacts revealed that preservice teachers' prior learning experiences may explain this relationship.

Swars and Dooley (2010) investigated the changes in teaching efficacy of preservice teachers during a science methods course. The course was designed within a professional development school model and in total, 21 preservice teachers took the course. In this mixed design research study, the data sources were STEBI-B and open-ended questionnaires administered both the onset and at the end of the methods course. The results showed that preservice teachers had significant gains in personal teaching efficacy beliefs. However, their outcome expectancy beliefs did not change. Analysis of the responses given to the open-ended questionnaire shed light on why the preservice teachers believed what they believed at the onset and completion of the course (negative, uncertain, or positive). It was revealed that preservice teachers who had negative beliefs about personal teaching efficacy at the onset (n = 4) and uncertainty (n = 8) expressed three salient factors: negative past experiences with science; lack of adequate science content knowledge; and a dislike toward science as a subject. Unlike to the beginning, at the end of the course, there was no preservice teachers who expressed negative personal teaching efficacy beliefs. The preservice teachers with uncertainty articulated two reasons of their doubts: inadequate content knowledge and lack of experiences teaching science. The researchers suggested that additional coursework for building the science content knowledge needed for teaching elementary science might better serve these preservice teachers.

Tanel (2013) similarly investigated preservice physics teachers' self-efficacy beliefs about teaching conceptual understanding for the subjects of force and motion. This study was a two-phase study in which the researcher first, examined participants' conceptual understanding, self-efficacy beliefs, and the relationships among these two variables by using survey research design; and second, explored how teaching sequence influenced participants' conceptual understanding, self-efficacy beliefs and the relationship among these two variables by using a one-group pre-test post-test design of experimental research. Teaching sequence lasted 7 weeks through which preservice teachers had the opportunity to learn about the topic force and motion, how to teach these subjects, and also remedy their misconceptions about force and motion. In total, 179 preservice physics teachers (136 of them for the first phase, 43 of them for the second phase) were administered two instruments; force concept inventory and the scale of self-efficacy about teaching force and motion. Similar to Bleicher and Lindgren (2005), the pre-data analysis revealed a significant correlation between the variables self-efficacy beliefs and conceptual understanding about force and motion topic; however, it was a weak correlation ($r = 0.31$). Also, for the posttest data, correlation coefficient was computed as significant and positive ($r = 0.45$). The results indicated that the correlation between preservice physics teachers' understandings and self-efficacy regarding teaching force and motion subjects were stronger compared to the pretest for the experimental group.

Another study investigating the relationships among content knowledge and teaching self-efficacy was conducted by Palmer (2006). This study was designed in a science methods course with primary science teacher education students. The main aim in was to explore the sources of self-efficacy. Palmer (2006) asserted that, along with the sources of efficacy proposed by Bandura (1997) (enactive mastery experiences, vicarious experiences, verbal persuasion, and physiological/affective states), there might be some other additional sources of self-efficacy such as cognitive content mastery, cognitive pedagogical mastery, and simulated modelling. Cognitive content mastery in this study referred to student teachers' successes in mastering understandings of science subject matter. In addition, cognitive pedagogical mastery referred to students' science pedagogical knowledge, and finally simulated modelling implied an environment in which teaching is role played by the student teachers. The research study was conducted in a regional university in Australia with 190 student teachers. The data collection sources were two formal surveys (two parts of STEBI-B to measure student teachers' self-efficacy levels) and three informal surveys (student teachers were asked open-ended questions about the course they were taking and their self-efficacy beliefs, in three different occasions), including both quantitative and qualitative data. The three informal surveys were used to provide data about the sources of self-efficacy and the relative importance of each source. The results showed that there was significant improvement on both scales of STEBI-B (personal science teaching efficacy and outcome expectancy beliefs). Besides, it was revealed that cognitive pedagogical mastery, cognitive content mastery, and simulated modelling can be the source of self efficacy in addition to those proposed by Bandura (1997). Cognitive pedagogical mastery was the most common sources articulated by the student teachers through informal scales. Cognitive content mastery was also stated by student teachers (9% to 19% of the participants) as a source of their self-efficacy beliefs. However, simulated modelling was a source of self-efficacy for only 5% to 10% of the student teachers. One interesting finding in was that several of Bandura's source of self-efficacy were not significant in this study. For instance, enactive mastery, actual modelling, and verbal persuasion were the ones very rarely mentioned in student teachers' responses.

Swackhamer, Koellner, Basile, and Kimbrough (2009) aimed to promote inservice middle-school math and science teachers' self-efficacy beliefs by increasing their content knowledge in Colorado. The overarching goal was to increase subject-matter content and pedagogical content knowledge of middle school teachers. To this end, they carried out a 5-year long project in which they developed and taught 17 content-based math and science courses. In total 277 teachers took at least one of these courses over the past four years of the project. The data were collected through a quantitative self-efficacy beliefs survey (a revised version of STEBI) and a post-course survey which led researcher to gather qualitative data to understand the effectiveness of the courses offered. 88 of the teachers responded to the data collection instruments. For data analyses, the participating teachers were divided into two groups: teachers who had taken four or more courses, and teachers who had taken one to three courses. The analysis of collected data revealed that the first group of teachers scored significantly more on teaching outcome expectancy dimension of STEBI instrument than the second group of teachers. However, there were no significant differences between the two groups on personal science teaching self-efficacy beliefs. In addition, qualitative data revealed teachers' motivations to participate to the courses. Regarding this, teachers in the high-efficacy, high-number of courses group were more likely to participate to the courses due to their intrinsic and personal motivations to become effective teachers. On the other hand, teachers in the high-efficacy, low-number of courses enrolled to the courses due to professional reason of increasing content knowledge and motivated to become certified in their area of study. Swackhamer et al. (2009) concluded that inservice teachers' teaching efficacy beliefs may be enhanced by an increase in content knowledge with a pedagogical emphasis.

In another study investigated preservice teachers' mathematics pedagogical beliefs, teaching efficacy beliefs, and content knowledge was conducted by Swars, Hart, Smith, Smith, and Tolar (2007). In this longitudinal study, the aim was to examine the changes in preservice teachers' mathematics pedagogical beliefs, teaching efficacy beliefs, and content knowledge during a mathematics methods course. In addition, the researchers aimed to investigate the relationships between pedagogical beliefs, teaching efficacy beliefs and content knowledge for teaching. In the study, data sources were the Mathematics Beliefs Instrument, the Mathematics Teaching Efficacy Beliefs

Instrument and the Learning Mathematics for Teaching Instrument. The first two instruments were administered to the participants four times during the teacher preparation program and the third instrument was administered at the end of student teaching. A total of five cohorts of preservice teachers (n = 103) participated to the study. According to the results, the participating preservice teachers increased significantly in their personal mathematics teaching efficacy beliefs, beliefs in their skills and abilities to teach mathematics effectively, and their outcome expectancy beliefs. Moreover, the study failed to report a relationship among content knowledge, and teaching efficacy beliefs (including both personal teaching efficacy and outcome expectancy beliefs dimensions). Swars et al. (2007) explained this as pre-service teachers can be quite efficacious about their teaching and not have developed strong content knowledge for teaching mathematics.

Two other studies investigating preservice teacher efficacy and content knowledge generated similar results. One of them, which is a previously mentioned study, conducted by Kilinc et al. (2013). Unlike to other studies reviewed in this part, this study examined SSI teaching efficacy beliefs, instead of general science teaching efficacy beliefs. In this mixed design study, the potential relationships among PSTs' science teaching efficacy, and their content knowledge, risk perception, religious beliefs, and moral beliefs in the context of GM foods were investigated through a structured model. In addition, the participants were interviewed after taking the quantitative instruments. There were mainly five quantitative instruments (one for science teaching efficacy beliefs and four for each of the independent variables) administered to 441 preservice teachers. Although the instrument used to measure PSTs' teaching efficacy beliefs was not STEBI-B, the researchers developed a new instrument by utilizing the items in STEBI-B. Therefore, instead of investigating teaching efficacy within the dimensions of personal teaching efficacy beliefs and outcome expectancy beliefs, Kilinc et al. (2013) categorized the dimensions as; teaching efficacy beliefs about general instructional strategies of GM foods teaching, teaching efficacy beliefs about family incorporation, teaching efficacy beliefs about nature of science, and teaching efficacy beliefs about expectations. The interview protocol was administered to eight of the participants who were chosen randomly. The results corresponding to the relationships between content knowledge and SSI teaching efficacy beliefs revealed that as PSTs' content knowledge about GM foods increased, their SSI teaching efficacy beliefs related to the issue of GM foods became stronger ($r = .34$, $p < 0.001$). The second study, conducted by Tastan-Kirik (2013), examined multiple factors (conceptual understanding, classroom management beliefs, science teaching attitudes, and antecedent factors such as participation in extracurricular activities, and number of science and science teaching methods courses taken) that might be correlated to preservice science teachers and preservice elementary teachers' general science teaching efficacy beliefs. To this end, Tastan-Kirik (2013) collected data from 71 science education majors and 262 elementary education majors. The data were collected through STEBI-B (including personal science teaching efficacy beliefs and outcome expectancy beliefs dimensions), the Science Concept Test, the Attitudes and Beliefs on Classroom Control Inventory and the Science Teaching Attitude Scale. Considering the relationships between conceptual understanding and science teaching efficacy beliefs, regression analysis revealed that there is a small but significant correlation between science concept knowledge and outcome expectancy beliefs. However, there were no any relationships between the participants' science concept knowledge and outcome expectancy beliefs. Unlike to previous studies that investigated general science teaching efficacy beliefs or science teaching efficacy beliefs in the context of an SSI, the study conducted by Tekkaya, Akyol, and Sungur (2012) examined teachers' knowledge and beliefs regarding the teaching of evolution. In the study, it was specifically aimed to investigate how the variables teachers' understanding of evolution and nature of science was related to the set of variables including teachers' acceptance of evolution and perceptions of teaching evolution (such as perceptions of the necessity of addressing evolution in their classrooms, perceptions of the factors that impede addressing evolution in their classrooms, and personal science teaching efficacy beliefs regarding evolution. In total, ninety-nine science and biology in-service teachers were selected conveniently. The data sources were Evolution Content Knowledge Test, Measure of Acceptance of the Theory of Evolution, Nature of

Science as Argument Questionnaire, and Teachers' Perceptions of Teaching Evolution Scale (including items in three domains: teachers' perceptions of the necessity of addressing evolution in their classrooms, teachers' perceptions of the factors that impede addressing evolution in their classrooms, and personal science teaching efficacy beliefs regarding evolution). Canonical correlation analysis revealed that there was a positive and significant correlation among teachers' understanding of evolution and NOS, and acceptance of the scientific validity of evolution and belief in the necessity of addressing evolution in the classrooms. However, it was reported in the study that, teachers who had thorough understanding of evolution and NOS did not necessarily had the belief that they have a stronger sense of self-efficacy beliefs regarding teaching evolution and that there are fewer obstacles to addressing evolution in the classroom.

Dissimilar to the previous studies, the final research study that was reviewed in this section was on self-efficacy beliefs and alternative conceptions of science. Schoon and Boone (1998) aimed to determine the relationships among preservice elementary teachers' science teaching efficacy and alternative conceptions of science. The participants were 619 junior and senior preservice elementary teachers and the data collection instruments were revised form of STEBI-B (including both personal teaching self-efficacy beliefs and outcome expectancy beliefs) and a multiple-choice test for common alternative conceptions of science. In the latter instrument, the questions covered concepts in the life, physical, and earth/space sciences. The study found that as the number of correct answers the participants gave increased, science teaching self-efficacy beliefs also increased. However, it was reported that there was no relationship between the number of alternative conceptions preservice teachers possessed and science teaching efficacy beliefs.

2.7 Research on the Relationship among Epistemological Beliefs, Risk-Benefit Perception, and Content Knowledge

In the present study, along with the relationships among SSI teaching self-efficacy beliefs and each of the independent variables, it was also aimed to investigate the relationships among the three independent variables. Although limited in number, research studies conducted to investigate the relationships among personal epistemological beliefs, risk-benefit perceptions, and content knowledge were reviewed below. It is important to note here again that, in the present study, it was proposed that PSTs' personal epistemological beliefs and GM foods content knowledge were directly related to their GM foods risk and benefit perception. Besides, it was hypothesized that PSTs' personal epistemological beliefs were directly related to their GM foods content knowledge. In the section below, first, the research studies explored the relationship between personal epistemological beliefs and risk-benefit perceptions were reviewed.

Retzbach, Marschall, Rahnke, Otto, and Maier (2011) investigated the roles of interest in science, methodological knowledge, epistemological beliefs, and beliefs about science in adults' risk and benefit perceptions of a controversial issue, nanotechnology. To this end, Retzbach et al. (2011) administered an online questionnaire to 587 people living in US. Risk and benefit perceptions were assessed by using a 6-point scale including six items (three items for benefit perception and three items for risk perception). In addition, epistemological beliefs were evaluated by three subscales of an inventory developed by Conley, Pintrich, Vekiri, and Harrison (2004). The items were rated on a 6-point scale and then an additive index was calculated for the dimensions; certainty (5 items), development (6 items), and justification (8 items). In addition to these subscales, the perceived uncertainty of scientific evidence was measured with two subscales developed by Marschall, Rahnke, Otto, and Maier (2011). Both subscales, objective and subjective perception of uncertainty, contain five items which are rated on a 6-point scale that are then summed up to create two indices with higher values standing for more sophisticated beliefs about the nature of scientific evidence. The results concerning the relations among epistemological beliefs and risk-benefit perceptions about biotechnology revealed that individuals with more sophisticated epistemological beliefs about the nature of scientific knowledge were more tend to perceive nanotechnology as positive. However, the objective perception of uncertainty of scientific evidence was the only variable that correlated negatively with benefit perceptions. According to Retzbach et al. (2011) this finding might indicate that laypersons who are aware of the tentativeness of scientific findings are slightly more cautious when presented with the benefits of a new technology.

Although not directly related to risk and benefit perceptions, two other research studies reviewed in this part are about epistemology and interpretation of controversial issues. The former was conducted by Schommer-Aikins and Hutter (2002). In this study, the relationship between personal epistemological beliefs and thinking about controversial issues was investigated. Schommer's Epistemological Questionnaire (Schommer, 1990) and a series of questions were utilized to measure 174 adults' personal epistemological beliefs and thinking about two controversial issues in a local newspaper. Results revealed that the more participants believed in complex and tentative knowledge, the more they were to take on multiple perspectives, acknowledge the complex, tentative nature of everyday issues, and be willing to modify their thinking. The latter study similarly explored sixty-five high school students' personal epistemology and critical interpretation of controversy (GM foods). To this end, Mason and Boscolo (2004) gave the participants different tasks such as writing a conclusion for the text involving two opposing positions and writing personal comments on the text. Epistemological understanding, which in this study referred to the participants' level of thinking about knowledge, that is absolutist, multiplist, or evaluativist levels according to Kuhn's (1999, 2000) model of development of epistemological meta-knowing, was measured through the 15-item instrument developed by Kuhn, Cheney, and Weinstock (2000). Examination of student conclusion writings indicated that epistemological understanding had an effect on students' critical interpretation of GM foods. Besides, qualitative analysis of students' text commenting revealed seven categories of student comments: the need for more research (when the need for further scientific investigation was pointed out), doubt (when doubts were raised about the effective value of GM food production, considering the various risks related to it), enriched knowledge (when it was appreciated that more information had been acquired from the text), the role of science (when epistemological reflections on the role of science and scientists work with respect to nature were expressed), personal positions (when positions pro or con GM food were strongly stated), the need for information (when the need to be kept informed about the topic from the mass media was stated), and social aspects (when considerations about the poverty of developing countries and/or the scientific and economic power of the richer countries were expressed). The results showed that epistemological understanding was related to students' commenting on the role of science and scientists' work with respect to nature, the need for further scientific investigation, and the effective value of transgenic food production.

In the following part, studies which examined the relationship between content knowledge and risk-benefit perceptions were reviewed. Review of the related literature showed that there is no consensus on the relationships among knowledge and risk-benefit perceptions. While some of the studies have asserted that as knowledge increases risk perception tend to decrease and benefit perception tend to increase, some other studies have proposed that people with lower levels of knowledge about controversial issues more likely to have high risk perceptions and low benefit perceptions. On the other hand, there are some studies in the literature which reported no relationships among knowledge and risk-benefit perceptions regarding controversial issues.

For instance, Kagai (2011) investigated to assess public perceptions of GM crops and foods in Kenya. In total, 179 adults including farmers and consumers were administered a survey. The main goal of the data analysis was to determine the predictors for the willingness to produce and consume GM crops and foods products. Results showed that participants' perceptions about GM crops and foods influenced their approval of the use of GM technology. Namely, farmers' basic knowledge about

GM technology influenced their adoption of GM technology. In addition, consumers who are knowledgeable about GM technology and government policies were more likely to approve the technology than the others. The study also reported that while the farmers were concerned with the environmental risks and effects on marketing crops, consumers were concerned about the possible health risks, the ability of the government to protect them, and the acceptance of GM products in the local market.

Another research study conducted by Mielby, Sandoe, and Lassen (2013) also reported similar results. In their study, the researchers aimed to explore whether individuals' biology knowledge influence their risk and benefit perceptions regarding GM technologies. To this end, a total of 2000 Danish people were chosen randomly and administered a questionnaire. The results revealed that the participants' scientific knowledge was positively correlated to the attitudes of acceptance of GM technologies for all of the investigated applications and for both methods of transformation. In a similar vein, Laux, Mosher, and Freeman (2010) explored the factors affecting college students' knowledge and opinions of genetically modified foods. For this purpose, they administered a questionnaire to 762 US (N = 718) and international (N = 43) college students. The researchers classified the participants' majors as physical science-based (N= 361) or non-physical science based (N = 344). Results indicated that comparing to the students from non-physical science based curriculum, physical science-based curriculum students had a more positive opinion of GM foods. According to Laux et al. (2010), it is expected to reach such a finding because students from physical science-based curriculum are more likely to have higher knowledge about GM foods and to be aware about the safety of the technology.

Chen and Li (2007) investigated the factors that may affect adults' (those who were above 20 years old) benefit and risk perceptions of applying gene technology to food production in Taiwan. In the study, the participants' perceptions were considered to determine their acceptance toward GM foods. The researchers proposed a structured model which included the variables; general attitude, risk-benefit perceptions, trust, and knowledge regarding GM foods. Participants' general attitude, risk-benefit perceptions, trust, and knowledge levels were assessed through questionnaires. Examination of the survey results of 564 participants revealed that knowledge has negative impacts on perceived risks of applying gene technology to food production. This finding indicated that the participants who had more knowledge perceived less risk from applying gene technology to food production. There was no significant relationship found between knowledge and perceived benefit perceptions in the study. Supporting this study, Sjöberg (2008), in his survey study investigating public (N = 469) and experts' (N = 49) risk perceptions and attitudes to GM foods, reported that, experts were much more positive to GM foods than were the member in the public. In a similar vein, Verdurme and Viaene (2003) reported a negative correlation between knowledge levels and risk perception regarding GM foods. They conducted a research study aiming to investigate consumer beliefs and attitudes towards GM foods. For this purpose, they administered a survey comprising 400 face-to-face interviews with Flemish consumers. The study revealed four consumer segments in relation to GM foods beliefs and attitudes. The four segments were the Halfhearted (those who had negative attitudes toward GM foods), the Green Opponents (those who were reluctant to GM foods), the Balancers (those who were neutral about GM foods), and the Enthusiasts (those who had positive attitudes toward GM foods). As a result of data analysis, it was shown that the knowledge level in the entire sample was rather low. Participants in the Halfhearted segment had little correct knowledge about GM foods. The Balancers also have a rather low knowledge score. Besides, while the Green Opponents segment had rated higher than the Halfhearted and the Balancers segments on knowledge level, the Enthusiasts have a higher knowledge score than the other segments. The researchers concluded that as the Enthusiasts illustrated, increasing correct knowledge about GM foods may reduce consumers' perception of risks, which may lead to a positive attitude towards GM food.

In another study, Zhang and Liu (2015) explored the influence of adults' knowledge on their perceptions (risk and benefit perception) and attitude towards GM foods. In this study, knowledge was categorized as subjective knowledge and objective knowledge. Subjective knowledge referred to the real knowledge consumers have about gene technology and GM foods. On the other hand, objective knowledge implied what individuals think they know about gene technology and GM foods. In the study, a structured model was proposed basing on the quantitative survey data collected from 570 adults in five cities in China. The results revealed that, in the proposed model, the paths from subjective knowledge to benefit perceptions and risk perceptions were both nonsignificant. That is, there were no relationships among subjective knowledge and risk-benefit perceptions of GM foods. However, the paths from objective knowledge to benefit receptions ($\beta = 0.769$, $p<0.001$) and risk perceptions ($\beta = -0.578$, $p<0.001$) were both significant. It can be understood from the results that objective knowledge was positively correlated to benefit perceptions and negatively correlated to risk perceptions. The study indicated that as adults' objective knowledge about GM foods increases, their benefit perceptions would also increase; however, their risk perception would decrease.

On the other hand, Gardner and Jones (2011) investigated science instructors' (preservice science teachers (n = 31), inservice science teachers (n = 20), biology graduate teaching assistants (n = 23), and university biology professors (n = 17)) perceptions of the risks of biotechnology. The study involved a convenient sample of 91 science educators and utilized Risk Perception Survey and Risk Card Sort Task for data collection. What the research study revealed about knowledge and risk-benefit perceptions were; university professors with extended knowledge of biotechnology tended to perceive the risks of biotechnology comparing to pre and inservice teachers, and graduate teaching assistants. Therefore, it can be understood from Gardner and Jones's (2011) study that, as the knowledge increases, risk perceptions about biotechnology tends to increase as well.

Unlike to abovementioned studies which revealed significant relationships (positive or negative) between knowledge and risk-benefit perceptions, Bredahl (2001) reported that there was no relation between adults' knowledge levels and their risk and benefit perceptions regarding GM foods. In her study, 2031 adults from Denmark, Germany, Italy, and the UK responded a questionnaire about attitudes towards genetic modification in food production and about purchase decisions with regard to genetically modified yoghurt and beer. The results regarding the relationships between knowledge and risk-benefit perceptions revealed that the measures of general attitudes and knowledge do not explain the perceived risks and benefits as well in all the four countries.

In the final part of the chapter, studies investigating the relationship between personal epistemological beliefs and content knowledge were reviewed. It has been evident in the literature that epistemological beliefs have an effect of many learner characteristics such as learning, motivation, achievement, etc. Although majority of these studies have explored the relationships among epistemological beliefs and achievement or learner performances, a limited number of research have examined whether individuals' personal epistemological beliefs influence their understanding in general or understanding of controversial issues.

For instance, Strømsø, Braten, and Samuelstuen (2008) aimed to investigate the relationship between personal epistemological beliefs and multiple text understanding including conflicting views on climate change. For this purpose, in total 157 university students were given seven texts which were about different aspects of climate change. In addition, the participants were administered word decoding test, prior knowledge measure, personal epistemological beliefs measure, and text understanding measures. Multiple regression analysis showed that the belief that knowledge incorporates highly interrelated concepts positively predicted scores on the reading tasks. Besides, those who had the belief that knowledge is tentative and evolving were more likely to score higher on intertextual understanding. Finally, the study revealed that there was a negative correlation between deeper understanding of single texts and the belief that the knower is an active constructor of meaning.

In a similar vein, Kardash and Scholes (1996) explored the effect of beliefs about the certainty of knowledge, the strength of beliefs about controversial issues and the tendency to enjoy effortful thinking on their interpretation of controversial issues. The study involved ninety-six undergraduate students across different grade levels. The data were collected through Epistemological Beliefs Questionnaire (Schommer, 1990), The Need for Cognition Scale (Cacioppo, Petty, & Kao, 1984), and the participants were asked to indicate to what extent they believe that HIV causes AIDS. The participants were then required to write a concluding paragraph to a text which involved two conflicting views about HIV-AIDS relationship. Regression analyses showed that university students who believe in certain knowledge less had less extreme initial beliefs and higher need for cognition. Besides, it was revealed that those participants were more likely to write conclusions reflecting the inconclusive nature of the mixed evidence that they were presented.

Mason and Boscolo (2004) hypothesized in their study that epistemological understanding and topic interest would affect high school students' conceptual understanding. To this end, they conducted a study in which sixty-five 10^{th} and 11^{th} grade students were given a dual-position expository text about genetically modified food. After reading the texts, the participants were asked to write a conclusion for the text, which presented two opposing positions without a concluding paragraph; to write personal comments on the text; to answer questions on conceptual understanding; and to rate their interest in the text. In addition to these, the participants rated their beliefs about transgenic foods before and after reading the text. Analysis of the collected data indicated that high school students' level of epistemological understanding affected their writing conclusion for the text they read and commenting on it. Another study which investigated the relationships among students' beliefs and intentions, and their understanding and acceptance of biological evolution was conducted by (Sinatra, Southerland, McConaughy, and Demastes, (2003). In total ninety-three undergraduate students responded quantitative measures on their content knowledge of their evolution, photosynthesis, and respiration; acceptance of theories of animal and human evolution, and photosynthesis; and epistemological beliefs and cognitive dispositions. The study reported that the three subscales, Ambiguous Information (Epistemological Beliefs), Actively Open-minded Thinking (Cognitive Dispositions), and Belief

Identification (Cognitive dispositions) were significantly correlated to high school students' evolutionary theory understanding.

Finally, May and Etkina (2002) examined the relationship between college physics students' epistemological self-reflection (also called epistemological preferences in the study) and conceptual learning. For this purpose, they chose a sample of college students (approximately two hundred students) from the two-quarter physics sequence for participants in the Freshman Engineering Honors program at a university in US. The participants' conceptual learning gains were assessed through three multiple-choice instruments; The Force Concept Inventory, The Mechanics Baseline Test, and Conceptual Survey of Electricity and Magnetism. The instruments were administered before and after the instruction and used to reveal the participants' understanding of Newton's laws of motion and Newtonian mechanics. Moreover, in order to collect data about epistemological preferences, students were required to submit weekly reports in which they reflected on how they learned specific physics content. In total, 12 reports collected from the participants were analyzed qualitatively. The results of the study indicated that the participants who acquired high conceptual gains tended to display reflection on their learning which was epistemologically more sophisticated comparing to the participants who acquired lower conceptual gains.

CHAPTER III

METHOD

3.1 Research Design

In the present study, mixed-method research design was used. Being a mixed method study, an explanatory design was used in which the researcher first collected and analyzed quantitative data and then obtained qualitative data to follow up and refine the quantitative findings (Creswell, 2008). First, quantitative data were collected and analyzed to explore the relationships among PSTs' personal epistemological beliefs, GM foods knowledge; GM foods risk-benefit perceptions, and GM foods teaching self-efficacy beliefs through quantitative instruments. Then, qualitative data were collected through interviews to deeply understand the relationships among the independent variables, personal epistemological beliefs, knowledge, risk-benefit perceptions and the dependent variable, teaching self-efficacy beliefs. Therefore, the qualitative data were utilized to deepen our understanding about the relationships in the model.

3.2 Participants and Sampling Procedure

For quantitative part of the study, convenient sampling was utilized. Junior and senior PSTs enrolled in elementary science education departments of Education Faculties in nine public universities located in Central Anatolia region in Turkey constituted the sample of the study. All of the eleven public universities in Central Anatolia region constituted the target population and the accessible population involves the PSTs enrolled in the nine public universities. The sample is totally 1077 (N_{male}= 208, N_{female}= 869) junior and senior PSTs which constitutes 51% of the accessible population. In Turkey, the total duration of preservice science teacher education programs is four years, therefore the participants of the present study, who are juniors and seniors, are about to graduate from science teacher education program.

Detailed information about the participants of the study and education level of their parents were displayed in Table 3.1. The number of female participants (80.7 %) was more than the number of male participants (19.3%) similar to the gender distribution of the accessible population. The average GPA of the participants is 2.78 (out of 4.00) and majority of them brought up in town or city centers. Most of the participants' parents are primary school graduates.

For the qualitative part of the study, Preservice Teacher Interview Protocol was used to conduct interview with 21 PSTs. Criterion sampling, which is one of the types of purposive sampling methods, was used to select the participants to the interview. Senior PSTs from one of the participating universities in Ankara, capital city of Turkey, were the participants of the qualitative part of the study. The reason of selecting this group of PSTs for the interview was that, they all have taken a 4^{th} grade course, which is specifically designed about SSI teaching in science education. Therefore, this group of PSTs was believed to provide richer information about SSI teaching self-efficacy beliefs both in quantity and quality. The course was taken by 36 (32 female and 4 male) students in total and 21 of them accepted to participate in the interview. Among the participants, two of them were male where the rest of the group was comprised of female participants.

Table 3.1

Characteristics of the Sample

Variable	*f*	%
Gender		
Male	208	19.3
Female	869	80.7
Grade Level		
Junior	428	39.9
Senior	644	60.1
Missing	5	
Mother Education Level		
Illiterate	54	5.0
Primary School	556	51.8
Middle School	204	19.0
High School	184	17.1
College	70	6.5
Masters Degree	5	0.5
PhD Degree	0	0
Missing	4	
Father Education Level		
Illiterate	3	0.3
Primary School	325	30.5
Middle School	204	19.2
High School	289	27.2
College	229	21.5
Masters Degree	11	1.0
PhD Degree	3	0.3
Missing	13	

Table 3.1 (Continued)

Variable	*f*	%
Home residence		
Village	124	11.6
Small town	267	24.9
Town	301	28.1
City center	379	35.4
Missing	6	

3.3 Instrumentation

3.3.1 Quantitative data collection instruments

The quantitative data were collected mainly through five instruments: Demographics Questionnaire, GM foods Teaching Self-efficacy Beliefs Instrument, GM foods Knowledge Scale, GM foods Risk and Benefit Perceptions Scale, and Epistemic Beliefs Inventory. Detailed information about each quantitative data collection instrument was displayed on Table 3.2.

3.3.1.1 Demographics Questionnaire

The Demographics Questionnaire is a self-developed instrument that assesses PSTs' gender, grade level, GPA, parental education level, home residence, general questions about GM foods (See Appendix A).

Table 3.2

Quantitative Data Collection Instruments and Variables Assessed

Instruments	Variables	References for the item sources
Demographics Questionnaire	Gender	Self-developed
	Grade level	
	GPA	
	Home residence	
	Parental education	
	General questions about GM foods (Participation in GM foods-related NGOs, GM foods information resources used, the way and frequency GM foods take place in undergraduate courses, level of concern if GM foods become free)	
GM foods Teaching Self-efficacy Beliefs Instrument	General instructional strategies of GM foods teaching	Baltaci and Kilinc (2014) (revised items 21, 22, 24)
	GM foods teaching outcome expectancy	Enochs and Rigss (1990) (revised items 2 to 5, 7 to 12, 25 to 34)

Table 3.2 (Continued)

Instruments	Variables	References for the item sources
	Fostering argumentation and decision making on GM foods	Kilinc et al. (2013) (revised items 1, 6, 13 to 19, 23) Self-written items (item 20)
GM foods Knowledge Scale	Content knowledge about GM Foods	Verdurme and Viaene (2003) (items 1 to 5) Frewer (1997) (items 6 to 9) Sjöberg (2008) (items 10, 11, and 12) European Comission (2006) (items 14 and 15) Self-written items (items 13, 16, 17)

Table 3.2 (Continued)

Instruments	Variables	References for the item sources
GM Foods Risk and Benefit Perceptions Scale	Risk perception about GM Foods Benefit perception about GM Foods	Bredahl (2001) (items 1 to 3, 10 to 12, 15 to 17, 21, 25, revised items 8 and 18) Frewer et al. 1997 (items 4 to 6) Sjöberg, 2008 (revised items 13, 20, 22 to 24)
Epistemic Beliefs Inventory	Quick learning Innate ability Simple knowledge Certain knowledge Omniscient authority	Self-written items (items 7, 9, 14) Bendixen, Schraw, and Dunkle (1998) (All the 32 items)

3.3.1.2 GM Foods Teaching Self-efficacy Beliefs Instrument

GM Foods Teaching Self-efficacy Beliefs Instrument was used to assess PSTs' teaching self-efficacy beliefs regarding GM foods teaching. The questionnaire was developed by the researcher of the present study. Most of the items in the instrument were selected from Science Teaching Efficacy Beliefs Instrument (STEBI) for preservice teachers developed by Enochs and Riggs (1990). Also, studies conducted by Kilinc et al. (2013) and Baltaci and Kilinc (2014) were utilized while determining the items. In addition to these items, some of the items in the instrument were originally written by the researcher of the study. STEBI was translated and adapted into Turkish by Tekkaya, Cakiroglu and Ozkan (2004) and the items in Kilinc et al. (2013) and Baltaci and Kilinc (2014) were already in Turkish. Turkish items were used to develop GM Foods Teaching Self-efficacy Beliefs Instrument. The developed questionnaire, like STEBI, is a five-point Likert scale ranging from "1=strongly disagree" to "5=strongly agree".

STEBI, as a widely used instrument in science teaching self-efficacy literature comprises two subcomponents: Personal science teaching efficacy beliefs and science teaching outcome expectancy (Enochs & Riggs, 1990). The former subcomponent assesses PSTs' anticipated beliefs about their ability to teach science and latter subcomponent measures beliefs about the effectiveness of their teaching on students' learning. Kilinc et al. (2013), in their study developing a teaching efficacy instrument specifically about GM foods, revealed four subcomponents: Teaching efficacy beliefs about general instructional strategies, Teaching efficacy beliefs about incorporating families, Teaching efficacy beliefs about teaching nature of science, and Teaching efficacy beliefs about making explanations. In addition to the items taken from these two research studies, four items about argumentation were taken from Baltaci and Kilinc (2014).

3.3.1.2.1 Pilot study

In the first step, the developed questionnaire included 34 items in total. For ensuring the content validity of these items, two experts from science education field were consulted. Necessary corrections like revising the items were made on the items. Then the developed questionnaire was pilot-tested with 201 PSTs. Reliability analysis and exploratory factor analysis (EFA) were conducted with the pilot data.

In order to examine the factor structure of the data and ensure the construct validity of the developed instrument, EFA with principle component analysis method with oblique rotation was conducted. Before performing EFA, the assumptions for the principle component analyses (sample size, factorability of correlation matrix, linearity, and outliers among cases) were checked and the researcher ascertained that the assumptions were met. For evaluating the items, minimum factor loading for an item was selected as .40. Before the factor analysis was performed, negative items were recoded. First, the factor number was not restricted. Descriptive analyses were conducted to interpret the emerging factors and their implications. Both of the Kaiser-Meyer-Oklin (.90) and the Barlett's (1954) Test of Sphericity ($p = .00$) values confirmed factorability of the data. Catell's (1966) scree test (scree plot) and Kaiser's (1970, 1974) criterion provided seven factors with eigenvalues greater than one. Investigation of the items showed that the number of factors should be less than seven According to Pallant (2007), while deciding on the number of factors, the number of factors can be limited if researchers think that a particular number is best describing the variables' interrelationships. Thus, the number of factors was limited to three for this study. Kaiser-Meyer-Oklin (.90) and the Barlett's (1954) Test of Sphericity ($p = .00$) values confirmed factorability of the data, which explained 49.65 % of the total sample variation. The three derived factors after omitting the items 2, 4, 28, and 31 were: Fostering argumentation and decision making on GM foods (Factor 1), General instructional strategies of GM foods teaching (Factor 2), and GM foods teaching outcome expectancy (Factor 3). Final versions of the factor structure and factor loadings of each item obtained as a result of pilot data analysis were presented in Table

3.3. Cronbach's alpha reliabilities for each dimension were .92, .85, and .83 respectively. Although the items 2, 4, 28, and 31 were omitted in pilot analysis, the researchers decided to remain these four items in the main study to double check the loadings. Therefore, the same version of the instrument was used in the main study.

Table 3.3

Pilot Study Factor Structure of GM foods Teaching Self-efficacy Beliefs Instrument

	Factor loading		
Item number	Factor 1	Factor 2	Factor 3
15	**.888**	-.137	.069
19	**.824**	-.028	.090
24	**.802**	-.025	-.009
22	**.775**	.056	-.036
20	**.764**	-.020	-.044
23	**.733**	.132	-.009
16	**.679**	-.022	.044
21	**.670**	.103	-.003
11	**.629**	-.076	-.093
17	**.597**	.095	.075
14	**.587**	.145	.012
18	**.499**	.109	.009
13	**.494**	.240	.047
3	-.069	**.824**	-.031
5	-.162	**.764**	.034
6	.042	**.717**	.016
8*	.112	**.655**	-.069
7	.103	**.602**	.057

Table 3.3 (Continued)

	Factor loading		
Item number	Factor 1	Factor 2	Factor 3
12*	.076	**.566**	-.042
10*	.365	**.452**	.077
1	.307	**.451**	-.074
9*	.111	**.445**	.049
30	-.023	.065	**.750**
33	.139	-.004	**.724**
32	-.198	.055	**.718**
26	.092	.042	**.688**
25	-.007	.090	**.674**
27	-.087	-.008	**.634**
34	.127	-.064	**.627**
29*	.016	-.155	**.610**

* Reverse coded

3.3.1.2.2 Main study

Once the final data collected, in order to confirm the factor structure of GM foods Teaching Self-efficacy Beliefs Instrument, the data were undergone EFA with principle component analysis method with oblique rotation. The main data was split into two so that half of the data would be used for EFA and the other half for CFA. The same pattern with the pilot study was followed prior to the EFA. First, the factor number was not restricted. Descriptive analyses were conducted to interpret the emerging factors and their implications. Both of the Kaiser-Meyer-Oklin (.92) and the Barlett's (1954) Test of Sphericity (p = .00) values confirmed factorability of the data. Catell's (1966) scree test (scree plot) and Kaiser's (1970, 1974) criterion provided six factors with eigenvalues greater than one. Investigation of the items showed that the number of factors should be less than six. Pallant (2007) stated that, while deciding on the number of factors, the number of factors can be limited if researchers think that a particular number is best describing the variables' interrelationships. Thus, the number of factors was limited to three for this study. Kaiser-Meyer-Oklin (.92) and the Barlett's (1954) Test of Sphericity (p = .00) values confirmed factorability of the data. The three factors explained 43.93 % of the sample variation. Similar to the results of the pilot analysis, the three derived factors, after omitting the items 28, 31, 6, 7, 29, 13, and 11 were: Fostering argumentation and decision making on GM foods (Factor 1), General instructional strategies of GM foods teaching (Factor 2), and GM foods teaching outcome expectancy (Factor 3). As can be understood, although the omitted items were not exactly the same with the pilot study, the factor structures revealed as the same. Final versions of the factor structure and factor loadings of each item were presented in Table 3.4.

Table 3.4

Main Study Factor Structure of GM foods Teaching Self-efficacy Beliefs Instrument

	Factor loading		
Item number	Factor 1	Factor 2	Factor 3
22	**.735**	-.021	.016
15	**.715**	.020	.063
20	**.706**	-.032	.005
19	**.705**	.059	-.039
21	**.681**	-.036	-.008
17	**.659**	.020	-.057
24	**.628**	-.048	.110
23	**.624**	-.063	.134
18	**.623**	.074	-.087
16	**.604**	.047	.051

Table 3.4 (Continued)

	Factor loading		
Item number	Factor 1	Factor 2	Factor 3
14	**.530**	.005	.179
8*	-.120	**.775**	-.028
4*	.034	**.721**	-.064
2*	-.101	**.696**	.000
10*	.172	**.644**	-.063
9*	-.001	**.592**	-.107
3	.037	**.577**	.178
12*	.187	**.571**	-.015
1	.206	**.452**	.109
5	.195	**.421**	.125
34	-.098	.100	**.720**
33	.019	.053	**.710**
30	-.027	-.001	**.637**
32	-.168	.002	**.632**
25	.098	-.113	**.607**
26	.187	.016	**.555**
27	.119	-.065	**.477**

* Reverse coded

Once the main data were collected, the researcher conducted confirmatory factor analysis (CFA) with the second half of the main data in order to confirm the 3-factor structure EFA revealed. Analysis of Moment Structures (AMOS) statistical package program version 21 for Windows was employed for the analyses.

Examination of the model fit indices obtained from CFA indicated that the data showed good model fit (χ^2/df = 2.82, GFI = .89, AGFI = .87, CFI = .90, RMSEA = .05, RMR = .03, SRMR = .04). In addition, the estimates corresponding to each item to the subdimensions of the instrument was significant. AMOS output of the CFA model with standardized estimates are provided in Appendix B. These findings provided evidence for the construct validity of 3-factor structure of GM foods Teaching Self-efficacy Beliefs Instrument. Items included in GM foods Teaching Self-efficacy Beliefs Instrument were provided in Appendix C. Sample items and Cronbach's alpha reliabilities for each dimension were presented in Table 3.5.

In GM Foods Teaching Self-efficacy Beliefs Instrument, the dimension fostering argumentation and decision making on GM foods refers to PSTs' beliefs about their ability to foster and utilize argumentation and decision making about GM foods. In addition, general instructional strategies of GM foods teaching refers to PSTs' beliefs about their ability to apply general instructional strategies successfully to teach GM foods, and the dimension GM foods teaching outcome expectancy refers to PSTs' beliefs that student GM foods learning can be influenced by effective teaching.

3.3.1.3 Epistemic Beliefs Inventory

Epistemic Beliefs Inventory (EBI), a five point Likert scale from "5 = strongly agree" to "1 = strongly disagree", was used to assess PSTs' beliefs about the nature and acquisition of knowledge, namely epistemological beliefs. EBI was first developed by as a 32-item inventory (Bendixen, Schraw, & Dunkle, 1998; Schraw, Dunkle, & Bendixen, 1995), then, Schraw, Bendixen, and Dunkle (2002) revised the inventory and developed the 28-item version of EBI. In this study, 32-item version of EBI was used.

This instrument was developed basing on Schommer's (1990, 1994) epistemological beliefs model, which consists of the dimensions certain knowledge, simple knowledge, innate ability, quick learning and omniscient authority. Bendixen et al. (1998) aimed mainly to develop a short, reliable, and efficient instrument that measures individuals' beliefs about these five dimensions of epistemological beliefs (certain knowledge, simple knowledge, innate ability, quick learning and omniscient authority), especially the one omniscient authority, which was failed to yield by Schommer's Epistemological Questionnaire (Bendixen et al., 1998; Schraw et al., 2002). In addition, contrary to unexplainable item loadings and item-to-factor overlap problems of using Schommer's Epistemological Questionnaire, Bendixen et al. (1998) constructed EBI as an instrument in which all of the items fit unambiguously into one of five dimensions.

Higher scores obtained from EBI indicate more naïve epistemological beliefs. On the other hand, lower scores obtained from EBI are indicators of more sophisticated epistemological beliefs. The Cronbach's alpha reliabilities of the dimensions of EBI reported ranging from .60 to .87 (Bendixen et al., 1998; Schraw, et al., 1995).

3.3.1.3.1 Pilot study

In this study, Turkish version of EBI was used. The 32 items were translated into Turkish by Tuncay-Yuksel, Yilmaz-Tuzun, and Zeidler (2015). The translated items were decided to be used after taking permission from the researchers however, the researcher of the present study changed the wording of some of the translated items. Although these were slight changes, this version of EBI was sent to two professors who are experts in the field of epistemological beliefs. Necessary corrections and revisions were also done in light of expert opinion and the final version of EBI was formed. This version of the inventory was pilot-tested with 201 PSTs.

In order to examine the factor structure of the EBI data EFA with principle component analysis method with oblique rotation was conducted. Before performing EFA, the assumptions for the principle component analyses (sample size, factorability of correlation matrix, linearity, and outliers among cases) were checked and the researcher ascertained that the assumptions were met. For evaluating the items, minimum factor loading for an item was selected as .40. Before the factor analysis was performed, negative items (items 2, 6, 14, 20, 24, 30 and 31) were recoded. First, the factor number was not restricted. Descriptive analyses were conducted to interpret the emerging factors and their implications. Both of the Kaiser-Meyer-Oklin (.70) and the Barlett's (1954) Test of Sphericity (p = .00) values confirmed factorability of the data. Catell's (1966) scree test (scree plot) and Kaiser's (1970, 1974) criterion provided eleven factors with eigenvalues greater than one. Investigation of the items showed that the number of factors should be less than eleven. Pallant (2007) stated that, while deciding on the number of factors, the number of factors can be limited if researchers think that a particular number is best describing the variables' interrelationships. Thus, the number of factors was limited to five (as in the original form of the inventory) for this study. Kaiser-Meyer-Oklin (.74) and the Barlett's (1954) Test of Sphericity (p = .00) values confirmed factorability of the data; however, the reliabilities of the factors were very low. Then, the researcher made a decision by examining the scree plot and decided to limit the factor number to three factors. The three derived factors explained 51.11 % of the sample variation. The three derived factors, after omitting the items 1, 2, 3, 4, 6, 7, 8, 9, 14, 15, 17, 19, 20, 22, 24, 27, 28, 30, 31, and 32 were: Quick learning and Certain knowledge (Factor 1), Innate ability (Factor 2), and Simple knowledge (Factor 3). Final versions of the factor structure and factor loadings of each item were presented in Table 3.6. The Cronbach's alpha reliabilities for each dimension were computed as .67, .66, and .63 respectively.

Since epistemological beliefs are abstract and culture-dependent, the researcher avoided to make sudden decisions and to omit the problematic items immediately. Therefore, it was decided to keep the problematic items in the main study; no items were omitted. By this way, the reseacher aimed to check whether these problematic items failed to load in factors and the data would be in 3-factor structure in the main study as well or not.

Table 3.5

Sample Items and Cronbach Alpha Reliabilities for GM Foods Teaching Self-efficacy Beliefs Instrument

Dimension	Sample item	n of items	Cronbach alpha value
Fostering argumentation and decision making on GM foods	I will be able to improve student ability to justify their claims with evidences during discussions about the issue of GM Foods.	12	.89
General instructional strategies of GM foods teaching	I know the steps necessary to teach the issue of GM Foods effectively.	11	.85
GM foods teaching outcome expectancy	When a student holds different viewpoints and becomes more knowledgeable about the issue of GM foods, it is often due to their teacher having found a more effective teaching approach.	8	.75

3.3.1.3.2 Main study

Once the final data collected, in order to confirm the factor structure of EBI, the data were undergone EFA with principle component analysis method with oblique rotation. The main data was split into two so that half of the data would be used for EFA and the other half for CFA. The same pattern with the pilot study was followed prior to the EFA. First, the factor number was not restricted. Descriptive analyses were conducted to interpret the emerging factors and their implications. Both of the Kaiser-Meyer-Oklin (.79) and the Barlett's (1954) Test of Sphericity (p = .00) values confirmed factorability of the data. Catell's (1966) scree test (scree plot) and Kaiser's (1970, 1974) criterion provided eight factors with eigenvalues greater than one. Investigation of the items showed that the number of factors should be less than eight. Pallant (2007) stated that, while deciding on the number of factors, the number of factors can be limited if researchers think that a particular number is best describing the variables' interrelationships. Thus, the number of factors was limited to five (as in the original form of the inventory) for this study. Kaiser-Meyer-Oklin (.77) and the Barlett's (1954) Test of Sphericity (p = .00) values confirmed factorability of the data; however, the reliabilities of the factors were very low. Then, the researcher decided to limit the factor number to three factors, by considering the scree plot and the pilot study. The three factors explained 40.33 % of the sample variation. Similar to the results of the pilot analysis, the three derived factors, after omitting the items 1, 2, 4, 6, 7, 9, 14, 15, 19, 20, 22, 24, 27, 28, 30, and 31 were: Quick learning and Certain knowledge (Factor 1), Innate ability (Factor 2), and Simple knowledge (Factor 3). As can be understood, although the omitted items were not exactly the same with the pilot study, the factor structures revealed as the same. Final versions of the factor structure and factor loadings of each item were presented in Table 3.7.

Table 3.6

Pilot Study Factor Structure of Epistemic Beliefs Inventory

	Factor loading		
Item number	Factor 1	Factor 2	Factor 3
25	**.672**	-.098	.265
23	**.649**	.183	.143
29	**.636**	-.056	-.248
21	**.633**	-.121	-.098
16	**.621**	.013	-.120
26	.002	**.799**	.027
5	.092	**.761**	-.005
12	-.177	**.716**	-.073
18	-.134	-.199	**.785**
11	-.092	.198	**.674**
10	.248	.103	**.633**
13	.297	.125	**.483**

After the factor structure was obtained through EFA, for the purpose of cross-validation, CFA was performed with the second half of the main data. CFA results also validate the three factor structure of EBI. Examination of the model fit indices obtained from CFA indicated that the data showed good model fit (χ^2/df = 2.61, GFI = .94, AGFI = .92, CFI = .86, RMSEA = .05, RMR = .06, SRMR = .05). In addition, the estimates corresponding to each item to the subdimensions of the instrument was significant. AMOS output of the CFA model with standardized estimates are provided in Appendix D.

Factor 1, Quick learning and Certain knowledge refers to the belief that learning is quick or not at all and knowledge is certain rather than tentative; Factor 2, Innate ability refers to the belief that the ability to learn is innate rather than acquired; and Factor 3, Simple knowledge refers to the belief that knowledge is simple rather than complex (Bendixen et al., 1998; Schommer, 1990). Sample items and reliability values for each factor were presented in Table 3.8. The complete version of Epistemic Beliefs Inventory can be found in Appendix E.

Table 3.7

Main Study Factor Structure of Epistemic Beliefs Inventory

	Factor loading		
Item number	Factor 1	Factor 2	Factor 3
25	**.667**	.006	-.080
21	**.666**	.057	.045
16	**.639**	-.031	.011
29	**.557**	-.055	.208
3	**.516**	.219	.011
23	**.499**	-.023	-.051
5	-.152	**.692**	-.130
26	-.115	**.678**	-.046
32	.264	**.600**	.010
17	.320	**.525**	.051
8	-.207	**.521**	.121
12	-.050	**.506**	.217
10	-.134	-.045	**.702**
13	-.103	-.080	**.666**
11	.031	.049	**.594**
18	.205	.116	**.581**

Table 3.8

Sample Items and Mean Inter-Item Correlations for Epistemic Beliefs Inventory

Factor	Sample item	n of items	Cronbach alpha value
Quick learning & Certain knowledge	If you don’t learn something quickly, you won’t ever learn it. What is true today will be true tomorrow.	7	.67
Innate ability	Smart people are born that way.	6	.65
Simple knowledge	Too many theories just complicate things.	6	.55

3.3.1.4 GM Foods Risk-Benefit Perceptions Scale

GM Foods Risk-Benefit Perceptions Scale was used to assess PSTs' risk and benefit perceptions regarding the issue GM Foods. The scale was developed by the researcher of the present study. Most of the risk and benefit items that constitute the scale were selected from different research studies (Bredahl, 2001; Frewer, Howard, & Shepherd, 1997; Sjöberg, 2008) and some of the items were researcher-written items. Since the items that were taken from different research studies were in English, they were first translated into Turkish. Some of the items were in phrases while the others were in sentence format. In order to have a uniform structure, the items that were written originally as phrases were transformed into complete sentences. The developed questionnaire is a five-point Likert scale ranging from "1=strongly disagree" to "5=strongly agree".

3.3.1.4.1 Pilot study

In the first step, there were 25 items in the developed scale. These items were translated into Turkish by the researcher. The translated items were checked by a language expert who speaks Turkish and is a native speaker of English. Necessary language revisions were done according to the feedbacks. For ensuring the content validity of the items, two experts from the fields of biology and chemistry, whose one of the research interests is GM Foods, were consulted. Necessary corrections like revising the items were made on the items. Then the developed questionnaire was pilot-tested with 201 PSTs. Reliability analysis and EFA with principle component analysis method with oblique rotation were conducted with the pilot data.

Before performing EFA, the assumptions for the principle component analyses (sample size, factorability of correlation matrix, linearity, and outliers among cases) were checked and the researcher ascertained that the assumptions were met. For evaluating the items, minimum factor loading for an item was selected as .40. First, the factor number was not restricted. Descriptive analyses were conducted to interpret the emerging factors and their implications. Both of the Kaiser-Meyer-Oklin (.76) and the Barlett's (1954) Test of Sphericity (p = .00) values confirmed factorability of the data. Catell's (1966) scree test (scree plot) and Kaiser's (1970, 1974) criterion provided seven factors with eigenvalues greater than one. Investigation of the items showed that the number of factors should be less than seven. Since the number of factors can be limited if researchers think that a particular number is best describing the variables' interrelationships (Pallant, 2007), in the present study the number of factors was limited to two. Kaiser-Meyer-Oklin (.76) and the Barlett's (1954) Test of Sphericity (p = .00) values confirmed factorability of the data, which explained 52.13 % of the total sample variation. After omitting some of the items, the two derived factors were: Benefit perception about GM Foods (Factor 1), and Risk perception about GM Foods (Factor 2). The Cronbach's alpha reliabilities were computed as .79 and .85 respectively. In Table 3.9, the factor structure and factor loadings of each item obtained from the pilot study were presented.

Results of the pilot analysis revealed that some of the items did not load on the anticipated factor while some of the items did not load to any of the two factors. While the items 8, 14, 2, 9, 13, 7, and 3 did not load on the anticipated factor, the items 5, 6, 11, 18, 19, 20, and 25 did not load to any of the two factors. The researchers decided that in the main study, instead of omitting these items, it would be better to make some of the items clearer and more understandable for the participants by revising the wordings. To this end, the researchers revised the wording of six of these items and remained the other three items same. Thus, the new version of the scale with the same number of items and the revised wordings was formed to be administered in the main study.

3.3.1.4.2 Main study

Once the final data collection finished, in order to examine the factor structure of the data and ensure the construct validity of the developed questionnaire, first, EFA with principle component analysis method with oblique rotation was conducted with the half of the main data. Then, to confirm and cross-validate the obtained factor structure, CFA was conducted with the other half of the main data. The abovementioned patterns were followed to conduct EFA with principle component analysis method with oblique rotation.

Table 3.9

Pilot Study Factor Structure of GM Foods Risk-Benefit Perceptions Scale

	Factor loading	
Item number	Factor 1	Factor 2
15	**.798**	-.028
16	**.745**	-.186
12	**.667**	.044
21	**.658**	-.049
4	**.601**	.167
17	**.557**	-.193
10	**.538**	-.054
5	**.471**	.071
23	-.028	**.924**
24	.059	**.891**
22	-.074	**.791**

First, the factor number was not restricted. Descriptive analyses were conducted to interpret the emerging factors and their implications. Both of the Kaiser-Meyer-Oklin (.84) and the Barlett's (1954) Test of Sphericity ($p = .00$) values confirmed factorability of the data. Catell's (1966) scree test (scree plot) and Kaiser's (1970, 1974) criterion provided six factors with eigenvalues greater than one. Investigation of the items showed that the number of factors should be less than six. Since the number of factors can be limited if researchers think that a particular number is best describing the variables' interrelationships (Pallant, 2007), in the present study the number of factors was limited to two.

Kaiser-Meyer-Oklin (.84) and the Barlett's (1954) Test of Sphericity (p = .00) values confirmed factorability of the data, which explained 49.78 % of the total sample variation. The items which had loadings under .40 and communality values lower than .30 were omitted. The factor structure and factor loadings of each item for the main study were presented in Table 3.10.

Once the EFA factor structure obtained, the researcher decided to cross-validate this two-factor structure through CFA. Examination of the model fit indices obtained from CFA indicated that the data showed good model fit for this sample (χ^2/df = 5.75, GFI = .89, AGFI = .85, CFI = .87, RMSEA = .08, RMR = .07, SRMR = .08). AMOS output of the CFA model with standardized estimates are provided in Appendix F. This finding provided supporting evidence for the construct validity of developed GM Foods Risk-Benefit Perceptions Scale and its two-factor structure.

In GM Foods Risk-Benefit Perceptions Scale, the dimension Benefit perception about GM Foods refers to PSTs' perception about beneficial aspects of GM Foods such as human health, environment, and economy. The second dimension, Risk perception about GM Foods, refers to PSTs' perception that GM Foods are risky considering their effects on human health, environment, and economy. Sample items and Cronbach's alpha reliabilities for each dimension were presented in Table 3.11. Items that constituted Risk and Benefit Perception about GM Foods Scale were provided in Appendix G.

3.3.1.5 GM Foods Knowledge Scale

GM Foods Knowledge Scale was utilized in this study to measure PSTs' knowledge about GM Foods. The scale was developed by the researcher of this study. Most of the items in the scale were selected from an item pool, which was created by utilizing three different research studies (European Comission, 2006; Frewer, 1997; Sjöberg, 2008; Verdurme & Viaene, 2003). In addition to these items, some of the items in the scale were originally written by the researcher of the study.

Table 3.10

Main Study Factor Structure of GM Foods Risk-Benefit Perceptions Scale

	Factor loading	
Item number	Factor 1	Factor 2
5	**.800**	.146
6	**.686**	.209
16	**.671**	-.261
4	**.646**	.080
15	**.636**	-.235
10	**.625**	-.002
12	**.553**	-.239
17	**.510**	-.281
21	**.452**	-.246
24	.043	**.879**
23	.014	**.840**
22	.052	**.767**
3	-.029	**.543**
2	-.279	**.507**

Respondents of the items were invited to say whether the given statement about GM Foods was true, false, or that they did not know the answer. 18 such items were decided to be included in the scale. These items were translated into Turkish by the researcher. The translated items were checked by a language expert who speaks Turkish and is a native speaker of English. Then, necessary language revisions were done according to the feedbacks. For ensuring the content validity of the items, two experts from the fields of biology and chemistry, whose one of the research interests is GM Foods, were consulted. Necessary corrections like revising the items were made on the items. Then the developed scale was pilot-tested with 201 PSTs. Reliability analysis was conducted with the pilot data. In light of this analysis, one item in the scale (“To be healthy, food should be sterile before it is eaten.” / “Sağlıklı olabilmesi için, yediğimiz gıdaların tüketilmeden önce steril hale getirilmesi gerekir.”) was omitted and another one item was revised. The 17 items included in the final version of the scale was administered in the full study and were presented in Appendix H. By adding up the number of correct answers given (correct answers were recoded as 1), each respondent could be assigned a score ranging from zero to seventeen (false answers and do not know option were recoded as 0), which acts as an overall indicator of knowledge about GM Foods.

In order to determine the internal consistency of the final scores, the data collected in full study were undergone reliability analysis. As reported in Kaplan and Saccuzzo (2009), Kuder-Richardson 20, or KR20 formula is used to calculate the reliability of a test in which the items are dichotomous, scored 0 or 1. Therefore, to compute the reliability of content knowledge items, KR20 formula was used in the present study. The formula is

$$\text{KR20} = r = \frac{N}{N-1}\left(\frac{S^2 - \Sigma pq}{S^2}\right)$$

where N is the number of items on the test, S^2 is the variance of the total test score, and Σpq is the sum of the products of p times q for each item on the test. The reliability score for the present study was computed as 0.73.

$$\text{KR20} = \frac{17}{17-1}\left(\frac{11{,}055 - 3{,}458}{11{,}055}\right) = 0.73$$

Sample items that were used to measure PSTs’ knowledge about GM Foods were as the following:

- Contrary to conventional food, GM Food contains genes.
- All processed foods are made using genetically modified products.
- Agricultural crops can be made resistant to certain diseases and plagues by modifying their hereditary material.

Table 3.11

Sample Items and Cronbach Alpha Reliabilities for GM Foods Risk-Benefit Perceptions Scale

Factor	Sample item	n of items	Cronbach alpha value
Benefit perception about GM Foods	GM Foods will solve the problem of malnutrition and hunger in the world. Applying gene technology in foods products can be used to solve environmental problems. GM Foods will improve the standard of living of the future generations.	9	.83
Risk perception about GM Foods	Applying gene technology in food production will cause environmental hazards. GM Foods will hurt children and future generations. Due to GM Foods, order of nature is disturbed.	5	.81

3.3.2 Qualitative data collection instruments

3.3.2.1 Preservice Teacher Interview Protocol

Preservice Teacher Interview Protocol, developed by the researcher of the present study, was used basically to reveal PSTs' GM foods teaching self-efficacy beliefs and their opinions and explanations regarding the correlations among the variables, GM foods teaching self-efficacy beliefs, personal epistemological beliefs, risk-benefit perceptions, and knowledge, in the model. Accordingly, the interview protocol includes detailed questions about GM foods teaching self-efficacy beliefs such as "Do you believe you will be able to create SSI (GM foods) discussion environments in your class? If yes, in which ways and how? If no, why?", and direct questions about the relationships among the variables in the model such as "Do you believe there is a relation between GM foods teaching efficacy belief and GM foods knowledge of a teacher or not? Why?". The questions that were asked to reveal PSTs' opinions regarding the relationships among the variables helped researchers to explain and confirm the paths in the model. Therefore, all the questions that constituted Preservice Teacher Interview Protocol were written in accordance with the variables and the relations revealed in the quantitative model.

In the process of interview protocol development, firstly, researcher of the present study prepared the interview questions with the help of the advisor professor, who has an expertise in the field of science education and science teacher education. The prepared interview protocol was sent to three experts in the mentioned fields to take expert opinions about both the content and language. In addition, one of the senior PSTs was asked to participate in the interview so that the researcher could have a chance to obtain prior feedback about the way questions were asked. The final version of the interview protocol was organized according expert opinions and participant feedbacks.

The semi-structured interview protocol included 16 questions which were prepared in Turkish, the participants' native language. Among the interview questions, six of them were related to PSTs' GM foods teaching self-efficacy beliefs and the rest of the questions were aimed to reveal PSTs' opinions regarding the relationships among GM foods teaching self-efficacy beliefs and the other variables in the proposed quantitative model. The interview questions were given in Appendix I. Individuals taking part in this research were interviewed separately. Since all the participants have administered the quantitative instruments before participating in the interviews, they were all quite familiar with the variables studied in the proposed model. In addition, since all the interviewees have taken a course related to SSI prior to the administration of interviews, they provided the researcher with thorough answers. The detailed information about qualitative data collection procedure and interview data analysis process can be found in the following parts.

3.4 Data Collection Procedure

As aforementioned, the present study aimed to investigate the relationship among PSTs' GM Foods teaching self-efficacy beliefs, personal epistemological beliefs, GM foods knowledge, and GM foods risk-benefit perceptions. The researcher of the present study began by reviewing the related literature regarding the variables studied. As the second step, the data collection instruments were determined. Before the data collection process, the researcher of the study applied for the permission of Ethics Committee of METU and the participant universities. After getting the permissions for conducting the research, the researcher firstly conducted the pilot study by administering the instruments to the PSTs in the universities determined for the pilot study. Once the pilot data were obtained, necessary revisions were made; then, the researcher collected the actual data.

Data collection was carried out over two semesters (2014-2015 Fall, 2014-1025 Spring). Participation to the study was based on voluntariness. Before the administration of the instruments, each participant was informed about the purpose of the study and the necessary information and directions regarding the instruments. In addition to this, the researcher of the study explained that the research will not cause any harm or deception to the participants, confidentiality of the data was ensured, their names and answers to the instrument questions will not be shared with anyone and only be used for the purpose of research. Finally, the researcher mentioned about the procedure of the study and their right to withdraw at any time they feel discomfort. Administration of the instruments took approximately 30-35 minutes and was done by the same researcher to ensure the consistency of data collection procedure. In each data collection site (nine universities) the participants participated in the study in their classrooms.

As mentioned before, criterion sampling was used to select the participants for the qualitative data collection. The criterion was to take a 4th grade must course specifically desgined to teach SSI in science education. Therefore, the researcher first obtained the course participant list and sent e-mail to each PST about participation to the interviews. Afterwards, meetings were arranged to conduct interview with the volunteer participants. Each interview session was audio-taped after getting permission from the participants. The interview location was arranged in advance and a quiet and relaxed environment was created for participants so that they feel comfortable during the interviews. In addition, the researcher tried to encourage the participants to feel free while presenting and reflecting on their opinions. At the beginning of each interview session, each participant was again informed about the purpose of the study, and they were all mentioned that the specific purpose of the interviews is to obtain more detailed information about their SSI teaching efficacy beliefs and the relationships among the variables in the model. There was no time limitation for the interviews but they lasted approximately 35-50 minutes for each participant. The entire qualitative data collection process was also carried out by the same researcher in the last two months of 2014-2015 spring semester, after the quantitative data collection was completed.

3.5 Data Analysis

Data analysis in the present study comprised of two main parts: quantitative data analysis and qualitative data analysis. Quantitative data analysis included preliminary analysis, descriptive statistics, and inferential statistics. IBM SPSS Statistics 22 and IBM AMOS 21 were used to analyze all quantitative data. IBM SPSS Statistics 22 was used to conduct preliminary analysis such as missing data analysis, outlier and normality analysis; and descriptive statistics such as mean and standard deviation regarding each variable in the study. IBM SPSS Statistics 22 was also used for the reliability analysis and factor analysis (EFA) for validation of the instruments. IBM AMOS 21 was used to carry out factor analysis (CFA) of the instruments and path analysis of the proposed model. A variety of model fit indices were used for assessing goodness of fit of the CFA and path analysis results, which indicate validity of the instrument factor structures. Besides, Chi-square statistics, GFI, RMSEA, RMR, and SRMR were used to determine the validity of the specified models. Table 3.12 displayes the model fit indices selected for the present study and their suggested values.

Table 3.12

Model Fit Indices Used for the Study

Model Fit Index		Values Indicating Good Fit
Chi-square	χ^2	The smaller the better
Degrees of Freedom	df	-
Normed Chi-square Fit Index	χ^2/ df (CMIN/df)	$\leq 2^a$ to 5^b
Goodness of Fit Index	GFI	$\geq .90^b$
Adjusted Goodness of Fit Index	AGFI	$\geq .90^b$
Comparative Fit Index	CFI	$\geq .90^{a,b}$
Root Mean Square Error of Approximation	RMSEA	$\leq .05^b$ to $.10^a$
Root Mean Square Residual	RMR	$\leq .08^c$ to $.10^d$
Standardized Root Mean Square Residual	SRMR	$\leq .08^c$ to $.10^d$

**Reference:* [a] Tabachnick & Fidell (2007), [b] Sumer (2000), [c] Hu & Bentler (1999), [d] Kline (2011)

Qualitative data analysis was carried out by using QSR Nvivo 10 for Windows. First of all, all audio-taped interviews were transcribed verbatim. The participants' answers to the interview questions were analyzed through constant comparative method (Glaser & Strauss, 1967). At the very beginning of the coding process, two coders (the author of this study and the advisor of the study) read the interviews and searched for PSTs' GM foods teaching self-efficacy beliefs and its' relation to the variables studied. Then, the first two interview transcripts were openly coded by two researchers. Both coders worked on the same data at the same time to come up with a common understanding by exploring the data. After this round of coding, a preliminary code list emerged. Then, three coders (the author, the advisor of the study and a researcher in science education) coded another five of the interview transcripts separately. The first turn of analysis resulted in some inconsistencies but after negotiation, the three coders tried to figure out these inconsistencies. The final inter-coder reliability was .92. During the process of data coding, the researchers reflected and worked on the coding list and made changes as the new data emerged new codes and the researcher decided to name the existing codes in a more explicit way. Related literature was also utilized while deciding on the names of some of the codes and finalizing the code list. Based on the agree-upon code list, the remaining fourteen interview transcripts were openly coded by the researcher. The final code list was also reviewed by a reviewer who was an expert of SSI and SSI teaching. In addition, the reviewer had several publications in top science education journals about the field of SSI and qualitative research. Since the reviewer's main language was English, one of the transcripts was translated from Turkish into English by the researcher. The Reviewer's comments were very beneficial to rewrite the codes in a more understandable and clear way.

In axial coding stage, the researcher first explored the codes and examined the relationships between them. The major aim at this stage was to review data to confirm associations and new codes as well as developing categories (Ezzy, 2002). This was a cycle of defining and sorting the data, which helped the researchers to recognize the relationships of one code to others. By combining codes or dividing them into different codes, the researcher determined the categories and subcategories based on the relationships between these codes (Glesne, 2011). Emergent categories and subcategories from the present study were described in the next chapter in detail.

In selective coding stage, as the main purpose was to identify a central phenomenon and connect other categories to this central phenomenon (Ezzy, 2002), the researcher and the advisor of the study got together to discuss on the categories in light of the existing literature. The researchers negotiated the categories until they arrived a 100% agreement. After the debate among the researchers, the four main themes were: GM foods teaching self-efficacy beliefs, GM foods teaching self-efficacy beliefs and personal epistemological beliefs, GM foods teaching self-efficacy beliefs and GM foods knowledge, and GM foods teaching self-efficacy beliefs and GM foods risk-benefit perceptions. Besides, the qualitative data emerged sixteen categories under these four themes: Personal GM foods teaching self-efficacy beliefs, Assessing students' SSI learning, Generating SSI discussion environment, Teaching nature of SSI, Classroom management in SSI lessons, Time management in SSI lessons, Teacher inculcation (Teacher stance), Misunderstandings about SSI and SSI teaching, Simplicity of knowledge and GM foods teaching self-efficacy beliefs, Certainty of knowledge and GM foods teaching self-efficacy beliefs, Innate ability and GM foods teaching self-efficacy beliefs, Omniscient authority and GM foods teaching self-efficacy beliefs, Quick learning and GM foods teaching self-efficacy beliefs, GM foods knowledge and teaching self-efficacy beliefs, GM foods risk perception and teaching self-efficacy beliefs, and GM foods benefit perception and teaching self-efficacy beliefs.

3.6 Validity and Reliability Issues

3.6.1 Internal validity threats for quantitative analysis

Internal validity implies that the differences on the dependent variables were directly related to the independent variable, not caused by any other unintended variables (Frankel & Wallen, 2006). The possible threats to the internal validity of a research study may be; subject characteristics, mortality, location, instrumentation, testing, history, maturation, attitude of subjects, regression, and implementation (Frankel & Wallen, 2006). In the present study, subjects were selected based on some characteristics such as being a junior and senior PST enrolled in preservice science teacher education program in a university in Central Anatolia Region in Turkey. Therefore, subject characteristics was not considered as a threat for the present study. However, some characteristics of the subjects such as motivation or intelligence could not be controlled. Mortality threat may occur when some of the subjects drop out of the study as the study progresses and they are absent in the administration day (Frankel & Wallen, 2006). Since, in the present study, the sample of the study constituted 51% of the accessible population, mortality was not a threat. Similar to subject characteristics and mortality, location and instrumentation were also not among the possible threats for the present study because the data collection instruments were administered in subjects' own classrooms and the location sites were similar in average. Besides, there was no any instrument change during the data collection process and the same researcher collected all the data and behaved in a standard way throughout the data collection sites.

As being threats that might occur generally in intervention studies, testing, implementation, maturation, and regression were not among the possible threats for the present study. The instruments in the study were used for one time and since the four main instruments were not related to each other, none of the instruments might cause a clue for the other three instruments.

Finally, since all the conditions were tried to be controlled by the data collector and there was no any unexpected or unplanned event during the course of the research study, history was not a threat for the study. Attitude of subjects threat was considered to be controlled by the researcher by the explanations that made before instrument administration (voluntary participation, etc.).

3.6.2 Trustworthiness of the qualitative analysis

Trustworthiness of a research study is an important quality. Ensuring the quality of social science traditionally relies on construct validity, internal validity, external validity, and reliability (Yin, 1994). However, validity and reliability measures in qualitative research are different from those of quantitative research. Qualitative research is concerned with the existence and meaning of the phenomenon and uses a different terminology for validity and reliability issues. Lincoln and Guba (1985) suggest the terms credibility, transferability, dependability, and confirmability respectively as the equivalents for internal validity, external validity, reliability, and objectivity.

Credibility refers to internal validity of a qualitative study. In order to ensure credibility, some techniques such as prolonged engagement, persistent observation, triangulation, referential adequacy, peer debriefing (or peer review), and member checking were suggested (Erlandson, Harris, Skipper, & Allen, 1993). In this study, triangulation and peer debriefing techniques were used to ensure the credibility of interview data. Triangulation, which refers to the use of multiple data sources (Lincoln & Guba, 1985), includes the types such as data collection triangulation, investigator triangulation, theory triangulation, and methodological triangulation. The present study, implementing and using both quantitative and qualitative data collection approach, satisfy the data collection triangulation. In addition, in order to ensure investigator triangulation, a second researcher involved in the data analysis process of interview transcripts. The second technique to ensure the credibility in this study was peer debriefing which refers to external check of the research process by external scholars (Lincoln & Guba, 1985). This study has been conducted by constant collaboration of two researchers and throughout the process these two researchers tried to come to an agreement regarding data collection, data analysis, and instrument development. Besides, both the qualitative and quantitative measures in this study were checked by different scholars from the field of science education. Necessary revisions were made based on their suggestions.

Transferability implies external validity and it deals with the generalizability of the findings (Merriam, 1998). Although generalizability is not a prior issue in qualitative research, there are some ways that has been suggested in literature to ensure transferability such as thick description, purposive sampling, and reflexive journal (Erlandson et al., 1993). In this study, the researcher tried to give detailed descriptions of the participants and the context. In addition, details of the data collection procedure and qualitative approach used during data analysis were provided to allow other researchers to share the findings. Moreover, criterion sampling, which is one of the types of purposive sampling, was used to obtain key informants' opinions about GM foods teaching self-efficacy beliefs and related factors.

The third issue in trustworthiness is dependability. Dependability refers to the term reliability in quantitative research (Merriam, 1998). Reliability refers to the extent to which research findings can be replicated (Merriam, 1998, p. 205). Since it is difficult to repeat a qualitative research due to the fact that participants and their interpretations of instrument questions are dynamic, reliability in qualitative research is different than reliability in quantitative research. Rather than the replication of research findings, in qualitative research, dependability deals with the issue that results are consistent with the data collected (Merriam, 1998, p. 207). There are some ways such as triangulation, dependability audit, and reflexive journal (Erlandson et al., 1993) to ensure dependability. In the present study, in addition to triangulation, which was also used to ensure credibility, dependability audit was used. During the research process, especially for data analysis, I studied with a second researcher to come to an agreement on codes, categories, and interpretations. The inconsistencies between the two researchers were negotiated in detail and the findings of interview questions were presented in accordance with agreement.

Finally, confirmability, which refers to objectivity, is an issue to be discussed for the trustworthiness of a qualitative study. For confirmability, audit trail was employed in this study (Lincoln & Guba, 1985). Two researchers involved in every step including instrument development, data collection and data analysis, and both researchers agreed on the objectivity of findings and interpretations. In addition to this, peer debriefing was utilized to prevent bias in every single step of the study. Finally, a detailed and clear description of the research process was provided to make it accessible to other researchers.

3.7 Assumptions and Limitations of the Study

Assumptions and limitations of research studies might affect the effective usefulness of the results. The following assumptions were made by the researcher for the present study:

1. PSTs responded to the quantitative data collection instruments and the interview questions sincerely and seriously.
2. The administration of the instruments was under standard conditions.
3. There was no interaction between PSTs during the administration of data collection instruments.
4. PSTs enrolled in different data collection sites (nine universities) were assumed to share similar characteristics such as SES, age, and being exposure to same teacher education program developed by The Council of Higher Education.
5. The characteristics of the sample in quantitative part of the study were assumed to be representative of the population.

The study was subjected to the following limitations:

1. The study was limited to the nine universities in Central Anatolia region in Turkey.
2. The study was limited by its reliance on self-reported data on participants' responses.
3. The low reliability of epistemological beliefs and content knowledge instruments can be regarded as a limitation. Although measuring complex psychological constructs such as epistemological beliefs with a high reliability and validity is a difficult process and the epistemological beliefs instrument in this study is a translated version of an English instrument that was developed in a different cultural context, higher reliabilities may be obtained with different samples and items. In addition, different types of questions such as multiple choice questions can be added to the content knowledge instrument to increase the reliability.
4. Although some researchers advocate the idea of domain generality of epistemological beliefs, some researchers strongly argue in the literature that epistemological beliefs should be domain specific. The instrument measuring epistemological beliefs in the present study was not specifically developed for the domain of science, instead it is domain independent. Considering that the other three quantitative instruments were specifically developed for the domain of

science (in the context of GM Foods), domain generality of epistemological beliefs instrument may also be regarded as a limitation in the present study.

CHAPTER IV

FINDINGS OF THE ANALYSES

This chapter was divided into three main sections. In the first section, the details about data screening that was performed to check whether the quantitative data met the required assumptions for the analyses were given. In the second section, descriptive analyses including quantitative and qualitative findings for GM foods teaching self-efficacy beliefs, and quantitative results for the other variables, personal epistemological beliefs, GM foods risk and benefit perception, and GM foods knowledge were presented. In the third section, findings regarding the proposed model were given. More specifically, in the third section, quantitative and qualitative findings for the relationships among GM foods teaching self-efficacy beliefs and each of the three variables; personal epistemological beliefs, GM foods risk and benefit perception, and GM foods knowledge were presented respectively. Then, quantitative results regarding the relationships among the three variables personal epistemological beliefs, GM foods risk and benefit perception, and GM foods knowledge were given. The chapter concludes with an overall summary of the findings.

4.1 Data Screening for Quantitative Analyses

Screening the data prior to analysis is crucial to increase its' appropriateness for the analysis. To this end, before analyzing the quantitative data, preliminary data analysis including missing data analysis, outliers, normality and linearity, sample size, absence of multicollinearity and singularity, and residuals check was performed by IBM SPSS Statistics 22.

Missing data analysis

Due to its potential effect on accuracy of data analysis, if any, missing data is an important problem to be considered (Tabachnick & Fidell, 2007). Although there are different ways of handling missing data, if the missing values are less than 5% and the data set is large enough, mean imputation method can be used (Tabachnick & Fidell, 2007). In this study, for majority of the items, missing value percentages were below 1 percent and the missing data values in total ranged from 0 percent to 2.8 percent. Firstly, the researcher simply dropped some of the cases with so many missing data. Then, mean imputation method was used; all missing values belonging to continuous variables were replaced by series of mean of the items and missing values belonging to dichotomous variable (true = 1, false and do not know = 0), GM foods knowledge, were assigned zero.

Outliers

Outliers are the cases with extreme values on one or more than one variables. If the outlier is on one variable, it is called univariate outlier, while on the other hand multivariate outliers are cases with an unusual combination of scores on two or more variables (Tabachnick & Fidell, 2007). Outliers may affect generalizability of the results and distort the data by leading to Type I and Type II errors (Tabachnick & Fidell, 2007). For this reason, both univariate and multivariate outliers should be detected prior to data analysis. In this study, the values belonging to the dichotomous variable, GM foods knowledge, were all among the required range 1-3. Therefore, there was no any categorical data outlier to be deleted.

Outlier values belonging to continuous variables were detected differently for univariate and multivariate outliers. For univariate outliers, standardized scores, z scores, for the variables were computed. Univariate outliers are the cases with very large standardized scores on one or more variables that are disconnected from the other z scores. Cases with standardized scores in access of 3.29 ($p < .001$, two-tailed test) are potential outliers. Examination of the calculated standardized scores revealed existence of a few outliers, which exceed 3.29 value. Nevertheless, considering the large sample size of the study, it is quite expected that a few outliers, which does not distort the data, may be existed (Pallant, 2007; Tabachnick & Fidell, 2007).

For detecting multivariate outliers, Mahalanobis distance, which is the distance of a case from the centroid of the remaining cases where the centroid is the point created at the intersection of the means of all the variables, was computed for each case. Then, calculated values were compared with the critical chi-square (χ^2) value at .01 alpha (α) level (Tabachnick & Fidell, 2007). Since there were 10 independent variables in this study, this value was determined to be 29.59. In the present study, there were four cases in the data with Mahalanobis distance greater than this critical value and the values for all the other cases were below 29.59.

In addition to computing Mahalanobis distance values, Centered Leverage value and Cook's distance were also computed for each case to check the multivariate outliers in the data. Centered Leverage value was computed by using the equation of 3 (k+1) /N, where N is the number of observations and k is the number of independent variables (Stevens, 2009). For the present study, this value was computed as .03. Results showed that Centered Leverage value of one of the variables exceeded .03. In addition to Mahalanobis distance and Centered Leverage values, Cook's distance was also computed. As displayed in Table 4.1, the entire Cook's distance values were below 1, which indicated that the detected multivariate outliers were not influential on the results of the analysis; therefore, they could be retained in the analysis.

Table 4.1

Residuals Statistics

	Min.	*Max.*	*M*	*SD*
Mahalanobis distance	.24	50.17	6.99	4.62
Centered Leverage value	.00	.04	.00	.00
Cook's distance	.00	.05	.00	.00

Normality and Linearity

Normality and linearity are the other important criteria that should be checked prior to data analysis. In order to check the univariate normality of the continuous variables in this study, skewness and kurtosis values were computed. Histogram of each variable was examined as well. Skewness and kurtosis values are considered to be excellent within the range of ± 1 and as acceptable within the range of ± 2 (George & Mallery, 2003). As presented in Table 4.2, normality values for the variables of the present study were considered to be excellent except the first variable, which has kurtosis value considered as acceptable. Therefore, the variables of the study have a normal distribution. Examination of the histograms for each variable supported this finding as well. Moreover, in order to assess linearity Tabachnick and Fidell (2007) suggested that scatterplots between selected variables could be examined since testing them between all the variables is not feasible. Therefore, prior to analysis, scatterplots between selected variables were examined to check whether the linearity assumption was met. Examination of the scatterplots showed that although the shapes did not indicate perfect linearity, the variables were linearly related.

Table 4.2

Univariate Normality Statistics

Variable	Skewness		Kurtosis	
	Statistic	Std. error	Statistic	Std. error
GM foods Teaching Self-efficacy Beliefs Dimension				
Fostering argumentation and decision making on GM foods	-0.41	0.07	1.75	0.14
General instructional strategies of GM foods teaching	-0.20	0.07	0.09	0.14
GM foods teaching outcome expectancy	-0.33	0.07	0.45	0.14
Epistemic Beliefs Dimension				
Quick learning + Certain knowledge	0.59	0.07	0.53	0.14
Innate ability	-0.21	0.07	0.07	0.14
Simple knowledge	-0.03	0.07	0.00	0.14
GM foods Risk-Benefit Perceptions Dimension				
GM foods benefit perception	0.16	0.07	-0.03	0.14
GM foods risk perception	-0.43	0.07	-0.12	0.14
GM foods Knowledge	-0.29	0.07	-0.27	0.14

Sample size

Parameter estimates and significance tests in path analysis are very sensitive to sample size (Tabachnick & Fidell, 2007); therefore, it requires large sample sizes. Literature has asserted different suggestions to how researchers determine what the large sample size is in SEM analysis. For example, Kline (2011) suggested that the sample size should at least be 200 cases for performing SEM analysis. Moreover, Bentler and Chou

(1987) and Kline (2011) asserted 5:1 and 10:1 ratio for response per parameter respectively, and Stevens (2009) suggested the criteria that there should be at least 15:1 ratio for response per measured variable. In this study, the number of cases used in path analysis was 1077, which exceeds the limit proposed by Kline (2011). This study also met the criteria of 5:1 and 10:1 ratio for response per parameter and 15:1 ratio for response per measured variable.

Absence of Multicollinearity and Singularity

Absence of multicollinearity and singularity is another important assumption for path analysis. The assumption of the absence of multicollinearity and singularity is violated when the independent variables are highly correlated (Tabachnick & Fidell, 2007). Like other regression based statistical techniques, path analysis requires the absence of multicollinearity among the independent variables. To test for the absence of multicollinearity and singularity in the present data, collinearity statistics (Tolerance and VIF values) and bivariate correlations among the exogenous variables were examined. As displayed in Table 4.3, none of the exogenous variables were highly correlated with each other (maximum correlation was $r = .42$). According to Kline (2011), tolerance values should be greater than .10 and VIF values should be smaller than 10. In this study, minimum Tolerance value was .83 and maximum VIF value was 1.20, which supported the absence of multicollinearity and singularity in the data (Kline, 2011).

Table 4.3

Bivariate Correlations among Exogenous Variables of the Path Model

	QLCK	IA	SK	BEN	RISK	KNOW
QLCK	1	.10**	.18**	.19**	-.08**	-.28**
IA	.10**	1	.25**	.04	.04	-.00
SK	.18**	.25**	1	.03	.08**	-.07*
BEN	.19**	.04	.03	1	-.42**	.09**
RISK	-.08**	.04	.08**	-.42**	1	.05
KNOW	-.28**	-.00	-.07*	.09**	-.05	1

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

Residuals

Another requirement of path analysis is that residuals should be small and centered around zero (Tabachnick & Fidell, 2007). In addition, the frequency distribution of the residual covariances should be symmetrical (Tabachnick & Fidell, 2007). Residuals in path analysis are calculated in forms of residual covariances. Examination of residual covariance matrices calculated by AMOS for the present data revealed that, as suggested, residuals of the variables in the model were small, centered around zero, and symmetrically distributed.

Other than the requirements mentioned above, since path analysis is a regression based analysis, homoscedasticity and independence of residuals assumptions, which are among the assumptions of multiple regression, were also checked. Homoscedasticity assumption, which requires that the variance of the residuals about predicted dependent variable scores should be the same for all predicted scores, was also checked. The variances of residuals were similar for all predicted scores. Moreover, Durbin-Watson statistics, which ranged from 1.97 to 2.04, revealed that residuals of the variables were independent from each other.

4.2 Descriptive Analyses

During the quantitative data collection, prior to the items associated with each of the variables, the participants were first asked some questions which aimed to reveal whether they participated in GM foods-related NGOs or not, GM foods information resources they used, the way and frequency GM foods take place in their undergraduate courses, and their level of concern if GM foods become free in Turkey and outside of Turkey. As shown in Table 4.4, majority of the participants have not actively involved in any GM food-related NGOs. Besides this, the descriptive results revealed that while internet is the mostly used information source of GM foods used by the PSTs, studies published by environmental NGOs are rarely used to collect information about GM foods. Another interesting finding was that, around eighty percent of the sample articulated that GM foods are not covered in their undergraduate courses and the remaining participants articulated that the argumentation processes are sometimes take place in their courses. Finally, the participants were asked about their level of concern if GM foods become free in Turkey and outside of Turkey. The level of concern was reported to be somewhat the same; the answers demonstrated that the participants would be a fair amount worried if GM foods become free.

Table 4.4

Frequency of Participant Responses to GM Foods Related Questions

Variable	*f*	%
Participated in NGOs related to GM foods?		
Yes	22	2.0
No	1047	97.9
Missing	8	
Resources used to reach information about GM foods		
Internet	940	87.3
Radio and television	563	52.3
Magazines and newspapers	507	47.1
Social environments, friends	407	37.8
Studies published by environmental NGOs	193	17.9
GM foods covered in undergraduate courses?		
Yes	889	77.2
No	262	22.8
Missing	11	
How frequent GM foods are covered in your undergraduate courses?		
Rarely	163	18.1
Sometimes	490	54.3
Frequently	179	19.8
Quite often	55	6.1
Very often	15	1.7
Missing	260	

Table 4.4 (Continued)

Variable	*f*	%
How frequent discussion environments are created while GM foods are covered in your undergraduate courses?		
Rarely	271	30.1
Sometimes	363	40.3
Frequently	171	19.0
Quite often	80	8.9
Very often	16	1.8
Missing	261	
How frequent evidence-based discussion environments are created while GM foods are covered in your undergraduate courses?		
Rarely	317	35.3
Sometimes	331	36.9
Frequently	169	18.8
Quite often	68	7.6
Very often	13	1.4
Missing	264	
How frequent opposing ideas are encouraged while GM foods are covered in your undergraduate courses?		
Rarely	259	28.9
Sometimes	347	38.7
Frequently	197	22.0
Quite often	75	8.4
Very often	18	2.0
Missing	266	

Table 4.4 (Continued)

Variable	*f*	%
How frequent rebuttal generation is encouraged while GM foods are covered in your undergraduate courses?		
Rarely	314	34.8
Sometimes	321	35.6
Frequently	181	20.1
Quite often	67	7.4
Very often	19	2.1
Missing	260	
How worried are you if GM foods would become free in Turkey?		
Not worried	13	1.2
A little worried	90	8.5
Unsure	76	7.2
A fair amount worried	464	43.8
A lot worried	417	39.3
Missing	102	
How worried are you if GM foods would become free in the countries other than Turkey?		
Not worried	63	6.0
A little worried	124	11.7
Unsure	158	15.0
A fair amount worried	465	44.0
A lot worried	246	23.3
Missing	106	

4.2.1 GM Foods Teaching Self-efficacy Beliefs

In this study, PSTs' GM foods teaching self-efficacy beliefs were assessed both quantitatively and qualitatively. In the quantitative part, GM foods teaching self-efficacy beliefs were measured on a Likert type instrument ranging from (1) "strongly disagree" to (5) "strongly agree". Higher scores obtained from the instrument indicated stronger GM foods teaching self-efficacy beliefs while lower scores were the indication of weaker GM foods teaching self-efficacy beliefs. Besides the quantitative results, the present study also revealed qualitative findings regarding GM foods teaching self-efficacy beliefs through interviews.

As displayed in Table 4.5, quantitative analysis showed that PSTs had moderately high levels of GM foods teaching self-efficacy beliefs with the mean scores ranging from 3.89 to 3.56. The highest mean score among the dimensions of GM foods teaching self-efficacy beliefs instrument was obtained on fostering argumentation and decision making on GM foods (M = 3.89, SD = .49). This finding indicated that PSTs' have moderately strong teaching self-efficacy beliefs to encourage argumentation and decision making while teaching about GM Foods. The mean score corresponding to another dimension, general instructional strategies of GM foods teaching, was also moderately high (M = 3.68, SD = .57). That means, PSTs' have also moderately strong teaching self-efficacy beliefs about instructional strategies of GM foods teaching. Although GM foods teaching outcome expectancy dimension mean score was lowest among the other dimensions, it was still above the midpoint of five-point scale (M = 3.56, SD = .58) implying that PSTs in this study has moderately strong teaching efficacy beliefs about GM foods teaching outcome expectancy. Mean and standard deviation values corresponding to each of the items in GM Foods Teaching Self-efficacy Beliefs Instrument were provided in Appendix J.

Table 4.5

Descriptive Statistics for GM foods Teaching Self-efficacy Beliefs

Dimensions	*M*	*SD*	*Min*	*Max*
Fostering argumentation and decision making on GM foods	3.89	0.49	1.36	5.00
General instructional strategies of GM foods teaching	3.68	0.57	1.78	5.00
GM foods teaching outcome expectancy	3.56	0.58	1.00	5.00

Regarding the qualitative findings, the interview data revealed different categories under the theme GM foods teaching self-efficacy beliefs. Categories and the descriptions of each code regarding this theme were displayed in Table 4.6. Under the theme, GM foods teaching self-efficacy beliefs, eight categories emerged. These categories were; personal GM foods teaching self-efficacy beliefs, assessing students' SSI learning, generating SSI discussion environment, teaching nature of SSI, classroom management in SSI lessons, time management in SSI lessons, teacher inculcation, misunderstandings about SSI and SSI teaching. Moreover, the qualitative data revealed some subcategories as displayed below.

Table 4.6

Description of Codes and Categories regarding GM foods Teaching Self-efficacy Beliefs

Category / Subcategory	Code	Frequency	Code description
Personal GM foods teaching self-efficacy beliefs			
• Impediments for GM foods teaching self-efficacy	Need experience	16	Statements that indicate participants are in need of more teaching experience to teach SSI in a more efficient way.
	Student readiness	5	Statements that imply students are not ready to be taught by using student-centered teaching methods, contribute discussions about controversial issues, engage in flexible classroom environment, generate arguments, etc.
• Sources of GM foods teaching self-efficacy	Teaching experience	3	Participants' previous teaching experiences in mentoring schools and undergraduate courses
	Teacher knowledge	3	Participants' knowledge about GM foods
	Teacher attitude	2	Statements that indicate teachers should be democratic in their personal lives to possess higher SSI teaching self-efficacy beliefs

Table 4.6 (Continued)

Category / Subcategory	Code	Frequency	Code description
Assessing students' SSI learning	Daily life connection	13	Considering students' connection of SSI to their daily lives as SSI learning assessment criteria
	Empathy	7	Considering showing empathy toward others as SSI learning assessment criteria
	Generating evidence	6	Considering generating evidences about the controversial issue as SSI learning assessment criteria
	Motivation to learn	11	Considering increased motivation to learning science as a result of SSI teaching as SSI learning assessment criteria
	Stating opposing evidences	3	Considering stating opposing evidences to others' counterarguments and rebuttals as SSI learning assessment criteria
	Student awareness	3	Considering increased student awareness about controversial issues as SSI learning assessment criteria

Table 4.6 (Continued)

Category / Subcategory	Code	Frequency	Code description
Generating SSI discussion environment	Claim-evidence-rebuttal	11	Statements that indicates PSTs use and fostering claim-evidence-rebuttal generation in SSI lessons
	Inquiry-do research	4	Statements indicating that PSTs encourage students to do research prior to SSI discussions and use inquiry during SSI lessons
	School context	3	Statements that consider inadequate infrastructure as an obstacle for SSI teaching
	Ways of generating discussions		Ways of generating SSI discussion environments such as using controversial-opposing ideas, concept cartoons, group work, questioning, different resources, and real life examples.
	• Use controversial-opposing ideas	15	
	• Use concept cartoon	2	
	• Use group work	7	
	• Use questioning	2	
	• Use of different sources	7	
	• Use real examples	7	

Table 4.6 (Continued)

Category / Subcategory	Code	Frequency	Code description
Teaching nature of SSI			
• Teaching complexity nature of SSI	Implicit teaching	6	Statements indicating that PSTs teach complexity nature of SSI implicitly (without emphasizing complexity and expect students to recognize)
	Explicit teaching	7	Statements indicating that PSTs teach complexity nature of SSI explicitly (presenting a clear explanation about complexity aspect)
	Society connection	2	Statements indicating that PSTs teach complexity by focusing on societal aspects of SSI
• Teaching multiple perspectives nature of SSI	Role assigning in SSI activities	4	Statements indicating that PSTs use SSI activities in which students are assigned different roles corresponding to different stakeholders of the controversial issue (e.g. environmentalist, politician, farmer, etc)
	Teacher value different opinions	7	Statements indicating that PSTs point out and value the existence of variety of perspectives on SSI

Table 4.6 (Continued)

Category / Subcategory	Code	Frequency	Code description
	Use of scientific papers	3	Statements indicating that PSTs provide students with scientific papers to emphasize on multiple perspectives of SSI
• Teaching ongoing inquiry	Use real life examples	13	Statements indicating that PSTs bring and discuss about real SSI examples which have been subjected to scientists ongoing inquiry
• Teaching skepticism nature of SSI	Implicit teaching	2	Statements indicating that PSTs teach complexity nature of SSI implicitly (without emphasizing scepticism and expect students to recognize)
	Explicit teaching	6	Statements indicating that PSTs teach scepticism nature of SSI explicitly (presenting a clear explanation about scepticism aspect)
	History of science	2	Statements indicating that PST would use history of science for teaching skepticism aspect of SSI
	Using reliable sources for evidences	5	Statements indicating that PST would lead students to utilize reliable sources while doing SSI investigation

Table 4.6 (Continued)

Category / Subcategory	Code	Frequency	Code description
Classroom management in SSI lessons	Getting better with experience	3	Statements indicating that the participants need more experience to overcome classroom management problems while teaching SSI
	Self reflection (high confidence)	5	Statements indicating that the participants feel efficacious about classroom management in SSI lessons
	Peer evaluation	2	Statements indicating that peer evaluation may a solution to overcome classroom management problems in SSI lessons
	Teacher authority	4	Statements indicating that teacher authority should be established for a successful classroom management in SSI lessons
• Obstacles to classroom management	Class size	2	Statements indicating that increased class size cause classroom management problems while teaching SSI
	Managing discussions	4	Statements indicating that difficulty of managing SSI discussions makes classroom management difficult

Table 4.6 (Continued)

Category / Subcategory	Code	Frequency	Code description
	Student centered	2	Statements indicating that since SSI teaching is student-centered, it is difficult to manage the classroom while teaching SSI
Time management in SSI lessons	Self reflection (confidence)	4	Statements indicating that the participants feel themselves efficacious about time management in SSI lessons
	Teacher preparation	6	Statements indicating that if teachers prepare well before the SSI lesson, time management would not be a problem
	Class size	3	Statements indicating that time management in crowded classrooms would be a serious problem for teachers
	Difficult to manage discussions	3	Statements indicating that since managing SSI discussions is difficult, time management would be a problem for teachers in SSI lessons
	Time consuming	5	Statements indicating that SSI acitivities are time consuming

Table 4.6 (Continued)

Category / Subcategory	Code	Frequency	Code description
Teacher inculcation	Refuse	7	Statements indicating that the participants refuse the idea that teachers may share their ideas about the SSI being discussed in the classroom
Misunderstandings about SSI and SSI teaching	Misunderstanding about SSI assessment	1	Misunderstanding that since SSI are open-ended and do not have clear-cut solutions, it is not possible to assess student learning in SSI lessons
	Misunderstanding about SSI teaching	4	Misunderstanding that it is not possible to teach a science topic through a SSI-based lesson
	Misunderstanding-certainty and SSI	3	Misunderstanding that scientific knowledge about SSI is not robust and reliable
	Misunderstanding-objectivity	1	Misunderstanding that scientific knowledge should be objective
	Misunderstanding-ongoing inquiry	5	Misunderstanding that emerging new information about SSI is the same as changing students' opinions in the discussions

Table 4.6 (Continued)

Category / Subcategory	Code	Frequency	Code description
	Misunderstanding-skepticism	1	Misunderstanding that skepticism aspect of SSI implies an opinion should not be judged as right or wrong
	Misunderstanding-tentativeness	4	Misunderstanding that as the new scientific information emerged, the previous information was no longer accepted as reliable and valid

4.2.1.1 Personal GM Foods Teaching Self-efficacy Beliefs: Its sources and impediments

PSTs were asked whether they feel efficacious to teach GM Foods or not. They were also directly asked to rate their belief out of five. Majority of the participants rated themselves 4 out of 5, while the quarter of them rated 3. Two of the participants rated themselves 2 and 5.

Although most of the participants rated themselves 4 out of 5, they all mentioned that they need experience to feel more efficacious to teach SSI. Therefore, it can be said that being in need of experience is the most stated impediment for feeling efficacious to teach SSI. In addition to this, PSTs had some concerns about how to communicate with students during the discussions, managing the discussions, time, and the classroom while teaching SSI. Some of PSTs consider themselves not knowledgeable about GM Foods nevertheless it was articulated that they know how to do research and reach the information. One of the PSTs stated that:

> I cannot say I have the necessary level of knowledge but I know how to reach information. I know how I am going to use that information. I am quite sure about these however when I will start to teach in the field, there would be some problems with communicating with students. (PST11).

Moreover, teachers reported student readiness as the other impediment for feeling efficacious to teach SSI. According to some of the participants, they have some doubts about whether students will be ready to learn science topics based on SSI and through student-centered teaching methods. In addition, as one of the participants stated, since SSI discussions require being knowledgeable about the issue, students should do prior research before coming to the lesson. If not, there would be some problems during discussions.

> First of all, I would make an introduction but I would also expect that students should have been prepared to the course beforehand. I would tell them about which topics they should do prior research one week earlier. It is for sure that this highly depends on the students. I mean, if the students used to learn through direct learning it would be very difficult for me at the beginning to do SSI teaching. Teacher should be very patient and passionate in this process. (PST6).

> I have concerns whether students get used to SSI teaching or not. (PST5).

In addition to the impediments of lower GM foods teaching self-efficacy beliefs, the participants reported the sources of their self-efficacy beliefs about GM foods teaching. The majorly reported sources of higher GM foods teaching self-efficacy beliefs were undergraduate courses taken and experiences in mentoring schools. PSTs especially mentioned about the SSI course they took at the final year of their teacher education program. As they expressed, in this course, they learnt much about nature of SSI and teaching strategies that can be used while teaching SSI. Besides, they indicated that it was very beneficial for them to design and perform a microteaching about a SSI topic. In addition to this course, the participants mentioned about the mentoring schools. Although none of them had chance to observe a SSI course in their mentoring schools, they thought that observing a real classroom environment provide them with the opportunity to see how group work activities are handled in crowded classrooms, and patterns in student-teacher interactions. PST14 and PST1 commented about this as the following:

> I believe I can teach SSI because many times I had the chance to practive this in my undergraduate courses. Of course there were times that we failed in this process, for instance, some of the groups in our course had difficulties to decide on their SSI topics. I mean we experienced every process with its rights and wrongs. So, as long as I prepared for the lesson well, I believe I can do SSI teaching. (PST14).

> We had prepared SSI lesson plan just for one time in just this SSI class and also it was not a real classroom environment, we taught our classmates. However even in that time, I observed that how much it can mess, because even university students learnt a lot of new things by searching much as ‘is it like that etc. (PST1).

Moreover, one of the participants articulated that, since the language of education in her university is English, it would be easy for them to investigate GM Foods from several national and international sources on the internet. This was considered as one of the factors that make this PST feel efficacious to teach SSI. She stated that:

> I believe I can teach (SSI). Maybe classroom management would be a problem but given that we are inexperienced now it is expected. Other than that, if we are knowledgeable, then no problem... We have internet and enough reliable resources. We know English and I guess this is the most important advantage we have. I believe that I will be able to teach SSI well enough by doing research (PST15).

According to another participant (PST4), possessing self-interest toward SSI would lead teachers to do more research on these topics. This, in turn was considered as a factor that may promote teacher belief to teach SSI in his or her classroom. In parallel to this assertion, one of the PSTs mentioned that she feels herself efficacious since she searched on GM Foods and knows the topic well. PST4 expressed that:

> I trust myself. I mean, first of all, I learnt a lot in my undergraduate courses. Secondly, I am interested in SSI. Besides, since I love doing research, it would not be difficult for me to teach those (SSI) topics. (PST4).

Finally, unlike to previous assertions, one of the participants highlighted that in order to believe efficacious to teach SSI, teachers should be democratic in their personal lives. According to this PST, it is very crucial that teachers, in their own private lives, should believe democracy so that they create rooms for sharing different opinions while teaching science. For instance, she mentioned about participating in local committees to take part in decision making processes concerning the environment she lives in. She articulated that:

> Well, I read SSI publications existed in the literature and the reading assignments in my undergraduate courses. However, in my opinion, it would be very hard to teach SSI for a teacher who does not give place to democratic values in his/her personal life. I myself live in that way. For instance, I take part in city council actively and have many friends there. What I mean is that, since my own perspective is in line with democratic education (SSI teaching), I believe it would not be difficult for me. Teachers' personal lives are very important and their perspectives on life matters. (PST3).

4.2.1.2 Assessing students' SSI learning

The participants interviewed were asked to mention about how they are going to understand that their students attained the outcomes of SSI courses. PSTs mainly pointed out their expectations to see an increase in students' motivation to learn science topics as a result of SSI teaching. According to them, if they observe that their students are better motivated to learn science as a result of SSI teaching, they would consider themselves as successful teachers. To illustrate, one of the participants stated that:

> For example, after a class discussion, students might have been interested in the issue and done further investigation on that. Also, if they come to the next class hour and tell us for example about a particular SSI-related news, ask for my opinions, then I would consider myself as successful in SSI teaching. I mean the point here is to arouse curiosity to investigate about and learn SSI. (PST17).

Another participant highlighted the same point as:

> After I've finished teaching genetically modified organisms, GM Foods, I actually regard myself as successful if my students ask me questions on the issue or they tell me that they've heard of something or read about this topic (PST1).

The other two important points that the participants stated to assess their students' SSI learning were; students' ability to connect SSI to their daily lives and showing empathy towards other people. PSTs mainly mentioned about connecting the SSI knowledge that students learn in the classroom into their own daily lives. For instance, according to the participants, students may be cautious about GM Foods while doing shopping, participate in activist organizations about GM Foods, or they may share their opinions about both negative and positive sides of GM Foods with their families, friends, and other people. One of the PSTs mentioned about this expectancy as the following:

> When they apply the SSI knowledge into their daily lives, it is also a success for me. For me, after I've taught the subject GM Foods, when one of my students come and tell me: "I used to eat corn but now I eat less" or "I do it in this and that way" , I infer that I'm really able to succeed teaching and my student can integrate the information into his/her daily life (PST1).

According to PSTs, showing empathy is the other important outcomes of SSI teaching. They asserted that since it is very probable that different people have different viewpoints about SSI issues, students should learn to respect others' opinions. One of the participants expressed her opinions about empathy, which was one of the most stated outcomes of SSI teaching, as the following:

> For instance, they first will learn their own opinions on the issue. But at the same time, they would also learn how to interpret the issue from someone else's point of view. These two should go together and support each other. (PST3).

Moreover, analysis of PSTs' responses revealed that ability to generate evidences and students' awareness about SSI were the other two important outcomes of SSI teaching. According to the participants of this study, SSI teaching should gain students to develop skills on proposing evidences. The evidences may either be to support their own perspectives or to rebut others' arguments. Two of the PSTs stated that:

> I would regard myself as successful when I see my students can defend their opinions. How strong their arguments in a discussion are, to what extent they did research on the issue and they are knowledgeable are my other expectancies that makes me feel successful in teaching SSI (PST6).
>
> I consider myself as a successful teacher in teaching SSI if my students are knowledgeable about the issue, can rebut others' opinions, and support their own positions and arguments (PST15).

Finally, a few PSTs indicated that as a result of SSI teaching, they would expect their students to raise awareness about SSI topics such as GM Foods, nuclear power plants or vaccination issue. As stated by two of the PSTs, students are expected to react to and express their own viewpoints related to news that they hear from media and share these with their family members and friends. One of these PSTs indicated that:

> For example, my students may discuss the issue with their families at their homes, while watching news about an SSI. Besides, I expect my students to present their evidences and supportive arguments while negotiating with their families on a controversial issue (PST21).

4.2.1.3 Generating SSI discussion environment

In order to get insight into PSTs' teaching self-efficacy beliefs to generate discussion environment on SSI related topics, they were requested to mention about how they will generate SSI discussion environment in their future classes.

Results of data analysis revealed that most of the participants emphasized using controversial (or opposing) ideas during SSI discussions in the classroom. Namely, teacher candidates indicated that they feel efficacious to use group work in which they assign different roles to students about a real-life SSI. By this way, they believe that students may be encouraged to generate different arguments, counterarguments, and rebuttals. Also, they would explore the issue from different viewpoints through which they establish empathy with other people. PST1 explained this by sharing her experience from an undergraduate SSI course:

> I would use role assigning technique. For instance, in our undergraduate course, we were environmentalists and there were people both taking the positive sides and negative sides of the issue. There were people who are supporting the construction of nuclear power plant. I mean, to me, environmentalists may generally say that it shouldn't be established but our teacher made two groups and we did like that. I may do the same thing in my own classrooms, especially not always giving the same role to the same group but I continuously change. Because I want them to see the different sides and how they think at different aspects (PST1).

Some of the participants mentioned that it would be better to use questioning method in SSI teaching. As one of the PSTs indicated, questioning is considered as an important method to start discussions and arouse curiosity among the students. Besides, they mentioned about student preparation to the SSI lesson and fostering prior research before coming to the class. PSTs believe that teacher should promote student inquiry and research prior to SSI lesson.

Similar to this code, the participants pointed out the importance of encouraging students to make claims, evidences, and rebuttals. PSTs stated that, during the process of SSI discussions, they would be able to implement argumentation. By the means of implementing argumentation in the classroom, teachers believe that students will be able to learn how to generate claims, present evidences, and provide rebuttals for counterarguments. To illustrate, PST13 and PST11 stated that:

> First of all, I would give them some time and then expect them to discuss about the issue and generate their own hypothesis regarding the issue (PST13).
>
> I might present the opposing claims about a particular SSI. Then, in order to create a discussion environment, I might ask some questions such as "Which claim you would prefer to support and why?" (PST11).

Moreover, participants mentioned about using different resources for their SSI teaching. For instance, most of the teachers pointed out the importance of using technology in SSI classrooms. They stated that they would use computers, educational videos, visuals about the SSI issue, scientific papers, news from magazines, teacher-prepared worksheets, and technological materials such as tablets to help students do research both prior to the lesson and in the classroom. They also considered concept cartoons as a good way to take students' attention about the controversial issue being discussed. PST1 and PST13 stated about the use of different resources as the following:

> I think I will absolutely utilize technology for students' research. If I have the opportunity in the schools I will work, I will enable them to find clues, establish their claims and hypothesis in some way and prove their claims by means of technology. Apart from that, speaking of technology, I like using video, presenting visuals related to subjects and such like very much and I definitely make use of pictures, power points videos and such (PST1).

> I tried to provide students with scientific papers that reflect opposing perspectives (on an SSI). I encourage students to realize that there always might be different perspectives and to avoid the idea of existence of a sole truth (on SSI). Besides, I pay attention to use videos, illustrations, and stories which reflect this idea accordingly (PST13).

Finally, results of interview data revealed that some of the participants have some concerns about school context to generate SSI discussion environments. According to them, school facilities are promoting factors for teachers to generate discussion environment about SSI issues. For instance, PSTs believe that they may face some difficulties unless there are internet connections or computers in the classroom. Two preservice teachers explained this as:

> Yes I believe but this also depends on the context students are living in; for instance, whether they have internet at home or not is very important. It would be difficult for me to teach GM foods in a village school; it is probable that students have no idea. On the contrary, in a well-known private school, I am sure students are used to these controversial issues, therefore can easily generate their arguments regarding the issue (PST5).

> It depends on which part of the Turkey I will be working in. Even I will work in the disadvantaged regions I would do my best and try to provide this. However, it totally depends on the climate in the class, circumstances, students' profile, and the participation of students to the teaching and learning processes (PST9).

4.2.1.4 Teaching nature of SSI

One of the interview questions was asked to reveal participants' teaching self-efficacy beliefs about teaching nature of SSI. To this end, PSTs were asked to respond whether they believe they can teach the four main characteristics of SSI to the students and in what ways they are planning to accomplish this. In light of the related literature, the main characteristics of SSI were determined to be complexity, multiple perspectives, being subject to ongoing inquiry, and skepticism. The questions were asked in accordance with these four aspects.

Participants were asked whether they can teach students the complexity and multiple perspectives nature of SSI or not. PSTs' responses revealed some insights into their teaching self-efficacy beliefs and to what extent they are aware of the complexity and multiple perspectives nature of SSI. First of all, most of the PSTs were aware that SSI are complex, open-ended, and lack simple and straightforward solutions and involve diversity of perspectives. When they were asked about in which ways they are planning to teach the complexity nature of SSI, most of them mentioned that since SSI involves different controversial viewpoints inherent in them, students will be able to recognize the complexity, namely the open-ended nature of SSI easily. That is, PSTs expect students to understand the complexity aspect of SSI during the discussions implicitly. Some of the respondents mentioned about explaining the complexity characteristic of SSI to the students explicitly. According to these participants, it would be difficult for students to understand the nature of SSI without a clear explanation of their characteristics. PST16 commented that:

> It would be very problematic for a teacher if s/he has difficulties to manage both time and the classroom. In such kinds of situations, teachers most of the time finish the course with a very weak explanation which does not help students to get the main point. To avoid this, teachers should use the time very efficiently. In the closing part of the course, as a teacher, we may tell the students that, "just like you scientists may also possess varying perspectives regarding these controversial issues. There is no middle regarding these issues. Due to both positive and negative aspects, there are always opposing sides (PST16).

Two of the participants focused on making society connection while teaching the complexity nature of SSI. According to them, emphasizing that SSI has a societal aspect and therefore open to public debate would make teaching the complexity aspect easier for teachers. PST5 stated that:

> When I want to wrap up the lesson, I would re-mention to the students that SSI has an influence on both us, as citizens, and the whole society. They would understand that SSI are more open to public discussion and sensitivity and think accordingly. I mean, they would learn SSI in anyway (PST5).

Similarly, PSTs proposed that they may use some activities in which they assign different roles to students and expect them to discuss the controversial issue from different perspectives. By this way, students are believed to gain the idea that individuals may have variety of perspectives regarding an SSI. Some of the teachers were more tend to explain the multiple perspectives nature to the students directly. To illustrate, PST9 and PST16 commented that:

> There would be different opinions in the classroom and this would usually not end up with a certain conclusion. They usually are open-ended issues. Students would accordingly realize that SSI are complex in nature. I could teach this in that way (PST9).
>
> Each group would have different viewpoints. For instance, students in one group might be genetic engineers, others might be patients, or CEO in a GDO company. When they discuss from these varying perspectives, they might generate different arguments; for example, they would be the supporters of GM foods if they want to increase the profit of the company if they acted as the CEO of this company. Or if they are the pations, they would be willing for GM technologies so that they could be cured by that means (PST16).

The participants' responses about teaching multiple perspectives of SSI also revealed that, PSTs value different opinions in the classroom. Most of them highlighted the importance of encouraging students to share their perspectives and creating an environment in which as a teacher, they would value opposing viewpoints. They argued that, classrooms would be more democratic by this way. To illustrate, PST3 argued that,

> I think I can teach the multiple perspectives aspect of SSI. I even believe that this would help classroom environment to be more peaceful. They anyway would see during the discussions that SSI has multiple perspectives. For instance, I may use the techniques such as Jigsaw so that students could experience to approach an issue from multiple perspectives. They [students] could be given the roles of being doctor, farmer, etc. (PST3).

Moreover, some of the participants mentioned about using scientific papers which reflects scientists' varying opinions about a controversial issue in SSI lessons. By this way, PSTs intends to focus on the multiple perspectives aspect of SSI. PST10 commented on that:

> As I have just mentioned before, for example, by the advancement of technology, perhaps with the measures taken, the ideas of scientists about GM foods could be changed. If I find and bring to class scientific articles that manifests that new scientific studies have been tested, implemented and actually are not found harmful, the ideas of students regarding GM foods may change (PST10).

The participants were also asked about teaching the ongoing inquiry and skepticism characteristics of SSI. Most of the participants mentioned that they believe to be able to teach the ongoing inquiry aspect of SSI in their future classes. Majority of the PSTs reported that they will use real-life issues to be discussed in the classrooms. They tend to prefer an issue about which scientists past interpretations have changed currently. Namely, participants of this study are planning to use a real-life SSI example to show that as scientific knowledge improves, opinions and judgments about that issue may be changed. Unlike to complexity and multiple perspectives aspects, none of the participants mentioned about giving the meaning of ongoing inquiry aspect to the students explicitly. One of the PSTs argued that:

> For example, I would find a research on GM Foods that was conducted 3 or 4 years ago and I would also show them a recent study to emphasize the differences between them. By tabulating the results of both visually, well, in a way that is the most appropriate, I think I could use that. That way they would be able to see the difference between them and observe their liability to change in a five or two years (PST1).

Another participant commented similarly that:

> I can directly show some topics which takes place on the recent media. If I bring about the topics on the agenda such as, today there is such an issue in our country, there are different perspectives regarding this, I mean what the students they directly engaged, so that they could more related to everyday life. I can make a comparison made of the situation which is considered in the past and the situation now. I suppose there were vaccinations, vaccinations came into my mind. If I do not remember it wrong, there was a type of vaccine that seemed to be harmful in the past and it is widely used daily. I could bring into such concrete examples for them ... (PST14).

Skepticism, which refers to recognizing potentially biased information and having ability to choose reliable information sources before making decisions, was the other question that participants were responded to. PSTs were asked whether they feel efficacious to teach the skepticism aspect of SSI and if yes, in what ways. Most of them replied they believe to teach the skepticism aspect by directly telling the students that they should not believe every information source they encounter. PSTs also stated that they may provide students with resources such as books, articles, and reliable webpage addresses prior to SSI investigation. According to some of the participants, a teacher is likely to fail teaching this aspect only by explaining the term. However, these participants (two PSTs) considered themselves as inefficacious and failed to propose ways to teach skepticism aspect of SSI to the students. Below, two participants, one feeling efficacious to teach skepticism, and the other feeling inefficacious, commented that:

> As I said I could give the evidence, I would not give all the evidences myself, if I was a teacher who was teaching socio-scientific topics in the class. Instead of giving all the evidence, I can assure the students to find resource by themselves and let them to have experienced to realize which criteria they should take into account in order to understand whether the resources are reliable or not, by saying now you search for the evidence. They would have decided according to that. I mean we have found this resource but how reliable is this and so on... Therefore, I could offer recommendations about internet sites. Not at the beginning of each lecture, but only explicitly would say pay attention to "the extension of the site, if the site has a date, date of the article, it is based on what, according to which research this news or article is written?" Thus, we would ensure that they pay regard to objectivity in their researches (PST16).

> I do not know how I could to teach, but we notice when we read whether they are written objectively or not. It's really clear from the expressions, but does the student notice it? Some students notice, whereas some students do not notice. I obviously do not know how to make realize who does not recognize it (PST20).

Two of the participants articulated that history of science can be used to teach skepticism aspect of SSI. One of them argued that,

> History of science can be used to teach SSI's skepticism aspect. These are, for example, developing and changing issues. It was said so, it was believed so, now it is so. The new technological developments that are revealed can be brought into the class. For example, when there was visibility by optical microscopy to a certain extent, now it is possible to look at living molecules by the nanoscope designed last year. I mean I think we can teach this aspect by specific examples (PST8).

4.2.1.5 Classroom management in SSI lessons

Participants of the study were asked to reveal their self-efficacy beliefs regarding classroom management while teaching SSI in their future science courses. The analysis of interview data showed that majority of the participants considered themselves in need of experience to handle classroom management problems while teaching SSI. Moreover, they thought that they will get better on SSI teaching with experience. On the other hand, some of the PSTs believe it is very unlikely that they will face difficulties about classroom management. To those PSTs, their teaching experience courses and mentoring schools that they go on a regular basis have been very beneficial for them to gain classroom management skills. One of the participants stated that:

> I no longer think classroom management will be a problem. Since, internship lessons become very helpful in this regard. At first we were getting very excited and such, but then you can manage the class in a way, this is happening through experience. I think I can manage. (PST9).

When asked about classroom management while teaching SSI, participants mostly focused on managing the discussions about the issue. Great majority of the participants mentioned their concerns about managing discussions. They also stated that comparing to direct teaching, classroom management would be more difficult in SSI teaching. They highlighted the possibility of losing the classroom control during the leading of discussions. The reasons of this were mainly gather around the difficulty of managing discussions in crowded classrooms and the fact that SSI teaching is a student-centered process. According to PSTs, if the class size will be large, they would probably have difficulty to manage the discussions. In addition, since students would be sharing their ideas and there will be some opposing ideas related to the issue being discussed, as a teacher, they may not be able to manage the classroom. Two PSTs commented on that:

> Since it is student-centered, it can be a little difficult. Students will search, so they will be required to talk, talk a lot, will be required to make discussions with friends. In the discussions within his/her own group, noise and chaos can be created. It might be difficult to manage, or student can argue with a friend who has opposing ideas. These may cause distress (PST10).

> Yes, as I mentioned before, classroom management is especially difficult in crowded classes. There might be some chaos when they divided into the groups, their materials will be abundant, they will search for the information themselves. I need to prevent this. I think classroom management is a bit harder in comparison to direct teaching (PST14).

Participants proposed some strategies to overcome the classroom management problems in an SSI course such as peer evaluation and getting agreement on student-determined rules prior to discussions as whole class. One interesting finding was that PSTs consider teacher authority as necessary to maintain the control during the discussions. According to them, students should feel the authority of the teacher in the classroom, which they think, will stop student misbehavior and embrace them to respect others' opinions. One of the PSTs articulated that:

> To this end, to be an authoritarian teacher is required, I do not think I would be able to that extent. It is necessary to ensure that situation you know as they say kind and firm, shall I say they need to be afraid a little bit? It is better if they are not to be afraid, but in some cases yes this line this borderline should be kept but it is very difficult when it is as such. In other words, when you perform group work that chaos in the class… Students are already cannot sit and cannot not stand where they are. You experience a lot of hardship even when you intend I shall teach a normal lesson. Whether this is in a public school or in a college, the students of present time are extremely hyperactive (PST20).

4.2.1.6 Time management in SSI lessons

Similar to classroom management, participants' self-efficacy beliefs to manage time in SSI lessons were also tried to be explored through interview questions. PSTs' responses revealed that majority of the teacher candidates believe that they may have difficulty to manage the time however after gaining experience, they believe to become more sufficient. A few of the participants articulated to be efficacious to manage the time efficiently during SSI teaching. These participants thought that their SSI teaching practices experienced in undergraduate courses and mentoring schools will make this process easier for them. Besides, these participants highlighted the significance of student preparation for successful time management. That is, for teachers not to have time management problems, students should be well prepared about the issue prior to the course. The following two excerpts were reported by PSTs feeling efficacious and not efficacious regarding time management in SSI lessons:

> I lectured on GMO so many times; therefore, I think I won't have any problems with that, but there may be some topics that I am unfamiliar with. Even if I was new in that topic, I would prepare myself really well with a lesson plan, I would do a research to determine which concepts to teach, I would study those to be taught but as I do not know what may come, I may experience some difficulty with them, anyway, I do not believe there will be a problem about time with these unfamiliar topics, either, after I practice more and more (PST1).

> I think I will have a time management problem. I am inexperienced and I do not know where the discussion could go to (PST19).

Nearly half of the participants highlighted that SSI teaching is time consuming. Especially, comparing to direct teaching, participants thought that SSI teaching requires more time. These PSTs mainly reflected on the reasons of class size, the difficulty of managing SSI discussions, and student-centered nature of SSI teaching. Crowded classrooms were considered to be a serious obstacle to implement and maintain SSI discussions in the classroom. In addition, according to the participants, since SSI teaching requires student-centered learning and teaching environments, both classroom management and time management would become difficult due to the fact that students will be more eager to spend time. One of the PSTs commented on that as the following:

> It would be very difficult I mean the students will be active since SSI teaching is student centred. The problem in the student-centred lectures is teacher’s inability to organize time. This is to say you arrange everything so that the student speaks for that much minutes. There are a lot of students, it is required to be planned as this much seconds to this student (PST5).

Unlike to these three reasons, one of the PSTs pointed out that SSI topics are considered as waste of time by some of the teachers and students. To this PST, teachers are under the pressure of preparing students to high stake exams and since SSI are not covered in high stake exams teachers tend to avoid spending time for teaching SSI. This participant stated that:

> Also, there is such a thing that I realized when I went to internship schools; socio-scientific subjects are not come up on the test anyway, so for instance teacher says let's quickly pass this, and begin frictional force. So I'm not sure if I sink into this idea. Because the expectation of the student is teacher shall prepare us for the exam, shall solve plenty of questions to come up, I do not know if I can do SSI teaching as comfortably. I want to use it, but I may not be able to do it in one class hour. But if I think that I have enough time, I can do it, I can finish it on time (PST10).

In order to minimize and overcome the problem of time management, most of the participants asserted that teachers should be well-prepared prior to the lesson. As PST21 and PST3 stated in the following, if the teacher prepares the lesson in an organized way, s/he would lead the discussions easily, therefore, manage the time more efficiently.

> I think I will have time problem if I do not plan well. At first stage I can do the planning part well, but in the application part planning may not comply (PST21).
>
> I try to plan the lecture well in advance. I also try to limit the discussions since one class hour is not enough for everything. For example, not all GMO, but GMO in that, it can be achieved by limiting as such (PST3).

4.2.1.7 Teacher inculcation

Teacher inculcation, referring to instill certain values in students directly (Chiappetta, Koballa, & Collette, 1998), was also emerged from the collected data. Since SSI are complex in their nature and it is very likely that there will be variety of perspectives in the classroom, teacher inculcation is crucial to be considered in SSI teaching. Most of the participants articulated that as a teacher, they should avoid sharing their own personal opinions about the issue being discussed. Their proposed reason was that if so, students would be influenced by their teachers' opinions and they may hesitate to declare their ideas. Two PSTs explained this as follows:

> In my opinion it is better if the teacher doesn't reflect much its self-perspective. Because if the teacher focuses on a point of view, all the students will understand it as if the teacher is thinking in that way. I think that a very successful discussion environment will not be achieved at that time. Therefore, the teacher will not feel efficient (PST16).
>
> At the end of the SSI course, I would say that there is not a single truth, that it changes from person to person and the result we reach may change from where we look. Obviously I wouldn't try to reach a conclusion (PST10).

Only one of the participants highlighted the importance of sharing opinions as a teacher for promoting democracy in the classroom. According to this PST, teacher should also be able to share his or her opinions regarding the controversial issue. Besides, according to her, considering teacher as an authority figure in SSI lessons will not encourage student understanding of scientific processes. She articulated that:

> In the scientific process, the processes are proceeding as in the way of approaching in such a critical way by raising scepticism. If I want students to gain this, I need to bring about different opinions. So authority wouldn't be there. If there would be authority, the student is bound to a single idea. Science will not progress (PST5).

Another participant also asserted that a teacher may share her own perspectives in the classroom however she would rather avoid telling personal opinions about the issue. She commented that:

> If I would think it's harmful, I don't say it directly to the students. I want them to decide first. Then, if it's convenient, I explain my ideas about the topic (PST1).

4.2.1.8 Misunderstandings about SSI and SSI teaching

The analyzed data emerged that the PSTs have misunderstandings about nature of science (NOS), nature of SSI, and SSI teaching. To illustrate, one of the participants mentioned about a misunderstanding that although the topics such as pressure in chemistry course are robust and reliable, SSI topics cannot be considered as robust knowledge. She stated that:

> Once if there are two different ideas, there is no certainty, that what is the student becomes aware of. For example, when I say the water is boiling at 100 degrees, it is a definite process. S/he makes its observation one way or the other if the appropriate conditions are provided reach to a definite result, but when there is a socio-scientific issue is the situation is different. As it's implied from its name socio is something related to society, so it's something which depends on the societies... Students already understand by the examples I give that it's something that changes through different views. Here you are the definite knowledge is the chemistry on our books, pressure, one way or another they would understand that they are certain are not as such. As a matter of fact, GMO, nuclear power plants and etc take place in the books (PST5).

Another misunderstanding that emerged from the interview data was about the ongoing inquiry aspect of SSI. One of the participants mixed the tentative nature of scientific knowledge and changing students' opinions in discussions. She asserted that students would learn the ongoing inquiry aspect of SSI during the discussions in which they may decide to change their perspectives with the presence of counterarguments or rebuttals. PST5 asserted that:

> As an example in that discussion environment I would ask the students if there are anybody who would change opinion. One side (group of students) give such persuading responses for instance and asks if anybody changed their mind. It happened in the lecture in our faculty as well; i.e two persons went to the counter-group by changing their opinions. Look, that means ideas can change, as it is understood they were not certain; what we think of as true may have been false, what we think of false may have been come out as true, I would say to students in this point that it is not required to reach to a one single true conclusion (PST5).

Similarly, this participant considered students' changing of their opinions during the discussions equal to tentativeness of scientific knowledge. Namely, she believes that she can teach the tentative nature of knowledge by engaging students in discussions through which they change their opinions about the issue as their peers justify counterarguments and convince them with evidences. She articulated that:

> To give an example I give student a chance to pass on to different groups. Here you go it is the scientific knowledge they made research themselves, they used certain scientific processes in that research proceeding. They come and persuaded each other, in that time period changed occurred in the group. Here we actually revealed that in reality scientific knowledge is changeable. Therefore, this shall be the goal that I would want to achieve, the second teacher is more effective in this regard but the first teacher, must have thought in such a superficial way by seeing it as unchangeable. It absolutely changes. That is to say this teacher is not prevalent in science in essence (PST5).

PSTs' another misunderstanding about the tentative nature of scientific knowledge was that they mentioned that as the new scientific information emerged, the previous information was no longer accepted as reliable and valid. That is, they believe that previous scientific information is completely eliminated as the new information emerges. One of the participants commented about that:

> I can show how SSI can change according to the ongoing research; I can get a real SSI example into the class. For example, I say, that I choose an SSI topic and present to the students the ideas of scientist in regards to that topic but I express that by new scientific developments it is now thought differently. So I do emphasize that the old opinion is now become eliminated (PST15).

Other aspect that the participants have misunderstanding about was the skepticism aspect of SSI. The data revealed that one of the participants was not clearly knowledgeable about the meaning of skepticism and mixed it with the multiple perspectives aspect of SSI. As aforementioned, while discussing about SSI, students are expected to exhibit skepticism to potentially biased information. As presented below, she would teach the skepticism aspect by expressing that an opinion should not be judged as right or wrong. She preferred to provide students with SSI examples that changed in time. Besides, as she said, this PST prefers to point out that there may be different opinions about any controversial issue.

> So I bring these changeable examples, is the most efficient way I think. If I can prevent the formation of definite truth in the heads, the goal is reached; regarding this issue this is not true but this is not wrong either. If I could present them various examples to make them recognize this, provide materials, I think they can approach me with suspicion. If they could say "Aa what I thought was not the truth either" I would be gained this (PST14).

The data also emerged that one of the participants was not aware of the subjectivity nature of scientific knowledge. The participant articulated that the scientific knowledge has to be objective. She commented about this as the following:

> In fact, scientific knowledge has to be objective (PST5).

Another misunderstanding that the data emerged was about teaching SSI and its assessment. One of the participants claimed that at the end of SSI teaching, it is not possible to measure students' knowledge. The reason was that, in SSI teaching there is no any clear-cut solution and teachers cannot come to a certain conclusion. Therefore, teachers cannot evaluate student understanding of the topic with respect to content knowledge. She stated that:

> There is no definite result anyhow, we will not have a definite result. I do not think that we can necessarily evaluate students too much in terms of knowledge (PST2).

Analysis of the interview data of the same participant revealed one more misunderstanding. According to this participant, SSI teaching cannot be used to teach a topic in the curriculum. Instead, she prefers using SSI in her science lessons to take student attention by presenting them some SSI from students' daily lives. She commented on that as the following:

> I wouldn’t say come on, come on, friends, today, when there is no relevance at all, lets discuss about socio scientific topics. One thing needs to lead another for me to do it. I mean, not as if this is such a separate issue, as if just have landed from the sky, rather there must be somethings I could bind I think. We can give a lecture about the structure of nutrition, when it comes to fifth class herein carbohydrates, fats, proteins are treated. After issuing those topics from there for instance by showing out the fruits that their colour changed, (you know students like that visuals so much) could be passed on from there on. In fact, even in the fifth class we can link this (PST2).

Similarly, another participant mentioned that SSI topics are better be used to attract student attention at the beginning of the lesson. According to this participant, instead of designing the whole course on SSI, she would prefer to use these controversial topics to engage students to the science courses. She argued that:

> Generally, in my opinion there is not much need that a lecture shall pass as such. You can dedicate the whole lecture to this but in general let’s say you deal with a subject, the class would be bored of that issue or you have two lectures one after another for example… I mean do not use SSI to teach the whole subject but insert them in between, this is to say these two are different. For example, I explain something irrelevant, but in the last 20 minutes of the lecture I read something the news about GM foods, interesting information as well. After that I ask what the students think about it, a discussion environment occurs, I mean right away as in haste. However, I haven’t reserved my whole lecture for this at the end of the day. However, I don’t know I mean when you are not loyal to lesson plan one hundred percent it is not that the world either. If the class is bored, if it does not move forward anymore, or if I am too tired I can use socioscientific subjects. Another words, it could be inserted in between when you are not directly teaching a lesson. Not just for this subject, you could insert different things as well, even it could be things that are so irrelevant. Just to make the lesson a little more attractive. (PST18).

4.2.2 Personal Epistemological Beliefs

Personal epistemological beliefs were measured by a five point Likert type instrument ranging from (1) “strongly disagree” to (5) “strongly agree”. Higher scores obtained from the instrument indicated less sophisticated personal epistemological beliefs while on the other hand lower scores was an indication of sophisticated personal epistemological beliefs.

As tabulated in Table 4.7, the highest mean score obtained from the dimensions of personal epistemological beliefs was Innate ability (M = 3.34, SD = .65), indicating that in this study, among the dimensions of personal epistemological beliefs, PSTs' Innate ability beliefs were revealed as the least sophisticated beliefs. This showed that the participants of this study possessing lower levels of sophistication in innate ability believed that learning is innate rather than acquired. On the other hand, the lowest mean score was obtained on the dimension Quick learning and Certain knowledge (M = 2.12, SD = .60). This finding showed that PSTs have moderately sophisticated beliefs about the certainty of knowledge and the speed of learning. They tended to believe that learning is not a quick and sudden process, and knowledge is tentative rather than certain. On the other hand, descriptive statistics for simple knowledge (M = 3.30, SD = .68) revealed that the participants of this study still tended to agree the simplicity of knowledge. Mean and standard deviation values corresponding to each of the items in Epistemic Beliefs Inventory were provided in Appendix K.

Table 4.7

Descriptive Statistics for Personal Epistemological Beliefs

Dimensions	*M*	*SD*	*Min*	*Max*
Quick learning & Certain knowledge	2.12	0.60	1.00	4.50
Innate ability	3.34	0.65	1.00	5.00
Simple knowledge	3.30	0.68	1.00	5.00

4.2.3 GM Foods Risk-Benefit Perceptions

The participants' GM Foods risk and benefit perceptions were measured through a scale that was developed for the present study. Scores calculated for the benefit perception dimension indicated PSTs' level of perception regarding the benefits of GM Foods such as benefits to human health and environment. On the other hand, statistics for the risk perception dimension of the questionnaire was an indication of PSTs' perceptions about the risks of GM Foods such as environmental risks and risks to human life.

As presented in Table 4.8, descriptive statistics revealed a mean value of 2.56 out of 5 (SD = 0.66) for the benefit perception dimension where the mean value for the risk perception was 3.83 (SD = 0.71). While the risk perception mean value was above the midpoint of five-point scale, the mean value for benefit perception was just around the midpoint of five-point scale. That means, PSTs' have moderately high benefit perception and they have high level of risk perceptions about GM Foods. It can be concluded that the issue of GM Foods was more perceived to be risky rather than beneficial by the participants of the present study. Mean and standard deviation values corresponding to each of the items in GM Foods Risk-Benefit Perceptions Scale were provided in Appendix L.

Table 4.8

Descriptive Statistics for GM foods Risk and Benefit Perceptions

Dimensions	*M*	*SD*	*Min*	*Max*
GM foods benefit perception	2.56	0.66	1.00	5.00
GM foods risk perception	3.83	0.71	1.00	5.00

4.2.4 GM Foods Knowledge

The scale measuring the PSTs' knowledge about GM Foods included 17 items. The participants responded these items as true, false, or "do not know". True answers were coded as 1 while the false and "do not know" answers were coded as 0; therefore, the maximum score that can be obtained from the questionnaire was 17. Descriptive statistics revealed that the participants of this study responded 9.73 correct answers on average. That means, PSTs do not have a high level nor do they have a low level of knowledge about GM Foods, their knowledge level was around the midpoint of the lowest and highest value that can be obtained from the scale items.

Table 4.9 displays some statistics corresponding to each item in the knowledge scale. Percentages of false and “do not know” answers were computed together and named as “not correct” in the table. Results revealed that PSTs scored highest on the item 6, “All bacteria found in food is harmful”. Among the participants, 90.3% percent of them responded to the statement correctly by saying that this statement is not correct while 9.7 percent of them responded that the item statement is correct. The second highest score obtained by the participants was for the item 1, “Agricultural crops can be made resistant to certain diseases and plagues by modifying their hereditary material”. While 82.4 of them answered item 1 correctly, 17.6 percent of the participants failed to give correct answer.

On the other hand, PSTs scored lowest on the item 16, “In Turkey, it is forbidden to use GM seeds in agriculture”. Although 11.0 percent of them knew that using GM seeds for agricultural purposes is forbidden in Turkey, 89.0 percent of the participants failed to respond to this item correctly. The second lowest scored item was the item 14, “By eating GM foods, a person’s genes could also become modified”. Among the participants, 16.7 of them gave correct response to this item while 83.3 of them failed to report correct response.

Table 4.9

Descriptive Statistics for GM foods Knowledge Items

Item		Percentage (%)	
		Not correct	Correct
1	Agricultural crops can be made resistant to certain diseases and plagues by modifying their hereditary material.	17.6	82.4
2	Some genetically altered bacteria are capable of cleaning oil-polluted beaches.	45.4	54.6
3	Genetic modifications are not used in medicine.	31.8	68.2
4	Contrary to conventional food, GM food contains genes.	30.1	69.9
5	Animal features can in no way be transferred to plants.	36.6	63.4
6	All bacteria found in food is harmful.	9.7	90.3
7	"Natural" does not necessarily mean healthy.	29.1	70.9
8	All processed foods are made using genetically modified products.	45.3	54.7
9	In the world, there are no laws or regulations on the use of gene technology in food production.	51.0	49.0
10	Genetically modified foods cannot be digested.	23.5	76.5
11	In order to modify the genes of a plant, its cells should be killed.	37.0	63.0
12	A plant's need for fertilizers and pesticides is decreased by changing its genetical structure.	34.9	65.1
13	In Turkey, there are no laws or regulations on the use of gene technology in food production.	60.1	39.9
14	By eating GM foods, a person's genes could also become modified.	83.3	16.7
15	Genetically modified animals are always bigger than ordinary ones.	55.4	44.6

Table 4.9 (Continued)

Item		Percentage (%)	
		Not correct	Correc t
16	In Turkey, it is forbidden to use GM seeds in agriculture.	89.0	11.0
17	In Turkey, some imported crops such as corn and soya are legally allowed to be used for animal feeding.	47.2	52.7

4.3 Findings Regarding the Proposed Model

In order to assess the proposed model, first, quantitative path analysis was performed. Then, interview analysis was conducted to gain deeper information about the proposed relations among the outcome variable GM foods teaching self-efficacy beliefs and each of the other three variables; personal epistemological beliefs, GM foods risk and benefit perception, and GM foods knowledge. The interview data revealed mainly four themes: GM foods teaching self-efficacy beliefs (see section 4.2.1), GM foods teaching self-efficacy beliefs and personal epistemological beliefs, GM foods teaching self-efficacy beliefs and GM foods knowledge, and GM foods teaching self-efficacy beliefs and GM foods risk-benefit perceptions. In the following parts, the findings concerning each of the relationships were presented in detail and quotations from the interviews were provided (see Appendix M for Turkish versions of the quotations). It is important to note that although the interview questions were asked in the context of GM foods, PSTs mostly responded to the intreview questions by considering SSI teaching in general.

4.3.1 Specified path model

Path analysis, one of the special types of structural equation modelling, was used for the quantitative analysis of the proposed model. The goal was to investigate the relationships among PSTs' GM foods teaching self-efficacy beliefs, personal epistemological beliefs, GM foods knowledge, and GM foods risk-benefit perceptions. It was mainly aimed to reveal out the variance in PSTs' GM foods teaching self-efficacy beliefs that was predicted by the variables personal epistemological beliefs, GM foods knowledge, and GM foods risk-benefit perceptions. As displayed in Figure 4.1, exogenous variables (independent variables) in the proposed path model were the three personal epistemological belief dimensions (quick learning and certain knowledge (QLCK), innate ability (IA), and simple knowledge (SK)), GM foods risk perception (RISK), GM foods benefit perception (BEN), and GM foods knowledge (KNOW). Endogenous variables (dependent variable) were the dimensions of GM foods teaching self-efficacy beliefs (Fostering argumentation and decision making on GM foods (ARG), General instructional strategies of GM foods teaching (GIS), and GM foods teaching outcome expectancy (OE). It was hypothesized in the model that the personal epistemological beliefs dimensions (QLCK, IA, and SK), risk perception about GM Foods (RISK), benefit perception about GM Foods (BEN), and knowledge about GM Foods (KNOW) were directly related to the dimensions of GM foods teaching self-efficacy beliefs (ARG, GIS, and OE). Moreover, in the model, personal epistemological beliefs dimensions (QLCK, IA, and SK) and GM foods knowledge (KNOW) were directly related to GM foods risk perception (RISK) and GM foods benefit perception (BEN). Finally, it was hypothesized in the model that, personal epistemological beliefs dimensions (QLCK, IA, and SK) were directly related to GM Foods knowledge (KNOW). In path analysis, maximum likelihood estimation, which is one of the most frequently used estimation approach in SEM literature (Kline, 2011), was used. As for the other statistical analysis techniques, conducting path analysis has some requirements that should be considered before performing it. Missing data, outliers, normality and linearity, sample size, absence of multicollinearity and singularity, and residuals assumptions were checked prior to analysis as mentioned above.

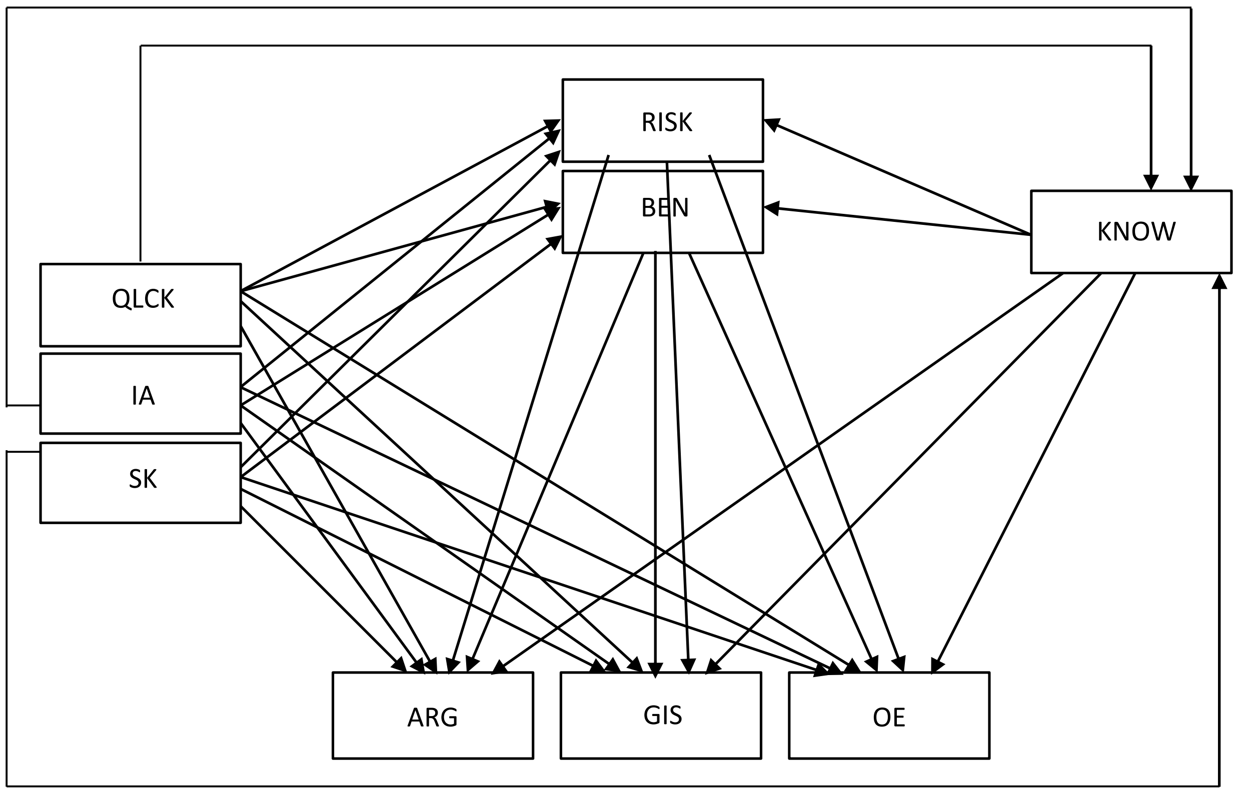

Figure 4.1 Variables and hypothesized relationships in the model. QLCK = quick learning + certain knowledge, IA = innate ability, SK = simple knowledge; RISK = risk perception, BEN = benefit perception; KNOW = knowledge; ARG = fostering argumentation and decision making on SSI, GIS = general instructional strategies of GM foods teaching, OE = GM foods teaching outcome expectancy.

Among the steps taken for path analysis, model specification is a very crucial step (Kline, 2011); therefore, the researcher of this study determined the variables and the proposed relations among the variables after a detailed review of related literature. As aforementioned, in the model, it was hypothesized that personal epistemological beliefs dimensions (QLCK, IA, and SK), GM foods knowledge, and GM foods risk-benefit perceptions were directly linked to PSTs' GM foods teaching self-efficacy beliefs dimensions (ARG, GIS, and OE). Moreover, paths were specified directly from personal epistemological beliefs dimensions (QLCK, IA, and SK) and GM Foods knowledge to GM foods risk-benefit perceptions. Finally, there are direct paths from personal epistemological beliefs dimensions (QLCK, IA, and SK) to GM Foods knowledge. In the proposed model, all the variables were identified as observed variables.

In the first steps of model specification, covariances were added between all pairs of exogenous variables and error variances were added to all endogenous variables (Kline, 2011). Right after model specification the researcher evaluated whether the specified model is identified or not. Model identification is necessary for statistical models to have meaningful results. It is required for a path model to be overidentified rather than underidentified or justidentified to perform the analysis and obtain model fit indices. Over-identified models refer that number of covariances in the model is greater than the number of model parameters. The researcher of this study assured that the proposed model is overidentified before the data collection started. After model specification, model identification and data collection, the proposed model was examined through path analysis utilizing AMOS statistical package program Version 22. While evaluating the goodness-of-fit of the path model, some model fit indices, which were described in method chapter in detail, were used.

First, the hypothesized conceptual model was tested. The fit indices revealed as a result of testing the hypothesized model indicated that the initial model did not fit the data very well. Based on these preliminary results, modifications were made and the new model was specified. For this purpose, some paths were added in accordance with AMOS suggestions (modification indices) and model was trimmed by removing nonsignificant paths (Kelloway, 1998; Kline, 2011). Examining Modification Index and Expected Parameter Change values indicated that allowing free estimation of the error covariances between the endogenous variables; ARG and GIS would substantially improve the model fits. Moreover, AMOS recommended to allow free estimation of the error covariances between the variables GM Foods benefit perception and GM foods risk perception, and the epistemological belief dimensions QLCK, IA, and SK. Adding these covariance resulted the fit indices; $\chi^2 = 68.96$, df = 2, $\chi^2/df = 34.48$, GFI = .99, AGFI = .70, CFI = .95, RMSEA = .17, SRMR = .07. Then, the nonsignificant paths were removed from the model step by step and the revised model was obtained. The resulted fit indices indicated that the model fits the data well (χ^2 = 81.97, df = 15, χ^2/df = 5.06, GFI = .98, AGFI = .95, CFI = .95, RMSEA = .06, SRMR = .03). All the fit indices were within the suggested ranges accept that the chi-square (χ^2 = 81.97), was significant (p = 0.00) with degrees of freedom, df = 15. Literature suggested that χ^2 statistics is dependent on sample size (Kline, 2011) and it is not unusual to obtain significant χ2 with large sample sizes, generally above 200 (Schumacker & Lomax, 1996). In the present study, the model was tested with 1077 PSTs; therefore significant χ^2 was not considered as a problem for the path analysis. The revised model with significant paths and corresponding standardized path coefficients were presented in Figure 4.2.

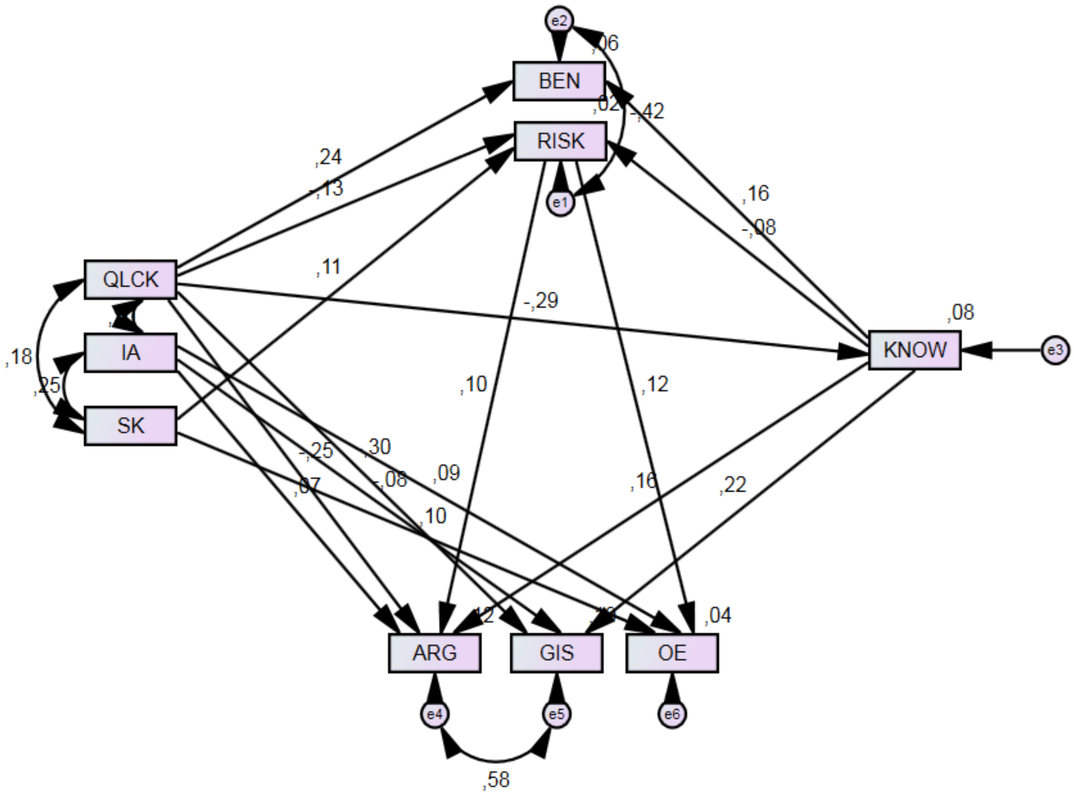

Figure 4.2 Revised model with significant paths and standardized path coefficients. QLCK = quick learning + certain knowledge, IA = innate ability, SK = simple knowledge; RISK = risk perception, BEN = benefit perception; KNOW = knowledge; ARG = fostering argumentation and decision making on SSI, GIS = general instructional strategies of GM foods teaching, OE = GM foods teaching outcome expectancy.

4.3.2 Relationships among GM foods teaching self-efficacy beliefs and each of the other variables in the model

4.3.2.1 Relationship between personal epistemological beliefs and GM foods teaching self-efficacy beliefs

In order to determine the relationships among endogenous variables (the dimensions of GM foods teaching self-efficacy beliefs: ARG, GIS, OE) and personal epistemological beliefs dimensions (QLCK, IA, SK) in the path model, path coefficients were examined. The path coefficients; Standardized (β) and unstandardized (Estimate) path coefficients, their standard errors (SE), critical ratio (CR) and p values, and squared multiple correlation coefficients (R^2) for each path in the model were given in Table 4.10. Critical ratio (CR), which is the t value concerning each path and the p value were used to evaluate significances of the path coefficients, while standardized values of the path coefficients (β) were used to determine the strength of the relationships among the variables and unique contribution of each exogenous variables to the variances in the endogenous variables.

Table 4.10

Parameter Estimates for Significant Direct effects on GM Foods Teaching Self-efficacy Beliefs of Epistemological Beliefs

Endogenous variable	Exogenous variable	β	Estimate	SE	CR	p
ARG	Quick learning+Certain knowledge	-.25	-.36	.04	-8.21	.00
	Innate ability	.06	.09	.04	2.31	.02
GIS	Quick learning+Certain knowledge	-.30	-.42	.04	-10.29	.00
	Innate ability	-.08	-.11	.03	-3.05	.00
OE	Innate ability	.09	.09	.03	2.89	.00
	Simple knowledge	.10	.14	.04	3.09	.00

The results revealed that the exogenous variable SK was found to be correlated only with GM foods teaching outcome expectancy beliefs dimension. In addition, QLCK variable was not significantly correlated with OE. Furthermore, the findings revealed that IA dimension was significantly correlated to each of the GM foods teaching self-efficacy beliefs dimensions (ARG, GIS, and OE). As displayed in Table 4.12, significant path coefficients from epistemological beliefs dimensions varies for the dimensions of GM foods teaching self-efficacy beliefs. More specifically, QLCK dimension of personal epistemological beliefs were found to have significant path coefficients for their relation with ARG dimension of GM foods teaching self-efficacy beliefs, indicating that this dimension has significant relationships with fostering argumentation and decision making on GM foods. QLCK dimension of personal epistemological beliefs was found to have negative relationship with ARG dimension of GM foods teaching self-efficacy beliefs (β = -.25). This finding indicates that PSTs who have sophisticated personal epistemological beliefs in quick learning and certain knowledge tended to have higher levels of GM foods teaching self-efficacy beliefs regarding fostering argumentation and decision making on GM foods. In addition, ARG dimension was found to be correlated significantly to IA dimension of epistemological beliefs. IA was found to have positive relationship with ARG dimension (β = .06). This finding indicates that PSTs who have sophisticated personal epistemological beliefs in innate ability tended to have lower levels of GM foods teaching self-efficacy beliefs regarding fostering argumentation and decision making on GM foods.

Regarding the relationship between GIS dimension of GM foods teaching self-efficacy beliefs and personal epistemological beliefs dimensions, the results revealed that QLCK and IA dimensions of personal epistemological beliefs were found to have significant path coefficients, indicating that these dimensions have significant relationships with self-efficacy beliefs about general instructional strategies of GM foods teaching. QLCK dimension of personal epistemological beliefs was found to have negative relationship with GIS dimension of GM foods teaching self-efficacy beliefs (β = -.30). This finding indicates that PSTs who have sophisticated epistemological beliefs in quick learning and certain knowledge tended to have higher levels of GM foods teaching self-efficacy beliefs regarding general instructional strategies about GM foods teaching. In addition, IA dimension of personal epistemological beliefs was found to have negative relationship with GIS dimension of GM foods teaching self-efficacy beliefs ($\beta = -.08$). Based on this finding, it can be concluded that, PSTs who have sophisticated personal epistemological beliefs in innate ability possess higher levels of GM foods teaching self-efficacy beliefs regarding general instructional strategies about GM foods teaching.

Finally, the statistics about the relationships between OE dimension of GM foods teaching self-efficacy beliefs and personal epistemological beliefs dimensions revealed that IA and SK dimensions of personal epistemological beliefs was in significant correlation with GM foods teaching outcome expectancy beliefs. IA dimension was found to have positive correlation with OE dimension of GM foods teaching self-efficacy beliefs ($\beta = .09$). This finding showed that PSTs' possessing sophisticated epistemological beliefs in IA tended to have lower levels of GM foods teaching outcome expectancy beliefs. Similarly, SK dimension was found to have positive correlation with OE dimension of GM foods teaching self-efficacy beliefs ($\beta = .10$).

Besides the quantitative findings, the interview questions were also aimed to reveal relationships among PSTs' GM foods teaching self-efficacy beliefs and personal epistemological beliefs. To this end, the participants were directly asked their opinions about whether there is a relation among these two belief types and their reasons to explain this relationship. In the following part, what the qualitative data emerged concerning the relationships among GM foods teaching self-efficacy beliefs and each dimension of personal epistemological beliefs were presented. Regarding these relationships, categories and description of codes emerged under these categories were displayed in Table 4.11.

4.3.2.1.1 Beliefs in Simplicity of Knowledge and GM Foods Teaching Self-efficacy

The participants were asked about the relationship between the beliefs in simplicity of knowledge and GM foods teaching self-efficacy beliefs. Analysis of data revealed varying results about PSTs' beliefs in simplicity of knowledge, and the relation between beliefs in simple knowledge and SSI teaching self-efficacy.

Firstly, data revealed that most of the PSTs were aware of the complex nature of knowledge. The participants stated that instead of being composed of simple bits, knowledge is complex and involves interrelationships. They commented that, such a teacher is more likely to aware of NOS and science process skills, therefore feel more efficacious to teach SSI. As most of the teachers suggested, since SSI is interdisciplinary in its nature, it is very difficult for a teacher to feel efficacious to teach SSI, if s/he does not believe that knowledge is not simple but interdisciplinary. Teachers having sophisticated epistemological beliefs in simple knowledge were considered by the participants to be more successful to respond students' variety of questions and lead discussions well. One of the PST commented on that:

> I believe the teacher who thinks as interdisciplinary is more comfortable, more self-confident and his/her leading would be more accurate. Namely; let's talk over global warming: When the teacher gives a lecture about energy due to a level of temperature is needed for the living beings, will mention that enzymes can work in accordance with this heat and in actuality all of these can be explained when global warming being talked about. Because the weather is warming up, why don't we want the warming up of the weather? The number of species is decreasing, why is it decreasing? Since the medium that is required for the life of living beings is vanishing. This interdisciplinary thinking motivates the students more in my opinion. Let's consider this too, think over this as well, the teacher can lead such as could this related to this (PST3).

Table 4.11

Description of Codes and Categories regarding the Relationships among GM foods Teaching Self-efficacy Beliefs and Personal Epistemological Beliefs

Category / Subcategory	Code	Frequency	Code description
Simplicity of knowledge and GM foods teaching self-efficacy beliefs	Fear of teaching complex knowledge	3	Statements indicating that teachers who consider SSI knowledge complex are likely to fear teaching it, which in turn decrease their SSI teaching self-efficacy beliefs
• Aware of SSI knowledge complex	Aware of NOS	5	Statements indicating that teachers who are aware of NOS are more likely to have higher SSI teaching self-efficacy beliefs
	Interdisciplinary approach	20	Statement indicating that since SSI involves variety of aspects from various disciplines (such as science, engineering, physics, and sociology), teachers who are aware the complex and interdisciplinary nature of knowledge are more likely to possess higher SSI teaching self-efficacy beliefs

Table 4.11 (Continued)

Category / Subcategory	Code	Frequency	Code description
	Using science process skills	5	Statements indicating that teachers who use science process skills to teach teach science are more likely to have higher SSI teaching self-efficacy beliefs
Certainty of knowledge and GM foods teaching self-efficacy beliefs	SSI are subject to change	17	Statements indicating that since SSI are subject to ongoing inquiry, if a teacher believes that knowledge is certain, this teacher is likely to be unsuccessful to lead SSI discussions which leads to lower SSI teaching self-efficacy beliefs
	Teacher as learner	3	Statements proposing that teachers who think that knowledge is not certain but tentative are more tend to do research and learn about the current developments in scientific knowledge; therefore more likely to possess higher SSI teaching self-efficacy beliefs

Table 4.11 (Continued)

Category / Subcategory	Code	Frequency	Code description
Innate ability and GM foods teaching self-efficacy beliefs	SSI learning is not innate	15	Statements indicating that teachers who believe that learning is not innate but occurs as a results of hardworking and time may feel more motive and efficacious to create variety of learning environment to teach SSI
	Innate ability and intelligence are different	3	Statements indicating that individuals do not have to be intelligent to learn something new; learning may occur through studying
Omniscient authority and GM foods teaching self-efficacy beliefs	Inquiry	9	Statements indicating that SSI teaching requires questioning the authority and generating personal justifications (scientific thinking). Therefore teachers who believe in omniscient authority are very unlikely to teach and lead discussions about SSI and possess lower SSI teaching self-efficacy beliefs

Table 4.11 (Continued)

Category / Subcategory	Code	Frequency	Code description
	Multiple perspectives	8	Statements indicating that teachers who believe in omniscient authority tend to prefer emphasizing one point of view instead of encouraging students to share their multiple perspectives about SSI. Therefore, such a teacher fails to teach SSI which results lower SSI teaching self efficacy beliefs
Quick learning and GM foods teaching self-efficacy beliefs	SSI learning takes time	14	Statements indicating that teachers who does not believe in quick learning would be more efficacious to teach SSI since SSI learning takes time and SSI teaching is a process instead of a sudden action.
	• Needs inquiry	10	Since SSI are complex and interdisciplinary, SSI learning needs student inquiry
	• New to student	6	Since SSI are complex and involves multiple perspectives, learning such issues in science classes may be new for student

Similarly, another teacher stated that:

> The teacher who defends that the scientific knowledge is simple possibly prefers to make direct instruction. Because the teacher would be inefficient to do research. Possibly would not prefer to make research, would think that knowledge is simple. However, the other teacher continuously searches the relation of the subject with the other sciences, so evaluate the subject in terms of social and cultural aspects. That teacher would be better, have more self-confidence (PST6).

Unlike to these participants, three of the PSTs asserted that teachers who think knowledge is simple rather than complex are likely to feel more efficacious about teaching SSI. One of these PSTs mentioned that if a teacher considers knowledge as simple, s/he more likely to feel self-sufficient. Because such a teacher does not see the complexity and interdisciplinarity inherent in SSI knowledge and believe that s/he can teach the knowledge which is simple and straightforward easily and successfully. She articulated that:

> I think for the one who thinks scientific knowledge is complex it is hard to believe sufficient to teach SSI. Perhaps these teachers can think themselves as inadequate for more complex thinking that I know this subject, I searched but I did not know the other potential relationships in other areas. I say who see it simple is more self-sufficient. Well, who believe that scientific knowledge is simple, will think she already knows such a simple things and they are perfectly adequate in this regard that they can handle. However, who believe that is complex, can see herself as inadequate because of the belief that it is hard to know all the information that complex science involves (PST1).

4.3.2.1.2 Beliefs in Certainty of Knowledge and GM Foods Teaching Self-efficacy

The participants generally considered the tentative nature of scientific knowledge and subject to ongoing inquiry characteristic of SSI while responding the interview question about the relationship between certainty of knowledge and GM foods teaching self-efficacy beliefs. That is, most of the PSTs thought that in SSI teaching, teachers should emphasize that SSI may change as the new information emerges therefore, if a teacher believe that knowledge is certain, then s/he would not be successful to lead the SSI discussions and to teach SSI topics hence feel efficacious to teach a topic involving multiple perspectives and subject to ongoing inquiry. PST2 commented on that:

> The teacher who believes knowledge changes feel more efficient. Since SSI has no definite truth... I mean everything could change day by day. We already see this in very own nature of the science as tentativeness. Therefore, if the teacher has an approach such as there would be a certain truth already, fell into a dilemma. Because the students may have different opinions during the discussion. And if the teacher already thinks that knowledge is unchangeable, even in that stage chaos starts up. For this reason, the teacher is required to think that is tentative (PST2).

Moreover, some of the participants highlighted that, teachers who believe that knowledge is not certain but tentative are more tend to do research about scientific issues. To these participants, such a science teacher is more interested in up-to-date changes in scientific knowledge, hence, is more likely to feel efficacious about SSI teaching. Because they consider SSI teaching as connected to our daily lives and requires being aware of recent changes in scientific knowledge. PST17 stated that:

> In my opinion the teacher who accepts that the scientific knowledge is tentative would make more research. Follow up current issues more in order to teach the most accurate. The other one is already saying it is unchangeable, I obviously don't think he/she do research and spend time to understand (PST17).

Another interesting finding was that, according to some of the participants, teachers who believe that knowledge is certain tend to choose direct teaching in her science classes. These participants asserted further that, instead of choosing student-centered teaching methods, such teachers prefer to do direct teaching in which they transfer the body of knowledge to the students. In addition, these kinds of teachers do not emphasize the tentative nature of knowledge but try to teach from one perspective as if knowledge is composed of unquestionable facts. PST6 articulated that:

> The teacher who says knowledge does not change possibly does not teach SSI. Uses direct teaching and there would be logic of just know this as such, learn it as it is, memorize. The other teacher prefers SSI and emphasizes to students that the knowledge could change continuously (PST6).

4.3.2.1.3 Beliefs in Innate Ability and GM Foods Teaching Self-efficacy

The participants were asked about whether there are any relationships among believing in innate ability to learn and GM foods teaching self-efficacy beliefs. Analysis of qualitative data revealed that according to PSTs, those who believe that learning is not innate would feel more efficacious to teach SSI. The participants asserted that learning is not innate and can be developed by experiences that the teachers foster in the classroom. For instance, to the participants, teachers who does not believe in innate ability but consider learning as achievable by the process of teaching would create more variety of learning environments, use multiple intelligences for teaching, and try to encourage student learning by designing the lesson as more attractive for students. On the other hand, teachers believing in innate ability would not make an effort to gain students new understandings about scientific concepts since they believe that if a student does not have learning ability from the birth, there is nothing to do. PST19 and PST17 mentioned that:

> In my opinion student could learn better throughout the experience. Teacher looks out for with which method the student has better learning for own self, we talk about the student here. Due to a teacher who thinks learning is innate could only impose one single perspective to students; actually you only learn it like this. But the other is aware that students can learn with different methods, not every student learns in the same way, for this reason we apply different methods in classrooms, we try different techniques (PST19).

> I think learning ability can be acquired in time, it does not have to be innate. In fact, learning is influenced by many things, it can be influenced by any kind of environment. If the teacher is able to provide that environment to the classroom, I would better learn if that course arouses my interest. I think it is more learning, even if I have never been interested before. I believe that a teacher who believes that learning can be achieved in time can better teach SSI, could make the lessons more interesting (PST17).

The interview data also revealed that innate ability and intelligence are considered to be different from each other as stated by some of the participants. To these participants, intelligence does not necessarily come from the birth. In addition, individuals do not have to be intelligent to learn something new; they may learn through studying hard. Two participants commented that:

> Because, she already emphasizes that no one from birth… I, on my own behalf believe that yes there exists what is called intelligence but to be good at something is not gained by intelligence, I myself think it occurs through studying (PST1).
>
> The ability to learn could be something to be gained afterwards I think. I do not think it would come inherently from birth because it is not intelligence. So intelligence is something different than ability to learn, absolutely someone learns fast, someone slowly learns, but I can do something to encourage the student to learn. His family can do something (PST5).

4.3.2.1.4 Beliefs in Quick Learning and GM Foods Teaching Self-efficacy

The participants were asked about whether there are any relationships among believing in quick learning and GM foods teaching self-efficacy beliefs. Analysis of qualitative data revealed that according to PSTs, those who believe that learning is not quick would feel more efficacious to teach SSI. Their main asserted reason was that; the participants consider SSI teaching as a process instead of a sudden action. Therefore, they argued that if a teacher believes learning is not quick but occurs step by step, s/he would be more efficacious to teach SSI in science classes. The participants commented about this as the following:

> What we call SSI is already what we come face to face in everyday life. Yes, we create a small discussion medium in the classroom environment, but when student returns to his/her daily life, could face such a thing and this would reinforce his/her own knowledge or use what he/she learns. Knowledge may become more permanent by these ways. So the student continues to learn, it's actually a process (PST10).

> A teacher who believes that learning takes place over time, in my opinion sees oneself as more efficient to teach SSI. Because the student has personal differences of oneself. You cannot expect the student to change immediately in the first discussion environment. It will take some time. There will be a few discussions, a few socio-scientific issues will be processed. Then perhaps you will see some changes in the student. Then you will say I have achieved, as a teacher. You will say to yourself, so I teach well this socio scientific issue that the student has become respectful to the opposing views. If the teacher can say that, I think, feels more efficient (PST16).

The participants also pointed out that SSI that are discussed in the classroom may be new to students therefore students need time to do inquiry to learn these issues. Besides, SSI is interdisciplinary and involves multiple perspectives. Hence, it might take some time for students to conceptualize the science behind SSI and generate their own arguments related to the controversial issue. For instance, they may do further research about the issue by connecting science to their daily lives. Two of the participants commented that:

> Since learning SSI is also a process, the student may not want to remain only with what he or she learns in the class. If student have an interest, s/he would do more research on these issues, or discuss it with the teacher. The idea that the student formed at the beginning of the class may change later with his/her research. So the idea of the student may change. Therefore, a teacher who believes that the learning takes place in the process feels more efficient to teach SSI subjects (PST9).
>
> Believing that the learners need the process is certainly more appropriate for the nature of SSI; because the student will go through a series of processes to learn SSI, first will understand its nature, then will do research and be part of discussions to come to a conclusion. I think we need such a process if we think in terms of SSI (PST4).

4.3.2.1.5 Beliefs in Omniscient Authority and GM Foods Teaching Self-efficacy

The interview participants were also asked about whether omniscient authority beliefs are related to teachers' GM foods teaching self-efficacy beliefs or not. Analysis of data revealed interesting results. First of all, according to the participants, questioning authority is vital and inevitable if a teacher tries to teach SSI in the classroom. The majorly asserted reason was that, SSI requires personal justifications and proposing evidences for personal arguments; therefore, in such an environment, teacher should encourage students to rely on personal evidences instead of accepting the authority. To accomplish this, PSTs argued that a teacher should possess sophisticated epistemological beliefs in omniscient authority because believing in omniscient authority indicates accepting only one answer, hence one perspective about controversial issues. That is, as teachers believe in omniscient authority, which indicates less sophisticated omniscient authority beliefs, it was proposed by the participant of this study that they would feel less efficacious to teach SSI. PST1 explained this as the following:

> The one who says it relies on the experiential evidences and reasoning believes more sufficient to teach SSI. SSI's nature is like this experiment is done and this is found, that experiment is done and that is found, I think this is perpetually changing thing and relies on experiments, reasoning skills, and interpretation (PST1).

While advocating the same idea, some of the participants also highlighted the importance of ability to think scientifically while teaching SSI. They believe that a teacher should be aware of and think in accordance with scientific processes to teach SSI well. Two of the participants commented on that:

> The teacher, who thinks that the source of scientific knowledge is not authority, sees oneself more efficient. Since the scientific knowledge is based on observations and experiments, this teacher could better explain these issues to the students. The other remains a little more inadequate in this regard, while transferring the scientific process to students. He therefore finds himself inadequate (PST9).

> Because how is science progressing; we solve the problem. We begin with the problem. We are hypothesizing according to it. We are predicting and we're doing measurements. Reach to the result or lay it on into something, it could be graphs, certain outputs. This is a matter of process, therefore my reasoning ability will be improved, and reasoning ability will be required when hypothesising such as "hmmm it would be like this due to it is this". As long I have as reasoning ability and criticism capacity, I would be more effective in the class. Otherwise it cannot be done (PST5).

Some of the participants focused on that, believing authority make teachers avoid valuing multiple perspectives about the issue being discussed in the classroom. According to these PSTs, if a teacher has naïve epistemological beliefs in omniscient authority, s/he would likely emphasize only one perspective and fail to encourage sharing of opposing ideas in a democratic classroom environment. Two of the participants mentioned that:

> Because who says the authority is the truth, already cuts the discussion from the very beginning. There is only one truth… This kind of a teacher knows what to reach and always dictates that in my opinion, only aims that the students reaching that point and say wrong for other views. But we are already do not say right or wrong in argumentation. This is contrary to the nature of SSI (PST3).

> Of course, the one who thinks that scientific knowledge is based on observations, scientific experiments… Since the other is already does not think about any controversial topic probably, rather accepts it directly. I do not think this teacher would do SSI teaching in the classroom (PST6).

4.3.2.2 Relationship between risk-benefit perceptions and GM foods teaching self-efficacy beliefs

To determine the relationships among the dimensions of GM foods teaching self-efficacy beliefs (ARG, GIS, OE) and the variables benefit perception and risk perception in the path model, path coefficients were examined. As displayed in Table 4.12, the variable RISK was found to have significant and positive correlation with ARG dimension of GM foods teaching self-efficacy beliefs (β = .10). This finding indicates that PSTs having higher GM foods risk perception tend to possess higher levels of GM foods teaching self-efficacy beliefs regarding fostering argumentation and decision making on GM foods. Moreover, RISK variable was found to be significantly and positively correlated with OE dimension of GM foods teaching self-efficacy beliefs (β = .12), showing that PSTs having higher GM foods benefit perception and GM foods risk perception tend to possess higher levels of GM foods teaching outcome expectancy beliefs.

Comparison of β values revealed that GM foods risk perception was significantly correlated with ARG and OE dimensions of GM foods teaching self-efficacy beliefs. However, there was no any significant correlation found among GM foods benefit perception and GM foods teaching self-efficacy beliefs dimensions, ARG, GIS, and OE. The results concerning the relationships between GM foods teaching self-efficacy belief and GM Foods risk perception showed that all the correlations were found to be positive correlation.

Table 4.12

Parameter Estimates for Significant Direct effects on GM foods Teaching Self-efficacy Beliefs of GM foods Risk-Benefit Perceptions

Endogenous variable	Exogenous variable	β	Estimate	SE	CR	p
ARG	GM foods risk perception	.10	.15	.03	4.37	.00
OE	GM foods risk perception	.12	.13	.03	4.02	.00

In addition to the quantitative results, analysis of qualitative data also emerged the relationships among SSI teaching self-efficacy beliefs and GM Foods risk and benefit perceptions. Regarding these relationships, categories and description of codes emerged under these categories were displayed in Table 4.13. The participants' responses can be categorized under three main parts. The first group of the participants, which was nearly half of the total participants, articulated that possessing risk perception or benefit perception about GM Foods does not differ believing efficacious to teach SSI or not. That is, both groups of teachers, having benefit or risk perception, might have high SSI teaching efficacy beliefs. They both may insist on teaching SSI topic and spend quite long times to make students knowledgeable and having the ability to make informed decision making about the SSI being discussed in the classroom. The point that the participant highlighted was that, teachers having risk perception about the SSI would focus more on the risky aspects of the SSI, while teachers having benefit perception would emphasize the beneficial consequences of the SSI. Two of the participants commented about this as the following:

> The teacher who thinks it is risky insists on teaching GM foods and can allocate time for this; considering that s/he will make students conscious. I think people who think it's useful can spare more time because there are opponents in society. The teacher could devote more time to break this perception. I mean both types of teacher may have high efficacy in regards to teaching this subject (PST4).
>
> I think both of them can actually make an effort. Because the one who thinks that it is risky, may want to raise awareness so that students do not consume GM foods. The other could say GM foods are useful, and may want to teach to break down the prejudice that GM foods are for sure harmful. In fact, they can both have high efficacy beliefs to teach SSI I mean (PST7).

Other group of respondents asserted that as teachers' risk perception becomes stronger, they would feel more efficacious to teach SSI topics. In the similar vein, some of the participants thought that teachers with high benefit perception would feel less efficacious to teach SSI. The participants asserted the idea that stronger risk perception leads to stronger SSI teaching self-efficacy beliefs proposed that if an issue has risky sides for people, this would alert them more comparing to an issue that is believed to have beneficial sides for. Therefore, the participants believed that these teachers would be more insisted on teaching the risky SSI, put more effort on teaching it well and feel more efficacious. Similarly, teachers with high benefit perception about an SSI would not put extra effort to teach the topic hence do not feel very efficacious to teach it. PST18 and PST17 explained this as the following:

> Yes, the one who thinks it is risky could more focus on teaching GM foods since that it is risky and and the students are at risk there due to that issue. The teacher would think I shall teach it so these students become conscious (PST18).

I think the one who thinks it is useful makes less effort comparing to the teacher who thinks it is harmful. Because according to this teacher, GM foods might be beneficial, and he/she tells the student as such, they use it or not it is up to them. But for the teacher who thinks it is harmful it is more necessary and essential to insist. As a result, I think there is a harmful situation and the teacher might feel himself responsible to increase his/her students' knowledge about GM foods in some way (PST17).

Table 4.13

Description of Codes and Categories regarding the Relationships among GM foods Teaching Self-efficacy Beliefs and GM foods Risk-Benefit Perceptions

Category / Subcategory	Code	Frequency	Code description
GM foods risk perception and teaching self-efficacy beliefs	High risk-high efficacy	9	Statements indicating that as teachers' GM foods risk perception increases, their teaching self-efficacy beliefs becomes stronger
	High risk-low efficacy	2	Statements indicating that as teachers' GM foods risk perception increases, their teaching self-efficacy beliefs becomes lower
	High risk-high efficacy & High benefit-high efficacy (no difference)	13	Statements do not mention any categorization as risk and benefit perception but indicate that both higher GM foods risk and benefit perceptions leads to stronger teaching self-efficacy beliefs
GM foods benefit perception and teaching self-efficacy beliefs	High benefit-high efficacy	4	Statements indicating that as teachers' GM foods benefit perception increases, their teaching self-efficacy beliefs becomes stronger

Table 4.13 (Continued)

Category / Subcategory	Code	Frequency	Code description
	High benefit-low efficacy	2	Statements indicating that as teachers' GM foods benefit perception increases, their teaching self-efficacy beliefs becomes lower
	High risk-high efficacy & High benefit-high efficacy (no difference)	13	Statements do not mention any categorization as risk and benefit perception but indicate that both higher GM foods risk and benefit perceptions leads to stronger teaching self-efficacy beliefs

One of the PSTs mentioned that teachers with higher risk perception about GM Foods would feel more efficacious to teach it because it is more likely and easier to find evidences on the internet and the media about the risky aspects of GM Foods. She thought that since it is easier to find evidences about the risky aspects of GM Foods comparing to beneficial aspects, teachers with higher risk perception would feel more efficacious to teach this issue. She explained this as the following:

> I think the one who focus on risks of GM foods definitely acts more persistent. Because if he thinks it's harmful, he wants to teach its harms to the students. Maybe the one who focus on the risks of GM Foods feels more sufficient. Because there are more evidences on GM Foods' harms. I think so. Because when I search GM Foods on the internet, I see many information about their harms. However, there are only a few information about its' benefits. That's why the one who is thinking they are harmful feels herself more sufficient as he has more evidence (PST1).

A small number of the participants asserted that higher risk perceptions about GM Foods leads to low GM Foods teaching self-efficacy beliefs. In parallel, it was articulated that higher benefit perceptions increase teachers' GM Foods teaching self-efficacy beliefs. One of these PSTs mentioned that if a teacher thinks that a topic is risky, s/he may avoid teaching it and be eager to spend less time on this issue. This kind of a teacher likely to think that there is no need to teach such risky topics to the students in order not to confuse their minds. PST14 explained this as the following:

> Because the teacher sees that there is a direct risk. The teacher can even avoid telling the subject. I mean, he even could be afraid. Because it's already harmful for him. I mean he could say I shall confuse the minds of the students and would avoid telling something that is harmful to them. It's a traditional way of teaching. That is to say, this kind of a teacher would only say it is such and such, but do not allocate time or think over so much on the issue (PST14).

Another PST stated that since majority of the society believe that GM Foods are risky, teachers may tend to deconstruct this idea by focusing on the beneficial aspects of GM Foods. Therefore, teachers with this perspective may be more eager to spend time and insist on teaching the beneficial aspects of GM Foods. This PST mentioned that:

> For the teacher who thinks it is risky, the vast majority of the community already agrees with him/her. Yes, they think that GM foods are risky. That is why I think that the other side [the teacher who thinks it is useful] will be more willing to try to break the perception (PST15).

The participants who asserted that high GM Foods benefit perception leads to high GM Foods teaching self-efficacy beliefs thought that if a teacher holds benefit perception and believe that GM Foods are necessary, s/he would incorporate SSI into science courses more. Moreover, similar to the previous participant, one of the PSTs articulated that since the general opinion in the society is GM Foods are risky, teachers may think that they should focus more on the beneficial aspects of GM Foods. Therefore, they would feel more efficacious and eager to teach the beneficial aspects of GM Foods. She stated that:

> It depends on the point of view that society possesses. For example, when we turn and stop 10 people in Turkey, nine out of them says GM foods are harmful. Because it is the thing that always comes out in the newspapers yes, in the way saying GM foods are harming us. So I think that the teacher who thinks it is beneficial may be more persistent in teaching this topic. Because s/he would try to break the existing social perception. I think that the person who thinks it is risky also tries to teach, but I do not think would be as insistent as the other (PST15).

4.3.2.3 Relationship between GM foods knowledge and GM foods teaching self-efficacy beliefs

In this section, findings concerning the relationships among the dimensions of GM foods teaching self-efficacy beliefs (ARG, GIS, OE) and the variable GM foods knowledge were presented. As displayed in Table 4.14, KNOW variable was significantly and positively correlated with the endogenous variable ARG (β = .16). It indicated that PSTs having higher levels of GM Foods knowledge tended to have higher levels of GM foods teaching self-efficacy beliefs regarding fostering argumentation and decision making on GM Foods. Similarly, KNOW variable was significantly and positively correlated with the endogenous variable GIS (β = .22), indicating that PSTs having higher levels of GM Foods knowledge tended to have higher levels of GM foods teaching self-efficacy beliefs regarding general instructional strategies about GM Foods teaching. KNOW variable was not found to be correlated to the OE dimension of GM foods teaching self-efficacy beliefs.

Table 4.14

Parameter Estimates for Significant Direct effects on GM foods Teaching Self-efficacy Beliefs of GM foods Knowledge

Endogenous variable	Exogenous variable	β	Estimate	SE	CR	p
ARG	GM foods knowledge	.16	.30	.05	5.50	.00
GIS	GM foods knowledge	.22	.40	.05	7.89	.00

As aforementioned, in the model, the paths among the dimensions of the dependent variable, GM foods teaching self-efficacy beliefs, and each of the other variables were specified. Squared multiple correlations were computed for each dimension of GM foods teaching self-efficacy beliefs. AMOS revealed that the independent variables personal epistemological beliefs dimensions, GM foods knowledge, and GM foods risk-benefit perceptions explained 12% ($R^2 = .12$) of the variance in the ARG variable; 19% ($R^2 = .19$) of the variance in GIS variable, and 4% ($R^2 = .04$) of the variance in OE variable.

Besides the quantitative results, the interview data also emerged the relationships between GM foods knowledge and GM foods teaching self-efficacy beliefs, and the possible reasons of this relationship. Regarding these relationships, categories and description of codes emerged under these categories were displayed in Table 4.15. PSTs majorly stated that as teachers' knowledge about SSI increases, their belief about teaching SSI better would become stronger. Only two of the participants stated that content knowledge alone is not enough to feel efficacious to teach SSI; that is, a teacher may know the content well but without knowing the teaching methods that should be used during the process of SSI teaching, and recognizing the interdisciplinary nature of SSI, it would be very difficult for that teacher to feel efficacious to teach SSI.

The participants asserted some reasons of why they think that increased content knowledge leads to increased SSI teaching self-efficacy beliefs. Among these reasons, the first one was the participants' assertion that as teachers' content knowledge increases, they would lead SSI discussions better. According to them, knowing SSI content well provides teachers with the ability to encourage student participation to express their opinions during the discussions. In addition, it was asserted that teachers with high content knowledge would respond student questions in a better way during the discussions. Two of the participants commented on that as the following:

> If the teacher is not well-knowledgeable on the subject, I think he cannot manage the class and the discussions which includes the different perspectives adequately (PST10).
>
> If you do not know about the subject you are teaching, as a teacher you fall into difficult situations in the classroom. After all, you have to be informed to remain in that class in the comfortable position of a teacher. Because students will ask questions and if you cannot answer it yourself, how you are going to start discussion in class? I think without the knowledge, without the proficiency, the teacher should not interfere in the discussion environment. Therefore, if such a socio-scientific subject is discussed, the teacher should do research before the lesson in order to feel himself / herself efficient and increase his knowledge about that subject (PST16).

Besides leading the SSI discussions, the participants asserted that as content knowledge increases teachers would be more open to different questions coming from students. As PST1 articulated as the following, this would make the teacher believe more efficacious and make the lesson more democratic.

If the teacher believes that she has teaching efficacy, she searches the subject at first and then if she finds herself proficient, she feels comfortable in class environment and the lesson flies in a democratic environment in which everyone can freely state their opinions. Also, as the teacher feels confident, even the possible questions from students don't cause any problem. For instance, personally, when they ask me something that I don't know, I never pretend that I know. Instead of this, I don't hesitate to say in this way: "I don't know the answer, let's search on this together and talk about it next lesson." That's why the greater content knowledge a teacher has, the more confident she will be. She feels comfortable and teaches better (PST1).

Table 4.15

Description of Codes and Categories regarding the Relationships among GM foods Teaching Self-efficacy Beliefs and GM foods Knowledge

Category / Subcategory	Code	Frequency	Code description
GM foods knowledge and teaching self-efficacy beliefs	Better teaching	2	Statements indicating that teachers with higher levels of SSI knowledge teach SSI in a better way.
	Leading discussions	6	Statements indicating that teachers with higher levels of SSI knowledge lead SSI discussions more successfully.
	Open to questions	4	Statements indicating that teachers with higher levels of SSI knowledge are more open to students' questions about the issue being discussed.
	Teacher confidence	6	Statements indicating that teachers with higher levels of SSI knowledge possess higher confidence to teach SSI
	SSI knowledge is not enough alone	2	Statements indicating that higher levels of SSI content knowledge is not enough to feel efficacious to teach SSI; teachers should also have pedagogical knowledge.

Finally, the participants thought that teachers with high content knowledge teach the SSI content well, that is, student understanding of that SSI topic would be more robust. Moreover, according to the participants, if the teacher believes that s/he knows the content well, they would feel more confident in the classroom to teach SSI. PST19 articulated that:

> If you know a subject well, you believe that you can teach it well. It is the case for me, I do not know how it is for other teachers, but it is as such. I think I will always teach better the subject that I'm good at. If I do not know the topic well, I would think I have to work more on that subject to feel more efficacious (PST19).

PST7 and PST17 mentioned about teachers' increased confidence of SSI teaching with increased content knowledge that:

> As the teacher has more knowledge about the subject, I believe that he/she believes to teach it in a better way. For example, I am like this, I do not think I have enough knowledge about many SSI, so I do not believe that I can teach it well either. But I think if I had knowledge I would think I can teach very well (PST7).

> For example, I think the reason that I rather have negative thinking is that I don't have knowledge at the moment. If would say if I had a little more knowledge, I may be able to teach it maybe (PST17).

Interestingly, two of the participants asserted that it cannot directly be considered that SSI teaching self-efficacy beliefs are related to increased content knowledge. According to these participants, knowing the SSI content cannot only be enough to feel efficacious to teach SSI because teachers should also be knowledgeable about the teaching methods that suits SSI teaching well. One of the participants mentioned that after she took the SSI course in the final year of undergraduate education, she realized that before taking this course she was not knowledgeable about the teaching methods that can be used in an SSI course. She also stated that, she now feels more efficacious to teach SSI in her classes. She explained this as:

> I think that the subject matter may not be directly related. Because, for example, the SSI course I took in faculty was very useful to me. For example, before the SSI lesson I used to think, ok these were very important, I had to treat them in the lecture, but the SSI course taught me a method. I mean, by keeping the other things constant I can say there is a direct relationship. It is not enough to know the subject alone, in my opinion teacher is required to know the method as well, we need to read the examples. The teacher will both know about the subject and the teaching methods. But if the teacher just knows the method for instance, if there is no content knowledge, then would be unable to teach I think (PST3).

Another PST who thought that knowing content about SSI cannot be considered directly related to SSI teaching self-efficacy beliefs articulated that only knowing the pure knowledge is not sufficient because SSI teaching requires being aware of multiple aspects of the issue under discussion. As the participant stated below, a teacher should know the political, social, and environmental aspects of an issue to feel efficacious about teaching that issue in the classroom:

> A person who knows the subject can see himself as efficacious to teach SSI, but, research, discussion… These are different things. Of course, one must be knowledgeable; required to know what nuclear energy is, how electricity is produced. But besides this, the teacher should be able to look at the events a little more socially, politically, environmentally. Subject knowledge is necessary, but not enough. Teacher needs to do a lot of research (PST6).

4.3.3 Relationships among the variables: Personal epistemological beliefs, risk-benefit perceptions, and knowledge

In this study, path analysis was used mainly for two reasons: first, to investigate the relationships among the endogenous variable GM foods teaching self-efficacy beliefs and each of the variables; personal epistemological beliefs dimensions, GM foods risk-benefit perceptions, and GM foods knowledge. Second, it was aimed to investigate the relationships among the variables personal epistemological beliefs dimensions, GM foods risk-benefit perceptions, and GM foods knowledge. In this part, results concerning the latter relationships were presented.

Regarding the relationship among the abovementioned three variables, it was proposed that personal epistemological beliefs dimensions are directly related to both GM foods benefit perception and GM foods risk perception. In addition, it was proposed that GM Foods knowledge was directly related to both GM Foods benefit perception and GM Foods risk perception. Results revealed that none of the personal epistemological beliefs dimensions except QLCK dimension were correlated with GM Foods benefit perception. As shown in Table 4.16, QLCK dimension of personal epistemological beliefs was significantly and positively correlated with BEN variable (β = .24). It indicates that PSTs who have sophisticated epistemological beliefs in quick learning and certain knowledge tended to have lower levels of GM Foods benefit perception. Results also showed that KNOW variable was significantly and positively correlated with BEN variable (β = .16), indicating that as PSTs' GM Foods knowledge increased, their benefit perception also increased.

Moreover, all the personal epistemological beliefs dimensions except IA dimension were significantly correlated with RISK variable (β = -.13 for QLCK, β = .11 for SK). Unlike for the SK dimension, the relationship between RISK and QLCK was negative. Results indicated that PSTs who have sophisticated epistemological beliefs in quick learning and certain knowledge tended to have higher levels of GM Foods risk perception. It was also revealed that PSTs possessing sophisticated epistemological beliefs in simple knowledge have a tendency to have lower levels of GM Foods risk perception. Finally, it was found that KNOW variable was significantly and negatively correlated with RISK variable (β = -.08), indicating that as PSTs' GM Foods knowledge increased, their risk perception would decrease.

Table 4.16

Parameter Estimates for Significant Direct effects on GM foods Risk and Benefit Perceptions of Personal Epistemological Beliefs and GM foods Knowledge

Endogenous variable	Exogenous variable	β	Estimate	SE	CR	p	R^2
BEN	Quick learning+Certain knowledge	.24	.40	.05	7.84	.00	.06
	GM foods knowledge	.16	.32	.06	5.13	.00	
RISK	Quick learning+Certain knowledge	-.13	-.12	.03	-3.99	.00	
	Simple knowledge	.11	.14	.03	3.85	.00	.02
	GM foods knowledge	-.08	-.10	.03	-2.63	.00	

With regard to the relationships among personal epistemological beliefs dimensions and GM Foods knowledge, the results revealed that QLCK dimension of personal epistemological beliefs was significantly correlated with GM Foods knowledge, while the dimensions IA and SK were not in significant correlation with knowledge. More specifically, as displayed in Table 4.17, the dimension QLCK was significantly and negatively correlated with GM foods knowledge ($\beta = -.29$), indicating that PSTs who have sophisticated epistemological beliefs in QLCK tended to have higher levels of GM Foods knowledge.

Table 4.17

Parameter Estimates for Significant Direct effects on GM foods Knowledge of Personal Epistemological Beliefs

Endogenous variable	Exogenous variable	β	Estimate	SE	CR	p	R^2
KNOW	Quick learning+Certain knowledge	-.29	-.23	.02	-9.84	.00	.08

4.4 Summary of the Findings

In the present study, the findings were obtained through qualitative and quantitative data analyses. The findings revealed some insights into PSTs' GM foods teaching self-efficacy beliefs, personal epistemological beliefs, GM foods risk-benefit perceptions, and GM foods knowledge. In addition, a model involving proposed relations among these four variables were also assessed. Descriptive analysis showed that the participants in the study had moderately high levels of GM foods teaching self-efficacy beliefs with the mean scores ranging from 3.89 to 3.56. The highest mean score among the dimensions of GM foods teaching self-efficacy beliefs instrument was obtained on fostering argumentation and decision making on GM foods (M = 3.89, SD = .49).

Interview data about GM foods teaching self-efficacy beliefs revealed variety of findings concerning to PSTs' beliefs, practices, and general opinions about teaching SSI in science classes. More specifically, the data emerged the categories the sources and impediments for personal GM foods teaching self-efficacy beliefs, assessing students' SSI learning, generating SSI discussion environment, teaching nature of SSI, classroom management in SSI lessons, time management in SSI lessons, teacher inculcation, and misunderstandings about SSI and SSI teaching.

In this study, although most of the participants reported that they feel themselves efficacious to teach GM foods, they all mentioned to be in need of more experience. They had concerns about how to communicate with students during discussions, managing the discussions, time and the whole classroom. In addition, some of the participants considered themselves not knowledgeable about GM foods issue. Moreover, the PSTs argued that student readiness is another impediment for them to feel efficacious to teach SSI in science classes. Besides the impediments, the participants mentioned that undergraduate courses, experiences in mentoring schools and self interest to SSI are the sources of their GM foods teaching self-efficacy beliefs.

The participants were asked about how they are going to understand that their students attained the outcomes of SSI courses. They mainly tend to expect an increase in students' motivation to learn science, students' ability to connect SSI to their daily lives, showing empathy towards other people, ability to generate evidences, and raised awareness about SSI issues.

Regarding the category of generating SSI discussion environments, although some of the participants had some concerns about school context and insufficient infrastructure in schools, most of the PSTs articulated that they would use role assigning, group work, and questioning to create SSI discussion environments. Also, they pointed out the importance of using argumentation and different resources such as technological sources during SSI discussions.

The interview questions were also aim to reveal the participants' teaching self-efficacy beliefs about teaching nature of SSI. According to PSTs' responses, most of them were aware that SSI are complex, open-ended, lack simple and straightforward solutions, and involve diversity of perspectives. PSTs argued that they can teach the complexity nature of SSI explaining this aspect to students explicitly while some of them plans to teach this characteristic implicitly. Some of the PSTs focusing on making society connection while teaching the complexity of SSI. In addition to complexity nature, PSTs were asked about teaching the multiple perspectives aspect of SSI. PSTs mentioned that they would prefer to use activities in which they assign different roles to students about the contoversial issue and value different opinions in the classes. Majority of the participants mentioned about using real life examples to teach the ongoing inquiry aspect of SSI and prefer to teach scepticism aspect explicitly telling the meaning of scepticism.

Classroom management and time management were the other two categories that emerged from the interview data. Nearly all of the participants agreed that comparing to traditional science teaching, classroom and time management becomes harder during SSI teaching. Most of the PSTs highlighted the importance of gaining more experience for them to become efficacious about time and classroom management. Only a few of the participants believed that they can manage the time and classroom efficiently while teaching SSI. The mostly stated reasons of not feeling efficacious to teach SSI were the difficulty of managing SSI discussions (especially in crowded classes) and the fact that SSI teaching is student-centered. The participants suggested some strategies such as using peer evaluation and trying to make students recognize teacher authority to overcome the classroom management problems during SSI teaching. Aside from classroom management, the participants argued that time management is an important handicap for them to overcome. They considered teaching SSI as time consuming especially in crowded classes. In addition, they reported that since teachers are under the pressure of preparing students to high stake exams, SSI are not covered very well in science classes. In order to minimize time management problem, the participants highlighted the importance of teacher preparation prior to science courses.

The analyzed data have also revealed that the PSTs have many misunderstandings about SSI and SSI teaching. To illustrate, PSTs have misunderstanding about the certainty of scientific (or SSI) knowledge, ongoing inquiry aspect of SSI, scepticism aspect of SSI, subjectivity nature of scientific (or SSI) knowledge, SSI teaching assessment, and the use of SSI in science classes. Moreover, majority of the PSTs in this study tend to avoid sharing their personal opinions about SSI in science classes in order not to influence students.

Considering personal epistemological beliefs, the participants scored 2.92 out of 5 on average on the personal epistemological beliefs scale. Since the higher scores obtained from this scale was an indication of naïve epistemological beliefs, it can be concluded that PSTs in this study had moderately sophisticated epistemological beliefs. The highest mean score obtained from the dimensions of epistemological beliefs was the innate ability dimension (M = 3.34, SD = .65). The descriptive statistics also revealed that the participants scored 2.56 out of 5 (SD = 0.66) and 3.83 (SD = 0.71) for the benefit perception and risk perception dimensions respectively. It showed that comparing to benefit perception, PSTs in this study perceived GM Foods as riskier. Finally, it was shown that on the knowledge questions, on average, the participants responded 9.73 correct answers to 17 questions.

Analysis of the specified path model revealed many significant paths from the dependent variable GM foods teaching self-efficacy beliefs to the other variables in the model. First, the quantitative analysis displayed that there were relations among the dimensions of GM foods teaching self-efficacy beliefs and personal epistemological beliefs. More specifically, it was revealed that the QLCK dimension of personal epistemological beliefs was in significant correlation with ARG and GIS dimensions of GM foods teaching self-efficacy beliefs. In addition, IA dimension of personal epistemological beliefs was found to be significantly correlated to ARG, GIS and OE dimensions of GM foods teaching self-efficacy beliefs. Finally, SK dimension of personal epistemological beliefs was significantly correlated to OE dimension of GM foods teaching self-efficacy beliefs. The interview data also emerged relationships among GM foods teaching self-efficacy beliefs and personal epistemological beliefs. It can be summarized that, according to the PSTs, as teachers' personal epistemological beliefs become sophisticated, they would have stronger SSI teaching self-efficacy beliefs. More specifically, the responses revealed that since SSI are complex and interdisciplinary, believing in complex nature of knowledge (rather than being composed of simple bits) and tentative nature of knowledge (rather than being certain and not changing) would foster teachers’ SSI teaching self-efficacy beliefs. In addition, since SSI learning is student-centered and a process, believing that learning is not innate (rather than being innate) and takes time (rather than being quick) would also increase teachers’ SSI teaching self-efficacy beliefs. Moreover, the participants asserted that as SSI are multidimensional and involves variety of positions, questioning authority (rather than accepting authority) is vital for a science teacher to believe efficacious to teach SSI.

Analysis of the specified model also revealed some insights into the relations among GM foods teaching self-efficacy beliefs and the independent variables GM foods knowledge, and GM foods risk-benefit perceptions. GM Foods risk perception was found to be correlated to ARG and OE dimensions of GM foods teaching self-efficacy beliefs. That is, as PSTs’ GM foods risk perception increased their GM foods teaching self-efficacy beliefs (with respect to ARG and OE dimensions) also increased. Differently, GM foods benefit perception was not found to be correlated to any of the dimensions of GM foods teaching self-efficacy beliefs. Moreover, the specified model revealed that the participants’ GM foods knowledge was significantly and positively correlated with their GM foods teaching self-efficacy beliefs (with respect to ARG and GIS dimensions). More specifically, it was found that PSTs’ GM Foods knowledge was in significant and positive correlation with the scores on ARG and GIS dimensions of GM foods teaching self-efficacy beliefs.

Considering the relationships among SSI teaching self-efficacy beliefs and knowledge, the participants asserted during the interviews that as teachers SSI knowledge increses, they would believe more efficacious to teach them. The reported reasons were that, increased knowledge was considered to strengthen the way teachers’ lead SSI discussions, to make teachers’ open to variety of questions and better teach SSI, and increase their confidence to teach these controversial issues. The PSTs’ also noted that knowledge was alone is not enough to feel efficacious to teach SSI; along with knowledge, teacher should also be knowledgeable about the pedagogy of teaching SSI.

Finally, the interview data emerged the relationships among GM foods teaching self-efficacy beliefs and GM foods risk-benefit perceptions. Some of the participants argued that both teachers with risk perception and benefit perception would possess high SSI teaching self-efficacy beliefs because they both want to raise awareness with respect to their own perspectives. Another group of the participants asserted that teachers with high risk perception and low benefit perception would be more efficacious to teach SSI because according to them, if an issue has risky sides for people, this would alert them more comparing to an issue that is believed to have beneficial sides. Therefore, these participants believed that these teachers would be more insisted on teaching the risky SSI, put more effort on teaching it well, and feel more efficacious. The last group of the participants mentioned that as SSI benefit perception increses and risk perception decreases, SSI teaching self-efficacy beliefs would become stronger. According to these PSTs, if a teacher thinks that a topic is risky, s/he may avoid teaching it and be eager to spend less time on this issue. Besides, another participant articulated that since the majority of the society believes that GM foods are risky, teachers may tend to deconstruct this idea by focusing on the beneficial aspects of GM foods.

Besides the relations among GM foods teaching self-efficacy beliefs and each of the independent variable, the quantitative analysis also revealed about the interrelationships among the independent variables which were personal epistemological beliefs, GM foods risk-benefit perceptions, and GM foods knowledge. It was revealed that PSTs' GM Foods benefit perception was significantly and positively correlated with their GM Foods knowledge and beliefs in quick learning and certain knowledge. In addition, the participants' GM Foods risk perception was found to be in significant correlation with their beliefs in quick learning and certain knowledge, simple knowledge, and GM foods knowledge. The correlations among risk perception and GM foods knowledge and the correlations among risk perception, and beliefs in quick learning and certain knowledge was negative. However, the participants' risk perception was found to be positively correlated with beliefs in simple knowledge. Finally, the analysis of the specified model revealed that PSTs'

GM Foods knowledge was significantly and negatively correlated with their beliefs in quick learning and certain knowledge.

CHAPTER V

DISCUSSION

5.1 Discussion of the Findings

In this chapter, interpretations regarding the findings of the study were presented. The discussions were mainly subsumed under two parts. In the first part, discussions related to the descriptive findings, namely GM foods teaching self-efficacy beliefs, personal epistemological beliefs, GM foods knowledge, and GM foods risk and benefit perceptions were presented. In the second part, findings regarding the hypothesized relationships among the variables were discussed. More specifically, the second part comprised of the discussions regarding the relationships among GM foods teaching self-efficacy beliefs and the variables existed in the proposed model (personal epistemological beliefs, GM foods knowledge, and GM foods risk and benefit perceptions), and the relationships among these three variables (personal epistemological beliefs, GM foods knowledge, and GM foods risk and benefit perceptions). Unlike to the parts regarding personal epistemological beliefs, GM foods knowledge, GM foods risk and benefit perceptions, and the relationhips among the three variables (personal epistemological beliefs, GM foods knowledge, and GM foods risk and benefit perceptions), which involves the interpretations of quantitative findings only, the rest of the chapter was comprised of the interpretations of both qualitative and quantitative findings. Toward the end of the chapter, implications for educational practice and policy, and recommendations for future research were presented.

5.1.1 Discussions for the descriptive findings

5.1.1.1 GM foods teaching self-efficacy beliefs

As being the outcome variable of the present study, GM foods teaching self-efficacy beliefs were examined in detail. Both the quantitative and the qualitative data revealed valuable findings regarding PSTs' teaching self-efficacy beliefs about GM foods. The descriptive statistics showed that PSTs scored 3.71 out of 5.00 on average on GM foods teaching self-efficacy beliefs. More specifically, they had the highest score on the fostering argumentation and decision making on GM foods dimension of GM foods teaching self-efficacy beliefs instrument with a mean value of 3.89. However, the participants had the lowest score on GM foods teaching outcome expectancy dimension with a mean value of 3.56 although it is still above the midpoint of 1-5 likert scale. Besides, the mean value corresponding to the general instructional strategies of GM foods teaching was found as 3.68. These findings revealed that the PSTs in this study had moderately high teaching self-efficacy beliefs about teaching GM foods in science classrooms.

These findings might be explained by the courses taken by the participants thus far (Schoon & Boone, 1998; Watters & Ginns, 2000). Considering that the participants in the present study are junior and senior PSTs, they would have taken several pedagogy courses. For instance, in their methods of science teaching courses, they have learnt about instructional strategies suitable for SSI teaching such as argumentation practices. Besides, the participants are anticipated to be knowledgeable about classroom and time management issues since they have taken a course specifically designed for teaching them classroom and time management. However, before interpreting teacher candidates' teaching self-efficacy beliefs, it should be considered that they have not experienced the field yet. That is, the participants in this study have no formal classroom experience. Therefore, as Hoy and Spero (2005) suggested, they might underestimate the complexity of SSI teaching and reflected pseudo beliefs regarding teaching self-efficacy. For this reason, rather than only relying on the self-reported instruments, in this study the participants' teaching self-efficacy beliefs were examined through interview questions.

During the interviews, the participants were first of all asked to rate their GM foods teaching self-efficacy beliefs over the range of 1 to 5. It was revealed that most of the PSTs rated their GM foods teaching self-efficacy beliefs 4 out of 5 while some of them rated as 3 out of 5. Alongside the findings regarding the extent of PSTs' GM foods teaching self-efficacy beliefs, the interview data revealed important findings under the categories of sources and impediments of GM foods teaching self-efficacy beliefs, assessing students' SSI learning, generating SSI discussion environment, teaching nature of SSI, classroom and time management in SSI lessons, teacher inculcation in SSI lessons, and PSTs' misunderstanding about SSI and SSI teaching. In the following paragraphs, the interpretations about these findings were presented.

Under the category sources and impediments of GM foods teaching self-efficacy beliefs, the mostly stated impediments were being in need of teaching experience, and the issue of student readiness. It was revealed that PSTs' majorly stated concern regarding being inexperienced were the difficulty of leading the SSI discussions, and managing the time and the classroom while teaching SSI. Most of the participants complained about the limited time and the difficulty of advocating time for SSI within the overloaded science content. According to them, due to the open-ended and complexity nature of SSI, it would not be possible to carry out discussions in limited time durations. The research studies reported somewhat similar findings. Lee et al. (2006), for instance, reported in their study with science teachers that, lack of time to plan and prepare materials to teach SSI, and the difficulties associated with implementing effective instructional approaches were among the impediments of SSI teaching.

The impediments reported by PSTs let us do some interesting interpretations. As mentioned before, the quantitative data regarding teaching self-efficacy were collected from a sample of PSTs who did not take any course specifically designed for SSI teaching (except one group of 4th grade students). Differently, the interview data were collected from a purposively selected group of students who have taken the course for SSI teaching. What we saw as a result of quantitative analyses was that, the participants had moderately high GM foods teaching self-efficacy beliefs. However, the participants of the interviews mentioned several challenges to teach SSI in their classrooms and even some of them considered themselves as having low levels of GM foods teaching self-efficacy beliefs. As Bandura (1997) suggested, among the four sources of self-efficacy beliefs, mastery experiences are the most powerful source of efficacy beliefs. Considering that the interview participants were intensively engaged with SSI teaching practices and became knowledgeable about SSI teaching and the nature of SSI, it would be interesting to demonstrate somewhat lower GM foods teaching self-efficacy beliefs comparing to the group who participated to the quantitative part of the study. That is, it can be interpreted that, as the experience in SSI teaching increased, the participants' teaching self-efficacy beliefs became lower. This finding is similar to what Hoy and Spero (2005) revealed. In their study, Hoy and Spero (2005) found that the participants' efficacy decreased with teaching experience. That is, there were significant declines in teaching self-efficacy beliefs in the first year of teaching comparing to student teacher years. The researchers interpreted this decline as might be a result of the gap between the standards novice teachers have set for themselves and their performance. More specifically, according to Hoy and Spero (2005), it is probable that teachers in their first year of teaching have some dissappointments due to the reason that they might have to lower their standards when confronted with the realities and challenges of the teaching task. In a similar vein with these interpretations, our study adds to the existing literature that, increased experience with the course taken might have decreased the participants' GM foods teaching self-efficacy beliefs. More clearly, with the SSI course taken, the interview participants became more knowledgeable about the complexities of SSI teaching in real class settings and more critical to evaluate the process of SSI teaching. Therefore, their self-confidence about SSI teaching decreased as compared to their peers who were not knowledgeable about SSI teaching.

In addition to the impediments, under the category of sources and impediments of GM foods teaching self-efficacy beliefs, PSTs' reported that undergraduate courses taken and experiences gained in practice schools were the main souces of their GM foods teaching self-efficacy beliefs. Considering that the participants have not spent enough time in the field, it would be expected to reveal impediments related to being inexperienced. Moreover, the sources of GM foods teaching self-efficacy beliefs, which were reported by the PSTs, aligned with Bandura's (1997) asserted sources of self-efficacy beliefs. As mentioned before, Bandura argued that mastery experiences, vicarious experiences, verbal persuasion, and physiological arousal are the four main sources of self-efficacy beliefs. As noted in Bandura's study, mastery experiences, such as teaching a class, having field experience or tutoring a child, are highly effective ways to develop strong teaching self-efficacy beliefs. In parallel to this assertion, the PSTs in the present study mentioned experiences gained in mentoring schools most as the sources of their GM foods teaching self-efficacy beliefs. In addition, undergraduate courses taken might create the opportunity for PSTs to gain vicarious experiences. In those courses, PSTs have the chance to observe science teachers' and professors' teaching performances. Thanks to these observations, the participants would have developed the belief that they also could teach well in their own classrooms (Ertmer, 2005). Given that the participants of the present study are in-experienced teacher candidates and have limited prior personal experiences in teaching, vicarious experiences are also of great importance for the development of their teaching self-efficacy beliefs (Labone, 2004). Supporting these interpretations, in their study tracing the development of preservice teachers' teaching self-efficacy beliefs, Charalambous, Philippou, & Kyriakides (2008) revealed that teaching experiences and interaction with mentors, tutors, peers, and pupils are the main factors that inform these beliefs. More specifically, in that study, the researchers argued that there could be three different ways mentors inform preservice teachers' teaching self-efficacy beliefs; by modeling teaching and providing feedback to them, by the latent messages, and by the feedback that mentors provided to their students.

Other than the sources and impediments of GM foods teaching self-efficacy beliefs, the interview analysis shed light on PSTs' beliefs about assessing students' SSI learning, generating SSI discussion environment, teaching nature of SSI, and classroom and time management in SSI lessons. Considering the category of beliefs about assessing students' SSI learning, PSTs' expectations as a result of SSI teaching were similar to what have reported in the related literature. Regarding the assessment of students' SSI learning, the participating PSTs mainly focused on students' ability to generate evidences, ability to connect SSI to their daily lives, showing empathy toward other people, increased awareness about SSI, and increase in student motivation to learn science as the indicators of students' SSI learning. Although assessment tools to measure students' SSI learning still in need of improvement (Sadler, 2011), researchers have so far revealed a variety of argumentation constructs, rubrics and scales that can be used for the assessment of SSI learning (e.g. Evagorou, 2011; Simon & Amos, 2011). The ways proposed by PSTs to assess students' SSI learning, which were somewhat related to assessing argumentation skills and moral development of students, showed that PSTs developed an awareness regarding the outcomes of SSI teaching (Zeidler, Applebaum, & Sadler, 2011). Accordingly, PSTs articulated that they would use argumentation practices such as fostering students to generate evidences, counterarguments, and rebuttals by creating discussion environments, using questioning, and presenting students opposing ideas on controversial issues as the most frequently used way to teach SSI and nature of SSI. Although PSTs were somewhat aware of the teaching strategies for effective SSI teaching, the interview data showed that they did not feel efficacious to manage time and classroom while teaching SSI. They suggested a number of ways regarding classroom management and time management in SSI lessons; however, most of the PSTs felt insecure about exhibiting an effective classroom management or using the time efficiently. Having lower levels of classroom and time management beliefs is something that has been reported in the literature very often. For instance, as reported in Ingersoll's (2001) study with 6700 teachers in the US, 30% of the teachers who preferred to give up teaching articulated classroom management, specifically student discipline, as one of the reasons that caused them to leave the profession. Similarly, Turnuklu and Galton (2001) revealed that noise, shouting out, and talking without permission were the most common problems in Turkish elementary schools. That being the case for general science teaching, we believe that, due to the open-ended nature of SSI, managing time and classroom would even be more difficult in the context of SSI. Besides, the issues of classroom and time management become more problematic for preservice and beginning teachers (Gencer & Cakiroglu, 2003). Given that these PSTs lack field experience, they might not be able to envision the real classroom environment and how they would teach in that environment before gaining experience. Supporting this interpretation, Appleton and Kindt (2002) asserted that beginning teachers try to avoid using interactive lessons or cooperative learning which requires more developed classroom management skills, and instead tend to choose “safe” teaching methods which they believe are easily managed. Therefore, if we would like our science teachers to integrate SSI topics into science education successfully and develop higher levels of classroom and time management skills to accomplish this, it would be beneficial and necessary to support teachers both during their preservice years and in their first years of teaching.

Finally, interviews revealed findings about PSTs’ beliefs regarding teacher inculcation in SSI lessons and their misunderstandings about SSI and SSI teaching. Majority of the PSTs in this study believed that science teachers should not express their personal opinions about the SSI being discussed in the classroom. According to them, if a teacher shares her personal position, students would be affected negatively and hesitate to participate in the discussions in case of having the opposite viewpoint. Unlike to PSTs’ responses, researchers assert that teachers should be open to share their own personal positions as long as they provide the justification for their claims (Cross & Price, 1996; Sadler et al., 2006). Teachers’ hesitation to share their personal viewpoints regarding SSI in science classes is something emerges also in some other studies. For instance, in Lee and Chang’s (2010) study with six science teachers investigated the ways these teachers develop understanding of SSI and their practical issues that were experienced while addressing SSI in science classes. It was revealed that two of the teachers struggled with whether or not to bring their own values and preferred to remain neutral in the class (Lee & Chang, 2010). Moreover, the other four teachers did not feel serious tension in taking their position in class although they stated they feel comfortable when they stay neutral while teaching SSI. Another research study examining the teaching of controversial issues in science classes, Oulton, Dillon, and Grace (2004) highlighted the importance of avoiding indoctrination while teaching SSI. However, keeping that in mind, Oulton et al. (2004) argued that it would not be appropriate to expect teachers be neutral while expecting students to be open to share what they think and feel. Also, the main concern in Oulton et al.'s (2004) study about staying neutral was the idea that percect balance (full neutrality of teachers) is impossible to achieve. According to them, teachers have to make subjective judgements about the information presented to students. In parallel to this assertation, we believe that starting from the preservice years, science teachers need to be supported to develop the belief that they should not be remain neutral but rather share their personal point of views regarding SSI. We believe, this would also contribute to creating more democratic classroom environments.

Besides revealing PSTs' beliefs about teacher inculcation, the interview questions helped us to gain a deeper understanding regarding their misunderstandings related to SSI teaching. It was revealed that PSTs' hold misunderstandings even in the basic concepts associated with the nature of scientific knowledge, the way scientific knowledge is obtained, and SSI. The emerged misunderstandings may be discussed under two main categories. The first category is their misunderstandings about the nature of SSI and the nature of scientific knowledge. The second category was about their misunderstandings of the place of SSI in science teaching, namely the purpose and use of SSI in science teaching, and the assessment of SSI learning.

To illustrate the former category, according to the PSTs, since SSI involves multiple perspectives and may change in time, the scientific content regarding SSI cannot be considered as reliable. In addition, as indicated in interview data, PSTs expected students to learn the ongoing inquiry aspect of SSI during the discussions in which students might change their perspectives with the presence of counterarguments or rebuttals. Similarly, the same PST considered students' changing of their opinions during the discussions as equal to tentativeness of scientific knowledge. Another two misunderstandings were the PSTs' articulations that as the new scientific information emerged about a SSI, the previous information was no longer accepted as reliable and valid, and that scientific knowledge should be objective.

It is important to note here that, we interpreted the participants' nature of scientific knowledge understandings in accordance with the postpositivist view. That is, scientific knowledge is never absolute and certain but tentative and subject to change; is culturally embedded and, subjective and theory-laden; involves human imagination and creativity; and based on empirical evidence (Lederman, 1992, 2007). Numerious studies have reported the importance and the need of preservice and inservice science teachers' understanding of the nature of scientific knowledge (e.g. Lederman, 1992, 1999). The main idea behind this need is that, without a sound understanding of nature of scientific knowledge, it would be difficult for teachers to enact an effective teaching in science classes (Lederman, 1999). After all, if the main goal would be to do effective teaching, teachers should have an adequate knowledge of what s/he attempts to communicate with students.

Regarding the definition of nature of science, researchers has started to suggest the need to include moral and ethical issues into the definition of nature of science because it was argued that with a robust understanding of nature of science, individuals are more likely to resolve SSI by utilizing scientific evidences and to understand the nature of those issues better (e.g. Zeidler et al., 2002). It has been argued that if the main goal of science education is to raise students who are capable of making informed decisions about societal issues (Sadler, 2011), then it would be necessary to consider moral and ethical issues as components of nature of science (Zeidler et al., 2002). Therefore, nature of science understandings is considered as somewhat related to individuals' understanding and resolution of the issues (Zeidler et al., 2002), which involve ethical, moral, and social considerations, and the nature of those issues.

As for the nature of science, science teachers should also be knowledgeable about the nature of SSI so that they can teach those society-related issues. The term nature of SSI, which refers to understanding and abilities about nature of SSI, was conceptualized by Sadler et al. (2007) as socioscientific reasoning. According to Sadler et al. (2007), individuals need to have an adequate understanding of nature of SSI to generate resolutions to solve SSI and to make informed decisions. In that way, we believe, they could be able to raise students with the ability to make informed decisions regarding SSI. Moreover, in order to lead SSI discussions through which students realize the ethical and moral aspects of SSI and to be respectful to others' opinions, science teachers should be aware of the nature of SSI. For instance, without recognizing the inherent complexity of SSI or multiple perspectives nature of SSI, it is probably impossible for a teacher to provide students with flexible and democratic discussion environments. Similarly, if a science teacher does not appreciate the ongoing inquiry nature of SSI or emphasize the skepticism aspect of SSI, s/he would tend to impose students to a particular viewpoint rather than presenting variety of perspectives. Therefore, teacher candidates should be supported in their teacher preparation programs to recognize the characteristics and nature of SSI.

Another two misunderstandings were about the assessment of SSI learning and the place of SSI in science education. According to the PSTs, due to open-ended nature of SSI, it is hard for teachers to come to a certain conclusion in SSI courses. Therefore, as they asserted, it would be very difficult to measure students' SSI learning. This finding leaded us to the interpretation that PSTs' misunderstandings about the assessment of SSI learning might be caused by insufficient knowledge of nature of SSI. That is, teachers who attributed the difficulty of SSI learning assessment to the reason that there are no any certain conclusions for SSI, possessed most probably limited knowledge about the nature of SSI. These participants were not knowledgeable that SSI are open-ended and lack clear-cut solutions and conclusions (Sadler & Ziedler, 2005). Moreover, some of the participants underestimated the place of SSI in science teaching in a way that, they would use SSI only to make the lesson more enjoyable rather than construction the whole lesson on a SSI. Besides, some of the participants distinguished textbook science from SSI. That is, according to them, SSI are different than the core scientific knowledge existed in science textbooks and teaching the textbook science have to come first to be taught in the classroom. All these implied that PSTs failed to consider science in society as a part of school science.

These findings were supported by Lee and Chang's (2010) study which was conducted with experienced science teachers. In that study, four of the six science teachers made a distinction among textbook science and science in the society such as SSI. Some of the teachers in Lee and Chang's study clearly stated that there are two kinds of sciences; the real science that they should teach to students, and the science in the society. In a similar vein, another teacher mentioned that she feels afraid to deal with SSI since it is too different from textbook science and addressing SSI in science classes creates the feeling that her teaching is disconnected. All these findings have some practical implications that were provided in detail in the following parts. Given that teacher beliefs and knowledge play a major role in their teaching practices and student learning of science (Bryan & Atwater, 2002; Haney et al., 1996; Zohar, 2006), successful SSI teaching requires some immediate actions to be taken. This being the case, science educators and policy makers would better to start educating future teachers in their preservice years and early years of professional teaching so that they have developed robust understandings about nature of SSI and SSI teaching in general.

5.1.1.2 Personal epistemological beliefs

Findings corresponding to factor structure of personal epistemological beliefs were in line with Schommer's (1990, 1994) epistemological beliefs model, based on which Bendixen et al. (1998) developed EBI. In the present study, three factors were extracted by EFA and confirmed by CFA. These factors were quick learning and certain knowledge, innate ability, and simple knowledge. This finding provided evidence for the multidimentional nature of epistemological beliefs as asserted by Schommer and some other researchers (e.g. Bendixen et al., 1998). Schommer, in her study, proposed that personal epistemology may be conceptualized as a system of beliefs; that is, personal epistemology is composed of more than one belief. Therefore, contrary to the previous research which asserted that personal epistemological beliefs are developmental and unidimensional, according to Schommer (1990, 1994), personal epistemological beliefs are multidimensional. Another contention that was suggested by Schommer (1990, 1994) was that, personal epistemological beliefs are more or less independent. That is to say, these beliefs do not necessarily mature in syncrony. The factor analysis of the EBI data supported also this contention. It was revealed in the present study that, the participants exhibited different sophistication levels regarding different EBI dimensions. For instance, the data revealed a mean value of 2.12 (which may be interpreted as moderately sophisticated) for quick learning and certain knowledge dimension; however, it was 3.34 (which may be interpreted as moderately less sophisticated) for the dimension of innate ability.

Although the EBI data confirmed the multi-faceted nature of epistemological beliefs by extracting more than one dimension, unlike to Schommer's finding EFA and CFA revealed three factors (quick learning and certain knowledge, innate ability, and simple knowledge) instead of five. Besides, the dimensions quick learning and certain knowledge were merged under one dimension and omniscient authority dimension did not form a pattern so did not emerge as an interpretable distinct factor. In the related literature, there have been some studies which also used EBI revealed less than five epistemological beliefs dimensions as well (e.g. Cam, Topcu, Sulun, Guven, & Arabacioglu, 2012; Chan, Ho, & Ku, 2011; Nussbaum & Bendixen, 2003). In the study conducted by Nussbaum and Bendixen (2003), EFA revealed three factors; omniscient authority and certain knowledge, innate ability, and simple knowledge. Similarly, in Chan et al.'s (2011) study, three factors, namely the dimensions certain knowledge, innate ability and simple knowledge, were extracted. In another study conducted in Turkish context, the three distinct dimensions certain knowledge, innate ability, and quick learning were determined. Similar to the present study, these studies also reported three distinct factors of EBI; however, the dimensions vary from one study to another. One explanation for revealing different dimensions might be the cultural context. As stated by Jehng, Johnson, and Anderson (1993), individuals' beliefs about the nature of knowledge and learning are shaped by the culture they live in. Supporting this idea, Chan and Elliott (2004) stated in their study that, epistemological beliefs structures may vary based on cultural differences. Moreover, as suggested by Yilmaz-Tuzun and Topcu (2008), different sample characteristics might lead to different factor structures. Therefore, it is not surprising to reveal different epistemological beliefs dimensions in different samples. Another explanation for revealing different dimensions might be the translation (Stahl & Bromme, 2007; Topcu & Yilmaz-Tuzun, 2008; Tuncay-Yuksel et al., 2015). That is, due to translation, the items in EBI might not capture the full meaning of the original items. This might have caused that the participants understand the items in a different way and the items fell into different dimension categorizations in factor analyses.

Mean scores corresponding to each extracted EBI factors revealed PSTs' personal epistemological beliefs characteristics. For instance, the participants in the present study scored highest on innate ability dimension. This implied that PSTs in this study exhibited the lowest level of sophistication for innate ability dimension of personal epistemological beliefs. In addition, the PSTs scored lowest on the dimension quick learning and certain knowledge; however, the mean value was still around the midpoint of the scale. That means, the participants exhibited the highest level of sophistication for quick learning and certain knowledge comparing to the other dimensions of EBI; but they still failed to demonstrate a sophisticated level of personal epistemological beliefs in quick learning and certain knowledge.

The fail to reveal developed personal epistemological beliefs could be attributed to educational context in Turkey. It is probable that majority of the participants in this study were exposed to traditional teaching strategies such as direct teaching in their elementary and high school education (Yilmaz-Tuzun & Topcu, 2008). Rather than aiming to design reflective and interactive processes, which promote students to realize the nature of knowledge and knowing, these teaching strategies create learning contexts in which teacher plays the major role in knowledge transmission (Cheng et al., 2009). Although it has been a while that the science program in Turkey shifted to a more constructivist perspective, there are still considerable number of teachers who resist to internalize teaching strategies used in constructivist teaching perspectives due to several reasons such as inadequate and insufficient in-service training (Aydin & Cakiroglu, 2010). Therefore, rather than constructivist education programs which are developed basing on the idea that learning occurs gradually through time (Ramos, 1999; Tucker & Batchelder, 2000), the participants were more familiar to the traditional teaching strategies and were more exposed to rote learning and memorization.

The recently revised teacher education programs in Turkey could be taken as an opportunity for preservice teachers to close this gap. In Turkey, teacher education programs revised in 2006. After then, teacher competencies were re-determined in the following two years (MoNE, 2008). During this revision process, The Council of Higher Education in Turkey changed both the structure and number of courses offered within science teacher education programs in universities. Within this scope, it was decided that about half of the courses in science teacher education programs should aim to teach the scientific knowledge and skills regarding chemistry, biology, and physics. Besides, pedagogy courses constitute nearly 30% of the offered courses and the remaining 20% of the courses was advised to be general interest courses, which are majorly comprised of elective courses (The Council of Higher Education, 2007). The revised program enabled flexibility to offer variety of courses. One of the most remarkable changes was that The Council of Higher Education encouraged faculties to open courses such as history of science and introduction to philosophy. Furthermore, with these new changes, education faculties revised the pedagogy courses (especially science teaching methods courses) they offer so that these courses include new teaching strategies such as argumentation or new perspectives such as SSI teaching. All these reforms provided PSTs with newly offered and revised undergraduate courses which mainly aim to teach nature and epistemology of science in broader ways. We believe that in the following years those undergraduate courses taken by PSTs will foster their personal epistemological beliefs and create the opportunity to raise science teachers who have developed personal epistemological beliefs.

5.1.1.3 GM foods knowledge

Another variable that was examined in the present study was PSTs' GM foods knowledge. In this study, out of 17 knowledge questions, the participants responded 9.73 correct answers on average. This result indicated that PSTs had moderate understanding about concepts regarding GM foods. When examined in detail, it was seen that some of the knowledge items were responded incorrectly by more than half of the PSTs. Among those five items, three of them were related to GM foods regulations in Turkey and in the world. Namely, the PSTs were not knowledgeable about whether it is forbidden to use GM seeds in agriculture in Turkey, and if there are any regulations or laws regarding the use of gene technology in food production both in Turkey and in the world. The remaining two knowledge items were about the consequences of genetic modification applications ("By eating GM foods, a person's genes could also become modified" and "genetically modified animals are always bigger than ordinary ones".).

As research studies revealed, the ability to engage in reasoned discussions of controversial issues requires a degree of knowledge (Lewis & Leach, 2006). As citizens of the society they live in, the PSTs should be able to involve in reasoning processes and make informed decision-making about the issue of GM foods. As Holbrook and Rannikmae (2009) asserted, being knowledgeable and having an understanding about those issues are one of the most crucial prerequisite to accomplish this. Moreover, given that those teacher candidates will teach GM foods and other controversial issues in their science classes, and Turkey has been incorporating SSI (such as GM foods) into the science curriculum (MoNE, 2013), they are expected to have knowledge about GM foods in order to be able to engage students in qualified argumentation processes and encourage students to evaluate alternative explanations (Sampson & Blanchard, 2012). Considering the nature of SSI, teaching GM foods requires a knowledge base regarding scientific, social, political, or ethical aspects (Bryce & Gray, 2004). For instance, without being knowledgeable about current GM foods regulations in Turkey and in the world, it would be very difficult for a science teacher to lead GM foods discussions in the classroom. Considering that one of the main reasons of PSTs' insufficiency of GM foods knowledge might be the lack of emphasis on these controversial issues in their teacher education programs, offering more courses on these issues might help to develop their knowledge. It is possible to include the issue of GM foods into biology courses such as general biology, ecology, or nutrition. Besides, it would be beneficial for PSTs to take environmental education courses which are designed to teach about the societal and political aspects of GM foods.

5.1.1.4 GM foods risk and benefit perceptions

In the present study, while the mean value was 2.56 for benefit perception, the mean value for the risk perception was 3.83 out of 5. It is clear from these findings that PSTs tend to perceive GM foods as risky. This might be due to several reasons. The first reason might be related to the gene technology itself. That is, GM foods, as one of the debatable issues in society, are the products of gene technology and will potentially influence health, environment, and economy (Gaskell et al. 2004). Tremendeous advancements in science and technology, such as gene technology, in the last century challenged people with several risks (Beck, 1992). Thereby, like people in other societies all around the world, citizens in Turkish society might have concerns about GM food safety. More specifically, they might want to be informed about the way the food is produced and more importantly the ingredients of the food they consume (Brom, 2000). While these concerns might be raised by the general society, there might be special group of consumers in the society who have extraordinary eating habits. Vegetarians, for example, would need to know whether their food contains any animal product or not (Brom, 2000). We believe that all these concerns may raise important conflicts in the society regarding GM food consumption.

Besides, individuals may possess higher risk perceptions due to unknown long term consequences of GM foods. There have been research studies published which investigated long term effects of GM food consumption. Some of these studies reported that GM foods consumption might cause some long term negative consequences (e.g. Malatesta, Biggiogera, Manuali, & Rocchi, 2003; Malatesta et al., 2008; Sissener, Sanden, Bakke, Krogdahl, & Hemre, 2009; Trabalza-Marinucci, 2008) on animals. Although research has revealed varying results on risk and benefit perceptions regarding GM foods, individuals living in different regions in the world are tend to approach the issue of GM foods cautiously. It has been reported that majority of the people living in developed countries such as UK, Australia, and Japan perceive the issue of GM foods as risky (Curtis, McCluskey, & Wahl, 2004). To illustrate, Lea (2005) reported in her study with a sample of five hundred Australian individuals whose age majorly in 20-30 years old range that great majority of the participants perceive the issue of GM foods as negative due to many reasons such as being unnatural, difficult to identify, and having unknown long-term health and environmental effects. Similarly, according to European Comission's report that was released in 1997, European consumers are highly sceptical of the foods which are produced through genetic modification.

The second reason that PSTs perceived GM foods as risky rather than beneficial might be attributed to the importance of agriculture for Turkish economy. Due to the large agricultural potential and rural area in Turkey, agricultural sector holds an important place in Turkish economy (Sayin, Mencet, & Ozkan, 2005). GM foods, however, have been considered to harm the environment (Conner, Glare, & Nap, 2003; Ferber, 1999). Environmentalists still raise questions about gene drift, super-weeds, and the harm that may be given to the biodiversity (Conner, Glare, & Nap, 2003). Therefore, it would be reasonable to interpret that the potential harm that might be given to the environment and agriculture could lead the participants in the present study to lean towards the use of GM foods and increase their GM foods risk perception.

5.1.2 Discussions for the hypothesized relationships in the path model

5.1.2.1 GM foods teaching self-efficacy beliefs and personal epistemological beliefs

Concerning the hypothesized relationships between GM foods teaching self-efficacy beliefs and personal epistemological beliefs, it was observed that the dimensions of personal epistemological beliefs were in correlation to GM foods taching self-efficacy beliefs. Quantitative results revealed that beliefs about control of knowledge (innate ability; IA) were significantly correlated to all the dimensions of GM foods teaching self-efficacy beliefs (Fostering argumentation and decision making on GM foods, general instructional strategies of GM foods teaching, and GM foods teaching outcome expectancy beliefs). However, while the relation between innate ability and teaching self-efficacy beliefs about general instructional strategies of GM foods teaching was positive, the relationships between innate ability and teaching self-efficacy beliefs about fostering argumentation and decision making on GM foods, and innate ability and GM foods teaching outcome expectancy beliefs were revealed to be negative.

The positive relationship between innate ability beliefs and teaching self-efficacy beliefs about general instructional strategies of GM foods teaching indicated that as PSTs' epistemological beliefs in innate ability become sophisticated, their beliefs about GIS would increase. As have been stated previously, innate ability refers to the belief that the ability to learn is innate rather than acquired. Therefore, PSTs possessing sophisticated innate ability beliefs believe that learning is not innate and students may learn in time. Besides, these PSTs believe that student learning can be developed by teachers' effective teaching practices. On the other hand, PSTs having naive innate ability beliefs believe that learning is innate and one cannot learn unless they have this ability from birth. The present study revealed that PSTs who believe themselves more efficacious about general instructional strategies of GM foods teaching were tend to believe that learning is not innate and can be developed by effective teaching. Considering that instructional strategies that are suitable to SSI (e.g. GM foods) teaching align with learning and teaching practices that require time, it is reasonable to reveal a positive correlation between innate ability beliefs and teaching self-efficacy beliefs about general instructional strategies of GM foods teaching. The related literature has also reported supporting findings. For instance, the study conducted by Yilmaz-Tuzun and Topcu (2008) revealed that PSTs' beliefs in innate ability significantly correlated to their teaching self-efficacy beliefs, which was categorized as self-efficacy and outcome expectancy beliefs. These findings are parallel to what Schommer (1994) reported in her study. According to Schommer (1994), epistemological beliefs affect individuals' learning. More specifically, it was asserted that personal epistemological beliefs are in close relationship to whether or not individuals actively engage in learning, persist in difficult tasks, comprehend written material, and cope with ill-structured domains (Schommer, 1994). Therefore, as revealed in the present study, PSTs' beliefs in innate ability have the potential to influence their beliefs about accomplishing successful SSI teaching in their future classes.

In addition, the negative correlations among innate ability beliefs and teaching self-efficacy beliefs dimensions, fostering argumentation and decision making on GM foods and GM foods teaching outcome expectancy beliefs, indicated that PSTs possessing more sophisticated epistemological beliefs in innate ability were tend to have lower teaching self-efficacy beliefs on fostering argumentation and decision making on GM foods and GM foods teaching outcome expectancy beliefs. These results may be explained in two ways. First, PSTs scored highest on the innate ability dimension of personal epistemological beliefs. That is, PSTs' beliefs in innate ability were the least sophisticated dimension comparing to others. Second, as argued by Kember (1997), there is not always a consistent relationship between underlying beliefs and teaching approaches. That is, there might be times that pre-service teachers face conflicts between their epistemological beliefs and teaching practices, such as time limitations, being inexperienced of teaching, or pressure to keep up with the regular schedule of the curriculum. One possible explanation for this inconsistency, as suggested by Brownlee, Purdie, and Boulton-Lewis (2001), was that preservice teachers are still in a transition process of changing from less sophisticated to sophisticated epistemological beliefs and therefore might have confusion while reflecting on their epistemological beliefs and teaching practices. In line with these ideas, PSTs in this study might think that teaching controversial SSI in science courses can be a very challenging task for them and believing in innate ability less may even strenghten this belief. More specifically, since PSTs do not possess sufficient experience about SSI teaching, the belief that students' SSI learning might be improved by effective teaching might let them feel insecure. On the contrary, believing that learning is fixed at birth might lessen the burden, that is, decrease their responsibility, as a teacher in the classroom.

Alongside the quantitative results, the qualitative data let us interpret further about the relationship between GM foods teaching self-efficacy beliefs and personal epistemological beliefs in innate ability. According to the responds given to the interview questions, PSTs thought that as teachers possess more sophisticated epistemological beliefs in innate ability, they would feel more efficacious to teach SSI. They asserted many reasons to justify this. For example, some of the PSTs mentioned that teachers who does not believe in innate ability but consider learning as achievable by the process of teaching would create more variety of learning environments, use multiple intelligences for teaching, and try to encourage student learning by designing the lesson as more attractive for students. On the other hand, teachers believing in innate ability would not make an effort to gain students new understandings about scientific concepts since they believe that if a student does not have learning ability from the birth, there is nothing to do. Supporting these qualitative findings, Chan (2003), in the study aiming to examine the relationships among preservice teachers' epistemological beliefs and approaches to learning, reported that the participants with naïve innate ability beliefs tended to approach learning as a simple task of memorization. Given that SSI teaching and learning practices are unlike the idea of rote learning and memorization and involves constructing bridges between science-related social issues and everyday life (Sadler, 2004), teachers with higher teaching self-efficacy beliefs would be expected to possess developed epistemological beliefs.

Regarding the relations among belief about speed of learning and certainty of knowledge (quick learning + certain knowledge; QLCK) and GM foods teaching self-efficacy beliefs, it was found that beliefs in quick learning and certain knowledge were positively correlated to teaching self-efficacy beliefs about fostering argumentation and decision making on GM foods and teaching self-efficacy beliefs about general instructional strategies of GM foods teaching, but not significantly correlated to GM foods teaching outcome expectancy beliefs. These findings indicated that PSTs' having sophisticated beliefs in quick learning and certain knowledge possess higher SSI teaching self-efficacy beliefs regarding general instructional strategies of GM foods teaching, and outcome expectancy beliefs. More specifically, this finding revealed that the participants who believe that learning occurs gradually rather than being quick and knowledge is tentative rather than unchanging had higher teaching self-efficacy beliefs regarding general instructional strategies of GM foods teaching, and GM foods teaching outcome expectancy beliefs. Given that SSI learning and teaching cannot be accomplished instantaneously or within very short period of times (Zeidler, et al., 2011), it would be reasonable to reveal that sophisticated quick learning beliefs are positively correlated to believing efficacious to teach these issues. Moreover, the positive correlation between certainty of knowledge and SSI teaching self-efficacy beliefs may be explained by the nature of SSI. That is to say that SSI involves multiple viewpoints and is complex; therefore, even scientists may change their point of views as the new scientific knowledge emerges. Hence, it is expected that believing in the stability of knowledge (that is the belief that knowledge is unchanging) hinder feeling efficacious to teach SSI. In other words, it would be plausible to propose that believing in tentative nature of knowledge promotes PSTs' SSI teaching self-efficacy beliefs. These findings support the contention that preservice teachers who believe the certainty of knowledge less would more likely to tend to adopt student-centered teaching strategies, as revealed in Cheng et al.'s (2009) study. As suggested by Zeidler et al. (2011), a fully enacted SSI teaching aligns with transformative processes rather than traditional processes in science classes. According to them, one of the main features of transformative teaching approaches is student-centeredness. That is, successful transformative teaching occurs when the teacher-centered approach shifts to student-centered classroom and the science curriculum becomes issues-driven (Zeidler et al., 2011). Therefore, in line with Cheng et al.'s (2009) study in which preservice teachers' sophisticated beliefs in certainty of knowledge was positively and significantly correlated to their student-centered teaching conceptions, in the present study, we propose that increased certain knowledge beliefs are in positive correlation to teaching self-efficacy beliefs regarding SSI such as GM foods. Another study conducted by Bahcivan (2014), which did not specifically focus on SSI teaching self-efficacy beliefs but instead investigated the relationships among personal epistemological beliefs and science teaching self-efficacy beliefs, also indicated similar results. It was reported in Bahcivan's (2014) study that as PSTs' sophistication in certainy of scientific knowledge increases, their science teaching self-efficacy beliefs became stronger. More specifically, this study contended that believing in the idea that scientific knowledge is evolving but not stable was in positive correlation to believing more efficacious to teach science.

These suggestions about the relationship between quick learning and certain knowledge dimension of personal epistemological beliefs and GM foods teaching self-efficacy beliefs have also supported by the qualitative data in the present study. It was articulated by the PSTs that, teachers who believe that knowledge is not certain and learning takes time would have higher teaching self-efficacy beliefs to teach SSI. They pointed out that, given the ongoing inquiry nature of SSI, if a teacher believe that knowledge is certain, then s/he would not be successful to lead the SSI discussions and to teach SSI topics; hence feel efficacious to teach a topic involving multiple perspectives and subject to ongoing inquiry. Besides, according to PSTs, teachers with naive beliefs in quick learning would most probably feel inefficacious to teach SSI sue to the reason that SSI learning requires some time to occur.

Finally, it was observed that beliefs about simplicity of knowledge (simple knowledge; SK) was negatively related to GM foods teaching outcome expectancy beliefs, but not significantly correlated to fostering argumentation and decision making and general instructional strategies dimensions of GM foods teaching self-efficacy beliefs. This finding did not align with our hypothesis that we proposed at the beginning. According to the results, PSTs who had higher GM foods teaching outcome expectancy beliefs possessed less sophisticated beliefs in simple knowledge. That is, PSTs who believed in the simplicity of knowledge revealed to have higher GM foods teaching outcome expectancy beliefs. The negative relationship would be explained in two ways. First, as the descriptive findings revealed, PSTs in this study did not possess sophisticated epistemological beliefs in simple knowledge. Second explanation might be associated to how PSTs believe about the structure of knowledge. Our findings showed us that PSTs who believe their future students would do well in SSI learning (e.g. GM foods) tended to feel confident about influencing students' achievement only when that knowledge about the corresponding issue is simple knowledge. This finding support the contention proposed by Yilmaz-Tuzun and Topcu (2008). Yilmaz-Tuzun and Topcu (2008) revealed in their study that as PSTs had less sophisticated beliefs about certainty knowledge, their science teaching outcome expectancy beliefs would become higher. That is, as they mentioned, PSTs believe they feel insecure about their students' success (outcome expectancy) if they accept scientific knowledge as always continuously developing. In addition, they feel secured to use student-centered teaching practices and implementation only when students successfully memorize the isolated facts or body of scientific knowledge. In parallel to these ideas, we believe it would be probable that believing in the simplicity of knowledge, that is, knowledge is comprised of isolated bits and pieces might let PSTs feel more secure. In other words, believing that knowledge involved integrated concepts may lead to the thinking that teaching these integrated concepts may be challenging. This interpretation was also supported by the qualitative findings. Some of the PSTs articulated that a teacher who believe that knowledge is simple more likely to have higher teaching self-efficacy beliefs about controversial issues. Her explanations were in line with our interpretation that believing in the complex nature of knowledge may frighten and discourage teachers which cause decreased teaching self-efficacy beliefs.

5.1.2.2 GM foods teaching self-efficacy beliefs and GM foods knowledge

With regard to the relationships among GM foods knowledge and the dimensions of GM foods teaching self-efficacy beliefs (Fostering argumentation and decision making on GM foods, general instructional strategies of GM foods teaching, and GM foods teaching outcome expectancy beliefs), it was observed that PSTs' GM foods knowledge was significantly and positively correlated to teaching self-efficacy beliefs regarding fostering argumentation and decision making on GM foods and teaching self-efficacy beliefs about general instructional strategies of GM foods teaching, but not significantly correlated to GM foods teaching outcome expectancy beliefs. These findings indicated that PSTs who have higher knowledge about GM foods believe more competent to foster argumentation and decision making on GM foods and use general instructional strategies of GM foods. Qualitative findings also supported these assertations and helped to explain the revealed relationships. More specifically, according to PSTs, increased knowledge enables teachers to teach better, to lead SSI discussions more successfully, and to be more open to student questions, which in turn promote teacher confidence in SSI teaching. Research studies have also reported similar findings thus far. For instance, Kilinc et al. (2013), in their study examining the predictors of SSI teaching efficacy beliefs, reported that knowledge is one of the factors that positively affect PSTs' teaching efficacy beliefs regarding SSI. Both the quantitative path analysis and the qualitative analysis in their study revealed that as PSTs' knowledge about GM foods increased, their teaching efficacy beliefs in general also increased. In a similar way, Menon and Sadler (2016) argued in their study that increased science content understandings may contibute to PSTs' positive perceptions toward science teaching.

The present study reported significant correlations among content knowledge and the ARG and GIS, but not OE dimensions of teaching self-efficacy beliefs. One explanation to these findings might be made by examining the interview responses provided by PSTs. Some of the PSTs asserted that, increased content knowledge does not necessarily enable teachers to believe competent in reaching all students. More specifically, it was evident in some of the PSTs' interview responses that, although a PST possesses a high level of knowledge on GM foods, due to being inexperienced of real pedagogical practices, PSTs may lack the belief that students' GM food learning can be influenced by effective teaching. Supporting our finding, Swars and Dooley (2010), in their study investigating whether PSTs' personal science teaching efficacy beliefs and outcome expectancy beliefs change during a science methods course, reported that at the end of the professional development method course, the participants' personal science teaching efficacy beliefs have increased; however, there were no change in their outcome expectancy beliefs. The examination of open-ended questionnaires in their study revealed that the PSTs who had less developed personal science teaching efficacy beliefs linked this belief to their lower levels of content knowledge. Given that increased teaching self-efficacy beliefs promotes effective science teaching and student achievement in science, we propose in this paper that increasing PSTs' and inservice teachers' content knowledge can be used as an effective way to improve their teaching self-efficacy beliefs regarding the dimensions fostering argumentation and decision making, general instructional strategies, and outcome expectancy beliefs.

5.1.2.3 GM foods teaching self-efficacy beliefs and GM foods risk and benefit perceptions

The final variable that was hypothesized to be in direct relation to GM foods teaching self-efficacy beliefs was GM foods risk and benefit perceptions. It was aimed to test the relationships among GM foods risk perception and each of the GM foods teaching self-efficacy beliefs dimensions. Similarly, the relationships among GM foods benefit perceptions and GM foods teaching self-efficacy beliefs dimensions were also tried to reveal out by analysing the path model. Analysis showed that PSTs' GM foods risk perception was significantly and positively correlated to their teaching self-efficacy beliefs regarding fostering argumentation and decision making on GM foods and GM foods teaching outcome expectancy beliefs. These findings indicated that PSTs who perceive the issue of GM foods riskier tended to believe more efficacious regarding fostering argumentation and decision making on GM foods and have higher GM foods teaching outcome expectancy beliefs. On the other hand, there were no any significant correlation between PSTs' GM foods benefit perceptions and GM foods teaching self-efficacy beliefs revealed in the quantitative analyses. Supporting these findings, in the qualitative analysis, PSTs' responses indicated that as a teacher's risk perception becomes stronger, s/he would believe more efficacious to teach SSI topics. According to the participating PSTs, the assertation that was behind this idea was that, perceiving an issue as risky alert people more comparing to perceiving it as beneficial. That is, risk perception evokes the idea of getting into action in order to raise students' awareness and develop the skills of informed decision making regarding the controversial issue. To this end, according to PSTs, these teachers are more tend to insist on teaching the risky SSI, put more effort on teaching it well and feel more efficacious. This assertation were also in parallel to the study conducted by Cross and Price (1996). Cross and Price (1996) reported that teachers have the desire to teach controversial issues to promote social justice and raise students with the capability of informed decision making. Therefore, it can be considered that teachers with higher risk perceptions about an issue may possess stronger beliefs to teach this issue due to having such a desire to shape next generations.

Another reason asserted by the PSTs was that, it is more likely and easier to find evidences in the media to support the risky aspects of GM foods. They also argued that media tends to reflect the negative sides of the controversial issues comparing to beneficial aspects. According to PSTs, this would also make teachers to believe more efficacious to teach these controversial issues in science classes.

On the other hand, analysis of interview data revealed some interesting findings that are unlike to the quantitative results. For instance, considering the relationships among GM foods benefit perception and teaching self-efficacy beliefs, PSTs articulated that higher benefit perceptions may lead to higher SSI teaching self-efficacy beliefs. According to these participants, if a teacher thinks that a topic possesses risky aspects, this teacher may avoid teaching it and be eager to spend less time on this issue in order not to confuse students' minds. In a similar vein, it was proposed by the PSTs that, since majority of the society believes GM foods are risky, science teachers may aim to deconstruct this idea; therefore, focus on the beneficial aspects of GM foods in the classroom more. Such a teacher may also aim to let students to see both sides of an issue and give them chance to make a more informed decision.

5.1.2.4 Relationships among the three variables: Personal epistemological beliefs, GM foods risk and benefit perceptions, and GM foods knowledge

Along with revealing the relationships among GM foods teaching self-efficacy beliefs and each of the variables in the path model, the quantitative data in the present study also shed light on the relationships among the variables personal epistemological beliefs, GM foods risk and benefit perceptions, and GM foods knowledge. Path analyses demonstrated significant paths among varying dimensions of these variables.

Considering the relationships among the dimensions of personal epistemological beliefs, and risk and benefit perceptions, it was revealed that there was a significant and negative relationship between GM foods benefit perception and beliefs in quick learning and certain knowledge. On the other hand, GM foods risk perception was found to be related significantly and positively to PSTs' beliefs in quick learning and certain knowledge. Moreover, GM foods risk perception was significantly and positively related to beliefs in simple knowledge. The findings revealed that as the PSTs' beliefs in quick learning and certain knowledge become more sophisticated, they tend to have lower GM foods benefit perceptions but higher risk perceptions. Besides, it can be interpreted that PSTs possessing naïve epistemological beliefs in simple knowledge tended to have higher GM foods risk perceptions.

One explanation for the positive relationship between quick learning and certain knowledge dimension of personal epistemological beliefs and GM foods risk perception, and negative relationship between quick learning and certain knowledge and GM foods benefit perception might be that as individuals have sophisticated beliefs about certainty of knowledge and speed of learning, they might approach the controversial issues from multiple aspects. That is, these individuals are less likely to accept the issue or interpret the issue as beneficial because they tend to consider all the sides including the potential harms. Besides, individuals with sophisticated beliefs about certainty of knowledge are more likely to recognize the uncertain nature of any controversial issue and interpret the risky sides of it. Therefore, it would be more probable that individuals who believe that knowledge is not certain but changing and learning occur in time perceive the risks that might occur as a result of eating GM foods comparing to individuals who have naive epistemological beliefs in certain knowledge and quick learning. Accordingly, these individuals are expected to be more cautious to accept the controversial issues as beneficial. This interpretation is in parallel to what Schommer (1994) and Schommer-Aikins and Hutter (2002) asserted. According to them, epistemological beliefs are related to individuals' ability to cope with and the ways they interpret ill-structured problems. Schommer (1994) proposed that, since ill-structured problems involve more than one answer or route to be solved, individuals need to have the ability to integrate information to cope with it. This, as she asserted, can be accomplished with higher levels of epistemological beliefs.

Unlike to the positive relationship between beliefs about quick learning and certain knowledge and GM foods risk perception, the data revealed that PSTs' beliefs in simple knowledge was negatively related to their GM foods risk perception. This finding indicated that as the participants consider knowledge as isolated bits rather than interdisciplinary, they would tend to perceive the issue of GM foods as riskier. In other words, as PSTs' possess more sophisticated epistemological beliefs in simple knowledge, that is, believing in the interdisciplinary nature of knowledge, their risk perception declines; therefore, they would perceive GM foods as less risky. One reason for this negative relationship might be that, given the uncertain and ill-structured nature of controversial issues, believing knowledge possesses an interdisciplinarity nature instead of comprising of isolated bits leads to individuals understand the nature of these issues (e.g. GM foods) in a better way. More specifically, this might help understanding the complex and uncertain aspects of SSI (e.g. GM foods) by the individuals. That is, understanding the connections among the disciplines corresponding to GM foods might help individuals to be convinced about the risky sides of the issue. Therefore, the participants having more sophisticated simple knowledge beliefs were more likely to have lower levels of risk perceptions regarding the issue of GM foods.

With regard to the relationships among GM foods knowledge, and risk and benefit perceptions, data analyses showed that GM foods benefit perception was significantly and positively correlated to GM foods knowledge. However, GM foods risk perception was found to be significantly and negatively correlated to GM foods knowledge. These findings indicated that as GM foods knowledge increases, PSTs tend to perceive the issue of GM foods as more beneficial, rather than riskier. Moreover, it can be concluded that the risks of GM foods are less worrying for the individuals in the presence of scientific knowledge.

One interpretation of these findings might be that, the participants in this study perceive the issue of GM foods as risky rather than beneficial and it is very likely that media has an influence on the existence of negative profile. The negative influence of media is caused by the presence of the risky aspects of controversial issues. In a result, individuals have a negative understanding about these controversial issues in their minds. However, increased knowledge might lead individuals to both understand and investigate different aspects of these issues which, in turn, let them to recognize the beneficial aspects as well. Therefore, increased knowledge abolishes the prejudgments about GM foods existed in individuals' minds and increases benefit perceptions (also decreases risk perception) regarding GM foods. In a similar vein, Sjöberg (2008) reported that as the individuals' GM food knowledge increases, their risk perception decreases. Moreover, studies in the related literature revealed that individuals' attitudes toward GM foods develop positively as their GM food knowledge increases (Chen & Li, 2007; Mielby, Sandøe, & Lassen, 2013; Verdurme & Viane, 2003).

Finally, path analyses yielded significant and positive relationship among the PSTs' beliefs in quick learning and certain knowledge and GM foods knowledge. This finding indicated that PSTs who had more sophisticated epistemological beliefs in quick learning and certain knowledge tended to possess higher GM foods knowledge. This finding can be interpreted in two ways. Firstly, as it was showned in research studies (e.g. May & Etkina, 2002; Schommer, 1990; Schommer, Crouse, Rhodes, 1992; Qian & Alvermann, 2000), epistemological beliefs affect individuals' conceptual understanding and evaluation of their own learning in a way that as epistemological beliefs become sophisticated, individuals' conceptual understanding and the ability to integrate their understanding of science concepts develop. Therefore, sophisticated beliefs in quick learning and certain knowledge might help participating PSTs to develop more robust understanding about GM foods in their undergraduate courses. Secondly, increased epistemological beliefs might affect their interpretation of controversial issues. That is, PSTs with more sophisticated beliefs in quick learning and certain knowledge were more likely to interpret GM foods news presented in media or other information sources more cautiously and consciously and not to accept misinformation without questioning. That might be the reason why they responded more correct answers to the questions in knowledge scale. Supporting this assertion, Mason and Boscolo (2004) reported that individuals' epistemological beliefs influence their interpretation of controversial issues (such as the need for further scientific investigation). Similarly, according to Kardash and Scholes (1996) sophisticated epistemological beliefs are related to individuals' interpretation of controversial issues such as how much extreme their initial beliefs about a controversial topic. More specifically, they asserted that, the less individuals believe in certain knowledge, the less extreme their initial beliefs about the issue of HIV/AIDS.

5.2 Implications for Educational Policy and Practice

The findings presented in this study have important implications for both research on SSI teaching and teacher education programs which need to develop strong SSI teaching self-efficacy beliefs and to aim equipping future teachers with the ability to teach SSI effectively in science classrooms. From the research perspective, the first implication was the instruments developed to measure PSTs' SSI teaching self-efficacy beliefs in the context of GM foods and the influencing factors; GM foods knowledge and GM foods risk and benefit perceptions. As aforementioned several times, teaching self-efficacy beliefs have been considered as one of the most influential factors that affect teaching. Thereby, there was a need for a valid and reliable instrument to measure teaching self-efficacy beliefs in SSI context both quantitatively and qualitatively. The developed quantitative instrument and the interview protocol can be used in research studies which aim to determine the level and structure of SSI teaching self-efficacy beliefs of science teachers, especially in SSI-based implementation studies. Furthermore, this study developed and presented two valid and reliable instruments to measure knowledge and risk-benefit perceptions regarding GM foods. In parallel to the related literature, increased knowledge and risk perception were found to have positive relationships with teaching self-efficacy beliefs. However, benefit perception was failed to have reported to be correlated to teaching self-efficacy beliefs. Further studies investigating the correlation among SSI teaching self-efficacy beliefs and those three constructs (knowledge, risk perception, and benefit perception) may utilize the instruments developed in the present study. Moreover, the research design utilized which mainly involved using interview data to further explain the found path correlations in the proposed structured model may be an example for the researchers in the field of SSI research.

Regarding the contributions to the related literature, the present study shed light on the existing profile regarding PSTs' SSI teaching self efficacy beliefs. The results revealed several important issues that PSTs face while teaching SSI. One important conclusion was that although PSTs describe themselves as efficacious to teach SSI, their responses to the interview questions revealed many misunderstandings regarding nature of SSI, SSI teaching, and more broadly, nature of science. Besides, the findings gave some clues about teacher candidates' beliefs on the place of SSI within science education. For example, some of the PSTs articulated that SSI cannot be used to teach the big ideas in science; instead, they may be used to attract student attention prior to transmitting scientific knowledge to the students. These findings obviously implied that there is a need for teacher education programs which has a broader emphasis on SSI and SSI teaching. Given that SSI teaching provide many opportunities for students such as learning nature of science, increased motivation and interest toward science, becoming familiar to argumentation processes, and informed decision making regarding societal issues, future science teachers should complete their undergraduate education with the qualifications to teach SSI effectively. To this end, teacher education programs may offer courses aiming to teach the nature of SSI, the instructional strategies that can be used for SSI teaching, and the reasons why SSI teaching need to take place in science classrooms. Besides, science teacher candidates can be given the opportunity to take practice-based courses in which they prepare and perform SSI related lesson plans. Once teacher candidates actively started to teach in the field, it is vital that, they continuously be supported by inservice teacher training programs. For instance, through these programs, science teachers may be provided with different SSI based lesson plans or activities that they can implement in their own science classes. Moreover, teachers may be encouraged to participate to different working groups in which they can design their own SSI related activities collaboratively.

One another important point was that, although the issue of GM foods is one of the hot topics in Turkey nowadays, PSTs' knowledge about GM foods was found to be average. As it is frequently noted in the literature, teachers cannot teach something they do not know (Zohar, 2006). Therefore, both PSTs and inservice science teachers should be fostered to learn the science behind these daily life controversial issues. For instance, undergraduate courses or inservice training programs may select a certain number of issues which are more locally relevant or more recently debated in the media and try to improve teacher candidates' scientific knowledge accordingly.

This research was also helpful to understand the influential factors of SSI teaching self-efficacy beliefs and the interrelations among these influential factors. Revealing the relationships among SSI teaching self-efficacy beliefs and the interrelationships among knowledge, personal epistemological beliefs, and risk-benefit perceptions may have some implications to both elementary science education and science teacher education programs in Turkey. In this context, with regard to its research questions and sample, the present study certainly has a unique importance for science education and science teacher education.

In Turkey, SSI has incorporated into elementary science program very recently. With the revisions that were made in 2013, SSI has been stated as one of the major themes that the science program was built on. According to these recent changes, elementary science program was based four main themes; scientific knowledge, science process skills and life skills, attitudinal skills, and the skills associated with science-technology-society-environment. Under the science-technology-society-environment theme, SSI learning has been stated as one of the goals along with nature of science, science and technology relationships, contribution of science to the society, sustainability awareness, and science and career awareness. Despite these recent changes in elementary science program, the attempts to revise science teacher education programs are very limited. In line with the contention in the related literature, we believe that successful implementation of reform efforts can only be accomplished if both preservice and inservice teacher education programs are prepared accordingly. Therefore, to us, it would be beneficial if science teacher education programs offer undergraduate courses related to nature of SSI and SSI teaching. At that point, the influential factors that were revealed in the present study could be taken as a starting point. That is, while aiming to improve SSI teaching self-efficacy beliefs, their knowledge regarding a certain SSI, risk and benefit perceptions of SSI, and personal epistemological beliefs may also aim to be developed. For example, an SSI course aiming to improve SSI teaching self-efficacy beliefs in the context of nuclear energy usage would also better to aim improving PSTs' nuclear energy knowledge, enlarging their risk and benefit perceptions of nuclear energy usage and increasing their beliefs in how knowledge is obtained and gathered by the learners. Similarly, inservice training programs that aiming to improve SSI teaching self-efficacy beliefs may be designed considering the influential factors of SSI knowledge, SSI risk and benefit perceptions, and personal epistemological beliefs.

Another way of strengthening SSI teaching self-efficacy beliefs may be enriching the already existing courses offered to PSTs. For example, science teaching methods courses may incorporate teaching strategies used for SSI teachings. More specificially, PSTs should be taught about teaching through argumentation. In addition, they should be given the opportunity to practice SSI teaching in their micro-teaching applications in the faculties and mentoring schools. Moreover, elective and must courses related to science-technology-society relationship may also be redesigned so that they raise SSI awareness and develop teacher candidates' attitudes toward local and global controversial issues.

5.3 Recommendations for Further Research

First of all, participant selection in the quantitative part of this study was based on convenience sampling. Therefore, generalizability of the findings was limited. Further research might be conducted by using one of random sampling strategies so that the findings regarding SSI teaching self-efficacy beliefs and the related factors would be more generalizable. In addition, the PSTs who responded to the instruments were all from one certain region in Turkey; therefore, living in similar context and from the same age group. Future studies that are performed with individuals from different age groups and living in different regions in Turkey might reveal different findings.

Moreover, in the qualitative part of the present study, we determined a criterion and selected the participants who have taken one of the elective courses offered in a university. This course aimed to raise PSTs' awareness and knowledge regarding SSI and provide them with the opportunity to design and present a SSI course. Therefore, the participants were quite knowledgeable about SSI and the processes required in a SSI course. We recommend further studies presenting interview data obtained from future teachers who have not taken any SSI course beforehand. This would also let researchers make comparison.

The present study provided important insights about the relationships among SSI teaching self-efficacy beliefs and the three variables of knowledge, risk-benefit perceptions, and personal epistemological beliefs through path analyses. Also, the interrelationships among the three variables knowledge, risk-benefit perceptions, and personal epistemological beliefs were explored. Despite the fact that relationship studies make crucial contributions to the related literature, percentages of the variances explained in SSI teaching self-efficacy beliefs could not reach to large effect sizes. This would imply the presence of some other variables in correlated to SSI teaching self-efficacy beliefs. Therefore, investigation of other potential variables in relation to SSI teaching self-efficacy beliefs such as pedagogical knowledge, pedagogical content knowledge, personal beliefs about the philosophy of teaching, and attitudes toward science teaching would be valuable for SSI literature.

In this study, the major aim was to examine PSTs' SSI teaching self efficacy beliefs and the influential factors both qualitatively and quantitatively and important findings were gathered in accordance with this aim. However, the findings presented in the present study were based on the participants' self-reported responses. In order to extend out insights about PSTs' SSI teaching self-efficacy beliefs, real classroom observations in mentoring schools and or micro-teaching performances in the courses offered in faculties might be suggested. Moreover, in order to make claims about whether changes in PSTs' personal epistemological beliefs, knowledge, and risk-benefit perceptions affect their SSI teaching self-efficacy beliefs, researchers are encouraged to utilize intervention studies. These research may further analyze in what ways SSI teaching self-efficacy beliefs may be improved; therefore, contribute greatly to the SSI teaching literature.

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APPENDICES

APPENDIX A

DEMOGRAPHICS QUESTIONNAIRE

Sevgili katılımcı,

Bu çalışmada, tez danışmanım Prof. Dr. Özgül Yılmaz Tüzün ile birlikte fen bilgisi öğretmen adaylarının sosyobilimsel bir konu olan GDO'lu gıdalar konusunun öğretimine yönelik inançlarını ve ilişkili faktörleri incelemeyi amaçlıyoruz. Çalışmaya katılım gönüllü olduğundan çalışmaya katılmamanız veya herhangi bir sebepten ötürü katılmaktan vazgeçmeniz durumunda olumsuz herhangi bir sonuçla karşılaşmanız muhtemel değildir. Çalışma sırasında elde edilen bütün bilgiler gizli tutulacaktır ve bu bilgiler sadece akademik araştırma amaçlı kullanılacaktır.

Teşekkür ederim

Nilay ÖZTÜRK

Kişisel Bilgiler

1. Cinsiyetiniz: ☐ Erkek ☐ Kadın

2. Şu anda kaçıncı sınıftasınız? ☐ 3. Sınıf ☐ 4. Sınıf

3. Genel not ortalamanız: ....

4. Anne ve babanızın eğitim seviyesi hangi düzeydedir?

Anneniz	Babanız
☐ Okuma yazma bilmiyor	☐ Okuma yazma bilmiyor
☐ İlkokul mezunu	☐ İlkokul mezunu
☐ Ortaokul mezunu	☐ Ortaokul mezunu
☐ Lise mezunu	☐ Lise mezunu
☐ Üniversite mezunu	☐ Üniversite mezunu
☐ Yüksek lisans	☐ Yüksek lisans
☐ Doktora	☐ Doktora

5. Çocukluğunuzun (18 yaşına kadar) geçtiği bölgeyi nasıl tanımlarsınız?

 Köy / Kasaba

 İlçe

 Şehir merkezi

 Büyük şehir

6. Şu ana kadar üniversitede aldığınız çevre ile ilgili dersler nelerdir?

………

7. GDO (Genetiği değiştirilmiş organizma) ile ilgili sivil toplum kuruluşlarında veya derneklerde yer aldım / alıyorum.

 Evet Hayır

8. GDO ile ilgili bilgiye ulaşırken aşağıdaki araçlardan hangilerini kullanırsınız? (Birden fazla işaretleyebilirsiniz)

 İnternet Radyo ve Televizyon programları

 Dergi, gazete Çevreyle ilgili sivil toplum örgütlerinin çalışmaları

 Sosyal çevre, arkadaşlar

9. Üniversitede aldığınız derslerde GDO konusuna yer veriliyor mu?

 Evet, yer veriliyor Hayır, yer verilmiyor

<u>**9. soruya verdiğiniz yanıt "Hayır, yer verilmiyor" ise 11. Soruya geçiniz.**</u>

10. Aşağıdaki soruyu, verilen ölçekte size uygun seçeneğe "X" işareti koyarak yanıtlayınız.

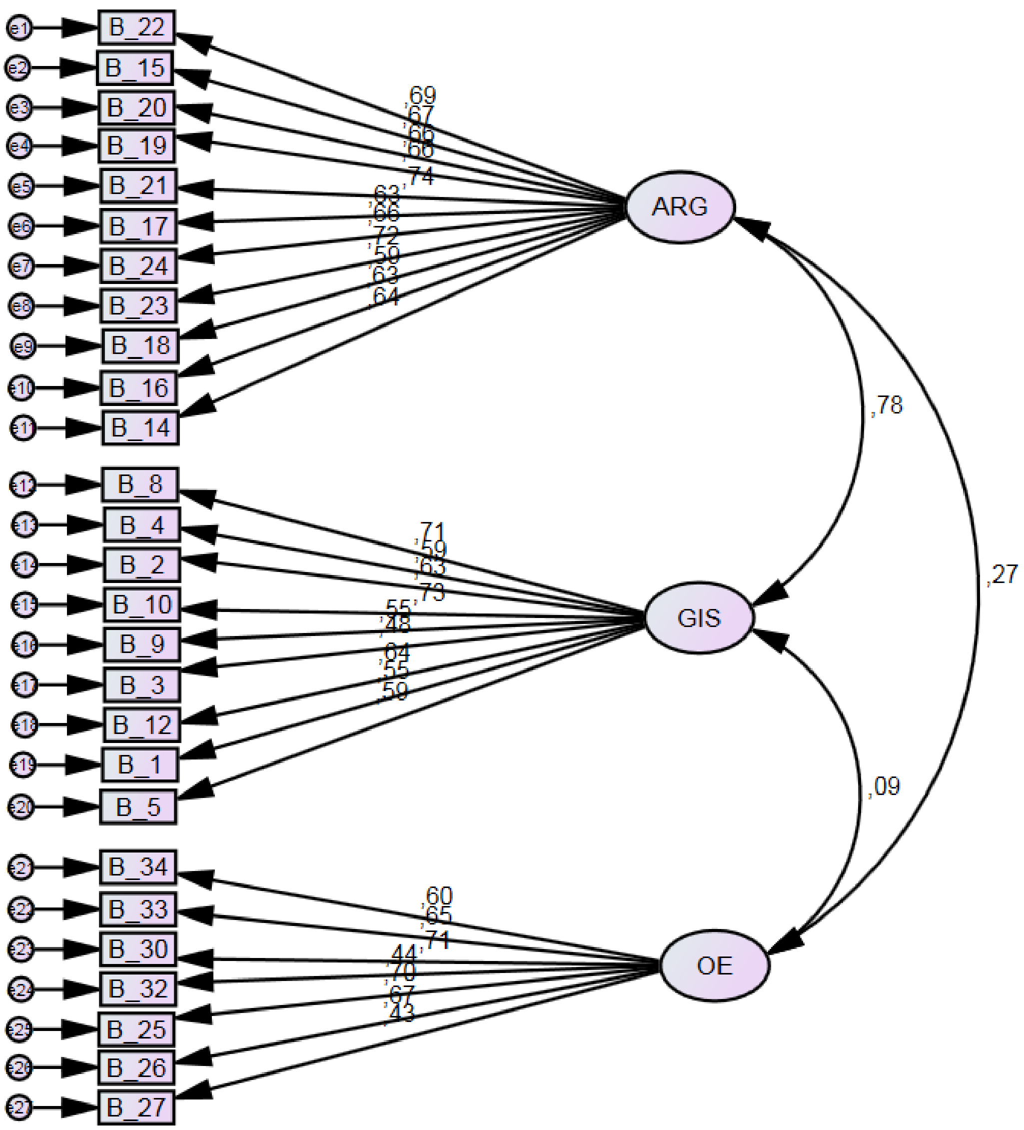
Üniversitede aldığınız derslerde;	Nadiren	Bazen	Sık	Oldukça	Çok sık
a. GDO'lu gıdalar konusuna ne kadar sık yer veriliyor?					
b. GDO'lu gıdalar konusuna yer verilirken tartışmalı bir ortam ne kadar sık oluşturuluyor?					
c. GDO'lu gıdalar konusuna yer verilirken verilerle tartışma ortamı ne kadar sık oluşturuluyor?					
d. GDO'lu gıdalar konusuna yer verilirken karşıt görüşlere ne kadar sık yer veriliyor?					
e. GDO'lu gıdalar konusuna yer verilirken öğrencilerin karşıt görüşleri çürütebilmesi için gerekli olan tartışma ortamı ne kadar sık oluşturuluyor?					

11. Aşağıdaki soruları, verilen ölçekte size uygun seçeneğe "X" işareti koyarak yanıtlayınız.

	Hiç endişelendirmez	Biraz endişelendirir	Kararsızım	Endişelendirir	Çok
a. GDO'lu gıdaların Türkiye'de serbest olması sizi ne kadar endişelendirir?					
b. GDO'lu gıdaların Türkiye dışındaki ülkelerde serbest olması sizi ne kadar endişelendirir?					

APPENDIX B

CFA MODEL OF THE GM FOODS TEACHING SELF-EFFICACY BELIEFS INSTRUMENT



APPENDIX C

GM FOODS TEACHING SELF-EFFICACY BELIEFS INSTRUMENT

Aşağıda tartışmalı bir konu olan GDO'lu gıdalar konusunun öğretimine yönelik düşünceler göreceksiniz. Belirtilen ifadelere katılım durumunuzu gösteren seçeneklerden birini işaretleyiniz. **Tartışmalı bir konu olan GDO'lu gıdalar ile ilgili olarak;**		**Kesinlikle Katılmıyorum**	**Katılmıyorum**	**Kararsızım**	**Katılıyorum**	**Kesinlikle Katılıyorum**
1.	GDO'lu gıdalar konusunun öğretilmesinde farklı öğretim tekniklerini başarılı bir şekilde kullanabilirim.					
2.	Ne kadar çok çaba harcasam da GDO'lu gıdalar konusunu öğretirken yeterince etkili olamayacağım.					
3.	GDO'lu gıdalar konusunu etkili bir şekilde öğretebilmek için gerekli basamakları biliyorum.					
4.	GDO'lu gıdalar konusunu genellikle etkili bir şekilde öğretemeyeceğim.					
5.	Etkili bir şekilde öğretecek kadar GDO'lu gıdalar konusundan iyi anlıyorum.					
6.	GDO'lu gıdalar ile ilgili yapılmış olan bilimsel deneyleri etkili bir şekilde açıklayabilirim.					
7.	Öğrencilerin GDO'lu gıdalar ile ilgili sorularını genellikle cevaplarım.					
8.	GDO'lu gıdalar konusunu öğretmek için gerekli becerilere sahip olacağımdan endişeliyim.					

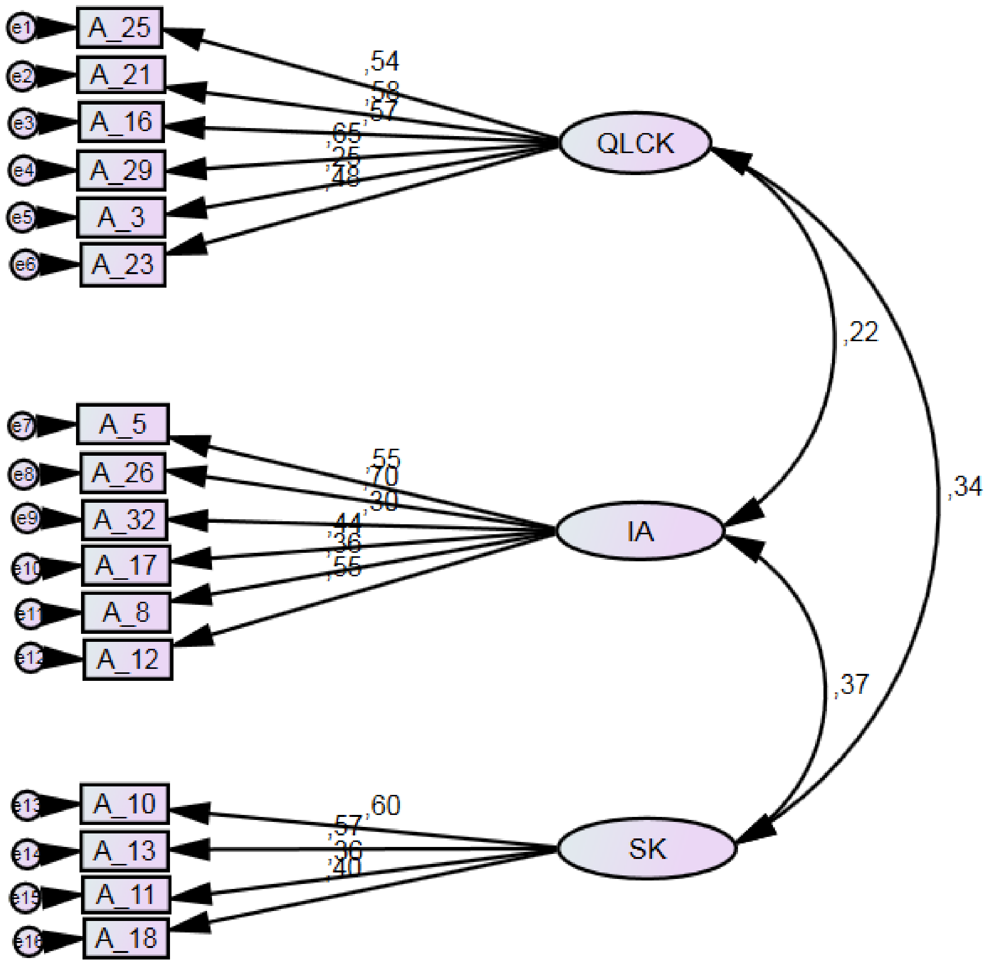
9.	Eğer seçim hakkı verilseydi, okul müdürünü veya müfettişleri beni değerlendirmesi için GDO'lu gıdalar konusunu işlediğim bir dersime çağırmazdım.					
10.	GDO'lu gıdalar konusunu anlamakta zorlanan öğrencilerime nasıl yardımcı olacağımı bilemem.					
11.	GDO'lu gıdalar konusunu öğretirken öğrencilerden gelecek soruları her zaman hoş karşılarım.					
12.	Öğrencilere GDO'lu gıdalar konusunu sevdirmek için ne yapmam gerektiğini bilmiyorum.					
13.	GDO'lu gıdalar konusunda bir ders hazırlamak için gerekli olan öğrenme kazanımlarını belirleyebilirim.					
14.	GDO'lu gıdalar konusundaki kavram ve tartışmaları öğrencilerin seviyesine uygun bir şekilde hazırlayabilirim.					
15.	GDO'lu gıdalar konusundaki tartışmalar sırasında konuya ilgisiz olan öğrencileri tartışmaya katmak için onları motive edebilirim.					
16.	GDO'lu gıdalar konusunda etkili karar verme becerilerini kırsal bölgelerdeki okullarda öğretebilirim.					
17	GDO'lu gıdalar ile ilgili karar verme süreçlerinin öğretiminde aileleri etkili bir şekilde sürece dahil edebilirim.					
18.	Öğrencilerin GDO'lu gıdalar konusunun anlaşılmasında değer ve inançların etkili olduğunu anlamalarını sağlayabilirim.					
19.	Öğrencilerin GDO'lu gıdalar ile ilgili olarak medyada yer alan farklı görüşlerin gerekçelerini anlamalarını sağlayabilirim.					
20.	GDO'lu gıdalar konusundaki tartışmalar sırasında farklı iddiaların ortaya atılabileceği bir tartışma ortamı oluşturabilirim.					
21.	Öğrencilerin, GDO'lu gıdalar konusundaki tartışmalar sırasında ileri sürdükleri iddialarını kanıtlarla gerekçelendirme becerilerini geliştirebilirim.					

22.	Öğrencilerin, GDO'lu gıdalar konusundaki tartışmalar sırasında karşı iddiaları çürütme becerilerini geliştirebilirim.					
23.	Sınıfımda, GDO'lu gıdalar konusunda yapılan tartışmaları yönetebilirim.					
24.	GDO'lu gıdalar ile ilgili tartışmalar sırasında "bilimsel veriler" ile "kişisel düşünceler" arasında farklar bulunabileceğini öğrencilere öğretebilirim.					
25.	Eğer bir öğrenci GDO'lu gıdalar konusunda her zamankinden daha fazla bilgi ve görüş sahibi ise, bunun nedeni çoğunlukla öğretmenin daha fazla çaba harcamasıdır.					
26.	Öğrencilerin GDO'lu gıdalar konusunda her zamankinden daha fazla bilgi ve görüş sahibi olması, genellikle öğretmenin daha etkili öğretim yöntemleri kullanmasının sonucudur.					
27.	Öğrencilerin GDO'lu gıdalar konusunda bilgi ve görüş sahibi **olmamalarının** nedeni büyük bir olasılıkla bu konunun etkili bir şekilde öğretilmemesidir.					
28.	İyi bir öğretimle, öğrencilerin GDO'lu gıdalar konusundaki bilgi yetersizliklerinin üstesinden gelinebilir.					
29.	Öğrencilerin GDO'lu gıdalar konusu ile ilgili bilgi ve görüş sahibi **olmamasından** öğretmen sorumlu tutulamaz.					
30.	Öğrencilerin GDO'lu gıdalar konusunda her zamankinden daha fazla bilgi ve görüş sahibi olması, genellikle öğretmenin onlara daha fazla ilgi göstermesinin sonucudur.					
31.	GDO'lu gıdalar konusunu öğretirken öğretmenin daha fazla çaba harcaması, bazı öğrencilerin bu konu hakkında bilgi ve görüş sahibi olmasını çok az oranda değiştirir.					
32.	Öğrencilerin GDO'lu gıdalar konusunda bilgi ve görüş sahibi olmasından genellikle öğretmen sorumludur.					

33.	Öğrencinin GDO'lu gıdalar konusu ile ilgili bilgi ve görüş sahibi olması, öğretmenin bu konuyu etkili bir şekilde öğretmesiyle doğrudan ilgilidir.					
34.	Bir veli, çocuğunun GDO'lu gıdalar konusuna daha fazla ilgi duyduğunu belirtiyorsa, bunun nedeni büyük olasılıkla öğretmenin dersteki performansıdır.					

APPENDIX D

CFA MODEL OF THE EPISTEMIC BELIEFS INVENTORY



APPENDIX E

EPISTEMIC BELIEFS INVENTORY

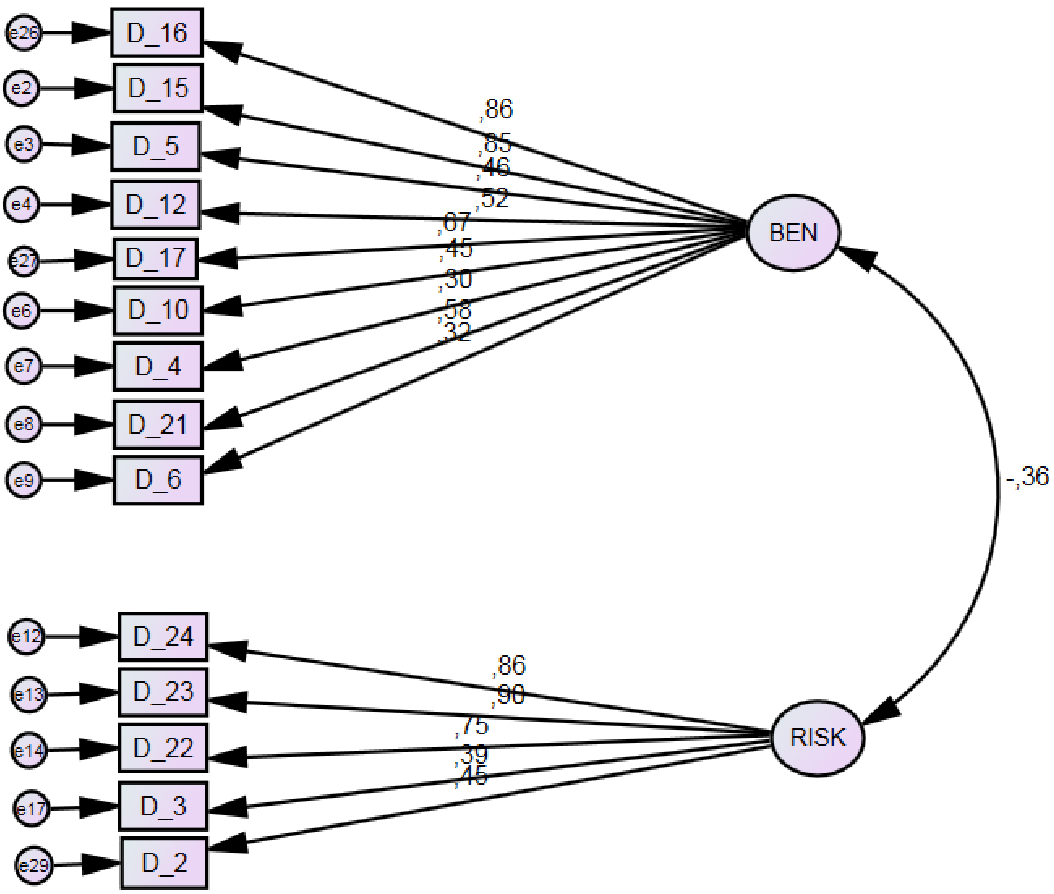
	Lütfen aşağıda verilen her bir ifadeye katılım durumunuzu gösteren seçeneklerden birini işaretleyiniz.	**Kesinlikle Katılmıyorum**	**Katılmıyorum**	**Kararsızım**	**Katılıyorum**	**Kesinlikle Katılıyorum**
1.	Öğretmenlerin öğrencilere karmaşık problemlerin cevaplarını söylememeleri beni rahatsız eder.					
2.	Doğru, farklı kişiler için faklı şeyler ifade eder.					
3.	Hızlı öğrenen öğrenciler, en başarılı olanlardır.					
4.	İnsanlar her zaman yasalara uymalıdır.					
5.	Bazı insanlar ne kadar çok çalışırlarsa çalışsınlar asla zeki olamazlar.					
6.	Kesin ahlaki doğrular yoktur.					
7.	Ebeveynler çocuklarına, hayata dair bilmeleri gereken her şeyi öğretmelidirler.					
8.	Gerçekten zeki olan öğrencilerin okulda başarılı olmaları için diğerleri kadar çok çalışmasına gerek yoktur.					
9.	Bir kişi bir problemi anlamak için çok fazla uğraşırsa, sonunda kafası büyük bir olasılıkla karışacaktır.					
10.	Çok fazla kuram/teori, işleri yalnızca karmaşık hale getirir.					
11.	En iyi fikirler, genellikle en basit olanlardır.					

12.	İnsanlar ne kadar zeki oldukları konusunda çok fazla bir şey yapamazlar.					
13.	Öğretmenler kuramlar/teoriler yerine gerçeklere odaklanmalıdır.					
14.	Ben öğretmenlerin farklı kuramları aynı anda verip, en iyi olanına öğrencilerinin karar vermesine olanak sağlayanını severim.					
15.	Okulda ne kadar başarılı olduğunuz ne kadar zeki olduğunuza bağlıdır.					
16.	Eğer bir şeyi çabucak öğrenemiyorsanız, hiçbir zaman öğrenemezsiniz.					
17	Bazı insanlar doğuştan öğrenme becerisine sahip iken bazıları değildir.					
18.	Öğrenilmesi gereken şeyler, çoğu üniversite hocasının sizi inandırdığından daha basittir.					
19.	İki kişi bir şey üzerinde tartışıyorsa, en az birisi yanılıyordur.					
20.	Çocukların ebeveynlerinin otoritesini sorgulamalarına izin verilmelidir.					
21.	Bir metni ilk okumada anlamadıysanız, başa dönüp tekrar okumanın bir yararı olmayacaktır.					
22.	Birçok gerçeği içerdiği için bilimi anlamak kolaydır.					
23.	Benim için geçerli olan ahlaki kurallar herkes için geçerlidir.					
24.	Bir konu hakkında ne kadar çok şey bilirseniz, o konu ile ilgili bilinmesi gereken o kadar çok şey vardır.					
25.	Bugün için doğru olan yarın için de doğru olacaktır.					
26.	Zeki insanlar doğuştan zekidir.					
27.	Otorite konumundaki bir kişi bana ne yapacağımı söylediği zaman genellikle onu yaparım.					
28.	Otoriteyi sorgulayanlar sorun çıkaran insanlardır.					
29.	Kısa sürede çözülemeyen bir problemle uğraşmak zaman kaybıdır.					

30.	Bir şey üzerinde yıllarca çalışıp, onu yine de tam olarak anlayamayabilirsiniz.					
31.	Bazen hayatın büyük problemleri için doğru cevaplar yoktur.					
32.	Bazı insanlar özel yetenek ve becerilerle doğar.					

APPENDIX F

CFA MODEL OF THE GM FOODS RISK-BENEFIT PERCEPTIONS SCALE



APPENDIX G

GM FOODS RISK-BENEFIT PERCEPTIONS SCALE

Aşağıda, GDO'lu gıdaların olası risk ve faydaları verilmiştir. GDO kullanımının sonucu olarak, aşağıdaki risk ve fayda ifadelerine katılım durumunuzu verilen ölçekte işaretleyiniz.		Kesinlikle Katılmıyorum	Katılmıyorum	Kararsızım	Katılıyorum	Kesinlikle Katılıyorum
1.	GDO'lu gıdalar insanlarda alerjiye sebep olabilir.					
2.	GDO'lu gıdalar insan sağlığı için tehdittir.					
3.	Gıda üretiminde gen teknolojisi kullanmak çevresel felaketlere yol açacaktır.					
4.	GDO'lu gıdalar dünyada var olan yetersiz beslenme ve açlığa çare olacaktır.					
5.	Gıda üretiminde gen teknolojisi kullanmak vitamin oranını artırmaya imkan sağladığından besin değerini artırır.					
6.	Gıda üretiminde gen teknolojisi kullanmak gıdaların lezzetini artırır.					
7.	Gen teknolojisi kullanmak, gıda üretimini GDO'lu tohum üreten birkaç firmanın tekeline bırakacaktır.					
8.	Gıda üretiminde gen teknolojisi kullanmak, ülkeleri GDO'lu tohum üreten birkaç firmaya bağlı hale getirecektir.					
9.	Gen teknolojisi kullanımının uzun vadede insan sağlığı üzerindeki etkileri konusunda yeterli bilgiye sahip değiliz.					

10.	Gıda üretiminde gen teknolojisi kullanmak çevre problemlerini çözmeye yardımcı olabilir.					
11.	Gıda üretiminde gen teknolojisi kullanmak gıda fiyatlarını düşürecektir.					
12.	Gıda üretiminde gen teknolojisi kullanmak gereklidir.					
13.	GDO'lu gıdaların çevre üzerinde geri döndürülmesi zor olumsuz etkileri olacaktır.					
14.	Gen teknolojisi uygulamaları, gelişmemiş ve gelişmekte olan ülkeler için adaletsizliğe yol açacaktır.					
15.	GDO'lu gıdalar gelecek nesillerin yaşam standardını yükseltecektir.					
16.	GDO'lu gıdalar benim ve ailemin yaşam standardını yükseltecektir.					
17	GDO'lu gıdalar diğer gıdalara göre daha sağlıklıdır.					
18.	Genetiği değiştirilmiş organizmalar doğadaki yabani türlere karışarak onların genetiğini değiştirebilir.					
19.	Gen teknolojisi kullanımının uzun vadede çevre üzerindeki etkileri konusunda yeterli bilgiye sahip değiliz.					
20.	Gen teknolojisi kullanmak, gıda üretiminde doğal olmayan yöntemlerin yaygınlaşmasına neden olacaktır.					
21.	GDO'lu gıdalar diğer gıdalara göre daha kalitelidir.					
22.	GDO'lu gıdalar kansere neden olur.					
23.	GDO'lu gıdalar çocuklara ve gelecek nesillere zarar verecektir.					
24.	GDO'lu gıdalar, doğanın dengesinin bozulmasına sebep olmaktadır.					
25.	Gıda üretiminde gen teknolojisi kullanmak tüketicilerin süpermarketlerdeki ürün seçeneğini artıracaktır.					

APPENDIX H

GM FOODS KNOWLEDGE SCALE

Aşağıda verilen bilgilerin size göre "Doğru" veya "Yanlış" olduğunu verilen ölçekte işaretleyiniz. Verilen bilgilerin doğru veya yanlış olduğu konusunda herhangi bir fikriniz yoksa "Bilmiyorum" seçeneğini işaretleyiniz.		Doğru	Yanlış	Bilmiyorum
1.	Tarımsal ürünler, kalıtsal yapıları değiştirilerek bazı hastalık ve salgınlara karşı dirençli hale getirilebilirler.			
2.	Genetiği değiştirilmiş bazı bakteriler petrol kirliliği olan plajları temizleme yeteneğine sahiptir.			
3.	Genetik modifikasyonlar tıpta kullanılmaz.			
4.	GDO'lu gıdalar gen içerirken, geleneksel tarım yoluyla elde edilen gıdalar gen içermez.			
5.	Hayvansal özellikler hiçbir yolla bitkilere aktarılamaz.			
6.	Besinlerde bulunan bakterilerin tümü zararlıdır.			
7.	"Doğal", her zaman sağlıklı anlamına gelmez.			
8.	İşlenmiş gıdaların tümü genetiği değiştirilmiş ürünler kullanılarak elde edilir.			
9.	Dünyada, gen teknolojileri kullanılarak gıda üretilmesi konusunda herhangi bir yasa veya yönetmelik yoktur.			
10.	Genetiği değiştirilmiş gıdalar sindirilemez.			
11.	Bir bitkinin genlerini değiştirmek için o bitkinin hücrelerini öldürmek gerekir.			
12.	Bitkilerin tarım ilacı ihtiyacı, genetik yapıları değiştirilerek azaltılabilir.			

13.	Türkiye'de, gen teknolojileri kullanılarak gıda üretilmesi konusunda herhangi bir yasa veya yönetmelik yoktur.			
14.	GDO'lu gıdalarla beslenmek insanların genlerinde değişikliğe yol açabilir.			
15.	Genetiği değiştirilmiş hayvanlar diğer hayvanlara göre her zaman daha büyüktür.			
16.	Türkiye'de GDO'lu tohumla tarım yapmak yasaktır.			
17	Türkiye'de, mısır ve soya gibi GDO'lu bazı ithal ürünlerin hayvan yemi olarak kullanımına yasal olarak izin verilmektedir.			

APPENDIX I

PRESERVICE TEACHER INTERVIEW PROTOCOL

Öğretmen adayının adı:
Gün ve Saat:

Merhaba, ben Nilay Öztürk. Ortadoğu Teknik Üniversitesi İlköğretim Fen Eğitimi alanında doktora yapıyorum. Fen bilgisi öğretmen adaylarının sosyobilimsel konuların öğretimine yönelik inançlarını ve ilişkili faktörleri araştırıyorum. Çalışmanın ilk kısmında uyguladığım ölçeklerden sonra, ikinci aşamasında detaylı bilgiler toplamak amacıyla görüşmeler yapıyorum. Dolayısıyla, vereceğiniz cevaplar benim çalışmam için çok önemli.

Vereceğiniz tüm bilgiler akademik çalışma amacıyla kullanılacak olup, isminiz hiçbir şekilde kullanılmayacaktır. Sizin için bir sakıncası yoksa görüşmemizi ses kayıt cihazıyla kayıt altına almak istiyorum. Görüşme yaklaşık bir saat sürecektir. İstediğiniz zaman soru sorabilir ve/veya görüşmeyi durdurabilirsiniz.

1. Gelecekteki sınıflarınızda sosyobilimsel konuları (örneğin GDO'lu gıdalar) öğretebileceğinize inanıyor musunuz?
   Evet ise, bu konudaki inancınızı 1-5 arasında derecelendirmeniz gerekirse, vereceğiniz puan kaç olurdu? Sebebini açıklar mısınız? Hayır ise, neden böyle düşünüyorsunuz?
2. Sınıfınızda sosyobilimsel konularla ilgili tartışma ortamı yaratabileceğinize inanıyor musunuz? Evet ise, bunu hangi yollarla / nasıl yapmayı planlıyorsunuz? Hayır ise, neden?

3. Öğrencilerinize sosyobilimsel konuların doğasını (sosyobilimsel konuların temel karakteristiklerini) öğretebileceğinize inanıyor musunuz? Evet ise, bunu hangi yollarla / nasıl yapmayı planlıyorsunuz? Hayır ise, neden?

a. Kompleks yapı (Complexity – basit ve kesin çözümleri olmayan, tartışmalı)
b. Çoklu perspektifler (Multiple perspectives – tartışmalı bakış açıları)
c. Sürmekte olan bilimsel tartışmalara-araştırmalara göre değişkenlik (Subject to ongoing inquiry)
d. Şüpheci bakış açısı gerektirmesi (Scepticism – bilgi kaynaklarına şüpheyle yaklaşmak, potansiyel önyargılı-taraflı fikirleri fark etmek)

4. Sosyobilimsel konularla öğretim yaptığınız bir dersinizde, zaman problemi yaşayacağınızı düşünüyor musunuz? Neden?
5. Sosyobilimsel konularla öğretim yaptığınız bir dersinizde sınıf yönetiminde zorlanacağınızı düşünüyor musunuz? Neden?
6. Sosyobilimsel konuların öğretildiği bir dersinizde öğrencilerin bu konuları öğrendiğinden nasıl emin olursunuz? (Öğrencilerde) hangi çıktılara erişirseniz başarılı olduğunuzu düşünürsünüz?
7. Sizce bir öğretmenin sosyobilimsel konuları öğretmede kendini ne kadar yeterli gördüğü ile o konuya yönelik alan (konu) bilgisinin bir ilişkisi var mıdır? Neden?
8. Sizce bir öğretmenin sosyobilimsel konuları öğretmede kendini ne kadar yeterli gördüğü ile bilimsel bilginin basit (ya da kompleks) olduğuna inanması arasında bir ilişki var mıdır? Neden?
9. Sizce bir öğretmenin sosyobilimsel konuları öğretmede kendini ne kadar yeterli gördüğü ile bilimsel bilginin değişmez (ya da değişebilir) olduğuna inanması arasında bir ilişki var mıdır? Neden?
10. Sizce bir öğretmenin sosyobilimsel konuları öğretmede kendini ne kadar yeterli gördüğü ile bilimsel bilginin kaynağının otorite (ya da deneysel kanıtlar ve muhakeme) olduğuna inanması arasında bir ilişki var mıdır? Neden?

11. Sizce bir öğretmenin sosyobilimsel konuları öğretmede kendini ne kadar yeterli gördüğü ile öğrenme yeteneğinin doğuştan (ya da birtakım deneyimlerle sonradan) olduğuna inanması arasında bir ilişki var mıdır? Neden?
12. Sizce bir öğretmenin sosyobilimsel konuları öğretmede kendini ne kadar yeterli gördüğü ile öğrenmenin hemen (ya da zaman içinde aşama aşama) gerçekleştiğine inanması arasında bir ilişki var mıdır? Neden?
13. Bildiğiniz gibi sosyobilimsel konular tartışmalı olan ve henüz üzerinde net bir anlaşma sağlanamamış konulardır. Örneğin bilim insanlarının bazıları GDO'lu gıdaların dünya için bir ihtiyaç olduğunu ve gıda teknolojisi yöntemlerinin güvenli olduğunu savunurken, bazı diğer bilim insanları GDO'lu gıdaların gerek insan sağlığı gerekse çevre üzerinde çeşitli zararlarının olduğunu düşünmekteler. Sizce bir öğretmenin GDO'lu gıdaların riskli olduğunu düşünmesi onun bu konuyu öğretmede kendini ne kadar yeterli gördüğünü (GDO'lu gıdalar konusunun öğretilmesinde ısrarcı olması, bu konunun öğretilmesinde öğrencilerle daha yakından ilgilenmesi, bu konunun öğretilmesine daha fazla zaman ayırması, vb.) etkiler mi? Etkiliyorsa hangi şekilde etkiler? Etkilemiyorsa, neden?
14. Bir önceki sorudaki açıklamaları düşünerek, sizce bir öğretmenin GDO'lu gıdaların faydalı olduğunu düşünmesi onun bu konuyu öğretmede kendini ne kadar yeterli gördüğünü (GDO'lu gıdalar konusunun öğretilmesinde ısrarcı olması, bu konunun öğretilmesinde öğrencilerle daha yakından ilgilenmesi, bu konunun öğretilmesine daha fazla zaman ayırması, vb.) etkiler mi? Etkiliyorsa hangi şekilde etkiler? Etkilemiyorsa, neden?
15. Sizce bir öğretmenin sosyobilimsel bir konu hakkındaki bilgisi ile (örneğin GDO'lu gıdalar) bu konunun riskli olduğunu düşünmesi (risk algısı) arasında bir ilişki var mıdır? Neden?
16. Sizce bir öğretmenin sosyobilimsel bir konu hakkındaki bilgisi ile (örneğin GDO'lu gıdalar) bu konunun faydalı olduğunu düşünmesi (fayda algısı) arasında bir ilişki var mıdır? Neden?

APPENDIX J

DESCRIPTIVE STATISTICS FOR THE ITEMS IN GM FOODS TEACHING SELF-EFFICACY BELIEFS INSTRUMENT

Dimension / Item	*M*	*SD*	*Min*	*Max*
ARG				
Item 22	3.80	0.71	1.00	5.00
Item 15	4.03	0.69	1.00	5.00
Item 20	3.92	0.71	1.00	5.00
Item 19	3.93	0.68	1.00	5.00
Item 21	3.83	0.69	1.00	5.00
Item 17	3.79	0.73	1.00	5.00
Item 24	3.99	0.68	1.00	5.00
Item 23	3.98	0.67	1.00	5.00
Item 18	3.75	0.79	1.00	5.00
Item 16	3.91	0.72	1.00	5.00
Item 14	3.93	0.74	1.00	5.00
GIS				
Item 8	3.65	0.92	1.00	5.00
Item 4	3.90	0.86	1.00	5.00
Item 2	3.90	0.83	1.00	5.00
Item 10	3.84	0.83	1.00	5.00
Item 9	2.45	1.06	1.00	5.00
Item 3	3.31	0.90	1.00	5.00
Item 12	3.58	0.95	1.00	5.00
Item 1	3.88	0.70	1.00	5.00
Item 5	3.49	0.87	1.00	5.00
OE				
Item 34	3.66	0.86	1.00	5.00
Item 33	3.68	0.81	1.00	5.00

Dimension / Item	*M*	*SD*	*Min*	*Max*
Item 30	3.58	0.84	1.00	5.00
Item 32	3.19	0.93	1.00	5.00
Item 25	3.44	0.97	1.00	5.00
Item 26	3.74	0.84	1.00	5.00
Item 27	3.68	0.99	1.00	5.00

APPENDIX K

DESCRIPTIVE STATISTICS FOR THE ITEMS IN EPISTEMIC BELIEFS INVENTORY

Dimension / Item	*M*	*SD*	*Min*	*Max*
QLCK				
Item 25	2.08	0.98	1.00	5.00
Item 21	1.80	0.92	1.00	5.00
Item 16	1.70	0.86	1.00	5.00
Item 29	2.19	0.99	1.00	5.00
Item 3	2.51	1.00	1.00	5.00
Item 23	2.47	1.15	1.00	5.00
IA				
Item 5	2.85	1.25	1.00	5.00
Item 26	3.18	1.18	1.00	5.00
Item 32	4.19	0.85	1.00	5.00
Item 17	3.83	0.97	1.00	5.00
Item 8	2.86	1.07	1.00	5.00
Item 12	3.18	1.09	1.00	5.00
SK				
Item 10	3.14	1.09	1.00	5.00
Item 13	3.20	1.06	1.00	5.00
Item 11	3.19	1.11	1.00	5.00
Item 18	3.67	0.89	1.00	5.00

APPENDIX L

DESCRIPTIVE STATISTICS FOR THE ITEMS IN GM FOODS RISK-BENEFIT PERCEPTIONS SCALE

Dimension / Item	*M*	*SD*	*Min*	*Max*
BEN				
Item 5	2.96	1.08	1.00	5.00
Item 6	2.64	1.09	1.00	5.00
Item 16	2.24	0.99	1.00	5.00
Item 4	3.13	1.07	1.00	5.00
Item 15	2.39	1.03	1.00	5.00
Item 10	2.98	1.01	1.00	5.00
Item 12	2.72	1.04	1.00	5.00
Item 17	1.93	0.96	1.00	5.00
Item 21	2.10	0.98	1.00	5.00
RISK				
Item 24	3.93	0.96	1.00	5.00
Item 23	3.88	1.00	1.00	5.00
Item 22	3.74	1.01	1.00	5.00
Item 3	3.64	0.91	1.00	5.00
Item 2	4.02	0.86	1.00	5.00

APPENDIX M

ENGLISH AND TURKISH VERSIONS OF THE USED QUOTATIONS

- Gerekli bilgiye sahibim diyemem kesinlikle ama bilgiye nasıl ulaşabileceğimi biliyorum. O bilgiyi nasıl hazırlayabileceğimi biliyorum. Bunlardan eminim bunlarda problem yok ama sahaya indiğimizde, öğrenciyle olan ilişkimde problem olabilir (PST11).

  I cannot say I have the necessary level of knowledge but I know how to reach information. I know how I am going to use that information. I am quite sure about these however when I will start to teach in the field, there would be some problems with communicating with students (PST11).

- Önce bir konuya giriş yaparım ama öğrencilerin de önceden hazır gelmeleri gerekiyor derse. Muhtemelen bir ders önce bahsederim araştırılması gereken yerleri. İşte biraz çocukların durumuna bağlı, yani gerçekten hep doğrudan öğrenme ile öğrenmeye alışkın bir sınıfsa ilk başlarda zor olur ama öğretmenin de bu süreçte sıkılmaması lazım, yılmaması lazım (PST6).

  First of all, I would make an introduction but I would also expect that students should have been prepared to the course beforehand. I would tell them about which topics they should do prior research one week earlier. It is for sure that this highly depends on the students. I mean, if the students used to learn through direct learning it would be very difficult for me at the beginning to do SSI teaching. Teacher should be very patient and passionate in this process (PST6).

- Karşı taraf [öğrenciler] alır mı almaz mı o konuda biraz tereddütüm var (PST5).

  I have concerns whether students get used to SSI teaching or not (PST5).

- Sosyobilimsel konuları öğretebileceğime inanıyorum. Çünkü üniversitede aldığım derslerde çok fazla uygulamasını yaptık. Yapamadığımız durumlar da oldu. Mesela bazı gruplar sosyobilimsel konu seçmemişti falan. Doğrusuyla yanlışıyla görebildik. Dediğim gibi, önceden bir çalışma yapıp öğretebileceğime inanıyorum (PST14).

  I believe I can teach SSI because many times I had the chance to practive this in my undergraduate courses. Of course there were times that we failed in this process, for instance, some of the groups in our course had difficulties to decide on their SSI topics. I mean we experienced every process with its rights and wrongs. So, as long as I prepared for the lesson well, I believe I can do SSI teaching (PST14).

- Bu sosyobilimsel konularda sadece STS dersinde bir kere ders anlatmıştık o da gerçek bir ortam değildi, arkadaşlarımıza anlatmıştık. Onda bile ama ne kadar karışabileceğini gördüm çünkü orada yetişkin insanlar bile bayağı bir araştırma yapıp "bu böyle miymiş" şeklinde sorular sormuşlardı, onlar bile birçok şey öğrenmişti (PST1).

  We had prepared SSI lesson plan just for one time in just this SSI class and also it was not a real classroom environment, we taught our classmates. However even in that time, I observed that how much it can mess, because even university students learnt a lot of new things by searching much as 'is it like that" etc. (PST1).

- Öğretebileceğime inanıyorum. Sınıf yönetiminde evet belki biraz zorlanabiliriz. Hani sonuçta yeniyiz ama onun dışında eğer kendimiz yeterince bilgiliysek sorun yok. İnternet var elimizin altında, açtığımız zaman bize zaten her şeyi veriyor. Yeterince güvenilir kaynağımız da var. Bir kere İngilizce biliyoruz. Bu bizim en büyük artımız diye düşünüyorum. Bu konuları yeterince araştırma yaparak, güzelce öğretebileceğime inanıyorum (PST15).

I believe I can teach (SSI). Maybe classroom management would be a problem but given that we are inexperienced now it is expected. Other than that, if we are knowledgeable, then no problem... We have internet and enough reliable resources. We know English and I guess this is the most important advantage we have. I believe that I will be able to teach SSI well enough by doing research (PST15).

- Kendime güveniyorum. Şöyle ki, burada aldığımız dersler bize çok şey kattı, birincisi o. İkincisi, ilgimi çeken bir konu. Araştırmayı da seven biri olduğum için bunun kolaylıkla üstesinden geleceğimi düşünüyorum (PST4).

  I trust myself. I mean, first of all, I learnt a lot in my undergraduate courses. Secondly, I am interested in SSI. Besides, since I love doing research, it would not be difficult for me to teach those (SSI) topics (PST4).

- Yani literatürde okudum aslında SSI ile ilgili epey kaynak var, derste de hocanın verdiği kaynakları da okudum. Diğer taraftan, ben şuna da inanıyorum kendi yaşamında demokratik değerlere göre yaşamayan bir insanın dersini o şekilde yapması çok zor. Ben şahsen özel hayatımda da öyle yaşıyorum; örneğin oturduğum semtin kent konseyinde aktif olarak yer alıyorum, orada arkadaşlarım var, sürekli haberleşiyoruz. Yani şöyle, benim kendi background'um bakış açım böyle olduğu için benim için zor olacağını düşünmüyorum, sürekli öyle bir perspektifimin olacağına inanıyorum. Öğretmenin bence kendi dünyası çok önemli, kendisi hayata nasıl bakıyor bu çok önemli (PST3).

Well, I read SSI publications existed in the literature and the reading assignments in my undergraduate courses. However, in my opinion, it would be very hard to teach SSI for a teacher who does not give place to democratic values in his/her personal life. I myself live in that way. For instance, I take part in city council actively and have many friends there. What I mean is that, since my own perspective is in line with democratic education (SSI teaching), I believe it would not be difficult for me. Teachers' personal lives are very important and their perspectives on life matters (PST3).

- Ben örneğin bir konuda tartışma yapmışımdır, öğrenci merak etmiştir, gidip araştırmıştır, bir sonraki hafta gelir, ben böyle bir şey okudum diye anlatır, benim fikrimi sorar. O araştırma ve öğrenme merakı uyandıysa ben tamam derim (PST17).

For example, after a class discussion, students might have been interested in the issue and done further investigation on that. Also, if they come to the next class hour and tell us for example about a SSI-related news, ask for my opinions, then I would consider myself as successful in SSI teaching. I mean the point here is to arouse curiosity to investigate about and learn SSI (PST17).

- Ben aslında bu konuyla ilgili mesela GDOlu gıdaları anlattıktan sonra bana getirip soru sormalarını ya da bu konu anlatıldıktan sonra öğretmenim ben şunu duydum bunu okudum diye anlattıklarında ben açıkçası başarılı olduğumu düşünürüm (PST1).

After I've finished teaching genetically modified organisms, GM Foods, I actually regard myself as successful if my students ask me questions on the issue or they tell me that they've heard of something or read about this topic (PST1).

- Öğrenciler sosyobilimsel konularla ilgili öğrendiklerini hayatlarında uyguladıklarında da kendimi başarılı sayarım ben. Benim için GDOlu gıdalar konusunu öğrendikten sonra öğrencilerin gelip “Önceden mısır yerdim ama şimdi daha az yiyorum” yada “artık bu şu şekilde yapıyorum” dediğinde ben kendimi başarılı görürüm ve öğrencilerimin bu bilgileri hayatlarına entegre ettiklerini düşünürüm (PST1).

When they apply the SSI knowledge into their daily lives, it is also a success for me. For me, after I've taught the subject GM Foods, when one of my students come and tell me: "I used to eat corn but now I eat less" or "I do it in this and that way", I infer that I'm really able to succeed teaching and my student can integrate the information into his/her daily life (PST1).

- Mesela öncelikle kendi rollerini öğrenmeleri çok önemli bence, kendi düşüncelerini. Ama kendi düşüncelerini edinirken de başkalarının bakış açısıyla görmeyi de öğrenecekler aynı zamanda. İkisi böyle birbirini destekleyici gider, gitmelidir (PST3).

  For instance, they first will learn their own opinions on the issue. But at the same time, they would also learn how to interpret the issue from someone else’s point of view. These two should go together and support each other (PST3).

- Gerçekten kendilerine ait bir fikri savunduklarını gördüğüm zaman kendimi bir öğretmen olarak başarılı hissederim. Tartışmada işte argümanları ne kadar sağlam, ne kadar araştırmışlar, bilgi sahibiler onları görürsem de bir öğretmen olarak kendimi başarılı sayarım (PST6).

  I would regard myself as successful when I see my students can defend their opinions. How strong their arguments in a discussion are, to what extent they did research on the issue and they are knowledgeable are my other expectancies that makes me feel successful in teaching SSI (PST6).

- Karşı tarafın fikrini çürütebiliyorsa, kendi fikrine güveniyorsa, yeterli araştırmayı yapmışsa ve konuyla ilgili bilgiliyse kendimi başarılı sayarım (PST15).

  I consider myself as a successful teacher in teaching SSI if my students are knowledgeable about the issue, can rebut others' opinions, and support their own positions and arguments (PST15).

- Mesela haberlerde tartışmaları izlerken bir görüş bildirip ailesi ile bunu konuşabilir. Televizyonda o tartışmayı izlerken mesela benim fikrim de bu, bu taraftan düşünüyorum ve bence doğrular bunlar diye annesi ya da babası ile bu konuyu konuşabilir. Böyle bir beklentide olurum ben öğretmen olarak açıkçası (PST21).

  For example, my students may discuss the issue with their families at their homes, while watching news about an SSI. Besides, I expect my students to present their evidences and supportive arguments while negotiating with their families on a controversial issue (PST21).

- Evet, kullanırım rol atama tekniğini. Mesela, aldığım derste environmentalist bakış açısından bakmıştık ve hem pozitif hem de negatif tarafından bakan arkadaşlarım vardı. Yani çevrecilerden nükleer santral kurulsun diyeni vardı bir de kurulmasın diyeni vardı. Yani aslında çevreciler genelde kurulmasın der diye düşünüyorum ama iki grup yapmıştı hocamız, o şekilde yapmıştık. Aynı şeyi ben de yaparım sınıfımda özellikle her zaman aynı gruba aynı rolü vermeyi değil de sürekli değiştirmeyi tercih ederim çünkü onların farklı fikirleri görmelerini ve bu farklı taraflardan baktıklarında nasıl düşündüklerini görmelerini isterim (PST1).

I would use role assigning technique. For instance, in our undergraduate course, we were environmentalists and there were people both taking the positive sides and negative sides of the issue. There were people who are supporting the construction of nuclear power plant. I mean, to me, environmentalists may generally say that it shouldn’t be established but our teacher made two groups and we did like that. I may do the same thing in my own classrooms, especially not always giving the same role to the same group but I continuously change. Because I want them to see the different sides and how they think at different aspects (PST1).

- Önce bir çalışmaları için süre veririm hani bir şekilde o konuyu tartışmaları ve kendi hipotezlerini oluşturmalarını isterim (PST13).

First of all, I would give them some time and then expect them to discuss about the issue and generate their own hypothesis regarding the issue (PST13).

- Herhangi bir sosyo bilimsel konu ile ilgili farklı argümanları öğrencilere açıklayıp, siz olsaydınız hangisini seçersiniz, neden seçersiniz gibi sorular sorarak tartışma ortamı yaratabilirim (PST11).

I might present the opposing claims about a particular SSI. Then, in order to create a discussion environment, I might ask some questions such as “Which claim you would prefer to support and why?” (PST11).

- I think I will absolutely utilize technology for students’ research. If I have the opportunity in the schools I will work, I will enable them to find clues, establish their claims and hypothesis in some way and prove their claims by means of technology. Apart from that, speaking of technology, I like using video, presenting visuals related to subjects and such like very much and I definitely make use of pictures, power points videos and such (PST1).

- Farklı perspektiflerden yazılmış bilimsel makaleler vermeye çalışırım öğrencilere. Öğrencilerin hiçbir zaman tek bir doğru olmadığını, farklı fikirlerin her zaman var olabileceğini anlamalarını sağlamaya çalışırım. Dersimde resim, video, yada hikayeler kullanırım ve bunların da farklı perspecktiflerin var olabileceğini yansıtmasına dikkat ederim. (PST13).

  I tried to provide students with scientific papers that reflect opposing perspectives (on an SSI). I encourage students to realize that there always might be different perspectives and to avoid the idea of existence of a sole truth (on SSI). Besides, I pay attention to use videos, illustrations, and stories which reflect this idea accordingly (PST13).

- İnanıyorum ama bu biraz da dediğim gibi öğrencinin bulunduğu ortama çok bağlı, çocuğun internete erişimi önemli mesela. Ben gidip de bir köy okulunda öğretmeye çalışsam çok zor olabilir belki, GDO ne diye sorarlar bana ama tanınmış iyi özel okullarda öğretmenlik yapsam, çocukların her türlü bilgisi var aşinalığı var en azından bilmeseler de bir şekilde fikir yürüteceklerini düşünüyorum ben (PST5).

  Yes, I believe but this also depends on the context students are living in; for instance, whether they have internet at home or not is very important. It would be difficult for me to teach GM foods in a village school; it is probable that students have no idea. On the contrary, in a well-known private school, I am sure students are used to these controversial issues, therefore can easily generate their arguments regarding the issue (PST5).

- Türkiye içinde hangi bölgede çalıştığıma bağlı açıkçası. Ama ben yine de elimden geldiğince bir Güneydoğu, Doğu'da bile olsam bir şekilde sağlamaya çalışacağım. Yine de sınıf ortamına bağlı; şartlara ve öğrencilere. Öğrencilerin sürece, derse katılımına bağlı (PST9).

It depends on which part of the Turkey I will be working in. Even I will work in the disadvantaged regions I would do my best and try to provide this. However, it totally depends on the climate in the class, circumstances, students' profile, and the participation of students to the teaching and learning processes (PST9).

- Mesela hem sınıf yönetiminde hem de zaman yönetiminde sıkıntı olduğunda öğretmen için çok zorlaşıyor durum. Bu durumda öğretmen sıradan ve yüzeysel bir açıklama yapıyor dersin sonunda, öğrencinin aklına tam oturmuyor. O yüzden öğretmen zamanı etkili kullanırsa daha iyi olur. En sonunda result kısmında "işte böyle böyleydi, arkadaşlar siz, böyle bir şeyler araştırdınız ama aslında bilim adamları da sizin gibi bir kısmı böyle diyor, bir kısmı da şu görüşü savunuyor. Aa bu işin ortası yok, hem artıları, hem eksilerinden dolayı iki taraf var" diye söyleyebiliriz (PST16).

It would be very problematic for a teacher if s/he has difficulties to manage both time and the classroom. In such kinds of situations, teachers most of the time finish the course with a very weak explanation which does not help students to get the main point. To avoid this, teachers should use the time very efficiently. In the closing part of the course, as a teacher, we may tell the students that, "just like you scientists may also possess varying perspectives regarding these controversial issues. There is no middle regarding these issues. Due to both positive and negative aspects, there are always opposing sides (PST16).

- Dersi toparlarken sosyobilimsel konuların bireyler olarak bizleri ve toplumu etkilediğinden bahsederim, faydalarından bahsederim. Sosyobilimsel konuların biraz daha topluma açık, duyarlılığa açık şeyler olduğunu görürler ve ona göre düşünürler diye düşünüyorum. Yani öğrenirler bir şekilde (PST5).

When I want to wrap up the lesson, I would re-mention to the students that SSI has an influence on both us, as citizens, and the whole society. They would understand that SSI are more open to public discussion and sensitivity and think accordingly. I mean, they would learn SSI in anyway (PST5).

- Sınıfta farklı görüşler ortaya çıkacaktır ve bu kesin bir sonuca bağlanmıyor genelde. Ucu açık konular oluyor. Öğrenciler de buna bağlı olarak SSI'ın kompleks yapısının farkına varacaklar. O şekilde öğretebilirim (PST9).

There would arise different opinions in the classroom and this would usually not end up with a certain conclusion. They usually are open-ended issues. Students would accordingly realize that SSI are complex in nature. I could teach this in that way (PST9).

- Grupların mesela farklı bakış açıları olur; işte siz, genetik mühendislerisiniz, siz hastalar olun, hadi siz şirket sahipleri olun. Böyle baktıklarında farklı argumanlar ortaya koyabilirler; eğer kendini bir GDO şirketinin sahibi yerine koyarsa, işte sırf kazancı düşüneceği için belki de ona izin verecek. Ya da kendini hasta yerine koyduğu için genlerinin bir an önce işte düzeltilmesini onaylayacak. (PST16).

Each group would have different viewpoints. For instance, students in one group might be genetic engineers, others might be patients, or CEO in a GDO company. When they discuss from these varying perspectives, they might generate different arguments; for example, they would be the supporters of GM foods if they want to increase the profit of the company if they acted as the CEO of this company. Or if they are the pations, they would be willing for GM technologies so that they could be cured by that means (PST16).

- SSI’ın çoklu perspektifler içerdiğini öğretebileceğimi düşünüyorum. Hatta bunun bence sınıf ortamını daha barışçıl hale getireceğini düşünüyorum. Zaten sınıf tartışmalarında SSI’ın tek bir bakış içermediğini görecekler; mesela bazı yöntemler var, jigsaw gibi, onlarla zaten birden fazla gözlükle bakmayı deneyimleyecekler. Bilim adamı olabilirler, çiftçi olabilirler ve doğrudan o kişilerin gözünden bakarlar olaylara (PST3).

  I think I can teach the multiple perspectives aspect of SSI. I even believe that this would help classroom environment to be more peaceful. They anyway would see during the discussions that SSI has multiple perspectives. For instance, I may use the techniques such as Jigsaw so that students could experience to approach an issue from multiple perspectives. They [students] could be given the roles of being doctor, farmer, etc (PST3).

- İşte biraz önce dediğim gibi, mesela teknolojinin ilerlemesiyle, belki alınan önlemlerle GDO’lu gıdalar konusundaki fikirleri değişebilir bilim insanlarının. Yeni bilimsel çalışmaların denenip, uygulanıp aslında bir zararının olmadığını ortaya koyan bilimsel makaleler bulup getirirsem sınıfa, öğrencilerin fikirleri değişebilir konuyla ilgili (PST10).

  As I have just mentioned before, for example, by the advancement of technology, perhaps with the measures taken, the ideas of scientists about GM foods could be changed. If I find and bring to class scientific articles that manifests that new scientific studies have been tested, implemented and actually are not found harmful, the ideas of students regarding GM foods may change (PST10).

- Mesela 3-4 yıl önce GDOlu gıdalar ile ilgili yapılan bir araştırmayı bulup bugün yapılan bir araştırmayı gösterip arasındaki farklılıkları vurgulayabilirim. İkisini görsel olarak tabloya döküp işte nasıl farklı şekilde daha iyi vurgulayabileceksem işte onlara çalışma kağıtları hazırlayıp vurgulayabilirim diye düşünüyorum. Bu şekilde aradaki farkı görüp bir 5 yada 2 yıl sonra değişebileceğini görebilirler bence.

  For example, I would find a research on GM Foods that was conducted 3 or 4 years ago and I would also show them a recent study to emphasize the differences between them. By tabulating the results of both visually, well, in a way that is the most appropriate, I think I could use that. That way they would be able to see the difference between them and observe their liability to change in a five or two years (PST1).

- Gündemde yer alan bazı konuları öğrenciye direkt gösterebilirim. Bugün mesela böyle bir konu var ülkemizde, bunun üzerine farklı bakış açıları var gibi gündemdeki konuları, hani direkt iç içe olduğu konuları getirirsem öğrencilere, böylece daha çok gündelik hayatla ilişkilendirebilirler. Bir geçmişte düşünülen durum, bir de şimdiki durum karşılaştırması yaptırabilirim. Aşılar vardı sanırım, aşılar geldi aklıma. Mesela geçmişte zararlı gibi görülen, şimdi günlük çok fazla kullanılan bir aşı türü vardı yanlış hatırlamıyorsam. Böyle somut örnekler getiririm onlara…(PST14).

I can directly show some topics which takes place on the recent media. If I bring about the topics on the agenda such as, today there is such an issue in our country, there are different perspectives regarding this, I mean what the students they directly engaged, so that they could more related to everyday life. I can make a comparison made of the situation which is considered in the past and the situation now. I suppose there were vaccinations, vaccinations came into my mind. If I do not remember it wrong, there was a type of vaccine that seemed to be harmful in the past and it is widely used daily. I could bring into such concrete examples for them ... (PST14).

- Az önce hani kanıt (evidence) veririm demiştim ya, tamamen bütün kanıtları kendim vermezdim, sosyo bilimsel konuları sınıfta işleyen bir öğretmen olsaydım. Bütün kanıtları vermek yerine hadi şimdi siz, kanıt araştırın deyip, çocuklara kendi kendilerine kaynak bulmalarını ve bu süreçte kaynakların güvenilir olup olmadığını anlamaları için hangi kriterlere dikkat edeceklerini deneyimlemelerini sağlayabilirim. Onlar, ona göre karar verirlerdi. Yani biz, bu kaynağı bulduk ama ne kadar güvenilir falan... Onun için belki internet siteleri ile ilgili öneriler sunabilirdim. Her dersin başında değil de, sadece işte, "arkadaşlar kaynak araştırırken, hem ödevleriniz için hem sosyo bilimsel konular için şu tarz bir yöntem kullanırsanız, işte sitenin uzantılarına bakarsanız, sitenin tarihi var mı, yazının tarihi, işte nereye dayanıyor, hangi araştırmalara göre yazılmış bu haber ya da yazı?" bunlara dikkat edin diye söylerim açıkça. Böylece araştırmalarında tarafsızlığı gözetmelerini sağlamış oluruz (PST16).

As I said I could give the evidence, I would not give all the evidences myself, if I was a teacher who was teaching socio-scientific topics in the class. Instead of giving all the evidence, I can assure the students to find resource by themselves and let them to have experienced to realize which criteria they should take into account in order to understand whether the resources are reliable or not, by saying now you search for the evidence. They would have decided according to that. I mean we have found this resource but how reliable is this and so on... Therefore, I could offer recommendations about internet sites. Not at the beginning of each lecture, but only explicitly would say pay attention to "the extension of the site, if the site has a date, date of the article, it is based on what, according to which research this news or article is written?" Thus, we would ensure that they pay regard to objectivity in their researches (PST16).

- Nasıl öğretirim bilmiyorum ama biz okuduğumuzda fark edebiliyoruz taraflı ya da tarafsız yazıp yazmadıklarını. İfadelerden gerçekten belli oluyor ama onu çocuk fark eder mi? Bazı çocuk fark eder, bazı çocuk fark etmez. Fark etmeyene de nasıl fark ettiririm bilmiyorum açıkçası (PST20).

I do not know how I could to teach, but we notice when we read whether they are written objectively or not. It's really clear from the expressions, but does the student notice it? Some students notice, whereas some students do not notice. I obviously do not know how to make realize who does not recognize it (PST20).

- SSI'ın skepticism aspect'ini öğretmek için bilim tarihinden yararlanılabilir. Mesela gelişen, değişen konular bunlar. Böyle söylenmişti, böyle inanıldı, şimdi böyle. Ortaya konulan yeni teknolojik gelişmeler getirilebilir sınıfa. Mesela optik mikroskobuyla belli bir yere kadar görebiliyorken işte geçen sene yapılan nanoskopla artık canlı moleküllere bakılabiliyor falan. Hani spesifik örneklerle bu aspect'i öğretebiliriz diye düşünüyorum (PST8).

History of science can be used to teach SSI's skepticism aspect. These are, for example, developing and changing issues. It was said so, it was believed so, now it is so. The new technological developments that are revealed can be brought into the class. For example, when there was visibility by optical microscopy to a certain extent, now it is possible to look at living molecules by the nanoscope designed last year. I mean I think we can teach this aspect by specific examples (PST8).

- Sınıf yönetiminin sorun olacağını düşünmüyorum artık. Çünkü, staj derslerinin çok faydası oldu bu konuda. İlk başta çok heyecanlanıyorduk falan ama sonra sınıfı yönetebiliyorsun bir şekilde, tecrübeyle oluyor bu da. Yönetebileceğimi düşünüyorum. (PST9).

I no longer think classroom management will be a problem. Since, internship lessons become very helpful in this regard. At first we were getting very excited and such, but then you can manage the class in a way, this is happening through experience. I think I can manage. (PST9).

- Öğrenci merkezli olduğu için biraz zor olabilir. Öğrenci araştıracak, işte konuşması, çok konuşması gerekecek, grup arkadaşlarıyla tartışması gerekecek. Kendi grubu içindeki tartışmalarında, işte gürültü, kaos ortamı yaratabilir. Onu yönetmek zor olabilir ya da karşı görüşlü bir arkadaşıyla tartışabilir. Bunlar sıkıntı olabilir (PST10).

Since it is student-centered, it can be a little difficult. Students will search, so they will be required to talk, talk a lot, will be required to make discussions with friends. In the discussions within his/her own group, noise and chaos can be created. It might be difficult to manage, or student can argue with a friend who has opposing ideas. These may cause distress (PST10).

- Evet hani biraz önce de bahsettiğim gibi, kalabalık sınıflarda özellikle sınıf yönetimi zor. Gruplara ayrılacaklar, materyalleri fazla olacak, kendileri bilgiyi araştıracak derken, biraz kaos yaşanabilir. Bunu engellemem gerekiyor. Sınıf yönetimi, doğrudan anlatıma (direct teaching) göre bence biraz daha zor (PST14).

  Yes, as I mentioned before, classroom management is especially difficult in crowded classes. There might be some chaos when they divided into the groups, their materials will be abundant, they will search for the information themselves. I need to prevent this. I think classroom management is a bit harder in comparison to direct teaching (PST14).

- Onun için otoriter bir hoca olmak lazım, ben öyle çok fazla olabileceğimi zannetmiyorum. İkisinin arasında hani böyle tatlı sert derler ya o durumu sağlamak lazım biraz korkmaları mı lazım diyeyim artık? Korkmamaları daha iyi ama bazı durumlarda da evet o çizgiyi o sınırı korumak lazım ama öyle olduğu zaman çok zor oluyor hocam. Yani grup yaptırdığınız zaman sınıftaki o karmaşa… zaten çocuklar oturamıyorlar yerlerinde duramıyorlar. Normal bir ders işleyim derseniz bile çok sıkıntı yaşıyorsunuz. Bu ister devlet okulunda olsun ister kolejde olsun çok hiperaktif şimdinin çocukları (PST20).

  To this end, to be an authoritarian teacher is required, I do not think I would be able to that extent. It is necessary to ensure that situation you know as they say kind and firm, shall I say they need to be afraid a little bit? It is better if they are not to be afraid, but in some cases yes this line this borderline should be kept but it is very difficult when it is as such. In other words, when you perform group work that chaos in the class… Students are already cannot sit and cannot not stand where they are. You experience a lot of hardship even when you intend I shall teach a normal lesson. Whether this is in a public school or in a college, the students of present time are extremely hyperactive (PST20).

- Mesela, GDO konusunu ben o kadar çok anlattım ki bu konuyu anlatırken problem olacağını düşünmüyorum ama aşina olmadığım bir konu da olabilir. Gerçi aşina olmasam da ben öncesinde bayağı bir hazırlık yapıp işte lesson planımı hazırlayıp, araştırmalarımı yapıp hangi kavramları öğreteceğim bunları araştırıp giderim ama bu konu hakkında ne geleceğini bilmediğim için belki zorluk yaşayabilirim diye düşünüyorum ama yeteri kadar pratik yaptıysam onlarda da düşünmüyorum zaman problem yaşayacağımı (PST1).

  I lectured on GMO so many times; therefore, I think I won't have any problems with that, but there may be some topics that I am unfamiliar with. Even if I was new in that topic, I would prepare myself really well with a lesson plan, I would do a research to determine which concepts to teach, I would study those to be taught but as I do not know what may come, I may experience some difficulty with them, anyway, I do not believe there will be a problem about time with these unfamiliar topics, either, after I practice more and more (PST1).

- Zaman yönetimi problemi yaşayacağımı düşünüyorum. Tecrübesizim, tartışmanın gideceği yerleri bilmiyorum çünkü (PST19).

  I think I will have a time management problem. I am inexperienced and I do not know where the discussion could go to (PST19).

- Çünkü çok zor yani çocuk aktif olacak SSI öğretimi öğrenci merkezli olduğu için. Öğrenci merkezli derslerde problem öğretmenin zamanı ayarlayamaması. Yani her şeyi ayarlayacaksın ki şu öğrenci şu kadar dakika konuşsun. Bir sürü öğrenci var, şuna şu kadar saniye dakika diye onu planlamak gerekiyor (PST5).

It would be very difficult I mean the students will be active since SSI teaching is student centred. The problem in the student-centred lectures is teacher's inability to organize time. This is to say you arrange everything so that the student speaks for that much minutes. There are a lot of students, it is required to be planned as this much seconds to this student (PST5).

- Bir de, staj okullarına gittiğimde de fark ettiğim şöyle birşey var; sosyobilimsel konular zaten sınavda çıkmıyor, o yüzden hemen hızlıca bunu geçelim de işte sürtünme kuvvetine gelelim diyor mesela öğretmen. İşte ben de bu fikre kapılır mıyım emin değilim. Çünkü öğrencinin beklentisi öğretmenden bizi sınava hazırlasın, bize çıkacak soruları bol soru çözsün beklentisi olduğu için SSI öğretimini rahatça yapabilir miyim bilmiyorum. Kullanmak istiyorum, ama işte bir ders saatinde yapamayabilirim. Ama yeterli zamanım olduğunu düşünürsem yapabilirim, yetiştirebilirim (PST10).

  Also, there is such a thing that I realized when I went to internship schools; socio-scientific subjects are not come up on the test anyway, so for instance teacher says let's quickly pass this, and begin frictional force. So I'm not sure if I sink into this idea. Because the expectation of the student is teacher shall prepare us for the exam, shall solve plenty of questions to come up, I do not know if I can do SSI teaching as comfortably. I want to use it, but I may not be able to do it in one class hour. But if I think that I have enough time, I can do it, I can finish it on time (PST10).

- İyi planlamazsam zaman problemi yaşayacağımı düşünüyorum. İlk etapta planlama kısmını iyi yapabilirim ama uygulama kısmında planlama belki uymayabilir (PST21).

  I think I will have time problem if I do not plan well. At first stage I can do the planning part well, but in the application part planning may not comply (PST21).

- Dersi önceden iyi planlamaya çalışırım. Bir de bir ders saatine herşey sığamayacağı için tartışmaları sınırlandırmaya çalışırım. Mesela tüm GDO değil de, işte şunda GDO, böyle sınırlandırarak olabilir (PST3).

  I try to plan the lecture well in advance. I also try to limit the discussions since one class hour is not enough for everything. For example, not all GMO, but GMO in that, it can be achieved by limiting as such (PST3).

- Bence öğretmenin kendi görüşünü çok yansıtmaması daha iyi olur. Çünkü öğretmen bir bakış açısı üzerinde focus oluyorsa, bütün öğrenciler bunu hoca o şekilde düşüüyor demek ki şeklinde anlayacak. Bence o zaman çok başarılı bir discussion ortamı sağlanamayacak. Dolayısıyla öğretmen de yeterli hissetmeyecek (PST16).

  In my opinion it is better if the teacher doesn’t reflect much its self-perspective. Because if the teacher focuses on a point of view, all the students will understand it as if the teacher is thinking in that way. I think that a very successful discussion environment will not be achieved at that time. Therefore, the teacher will not feel efficient (PST16).

- SSI dersinin en sonunda da tek bir doğrunun olmadığını, kişiden kişiye değişebileceğini, baktığımız yerden ulaştığımız sonucun değişebileceğini söylerim. Bir sonuca bağlamaya çalışmam açıkçası (PST10).

  At the end of the SSI course, I would say that there is not a single truth, that it changes from person to person and the result we reach may change from where we look. Obviously I wouldn’t try to reach a conclusion (PST10).

- Bilimsel süreçte sonuçta şüphecilik uyandırılarak böyle eleştirel yaklaşa yaklaşa süreçler ilerliyor. Çocuğa bunu kazandırmak istiyorsam benim farklı görüşler ortaya çıkarmam gerekiyor. Dolayısıyla otorite olmaz yani. Otorite olursa, çocuk tek bir düşünceye bağlı kalır. İlerlemez bilim (PST5).

  In the scientific process, the processes are proceeding as in the way of approaching in such a critical way by raising scepticism. If I want students to gain this, I need to bring about different opinions. So authority wouldn't be there. If there would be authority, the student is bound to a single idea. Science will not progress (PST5).

- Ben zararlı olduğunu düşünsem bile direct zararlı demem öğrencilere. İlk önce onların karara varmasını isterim. Sonra ortam uygunsa kendi fikrimi açıklarım (PST1).

  If I would think it's harmful, I don't say it directly to the students. I want them to decide first. Then, if it's convenient, I explain my ideas about the topic (PST1).

- Bir kere iki farklı düşünce varsa kesinlik yoktur, onun farkına varır çocuk. Atıyorum su 100 derecede kaynar denildiğinde bu kesin bir süreçtir. Gözlemlemesini yapar şöyle yapar böyle yapar uygun şartlar sağlanırsa kesin bir sonuca ulaşır ama sosyo bilimsel konu olunca durum farklı. Adı üzerine sosyo, toplumla ilgili bir şey yani toplumlara bağlı olan bir şey... Farklı görüşlere göre değişen bir şey olduğunu zaten verdiğim örneklerden de anlar öğrenciler. Kesin bilgiler işte kitaplarımızdaki kimyadır, basınçtır, şöyle böyle kesin olduklarını anlarlar onların ama sosyo bilimsel konular öyle değil. Zaten GDO, nükleer santraller falan yer alıyor kitaplarda (PST5).

Once if there are two different ideas, there is no certainty, that what is the student becomes aware of. For example, when I say the water is boiling at 100 degrees, it is a definite process. He/she makes its observation one way or the other if the appropriate conditions are provided reach to a definite result, but when there is a socio-scientific issue is the situation is different. As it's implied from its name socio is something related to society, so it's something which depends on the societies... Students already understand by the examples I give that it's something that changes through different views. Here you are the definite knowledge is the chemistry on our books, pressure, one way or another they would understand that they are certain are not as such. As a matter of fact, GMO, nuclear power plants and etc take place in the books (PST5).

- Öğrencilere işte o tartışma ortamında şey yaparım mesela fikrini değiştiren var mı? diye sorarım. Bir taraf çok ikna edici cevaplar verir örneğin ve sorar fikrini değiştirenin olup olmadığını. Bizim fakültedeki derste de oldu; fikrini değiştirip iki kişi geçmişti karşıt düşüncedeki gruba mesela. Bakın fikirler değişebiliyormuş, kesin değilmiş; doğru düşündüğümüz şeyler yanlış, yanlış düşündüğümüz şeyler doğru da çıkabilirmiş, tek bir doğru sonuca ulaşmamız gerekmiyormuş diye söylerim bu noktada öğrencilere (PST5).

As an example in that discussion environment I would ask the students if there are anybody who would change opinion. One side (group of students) give such persuading responses for instance and asks if anybody changed their mind. It happened in the lecture in our faculty as well; i.e two persons went to the counter-group by changing their opinions. Look, that means ideas can change, as it is understood they were not certain; what we think of as true may have been false, what we think of false may have been come out as true, I would say to students in this point that it is not required to reach to a one single true conclusion (PST5).

- Ben örneğin çocuklara farklı gruplara geçme şansı tanıyorum. Bilimsel bilgi işte kendileri araştırma yaptılar, belli bilimsel süreçler kullandılar o araştırma süresinde. Geldiler birbirlerini ikna ettiler, grupta değişiklik oldu o zaman süresinde. Burada aslında bilimsel bilginin değişebilir olduğunu gösterdik çocuğa. Dolayısıyla benim ulaştırmak istediğim amaç da bu olmalı, ikinci öğretmen daha etkili bu konuda ama birinci öğretmen, değişmez olduğunu görerek çok sığ düşünmüş ki muhakkak değişir. Demek ki fen bilgisine hâkim değil aslında bu öğretmen (PST5).

  To give an example I give student a chance to pass on to different groups. Here you go it is the scientific knowledge they made research themselves, they used certain scientific processes in that research proceeding. They come and persuaded each other, in that time period changed occurred in the group. Here we actually revealed that in reality scientific knowledge is changeable. Therefore, this shall be the goal that I would want to achieve, the second teacher is more effective in this regard but the first teacher, must have thought in such a superficial way by seeing it as unchangeable. It absolutely changes. That is to say this teacher is not prevalent in science in essence (PST5).

- SSI'ın sürmekte olan araştırmalara göre değişebileceğini şöyle gösterebilirim; sınıfa gerçek bir SSI örneği getirebilirim. Örneğin bir SSI konusu seçerim ve o konuyla ilgili bilim insanlarının geçmişteki fikirlerini sunarım öğrencilere fakat yeni bilimsel gelişmelerle artık farklı türlü düşünüldüğünü söylerim. O yüzden eski görüşün artık elendiğini vurgularım (PST15).

  I can show how SSI can change according to the ongoing research; I can get a real SSI example into the class. For example, I say, that I choose an SSI topic and present to the students the ideas of scientist in regards to that topic but I express that by new scientific developments it is now thought differently. So I do emphasize that the old opinion is now become eliminated (PST15).

- Yani bu değişebilir örnekleri göstermem bence en verimli yolu bunun. Hani kafalarında kesin doğrunun oluşmasını engelleyebilirsem amacıma ulaşmış olurum; bu konu üzerinde bu doğru değil ama bu yanlış da değil. Bunu onlara fark ettirebileceğim çeşitli örnekler sunarsam, materyaller sunabilirsem, bence şüpheyle yaklaşabilirler. Aa benim düşündüğüm de doğru değilmiş diyebilirse, bunu kazandırmış olurum (PST14).

  So I bring these changeable examples, is the most efficient way I think. If I can prevent the formation of definite truth in the heads, the goal is reached; regarding this issue this is not true but this is not wrong either. If I could present them various examples to make them recognize this, provide materials, I think they can approach me with suspicion. If they could say “Aa what I thought was not the truth either” I would be gained this (PST14).

- Aslında bilimsel bir bilgi tarafsız olmak zorunda, objektif olmak zorunda (PST5).

  In fact, scientific knowledge has to be objective (PST5).

- Zaten kesin bir sonuç yok, kesin bir sonuca varamayacağız. Bilgi anlamında ister istemez yani öğrencileri çok fazla değerlendirebileceğimizi düşünmüyorum (PST2).

  There is no definite result anyhow, we will not have a definite result. I do not think that we can necessarily evaluate students too much in terms of knowledge (PST2).

- Hani hadi gelin bugün arkadaşlar, hiç alakası yokken, socio scientific issue'ları tartışalım demem ben. Bir konunun bir konuyu açması gerekir benim bunu yapabilmem için. Yani sanki bu çok ayrı, gökten inmiş bir konuymuş gibi değil de, bağlayabileceğim bir şeylerin olması gerektiğini düşünüyorum. Besinin yapısından anlatabiliriz, beşinci sınıflarda işte karbonhidratlar, yağlar, proteinler işleniyor. Oradan o konuları verdikten sonra örneğin rengi değiştirilmiş meyveleri gösterip, (hani çocuklar da o tür görsellerden çok hoşlanıyorlar) oradan geçilebilir. Ki beşinci sınıfta bile hani bağlayabiliyoruz bunu (PST2).

  I wouldn't say come on, come on, friends, today, when there is no relevance at all, lets discuss about socio scientific topics. One thing needs to lead another for me to do it. I mean, not as if this is such a separate issue, as if just have landed from the sky, rather there must be somethings I could bind I think. We can give a lecture about the structure of nutrition, when it comes to fifth class herein carbohydrates, fats, proteins are treated. After issuing those topics from there for instance by showing out the fruits that their colour changed, (you know students like that visuals so much) could be passed on from there on. In fact, even in the fifth class we can link this (PST2).

- Genel olarak bir dersin öyle geçmesine bence çok da gerek yok. Bütün bir dersi ona da adayabilirsin ama genel olarak mesela bir konu işliyorsundur, sınıf sıkılır o konudan ya da işte sen de iki saat arka arkaya ders var mesela… Bir konuyu öğretmek için SSI değil de, araya sokmaktan bahsediyorum yani ikisi farklı. İşte bir şey anlatıyorum mesela alakasız, ama sonra dersin son 20 dakikasında da GDO'lu gıdalarla ilgili bir şey okurum haber okurum, ilginç bir bilgi okurum. Sonra çocukların ne düşündüğünü sorarım, bir tartışma ortamı olur, öyle hemen ayak üstü yani. Ama bütün dersimi ona ayırmış değilim sonuçta. Ama bilmiyorum yani ders planına yüzde yüz sadık kalmadığında da dünya yok olmuyor. Sınıf sıkıldıysa, gitmiyorsa artık, yada ben çok yorgunsam kullanabilirim sosyobilimsel konuları. Doğrudan ders işlemediğin zaman aralara sokuşturulabilir yani. Sadece bu konu değil, farklı şeyler de sokuşturabilirsin, çok alakasız şeyler bile olabilir. Sadece dersi biraz daha ilgi çekici yapmak için (PST18).

  Generally, in my opinion there is not much need that a lecture shall pass as such. You can dedicate the whole lecture to this but in general let's say you deal with a subject, the class would be bored of that issue or you have two lectures one after another for example… I mean do not use SSI to teach the whole subject but insert them in between, this is to say these two are different. For example, I explain something irrelevant, but in the last 20 minutes of the lecture I read something the news about GM foods, interesting information as well. After that I ask what the students think about it, a discussion environment occurs, I mean right away as in haste. However, I haven't reserved my whole lecture for this at the end of the day. However, I don't know I mean when you are not loyal to lesson plan one hundred percent it is not that the world either. If the class is bored, if it does not move forward anymore, or if I am too tired I can use socioscientific subjects. Another words, it could be inserted in between when you are not directly teaching a lesson. Not just for this subject, you could insert different things as well, even it could be things that are so irrelevant. Just to make the lesson a little more attractive. (PST18).

- Bence interdisipliner düşünen öğretmen daha rahat, daha kendine güvenir ve öğrencilere olan yönlendirmeleri de daha doğru olur. Şöyle ki; mesela global warming üzerinden konuşalım: Öğretmen enerji konusunu işlerken canlılar için gerekli bir sıcaklık seviyesi gerektiğinden, enzimlerin bu sıcaklık seviyesine uygun olarak çalışabileceğinden bahsedecek ve aslında bunların hepsini global warming konuşurken anlatabilir. Çünkü hava ısınıyor, biz havanın ısınmasını niye istemiyoruz? Canlı türü azalıyor, niye azalıyor? Çünkü canlıların yaşaması için gerekli ortam kayboluyor. Bu interdisciplinary düşünmesi öğrencileri bence daha motive eder. Hadi şunu da düşünün bakalım, bunu da düşünün, bak şununla da ilgisi olabilir mi şeklinde yönlendirmeler yapabilir öğretmen (PST3).

  I believe the teacher who thinks as interdisciplinary is more comfortable, more self-confident and his/her leading would be more accurate. Namely; let's talk over global warming: When the teacher gives a lecture about energy due to a level of temperature is needed for the living beings, will mention that enzymes can work in accordance with this heat and in actuality all of these can be explained when global warming being talked about. Because the weather is warming up, why don't we want the warming up of the weather? The number of species is decreasing, why is it decreasing? Since the medium that is required for the life of living beings is vanishing. This interdisciplinary thinking motivates the students more in my opinion. Let's consider this too, think over this as well, the teacher can lead such as could this related to this (PST3).

- Bilimsel bilginin basit olduğunu savunan öğretmen direct instruction yapmayı tercih eder muhtemelen. Çünkü kendi de araştırmada yetersiz olur. Muhtemelen araştırmayı tercih etmez, bilginin basit olduğunu düşünür. Ama diğer öğretmen sürekli konunun diğer bilimlerle ilişkisini araştırır, işte konuyu sosyal ve kültürel açılardan değerlendirir. O öğretmen daha iyi olur, kendine güveni daha yüksek olur (PST6).

The teacher who defends that the scientific knowledge is simple possibly prefers to make direct instruction. Because the teacher would be inefficient to do research. Possibly would not prefer to make research, would think that knowledge is simple. However, the other teacher continuously searches the relation of the subject with the other sciences, so evaluate the subject in terms of social and cultural aspects. That teacher would be better, have more self-confidence (PST6).

- Bilimsel bilginin kompleks olduğunu düşünen bence SSI'ı öğretmede kendini yeterli görmekte daha çok zorlanır. Çünkü ben bu konuyu biliyorum, araştırdım ama bilmediğim daha başka ilişkileri de olabilir farklı alanlarda diye düşünür. Basit olduğunu gören kendini daha yeterli görür bence. Yani, bilimsel bilginin basit olduğunu düşünen zaten bu basit ben de biliyorum birçok şeyi deyip, ben yeterliyim bu konuda dolayıısyla zaten halledebilirim diye düşünür. Bilimsel bilginin kompleks olduğunu düşünen ben bu kadar şeye hakim olamayabilirim deyip daha yetersiz görebilir kendini (PST1).

I think for the one who thinks scientific knowledge is complex it is hard to believe sufficient to teach SSI. Perhaps these teachers can think themselves as inadequate for more complex thinking that I know this subject, I searched but I did not know the other potential relationships in other areas. I say who see it simple is more self-sufficient. Well, who believe that scientific knowledge is simple, will think she already knows such a simple things and they are perfectly adequate in this regard that they can handle. However, who believe that is complex, can see herself as inadequate because of the belief that it is hard to know all the information that complex science involves (PST1).

- Değişebilir olduğunu düşünen öğretmen daha yeterli hisseder. Çünkü SSI'ın kesin ve net bir doğrusu yok. Yani gün geçtikte her şey değişebilir. Zaten bunu hani bilimin kendi doğasında da görüyoruz tentativeness şeklinde. O yüzden zaten kesin bir doğru vardır diye yaklaşırsa, burada ikileme düşer. Çünkü öğrenciler farklı görüşlere sahip olabilirler tartışma esnasında. Ve zaten öğretmen bilginin değişmez olduğunu düşünüyorsa daha o aşamada karmaşa çıkmaya başlar. O yüzden kesinlikle değişebilir olduğunu düşünmesi gerekiyor (PST2).

  The teacher who believes knowledge changes feel more efficient. Since SSI has no definite truth... I mean everything could change day by day. We already see this in very own nature of the science as tentativeness. Therefore, if the teacher has an approach such as there would be a certain truth already, fell into a dilemma. Because the students may have different opinions during the discussion. And if the teacher already thinks that knowledge is unchangeable, even in that stage chaos starts up. For this reason, the teacher is required to think that is tentative (PST2).

- Bilimsel bilginin değişebilir olduğunu kabul eden öğretmen daha fazla araştırır bence. Güncel konuları daha fazla takip eder en doğrusunu öğretebilmek için. Diğeri zaten değişmez diyor, çok araştırıp düşüneceğini sanmıyorum açıkçası (PST17).

  In my opinion the teacher who accepts that the scientific knowledge is tentative would make more research. Follow up current issues more in order to teach the most accurate. The other one is already saying it is unchangeable, I obviously don't think he/she do research and spend time to understand (PST17).

- Muhtemelen SSI yapmaz değişmez diyen öğretmen. Direkt direct anlatır ve çocuklara sadece bunu böyle bilin, böyle öğrenin, ezberleyin mantığı olur. Diğer öğretmen SSI'ı tercih eder ve o da sürekli bilgilerinin değişebileceğini çocuklara vurgular (PST6).

  The teacher who says knowledge does not change possibly does not teach SSI. Uses direct teaching and there would be logic of just know this as such, learn it as it is, memorize. The other teacher prefers SSI and emphasizes to students that the knowledge could change continuously (PST6).

- Deneyimlerle bence daha güzel öğrenebilir. Sonuçta bakar hangi yöntemle daha iyi öğreniyor çocuk kendisi için, öğrenci için konuşuyoruz burada. Çünkü doğuştan geldiğini düşünen hoca tek bir şey empoze edebilir çocuklara; hani siz zaten bu şekilde öğrenirsiniz. Ama diğeri çocukların farklı yöntemlerle öğrenebildiğinin farkındadır, sonuçta her çocuk aynı şekilde öğrenmiyor, o yüzden sınıflarda farklı yöntemler uyguluyoruz, farklı teknikler deniyoruz (PST19).

  In my opinion student could learn better throughout the experience. Teacher looks out for with which method the student has better learning for own self, we talk about the student here. Due to a teacher who thinks learning is innate could only impose one single perspective to students; actually you only learn it like this. But the other is aware that students can learn with different methods, not every student learns in the same way, for this reason we apply different methods in classrooms, we try different techniques (PST19).

- Öğrenme yeteneği sonradan da kazanılabilir bence, doğuştan olmak zorunda değil. Aslında bakarsak öğrenme çok şeyden etkileniyor, her ortamdan etkilenebiliyor. Eğer öğretmen sınıfta o ortamı sağlayabiliyorsa, hani o ders benim ilgimi çekiyorsa ben daha iyi öğrenirim. Daha önce hiç ilgim olmasa bile daha çok öğrenirim diye düşünüyorum. Öğrenmenin sonradan da gerçekleşebileceğine inanan öğretmen SSI'ı daha iyi öğretebilir bence. Daha ilgi çekici hale getirir dersi (PST17).

  I think learning ability can be acquired in time, it does not have to be innate. In fact, learning is influenced by many things, it can be influenced by any kind of environment. If the teacher is able to provide that environment to the classroom, I would better learn if that course arouses my interest. I think it is more learning, even if I have never been interested before. I believe that a teacher who believes that learning can be achieved in time can better teach SSI, could make the lessons more interesting (PST17).

- Çünkü öğrencilerine zaten bunu vurgular hiç kimse doğuştan… Ben kendi adıma, evet zeka diye bir şey var ama gerçekten bir şeyde başarılı olmak zekayla olmuyor, çalışmayla oluyor diye düşünenlerdenim.

  Because, she already emphasizes that no one from birth… I, on my own behalf believe that yes there exists what is called intelligence but to be good at something is not gained by intelligence, I myself think it occurs through studying (PST1).

- Öğrenme yeteneği bence sonradan kazanılan bir şey de olabilir. Doğuştan geleceğini düşünmüyorum bu zekâ değil çünkü. Yani zekâ farklı bir şey öğrenme kabiliyeti farklı bir şey, biri hızlı öğrenir, biri yavaş öğrenir kesinlikle ama çocuğu öğrenmeye teşvik etmek için ben bir şeyler yapabilirim. Ailesi bir şeyler yapabilir (PST5).

The ability to learn could be something to be gained afterwards I think. I do not think it would come inherently from birth because it is not intelligence. So intelligence is something different than ability to learn, absolutely someone learns fast, someone slowly learns, but I can do something to encourage the student to learn. His family can do something (PST5).

- SSI dediğimiz şey zaten günlük hayatta sürekli karşılaştığımız bir şey. Sınıf ortamında evet küçük bir tartışma ortamı yaratıyoruz ama o günlük hayatına döndüğü zaman böyle bir şeyle karşılaşıp bilgisini pekiştirebilir ya da öğrendiği şeyi kullanabilir, daha kalıcı hale gelebilir bilgi. Yani öğrenmeye devam eder, aslında bir süreç bu (PST10).

  What we call SSI is already what we come face to face in everyday life. Yes, we create a small discussion medium in the classroom environment, but when student returns to his/her daily life, could face such a thing and this would reinforce his/her own knowledge or use what he/she learns. Knowledge may become more permanent by these ways. So the student continues to learn, it's actually a process (PST10).

- Öğrenmenin bence zaman içerisinde gerçekleştiğine inanan bir öğretmen, kendini daha yeterli görür SSI öğretmek konusunda. Çünkü öğrencinin kendi kişisel farklılıkları var mesela. İlk discussion ortamında çocuğun hemen değişmesini bekleyemezsin. Biraz zaman geçecek. Birkaç discussion olacak, birkaç sosyo bilimsel konu işlenecek. Daha sonra çocukta böyle belki birtakım değişimler gözlemleyeceksin. Ben başardım diyeceksin o zaman, bir öğretmen olarak. Demek ki iyi öğretiyorum ki bu socio scientific konuyu çocuklar karşıt görüşlere saygı duyar hale geldi diyeceksin kendine. Bunu diyebiliyorsa öğretmen, bence daha yeterli hisseder (PST16).

A teacher who believes that learning takes place over time, in my opinion sees oneself as more efficient to teach SSI. Because the student has personal differences of oneself. You cannot expect the student to change immediately in the first discussion environment. It will take some time. There will be a few discussions, a few socio-scientific issues will be processed. Then perhaps you will see some changes in the student. Then you will say I have achieved, as a teacher. You will say to yourself, so I teach well this socio scientific issue that the student has become respectful to the opposing views. If the teacher can say that, I think, feels more efficient (PST16).

- Çünkü SSI konularını öğrenmek de bir süreci kapsadığı için öğrenci sadece sınıfta öğrendiğiyle kalmak istemeyebilir. İlgisi varsa gider daha çok araştırma yapar. Gelir öğretmeniyle bu konuyu tartışabilir. Sınıfta ilk başta oluşturduğu düşünce daha sonra yaptığı araştırmalarla değişebilir. Fikri değişebilir yani. O yüzden, öğrenmenin süreç içinde gerçekleştiğine inanan bir öğretmen SSI konularını öğretmede kendini daha yeterli hisseder (PST9).

Since learning SSI is also a process, the student may not want to remain only with what he or she learns in the class. If student have an interest, s/he would do more research on these issues, or discuss it with the teacher. The idea that the student formed at the beginning of the class may change later with his/her research. So the idea of the student may change. Therefore, a teacher who believes that the learning takes place in the process feels more efficient to teach SSI subjects (PST9).

- Öğrenmenin süreç gerektirdiğine inanmak SSI'ın doğasına kesinlikle daha uygun; çünkü çocuk SSI öğrenmek için de bir takım süreçlerden geçecek, önce doğasını anlayacak, daha sonra konuya ilişkin araştırma ve tartışmalar yapıp karar verecek. Böyle bir süreç lazım bence SSI açısından düşünürsek (PST4).

Believing that the learners need the process is certainly more appropriate for the nature of SSI; because the student will go through a series of processes to learn SSI, first will understand its nature, then will do research and be part of discussions to come to a conclusion. I think we need such a process if we think in terms of SSI (PST4).

- Deneysel kanıtlara ve muhakemeye dayanır diyen öğretmen SSI öğretmede kendini daha yeterli görür. SSI'ın doğası gereği üstünde çalışmalar deneyler yapılıyor ve ölçülüyor, şu deney yapılmış bu bulunmuş, bu deney yapılmış bu bulunmuş gibi… SSI sürekli değişiyor ve deneylere dayanıyor, muhakeme yeteneğine, yorumlamaya dayanıyor (PST1).

  The one who says it relies on the experiential evidences and reasoning believes more sufficient to teach SSI. SSI's nature is like this experiment is done and this is found, that experiment is done and that is found, I think this is perpetually changing thing and relies on experiments, reasoning skills, and interpretation (PST1).

- Bilimsel bilginin kaynağının otorite olmadığını düşünen öğretmen kendini daha yeterli görür. Çünkü bilimsel bilgi gözlem ve deneylere dayandığı için öğrenciye açıklarken de daha rahat açıklayabilir. Öbürü biraz daha yetersiz kalır bu konuda, bilimsel süreci öğrenciye aktarırken. Dolayısıyla kendisini yetersiz görür (PST9).

  The teacher, who thinks that the source of scientific knowledge is not authority, sees oneself more efficient. Since the scientific knowledge is based on observations and experiments, this teacher could better explain these issues to the students. The other remains a little more inadequate in this regard, while transferring the scientific process to students. He therefore finds himself inadequate (PST9).

- Çünkü bilim nasıl ilerliyor; problem çözüyoruz. Problem ile başlıyoruz. Ona göre hipotez kuruyoruz. Tahminde bulunuyoruz. Ölçümler yapıyoruz. Sonuca ulaşıyoruz ya da bir şeye döküyoruz onu bir şekilde grafikler olur, belli bir çıktılar olur. Bu bir süreç işi dolayısıyla benim muhakeme yeteneğim de gelişmiş olacak, hipotez kurarken muhakeme yeteneği gerekecek hmm böyle olursa şöyle olur gibi. Sonuca ulaşırken de demek ki şöyle olduğu için böyle oldu. Muhakeme yeteneğim, eleştirme gücüm olduğu sürece ben daha etkili olurum derste. Diğer türlü olmaz (PST5).

  Because how is science progressing; we solve the problem. We begin with the problem. We are hypothesizing according to it. We are predicting and we're doing measurements. Reach to the result or lay it on into something, it could be graphs, certain outputs. This is a matter of process, therefore my reasoning ability will be improved, and reasoning ability will be required when hypothesising such as “hmmm it would be like this due to it is this”. As long I have as reasoning ability and criticism capacity, I would be more effective in the class. Otherwise it cannot be done (PST5).

- Çünkü otorite doğrudur diyen zaten tartışmayı baştan kesmiş oluyor, tek bir doğru var, neye ulaşacaklarını biliyor ve hep onu bence dikte eder, öğrencilerin sadece o noktaya ulaşmalarını hedefler, diğer görüşlere yanlış der. Ama biz zaten argumantasyonda yanlış-doğru demiyoruz. Bu, SSI'ın doğasına aykırı (PST3).

  Because who says the authority is the truth, already cuts the discussion from the very beginning. There is only one truth… This kind of a teacher knows what to reach and always dictates that in my opinion, only aims that the students reaching that point and say wrong for other views. But we are already do not say right or wrong in argumentation. This is contrary to the nature of SSI (PST3).

- Tabii ki bilimsel bilginin işte gözleme, bilimsel deneylere dayandığını düşünen daha yeterli görür. Çünkü diğeri zaten herhangi bir tartışmalı konu üzerinde düşünmez muhtemelen, direkt kabul eder. SSI yaptırmaz bence derste (PST6).

  Of course, the one who thinks that scientific knowledge is based on observations, scientific experiments… Since the other is already does not think about any controversial topic probably, rather accepts it directly. I do not think this teacher would do SSI teaching in the classroom (PST6).

- Eğer öğretmen o konuya hakim değilse, yeterince yönetemez sınıfı, kendinin yeterince fikri yoksa değişik bakış açılarını içeren tartışmaları yönetemez bence (PST10).

  If the teacher is not well-knowledgeable on the subject, I think he cannot manage the class and the discussions which includes the different perspectives adequately (PST10).

- Öğrettiğin konu hakkında bilgin yoksa öğretmen zor duruma düşebilir. Sonuçta hakkında bilginin olması lazım ki sınıfta o rahat öğretmen pozisyonunda durabilesin bence. Çünkü öğrenciler soru soracaklar ve sen yeterli değilsin. Kendin cevap veremiyorsun ki sen, bu tartışmayı sınıfta nasıl başlatıyorsun. Bence bilgisi olmadan, yeterliliği olmadan hoca, discussion ortamına hiç karışmamalı. O yüzden eğer böyle bir sosyo bilimsel konu tartışılacaksa, öğretmen kendini yeterli hissetmek adına ders öncesinde araştırmalar yapıp, bilgisini artırmalı o konuda (PST16).

If you do not know about the subject you are teaching, as a teacher you fall into difficult situations in the classroom. After all, you have to be informed to remain in that class in the comfortable position of a teacher. Because students will ask questions and if you cannot answer it yourself, how you are going to start discussion in class? I think without the knowledge, without the proficiency, the teacher should not interfere in the discussion environment. Therefore, if such a socio-scientific subject is discussed, the teacher should do research before the lesson in order to feel himself / herself efficient and increase his knowledge about that subject (PST16).

- Eğer öğretmen kendini yeterli görürse araştırır ilk başta anlatacağı konuyu, böylelikle kendisi de sınıf ortamında kendini rahat hisseder ve ders gerçekten demokratik bir ortamda herkesin fikrini söylediği bir şekilde akıp gider ve öğretmen kendine güvendiği için öğrencilerden gelecek sorular problem oluşturmaz onun için. Kendi adıma söyleyeyim, öğrenciler bana bilmediğim bir şey sorsalar bile kesinlikle biliyorum demem. Onun yerine, "bilmiyorum ben bunu birlikte bir araştıralım sen de araştır ben de araştırayım diğer derste bunu konuşalım" derim, yani bilmiyorum demeye çekinmem. O yüzden bence alan bilgisi ne kadar yüksek olursa güven de o kadar yüksek olur bu konuda. Kendini daha rahat hisseder ve daha iyi öğretir (PST1).

If the teacher believes that she has teaching efficacy, she searches the subject at first and then if she finds herself proficient, she feels comfortable in class environment and the lesson flies in an democratic environment in which everyone can freely state their opinions. Also, as the teacher feels confident, even the possible questions from students don't cause any problem. For instance, personally, when they ask me something that I don't know, I never pretend that I know. Instead of this, I don't hesitate to say in this way: "I don't know the answer, let's search on this together and talk about it next lesson." That's why the greater content knowledge a teacher has, the more confident she will be. She feels comfortable and teaches better (PST1).

- Sonuçta bir konuya hakimsen o konuyu iyi öğretebileceğine inanırsın. Benim için böyle, diğer öğretmenler için nasıl bilmiyorum ama öyle. İyi olduğum bir konuyu her zaman daha iyi öğreteceğimi düşünüyorum ben ama az bildiğim konuları da biraz daha fazla çalışarak öğretebileceğimi düşünüyorum (PST19).

  If you know a subject well, you believe that you can teach it well. It is the case for me, I do not know how it is for other teachers, but it is as such. I think I will always teach better the subject that I'm good at. If I do not know the topic well, I would think I have to work more on that subject to feel more efficacious (PST19).

- Konuyla ilgili bilgisi arttıkça o konuyu bence iyi bir şekilde öğretebileceğine inanır, öyle bir ilgisi var. Mesela ben de öyleyim, birçok sosyobilimsel konuyla ilgili yeterli bilgim olduğunu düşünmüyorum o yüzden iyi öğretebileceğime de inanmıyorum. Ama bilgim olsa çok iyi öğretebilirim diye düşünürüm (PST7).

  As the teacher has more knowledge about the subject, I believe that he/she believes to teach it in a better way. For example, I am like this, I do not think I have enough knowledge about many SSI, so I do not believe that I can teach it well either. But I think if I had knowledge I would think I can teach very well (PST7).

- Örneğin benim şu an daha çok negatif düşünmemin sebebi bilgimin olması. Biraz daha bilgim olsa ben de belki öğretebilirim herhalde derim (PST17).

  For example, I think the reason that I rather have negative thinking is that I don't have knowledge at the moment. If would say if I had a little more knowledge, I may be able to teach it maybe (PST17).

- Bence konu bilgisinin doğrudan ilişkisi olmayabilir. Çünkü mesela üniversitede aldığım SSI dersi çok faydalı oldu bana. Mesela SSI dersinden önce tamam bunlar çok önemli, bunları derste işlemem gerekiyor diye düşünürdüm, ama SSI dersi bir metot öğretti aslında. Yani diğer şeyleri sabit tutarsak doğrudan ilişki var diyebilirim. Tek başına konuyu bilmesi de yeterli değil, metot da bilmemiz gerekiyor bence. Hem öğretim metotlarını bilecek, hem konuyu bilecek. Ama sadece metot biliyorsa mesela, content knowledge yoksa o zaman da öğretemez bence (PST3).

  I think that the subject matter may not be directly related. Because, for example, the SSI course I took in faculty was very useful to me. For example, before the SSI lesson I used to think, ok these were very important, I had to treat them in the lecture, but the SSI course taught me a method. I mean, by keeping the other things constant I can say there is a direct relationship. It is not enough to know the subject alone, in my opinion teacher is required to know the method as well, we need to read the examples. The teacher will both know about the subject and the teaching methods. But if the teacher just knows the method for instance, if there is no content knowledge, then would be unable to teach I think (PST3).

- Konuyu bilen kendini SSI öğretmek konusunda yeterli görebilir, ama yani tartışma, araştırma, daha farklı şeyler. Elbette ki bilgi sahibi olması lazım; nükleer enerji nedir, işte nasıl elektrik üretilir bunları bilmesi lazım. Ama bunun yanı sıra olaylara biraz daha toplumsal açıdan siyasi açıdan, çevre açısından bakabilmeli öğretmen. Konu bilgisi gerekli ama, yeterli değil. Araştırma yapması gerekiyor çok fazla (PST6).

A person who knows the subject can see himself as efficacious to teach SSI, but, research, discussion… These are different things. Of course, one must be knowledgeable; required to know what nuclear energy is, how electricity is produced. But besides this, the teacher should be able to look at the events a little more socially, politically, environmentally. Subject knowledge is necessary, but not enough. Teacher needs to do a lot of research (PST6).

- Riskli olduğunu düşünen öğretmen GDO'lu gıdalar konusunu öğretmekte ısrarcı olup zaman ayırabilir. Çocukları bilinçlendireceğini düşünerek. Bence faydalı olduğunu düşünen de daha çok zaman ayırabilir çünkü toplumda karşı olanlar var. Bu sefer o da bu algıyı kırmak için daha fazla zaman ayırabilir bu konuya. Yani ikisinin yeterlik inancı da yüksek olabilir bu konuyu öğretmeye dair (PST4).

  The teacher who thinks it is risky insists on teaching GM foods and can allocate time for this; considering that s/he will make students conscious. I think people who think it's useful can spare more time because there are opponents in society. The teacher could devote more time to break this perception. I mean both types of teacher may have high efficacy in regards to teaching this subject (PST4).

- Bence aslında ikisi de çaba sarf edebilir. Çünkü riskli olduğunu düşünen kendi açısından bakıp işte onlar tüketmesinler, kullanmasınlar diye farkındalığı artırmak isteyebilir. Diğeri de bunlar faydalı, sürekli zararlı zararlı diyoruz, bu önyargıyı yıkmak için öğretmek isteyebilir. Aslında ikisinin de özyeterlik inancı yüksek olabilir yani (PST7).

I think both of them can actually make an effort. Because the one who thinks that it is risky, may want to raise awareness so that students do not consume GM foods. The other could say GM foods are useful, and may want to teach to break down the prejudice that GM foods are for sure harmful. In fact, they can both have high efficacy beliefs to teach SSI I mean (PST7).

- Evet riskli olduğunu düşünen daha çok focus olabilir öğretmeye çünkü riskli ve orada çocuklar risk altında yani o konudan kaynaklı. Ben bunu öğreteyim ki bu çocuklar bilinçlensin diye düşünür (PST18).

  Yes, the one who thinks it is risky could more focus on teaching GM foods since that it is risky and and the students are at risk there due to that issue. The teacher would think I shall teach it so these students become conscious (PST18).

- Faydalı olduğunu düşününende zararlı olduğunu düşünene göre biraz daha az çaba olur diye düşünüyorum. Çünkü ona göre faydalıdır, çocuklara söyler böyle böyle diye, kullanırlar kullanmazlar ona kalmış. Faydalı olsa bile açıkçası çok da hayati değil, öyle söyleyim. Ama zararlı olduğunu düşünen bir öğretmen için biraz daha elzem bir durum var ısrar etmek için. Sonuçta zararlı bir durum var ve öğrencilerine bunu bir şekilde öğretmesi, bu konuda bilgilerini artırması gerekiyor diye düşünebilir (PST17).

  I think the one who thinks it is useful makes less effort comparing to the teacher who thinks it is harmful. Because according to this teacher, GM foods might be beneficial, and he/she tells the student as such, they use it or not it is up to them. But for the teacher who thinks it is harmful it is more necessary and essential to insist. As a result, I think there is a harmful situation and the teacher might feel himself responsible to increase his/her students' knowledge about GM foods in some way (PST17).

- Bence riskleri üzerinde yoğunlaşan bir öğretmen daha ısrarcı davranabilir bu konuda. Çünkü zararları olduğunu düşünüyor bu durumun ve bu zararları öğrencilerine öğretmek isteyebilir. Belki riskleri üzerinde duran öğretmen kendini daha yeterli görebilir çünkü GDOlu gıdaların zararları üzerine daha çok kanıt var. Öyle düşünüyorum. Çünkü örneğin ben internette bu konuda araştırma yaptığımda daha çok GDO'lu besinlerin zararlı olduğuna dair bilgiler var. Yararlı olduğuna dair ise az bilgi var. O yüzden bence zararlı olduğunu düşünen elinde daha çok veri olduğu için daha yeterli görebilir kendini (PST1).

  I think the one who focus on risks of GM foods definitely acts more persistent. Because if he thinks it's harmful, he wants to teach its harms to the students. Maybe the one who focus on the risks of GM Foods feels more sufficient. Because there are more evidences on GM Foods' harms. I think so. Because when I search GM Foods on the internet, I see many information about their harms. However, there are only a few information about its' benefits. That's why the one who is thinking they are harmful feels herself more sufficient as he has more evidence (PST1).

- Çünkü hani direkt riskli olduğunu görüyor. Öğretmen, o konuyu anlatmaktan kaçınabilir bile. Yani geçiştirir, hatta bence korkabilir. Çünkü zaten zararlıdır onun için. Hani çocukların da aklını karıştırmayayım der. Öğrencisi için zararlı olan birşeyi onlara anlatmaktan, aktarmaktan kaçınır gibi bir durum olabilir bu. Geleneksel bir yapı… Geçiştirir biraz. Nasıl diyeyim; evet, böyledir, şöyledir ama hani üzerinde çok durmaz konunun (PST14).

Because the teacher sees that there is a direct risk. The teacher can even avoid telling the subject. I mean, he even could be afraid. Because it's already harmful for him. I mean he could say I shall confuse the minds of the students and would avoid telling something that is harmful to them. It's a traditional way of teaching. That is to say, this kind of a teacher would only say it is such and such, but do not allocate time or think over so much on the issue (PST14).

- Riskli olduğunu düşünen öğretmen için, zaten toplumun büyük çoğunluğu ona katılıyor. Evet, riskli, GDO'lu gıdalar riskli diye düşünüyorlar. Bu yüzden hani diğer taraf [faydalı olduğunu düşünen öğretmen], algıyı kırmaya çalışan taraf daha istekli olur diye düşünüyorum (PST15).

For the teacher who thinks it is risky, the vast majority of the community already agrees with him/her. Yes, they think that GM foods are risky. That is why I think that the other side [the teacher who thinks it is useful] will be more willing to try to break the perception (PST15).

- Konunun toplumsal bakış açısına göre değişir bu. Mesela Türkiye'de sokaktan on kişiyi çevirdiğimizde, dokuzu GDO'lu gıdaların zararlı olduğunu söyler. Çünkü gazetelerde falan hep çıkan şey evet, genetiği değiştirilmiş organizmalar bize zarar veriyor şeklinde. Bu yüzden faydalı olduğunu düşünen öğretmen, bu konuyu öğretmekte daha ısrarcı olabilir diye düşünüyorum. Çünkü var olan toplumsal algıyı yıkmaya çalışacaktır. Riskli olduğunu düşünen de öğretmek için çaba sarf eder ama diğeri kadar ısrarcı olacağını düşünmüyorum açıkçası (PST15).

It depends on the point of view that society possesses. For example, when we turn and stop 10 people in Turkey, nine out of them says GM foods are harmful. Because it is the thing that always comes out in the newspapers yes, in the way saying GM foods are harming us. So I think that the teacher who thinks it is beneficial may be more persistent in teaching this topic. Because s/he would try to break the existing social perception. I think that the person who thinks it is risky also tries to teach, but I do not think would be as insistent as the other (PST15).

APPENDIX N

TURKISH SUMMARY / TÜRKÇE ÖZET

FEN BİLGİSİ ÖĞRETMEN ADAYLARININ SOSYOBİLİMSEL KONULARIN ÖĞRETİMİNE YÖNELİK ÖZ-YETERLİK İNANÇLARI VE BU İNANÇLARIN BİLGİ DÜZEYİ, RİSK VE FAYDA ALGISI VE KİŞİSEL EPİSTEMOLOJİK İNANÇLAR İLE İLİŞKİSİ

Giriş

Bilim ve teknoloji ile ilgili sosyal konuların toplumların ilgisini çekmeye başlaması ile birlikte sosyobilimsel konuların fen eğitimine entegre edilmesi fikri önemli bir ihtiyaç olarak düşünülmeye başlanmıştır (Christensen & Fensham, 2012). Bu amaçla, geçmişte birçok kez sosyal konuları bilimsel bağlamda entegre etmeyi amaçlayan öğretim programları geliştirilmeye çalışılmıştır (Sadler & Dawson, 2012). Bilim-Teknoloji-Toplum ve Bilim-Teknoloji-Tolum-Çevre öğretim programlarından sonra ortaya çıkan sosyobilimsel konuların (SBK) öğretimi, bu öğretim programlarından en güncel olanıdır. SBK öğretimi ile öğrencilerin bilimsel ve sosyal boyutları olan ve zaman zaman öğrencilerin kendi inançları ile ters düşen ahlaki ve etik konuları tartışabilmesi amaçlanmaktadır (Zeidler, Sadler, Applebaum, & Callahan, 2009). Bilimin ahlaki, etik ve epistemolojik boyutlarını kapsamasının yanı sıra SBK öğretimi, sosyokültürel kuramlar ve durumlu öğrenme perspektifleri gibi gelişimsel psikoloji, sosyoloji, ve felsefe disiplinlerinden oluşan kuramsal bir çerçeve üzerine oturmaktadır (Sadler & Dawson, 2012).

SBK, 'bilimsel kavramlar veya problemlerden temel alan, politik ve sosyal etkilere maruz kalan ve toplumda tartışılmaya devam eden konular' (Sadler & Zeidler, 2005, p. 113) olarak tanımlanmaktadır. Bu konular kesin çözümleri olmayan ucu açık problemlerdir (Sadler, 2004; Sadler & Zeidler, 2005). Genetiği mühendisliği, çevresel problemler, nükleer enerji ve cep telefonu kullanımının örnek olarak verilebileceği bu konular, bireylerin gündelik hayatlarında kolayca karşılaşabileceği sorunlardır.

Literatürde yer alan araştırmalar SBK'nın birçok nedenden dolayı fen eğitiminin bir parçası olması gerektiğini savunmaktadır. Araştırmacılara göre, SBK'nın fen eğitiminde yer almasının toplumun fene olan ilgisinin artırması (Zeidler ve diğerleri, 2005), öğrencilerin fene karşı motivasyon ve ilgisinin artması (Dori, Tal, & Tsaushu, 2003; Lee & Erdogan, 2007; Yager, Lim, & Yager, 2006), vatandaşlık eğitimi (Sadler, Barab, & Scott, 2007) ve toplumun bilimi anlamasına katkı sağlaması (Kolsto, 2001), öğrencilerin bilimin doğasını anlamalarını kolaylaştırması (Khishfe & Lederman, 2006; Walker & Zeidler, 2007) ve argümantasyon becerilerini geliştirmesi (Grace, 2009; Pedretti, 1999; Zohar & Nemet, 2002) gibi birçok faydası vardır. SBK'ın fen eğitimine dahil edilmesini savunan araştırmacılar tüm bu potansiyel kazanımların gelecek nesillerin bilinçli karar verme becerilerini geliştireceğini ve bu durumun da onların bilimsel okuryazarlığını artıracağını öne sürmektedirler (Sadler, Amirshokoohi, Kazempour, & Allspaw, 2006; Zeidler ve diğerleri, 2005).

Tüm bunlara rağmen, yapılan araştırmalar göstermiştir ki, fen öğretmenleri tartışmalı konuları düzenli bir şekilde sınıflarına dahil etmek fikrine oldukça uzaktırlar (Lee, Abd-El-Khalick, & Choi, 2006; Sadler ve diğerleri, 2006). Öte yandan reform çalışmalarının başarılı bir şekilde uygulanabilmesi büyük ölçüde öğretmen inançlarına ve eğilimlerine bağlıdır (Bybee, 1993; Lumpe, Haney, & Czerniak, 2000; Knoblauch & Woolfolk-Hoy, 2008). Fen eğitiminde SBK öğretiminin genişletilmesi gerektiği ve öğretmenlerin öz-yeterlik inançlarının bu noktada büyük öneme sahip olduğu düşünüldüğünde, bu çalışmada fen bilgisi öğretmen adaylarının SBK'ların öğretimine yönelik öz-yeterlik inançları araştırılmıştır. Geniş bir literatür taramasının sonucunda, kişisel epistemolojik inançların, içerik bilgisinin, ve risk ve fayda algısının SBK'ların öğretimine yönelik öz-yeterlik inançları ile ilişkili olabileceği düşünülmüştür. Bunun yanı sıra, kişisel epistemolojik inançlar, bilgi düzeyi ve risk ve fayda algısı değişkenlerinin birbirleri ile ilişkili olabileceği öne sürülmektedir; kişisel epistemolojik inançların risk ve fayda algısı ile içerik bilgisi ile ilişkili olduğu, içerik bilgisinin de risk ve fayda algısı ile ilişkili olduğu düşünülmektedir. Bu çalışmada, tüm bu ilişkileri içeren bir model öne sürülmüş ve test edilmiştir. Test edilen bu ilişkiler ile ilgili detaylı bilgi elde etmek amacıyla nicel verilerin yanı sıra nitel veriler de kullanılmıştır. Bu amaçla, katılımcılara SBK'ların öğretimine yönelik öz-yeterlik inançları ve diğer değişkenlerle ilgili birçok soru yöneltilmiştir. Çalışmanın uygulanabilirliği için nitel veri toplama sürecinde yalnızca öz-yeterlik inancı ve diğer üç değişken arasındaki doğrudan ilişkilere odaklanılmıştır. Bu çalışmada, SBK olarak GDO'lu gıdalar konusu seçilmiştir.

Çalışmanın Amacı ve Araştırma Soruları

Bu çalışmanın amacı fen bilgisi öğretmen adaylarının GDO'lu gıdalar konusunun öğretimine yönelik öz-yeterlik inançları ile kişisel epistemolojik inançlar, GDO'lu gıdalar risk ve fayda algısı ve GDO'lu gıdalar hakkındaki bilgi düzeyi arasındaki ilişkiyi araştırmaktır. Çalışmada yer alan araştırma soruları şunlardır:

1. Fen bilgisi öğretmen adaylarının GDO'lu gıdalar konusunun öğretimine yönelik öz-yeterlik inançları, kişisel epistemolojik inançları, GDO'lu gıdalar risk ve fayda algıları ve GDO'lu gıdalar hakkındaki bilgi düzeyleri nelerdir?

2. Fen bilgisi öğretmen adaylarının GDO'lu gıdalar konusunun öğretimine yönelik öz-yeterlik inançları ile sırasıyla kişisel epistemolojik inançları, GDO'lu gıdalar risk ve fayda algıları ve GDO'lu gıdalar hakkındaki bilgi düzeyleri arasındaki direkt ilişkiler nelerdir?

3. Fen bilgisi öğretmen adaylarının kişisel epistemolojik inançları, GDO'lu gıdalar risk ve fayda algıları ve GDO'lu gıdalar hakkındaki bilgi düzeyleri arasındaki direkt ilişkiler nelerdir?

4. Nicel modelde ortaya çıkan GDO'lu gıdalar konusunun öğretimine yönelik öz-yeterlik inançları ve diğer değişkenler arasındaki ilişkileri açıklayan faktörler nelerdir?

Modelde Yer Alan İlişkiler

Yukarıda bahsedildiği gibi, öne sürülen model, SBK'ların öğretimine yönelik öz-yeterlik inançları, kişisel epistemolojik inançlar, içerik bilgisi ve risk ve fayda algısı olmak üzere dört ana değişken içermektedir. Modelde, SBK'ların öğretimine yönelik öz-yeterlik inançları ve kişisel epistemolojik inançlar değişkenleri bazı alt boyutlar ile yer almaktadır. SBK'ların öğretimine yönelik öz-yeterlik inançları değişkenine ait üç tane alt boyut vardır: GDO'lu gıdalar konunun öğretimine yönelik genel öğretim stratejileri, GDO'lu gıdaların öğretimi sonuç beklentisi inançları ve GDO'lu gıdalar ile ilgili argümantasyon ve karar vermenin teşvik edilmesine dair inançlar. Kişisel epistemolojik inançlar ise beş farklı alt boyuta sahiptir: "öğrenme hemen gerçekleşir" (Quick learning; QL), "öğrenme yeteneği doğuştandır" (Innate ability; IA), "bilgi basittir" (Simple knowledge; SK), "bilgi kesindir" (Certain knowledge; CK) ve "bilginin kaynağı her şeyi bilen otoritedir" (Omniscient authority; OA) (bkz. Figür N.1).

Bu model, spesifik olarak kişisel epistemolojik inançların alt boyutları, ("öğrenme hemen gerçekleşir", "öğrenme yeteneği doğuştandır", "bilgi basittir", "bilgi kesindir" ve "bilginin kaynağı her şeyi bilen otoritedir"), GDO'lu gıdalar risk ve fayda algısı ve GDO'lu gıdalar konusundaki bilgi düzeyi değişkenlerinin katılımcıların GDO'lu gıdalar konunun öğretimine yönelik genel öğretim stratejileri, GDO'lu gıdaların öğretimi sonuç beklentisi inançları ve GDO'lu gıdalar üzerine argümantasyon ve karar vermeyi teşvik etmeye dair inançları ile doğrudan ilişkili olduğunu öne sürmektedir. Bu modelde ayrıca kişisel epistemolojik inançlar değişkenine ait alt boyutların GDO'lu gıdalar konusundaki bilgi düzeyleri ve GDO'lu gıdalar risk ve fayda algısı değişkenleri ile doğrudan ilişkili olduğu öne sürülmektedir. Son olarak, modelde

GDO'lu gıdalar konusundaki bilgi düzeyinin GDO'lu gıdalar risk ve fayda algısı değişkeni ile doğrudan ilişkili olduğu öne sürülmektedir.

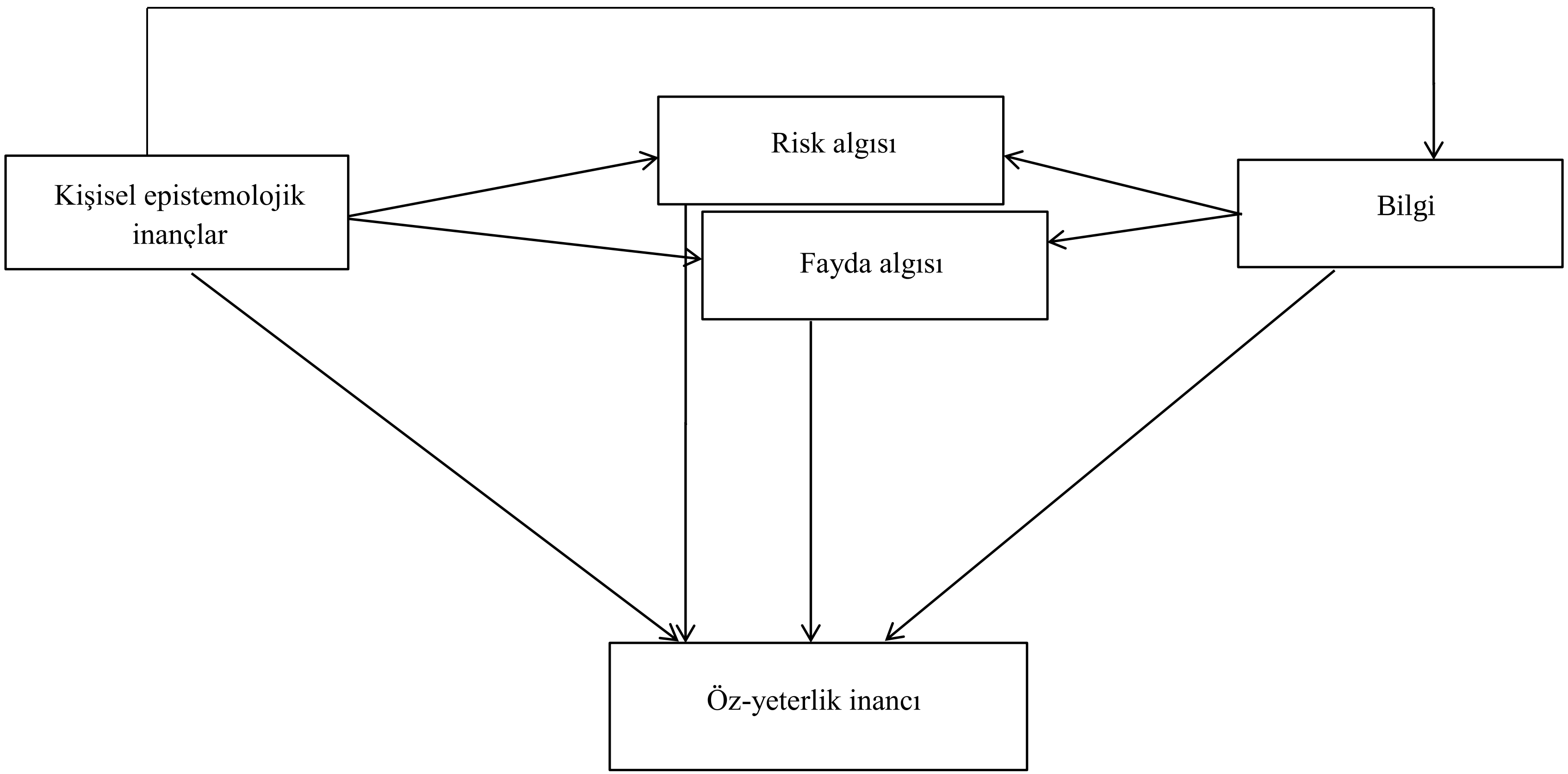


Figure N.1 Öne sürülen ilişkilerin modeli

Yöntem

Karma araştırma deseninin kullanıldığı bu çalışmada nicel ve nitel veriler toplanmıştır. Çalışmanın nicel kısmına katkı sunan katılımcılar Türkiye'nin İç Anadolu Bölgesi'ndeki dokuz devlet üniversitesinin üçüncü ve dördüncü sınıflarında öğrenim görmekte olan fen bilimleri öğretmen adayları arasından seçilmiştir. Örneklem seçme yöntemi olarak uygun örnekleme kullanılmıştır. Nitel kısımda yer alan katılımcılar ise Ankara'da yer alan bir devlet üniversitesinin dördüncü sınıfında öğrenim görmekte olan fen bilimleri öğretmen adayları arasından ölçüt örnekleme yöntemi kullanılarak seçilmiştir. Temel alınan ölçüt ise SBK'nın öğretimi ile ilgili olan ve katılımcıların öğrenim gördüğü üniversitede veriliyor olan bir lisans dersini almış olmaktır. Çalışmanın nicel kısmına 1077 (N_{erkek}= 208, $N_{kadın}$= 869), nitel kısmına ise 21 öğretmen adayı katılmıştır. Katılımcılarla ilgili detaylı bilgiler Tablo N.1'de gösterilmiştir.

Table N.1

Katılımcıların Demografik Özellikleri

Değişken	*f*	%
Cinsiyet		
Erkek	208	19.3
Kadın	869	80.7
Sınıf seviyesi		
Üçüncü sınıf	428	39.9
Dördüncü sınıf	644	60.1
Cevapsız	5	
Anne eğitim düzeyi		
Okuma-yazma bilmiyor	54	5.0
İlkokul	556	51.8
Ortaokul	204	19.0
Lise	184	17.1
Üniversite	70	6.5
Yüksek lisans	5	0.5
Doktora	0	0
Cevapsız	4	
Baba eğitim düzeyi		
Okuma-yazma bilmiyor	3	0.3
İlkokul	325	30.5
Ortaokul	204	19.2
Lise	289	27.2
Üniversite	229	21.5
Yüksek lisans	11	1.0
Doktora	3	0.3
Cevapsız	13	

Table N.1 (Devamı)

Değişken	*f*	%
Çocukluğun geçtiği bölge		
Köy/ Kasaba	124	11.6
İlçe	267	24.9
Şehir merkezi	301	28.1
Büyükşehir	379	35.4
Cevapsız	6	

Veri Toplama Araçları

Bu çalışmada nicel verilerin toplanması amacıyla beş farklı ölçme aracı kullanılmıştır. Bu ölçme araçları şunlardır: Demografik Bilgiler Anketi, GDO'lu Gıdalar Konusunun Öğretimi Öz-yeterlik İnancı Ölçeği, GDO'lu Gıdalar Bilgi Ölçeği, GDO'lu Gıdalar Risk ve Fayda Algısı Ölçeği ve Epistemolojik İnançlar Envanteri. Nicel veri toplama araçları ile ilgili detaylı bilgi Tablo N.2'de verilmiştir. Bunların yanı sıra, bu çalışmada nitel verilerin toplanması amacıyla Öğretmen Adayı Görüşme Protokolü kullanılmıştır. Epistemolojik İnançlar Envanteri dışındaki tüm veri toplama araçları bu çalışma kapsamında geliştirilmiştir. Veri toplama araçlarının geliştirilmesi süreci birçok aşamadan oluşmaktadır. Her bir ölçme aracı için ilk aşamada maddeler belirlenmiş ve çevirileri yapılmış, sonrasında ise uzman görüşleri alınmıştır. Son hali verilen ölçme araçları pilot uygulamadan geçirilmiş ve gerekli revizyonlar yapıldıktan sonra ana çalışmada kullanılmıştır. Ana çalışmada elde edilen veriler ile öncelikle açımlayıcı faktör analizi yapılmış ve sonrasında doğrulayıcı faktör analizi yapılmıştır. Aşağıdaki kısımda, her bir ölçme aracı ile ilgili daha detaylı bilgiler verilmektedir.

Demografik Bilgiler Anketi. Demografik Bilgiler Anketi, araştırmacı tarafından geliştirilmiş olan ve katılımcıların cinsiyet, sınıf düzeyi, not ortalaması, ebeveyn eğitim düzeyi, çocukluğun geçtiği bölge gibi bilgiler ile GDO'lu gıdalarla ilgili birtakım genel sorulara verecekleri cevapları ortaya çıkarmak için kullanılmıştır.

Tablo N.2

Nicel Veri Toplama Araçları ve Ölçülen Değişkenler

Ölçme aracı	Değişken	Maddelerin seçildiği referanslar
Demografik Bilgiler Anketi	Cinsiyet Sınıf düzeyi Not ortalaması Çocukluğun geçtiği bölge Ebeveyn eğitim düzeyi GDO'lu gıdalarla ilgili genel sorular	Araştırmacı tarafından geliştirilmiştir.
GDO'lu Gıdalar Konusunun Öğretimi Öz-yeterlik İnancı Ölçeği	GDO'lu gıdaların öğretimine yönelik genel öğretim stratejileri GDO'lu gıdaların öğretimi sonuç beklentisi GDO'lu gıdalar ile ilgili argümantasyon ve karar vermenin teşvik edilmesi	Baltaci ve Kilinc (2014) (madde 21, 22, 24) Enochs ve Rigss (1990) (madde 2-5, 7-12, 25-34) Kilinc ve diğerleri (2013) (madde 1, 6, 13-19, 23) Yeni madde (madde 20)

Tablo N.2 (Devamı)

Ölçme aracı	Değişken	Maddelerin seçildiği referanslar
GDO’lu Gıdalar Bilgi Ölçeği	GDO’lu gıdalar konusundaki bilgi düzeyi	Verdurme ve Viaene (2003) (madde 1-5) Frewer (1997) (madde 6-9) Sjöberg (2008) (madde 10, 11, 12) European Comission (2006) (madde 14,15) Yeni madde (madde 13, 16, 17)
GDO’lu Gıdalar Risk ve Fayda Algısı Ölçeği	GDO’lu gıdalar risk algısı GDO’lu gıdalar fayda algısı	Bredahl (2001) (maddeler 1-3, 10-12, 15-17, 21, 25, revize maddeler 8 ve 18) Frewer ve diğerleri 1997 (maddeler 4-6) Sjöberg, 2008 (revize maddeler 13, 20, 22-24) Yeni madde (maddeler 7, 9, 14)

Tablo N.2 (Devamı)

Ölçme aracı	Değişken	Maddelerin seçildiği referanslar
Epistemolojik İnançlar Envanteri	Öğrenme hemen gerçekleşir	Bendixen, Schraw ve Dunkle (1998)
	Öğrenme yeteneği doğuştandır	(Tüm maddeler)
	Bilgi basittir	
	Bilgi kesindir	
	Bilginin kaynağı her şeyi bilen otoritedir	

GDO'lu Gıdalar Konusunun Öğretimi Öz-yeterlik İnancı Ölçeği. Tablo N.2'de belirtildiği üzere, çalışma kapsamında geliştirilen bu ölçekte çeşitli madde kaynakları kullanılarak (Baltaci & Kilinc, 2014; Enochs & Rigss, 1990; Kilinc ve diğerleri, 2013) ve araştırmacı tarafından da bazı maddeler oluşturularak ölçeğin son hali elde edilmiştir. 5li Likert tipindeki bu ölçekte toplamda 34 madde yer almıştır ve her bir madde için uzman görüşü alınmıştır.

Çalışmanın asıl verileri toplandıktan sonra pilot çalışmada elde edilen faktör yapısını doğrulamak için öncelikle asıl verinin yarısı kullanılarak ana bileşen analizi ile açımlayıcı faktör analizi yapılmış, sonrasında ise verilerin kalan yarısı ile doğrulayıcı faktör analizi yapılmıştır. Pilot analize benzer olarak açımlayıcı faktör analizi sonucu toplamda üç faktör elde edilmiştir. Madde 28, 31, 6, 7, 29, 13 ve 11 ölçekten çıkarılmıştır. Faktör yapısı ve yüklerinin son haline ilişkin bilgiler Tablo N.3'te gösterilmiştir. Açımlayıcı faktör analizi sonucu elde edilen üç faktörlü yapının doğrulanması amacıyla doğrulayıcı faktör analizi yapılmıştır. Elde edilen verilere göre (χ^2/df = 2.82, GFI = .89, AGFI = .87, CFI = .90, RMSEA = .05, RMR = .03, SRMR = .04) verinin iyi bir model uyumu gösterdiği ortaya çıkmıştır. Asıl very analizine göre güvenirlik alfa değerleri her bir alt boyut için sırasıyla .89, .85 ve .75 olarak hesaplanmıştır.

Table N.3

GDO'lu Gıdalar Konusunun Öğretimi Öz-yeterlik İnancı Ölçeği Asıl Çalışma Faktör Yapısı

	Faktör yükleri		
Madde	Faktör 1	Faktör 2	Faktör 3
22	**.735**	-.021	.016
15	**.715**	.020	.063
20	**.706**	-.032	.005
19	**.705**	.059	-.039
21	**.681**	-.036	-.008
17	**.659**	.020	-.057
24	**.628**	-.048	.110
23	**.624**	-.063	.134
18	**.623**	.074	-.087
16	**.604**	.047	.051
14	**.530**	.005	.179
8*	-.120	**.775**	-.028
4*	.034	**.721**	-.064
2*	-.101	**.696**	.000
10*	.172	**.644**	-.063
9*	-.001	**.592**	-.107
3	.037	**.577**	.178
12*	.187	**.571**	-.015
1	.206	**.452**	.109
5	.195	**.421**	.125
34	-.098	.100	**.720**
33	.019	.053	**.710**
30	-.027	-.001	**.637**
32	-.168	.002	**.632**

* Ters kodlanmış

Table N.3 (Devamı)

	Faktör yükleri		
Madde	Faktör 1	Faktör 2	Faktör 3
25	.098	-.113	**.607**
26	.187	.016	**.555**
27	.119	-.065	**.477**

* Ters kodlanmış

Epistemolojik İnançlar Envanteri. Epistemolojik İnançlar Envanteri ilk olarak 32 maddeden oluşacak şekilde geliştirilmiş olup (Bendixen, Schraw, & Dunkle, 1998; Schraw, Dunkle, & Bendixen, 1995) sonrasında Schraw, Bendixen, ve Dunkle (2002) tarafından 28 maddelik versiyonu geliştirilmiştir. Bu çalışmada, 32 maddelik envanter kullanılmıştır. Bu ölçme aracının Türkçe'ye Tuncay-Yuksel, Yilmaz-Tuzun ve Zeidler (2015) tarafından yapılan çevirisi kullanılmış; fakat maddelerde değişiklik yapıldığından dolayı tekrar uzman görüşü alınıp envantere son hali verilmiştir. 5li Likert tipinde geliştirilen bu ölçme aracından elde edilen yüksek puanlar gelişmemiş epistemolojik inancın göstergesi iken daha düşük puanlar gelişmiş epistemolojik inancın belirtisi olarak kabul edilmektedir.

Çalışmanın asıl verileri toplandıktan sonra pilot çalışmada elde edilen faktör yapısını doğrulamak için öncelikle asıl verinin yarısı kullanılarak ana bileşen analizi ile açımlayıcı faktör analizi yapılmış, sonrasında ise verilerin kalan yarısı ile doğrulayıcı faktör analizi yapılmıştır. Pilot analize benzer olarak açımlayıcı faktör analizi sonucu toplamda üç faktör elde edilmiştir. Madde 1, 2, 4, 6, 7, 9, 14, 15, 19, 20, 22, 24, 27, 28, 30 ve 31 ölçekten çıkarılmıştır. Faktör yapısı ve yüklerinin son haline ilişkin bilgiler Tablo N.4'te gösterilmiştir. Açımlayıcı faktör analizi sonucu elde edilen üç faktörlü yapının doğrulanması amacıyla doğrulayıcı faktör analizi yapılmıştır. Elde edilen verilere göre (χ^2/df = 2.61, GFI = .94, AGFI = .92, CFI = .86, RMSEA = .05, RMR = .06, SRMR = .05). verilerin iyi bir model uyumu gösterdiği ortaya çıkmıştır. Asıl very analizine göre güvenirlik alfa değerleri her bir alt boyut için sırasıyla .89, .85 ve .75 olarak hesaplanmıştır.

Table N.4

Epistemolojik İnançlar Envanteri Asıl Çalışma Faktör Yapısı

	Faktör yükleri		
Madde	Faktör 1	Faktör 2	Faktör 3
25	**.667**	.006	-.080
21	**.666**	.057	.045
16	**.639**	-.031	.011
29	**.557**	-.055	.208
3	**.516**	.219	.011
23	**.499**	-.023	-.051
5	-.152	**.692**	-.130
26	-.115	**.678**	-.046
32	.264	**.600**	.010
17	.320	**.525**	.051
8	-.207	**.521**	.121
12	-.050	**.506**	.217
10	-.134	-.045	**.702**
13	-.103	-.080	**.666**
11	.031	.049	**.594**
18	.205	.116	**.581**

GDO'lu Gıdalar Risk ve Fayda Algısı Ölçeği. Bu çalışma kapsamında geliştirilen GDO'lu Gıdalar Risk ve Fayda Algısı Ölçeğin'de yer alan maddelerin bir kısmı farklı kaynaklardan alınmış (Bredahl, 2001; Frewer, Howard, & Shepherd, 1997; Sjöberg, 2008), bir kısmı ise araştırmacı tarafından yazılmıştır. 5li Likert tipinde olan bu ölçekte bulunan ve farklı kaynaklardan alınan maddeler öncelikle Türkçe'ye çevrilmiş ve ölçeğin son hali için dil ve içerik bakımından uzman görüşü alınmıştır. Ölçeğin geliştirilen ilk halinde 25 madde bulunmaktadır.

Çalışmanın asıl verileri toplandıktan sonra pilot çalışmada elde edilen faktör yapısını doğrulamak için öncelikle asıl verinin yarısı kullanılarak ana bileşen analizi ile açımlayıcı faktör analizi yapılmış, sonrasında ise verilerin kalan yarısı ile doğrulayıcı faktör analizi yapılmıştır. Pilot analize benzer olarak açımlayıcı faktör analizi sonucu toplamda iki faktör elde edilmiştir. Faktör yapısı ve yüklerinin son haline ilişkin bilgiler Tablo N.5'te gösterilmiştir. Açımlayıcı faktör analizi sonucu elde edilen iki faktörlü yapının doğrulanması amacıyla doğrulayıcı faktör analizi yapılmıştır. Elde edilen verilere göre (χ^2/df = 5.75, GFI = .89, AGFI = .85, CFI = .87, RMSEA = .08, RMR = .07, SRMR = .08). verinin iyi bir model uyumu gösterdiği ortaya çıkmıştır. Asıl veri analizine göre güvenirlik alfa değerleri her bir alt boyut için sırasıyla .83 ve .81 olarak hesaplanmıştır.

Tablo N.5

GDO'lu Gıdalar Risk ve Fayda Algısı Ölçeği Asıl Çalışma Faktör Yapısı

Factor loading		
Item number	Factor 1	Factor 2
5	**.800**	.146
6	**.686**	.209
16	**.671**	-.261
4	**.646**	.080
15	**.636**	-.235
10	**.625**	-.002
12	**.553**	-.239
17	**.510**	-.281
21	**.452**	-.246
24	.043	**.879**
23	.014	**.840**
22	.052	**.767**
3	-.029	**.543**
2	-.279	**.507**

GDO'lu Gıdalar Bilgi Ölçeği. Bu çalışma kapsamında geliştirilen ölçekte yer alan maddeler büyük ölçüde belirlenen bir madde havuzundan (European Comission, 2006; Frewer, 1997; Sjöberg, 2008; Verdurme & Viaene, 2003) seçilmiştir. Bunun yanı sıra, ölçekte, araştırmacı tarafından yazılan maddeler de yer almaktadır. Madde havuzundan seçilen maddeler öncelikle Türkçe'ye çevrilmiştir ve tüm maddeler için hem dil hem de içerik konusunda uzman görüşü alınmıştır. Çalışmanın katılımcılarından verilen maddeleri doğru, yanlış veya bilmiyorum seçeneklerinden birini tercih ederek cevaplamaları beklenmiştir. Pilot analizi sonucu elde edilen veriler doğrultusunda maddelerden birisi ölçekten çıkarılmış, bir diğeri ise revize edilmiştir. Ölçeğin son halinde toplamda 17 madde yer almıştır. Katılımcıların verdiği doğru yanıtların her birine 1 puan verilmiş, verilen yanlış yanıtlar ve bilmiyorum şeklinde işaretlenen yanıtlar ise 0 olarak kodlanmıştır. Elde edilen toplam puan katılımcıların GDO'lu gıdalar konusundaki bilgi düzeyini belirlemiştir. GDO'lu Gıdalar Bilgi Ölçeği'ne ait güvenirlik puanı 0.73 olarak hesaplanmıştır.

Öğretmen Adayı Görüşme Protokolü. Bu çalışmada, nicel veri toplama araçlarının yanı sıra, nitel bir veri toplama aracı olan Öğretmen Adayı Görüşme Protokolü kullanılmıştır. Bu protokol, araştırmacı taafından oluşturulmuş olup, katılımcıların GDO'lu konuların öğretimine yönelik öz-yeterlik inançlarını ve bu inançların kişisel epistemolojik inançlar, GDO'lu gıdalar risk ve fayda algısı ve GDO'lu gıdalar bilgi düzeyi ile olan ilişkisini ortaya çıkarmayı hedeflemektedir. Protokolün geliştirilme sürecinde alan uzmanlarından görüş alınmış, bunun yanı sıra görüşme yapılacak olan katılımcıların bazıları ile öngörüşmeler yapılmış ve soruların anlaşılabilirliği üzerine geri-dönütler alınmıştır. Yarı-yapılandırılmış olan bu görüşme protokolünde toplamda 16 soru yer almaktadır. Bu sorulardan altı tanesi katılımcıların GDO'lu konuların öğretimine yönelik öz-yeterlik inançlarını ortaya çıkarmayı hedeflerken, kalan on soru ile katılımcıların, GDO'lu konuların öğretimine yönelik öz-yeterlik inançları ve sırasıyla kişisel epistemolojik inançlar, GDO'lu gıdalar risk ve fayda algısı ve GDO'lu gıdalar bilgi düzeyi ile olan ilişkisine dair görüşlerini ortaya çıkarmayı hedeflemektedir.

Verilerin Analizi

Bu çalışmada, verilerin analizi iki ana bölümden oluşmaktadır: nicel veri analizi ve nitel veri analizi. Nicel verilerin analiz için ön analizler, betimsel ve çıkarımsal analizlerden faydalanılmıştır. Nicel veri analizi için IBM SPSS Statistics 22 ve IBM AMOS 21 programları kullanılmıştır. Doğrulayıcı faktör analizi ve yol analizinde kullanılan uyum indekseleri Tablo N.6'da gösterilmiştir. Nitel veri analizi için QSR Nvivo 10 for Windows programından faydalanılmıştır. Elde edilen tüm ses kayıtları birebir deşifre edilmiştir ve görüşme sorularına verilen yanıtlar sabit karşılaştırma yöntemi (Glaser & Strauss, 1967) ile analiz edilmiştir.

Tablo N.6

Çalışmada Kullanılan Model Uyum İndeksleri

Model Uyum İndeksi		İyi Uyum
Chi-square	χ^2	Mümkün olduğunca küçük
Degrees of Freedom	df	-
Normed Chi-square Fit Index	χ^2/ df (CMIN/df)	≤ 2[a] to 5[b]
Goodness of Fit Index	GFI	≥ .90[b]
Adjusted Goodness of Fit Index	AGFI	≥ .90[b]
Comparative Fit Index	CFI	≥ .90[a,b]
Root Mean Square Error of Approximation	RMSEA	≤ .05[b] to .10[a]
Root Mean Square Residual	RMR	≤ .08[c] to .10[d]
Standardized Root Mean Square Residual	SRMR	≤ .08[c] to .10[d]

**Kaynak:* [a] Tabachnick & Fidell (2007), [b] Sumer (2000), [c] Hu & Bentler (1999), [d] Kline (2011)

Bulgular

Bu çalışmada, temel olarak, fen bilgisi öğretmen adaylarının GDO'lu gıdalar konusunun öğretimi öz-yeterlik inançları ve bu inançların onların kişisel epistemolojik inançları, GDO'lu gıdalar risk ve fayda algıları ve GDO'lu gıdalar bilgi düzeyi ile ilişkisinin incelenmesi amaçlanmıştır. Bunun yanı sıra, kişisel epistemolojik inançlar, GDO'lu gıdalar risk ve fayda algısı ve GDO'lu gıdalar bilgi düzeyi değişkenlerinin arasındaki ilişki de incelenmiştir. Bu amaçla, bu çalışmada istatistiksel bir model öne sürülmüştür. Bu bağlamda, belirtilen değişkenlere ait nicel veriler toplanmış, sonrasında da görüşme soruları aracılığı ile nitel veriler toplanmıştır. Nicel veri analizi öncesi ön veri analizi yapılmış, veri setinin analize uygunluğu test edilmiştir. Nicel veriler ile katılımcıların GDO'lu konuların öğretimine yönelik öz-yeterlik inançları ve bu inançların modelde yer alan diğer üç değişken (kişisel epistemolojik inançlar, GDO'lu gıdalar risk ve fayda algısı, GDO'lu gıdalar bilgi düzeyi) ile doğrudan olan ilişkileri hakkında daha detaylı bilgilerin elde edilmesi amaçlanmıştır. Aşağıdaki bölümlerde, katılımcıların nicel ve nitel veri toplama araçlarına verdikleri cevaplar, betimsel analizler ve öne sürülen modele yönelik analizler olarak iki başlık altında sunulmuştur.

Betimsel Analizler

GDO'lu Gıdalar Konusunun Öğretimi Öz-yeterlik İnancı. Bu çalışmada, katılımcıların GDO'lu gıdalar konusunun öğretimi öz-yeterlik inancı hem nitel hem de nicel olarak ölçülmüştür. Tablo N.7'de gösterildiği gibi, fen bilgisi öğretmen adaylarının GDO'lu gıdaların öğretimine yönelik sahip oldukları öz-yeterlik inançları kısmen yüksek düzeydedir, ortalama değerler 3.89 ile 3.56 arasındadır. Görüşme sonucu elde edilen nitel verilerin analiz sonuçları GDO'lu gıdalar konusunun öğretimi öz-yeterlik inancı konusunda farklı boyutlar açığa çıkarmıştır. GDO'lu gıdalar konusunun öğretimi öz-yeterlik inancı teması altında elde edilen veriler toplamda sekiz ana kategoride toplanmıştır. Bu kategoriler: GDO'lu gıdalar konusunun öğretimi kişisel öz-yeterlik inancı, öğrencilerin SBK öğreniminin değerlendirilmesi, SBK tartışma ortamlarının oluşturulması, SBK'nın doğasının öğretimi, SBK derslerinde sınıf yönetimi, SBK derslerinde zaman yönetimi, öğretmen telkini, SBK ve SBK'nın öğretimi ile ilgili sahip olunan yanlış bilgiler.

Table N.7

GDO'lu Gıdalar Konusunun Öğretimi Öz-yeterlik İnancı Betimsel Analiz Sonuçları

Boyutlar	*M*	*SD*	*Min*	*Max*
GDO'lu gıdalar ile ilgili argümantasyon ve karar vermenin teşvik edilmesine dair inançlar	3.89	0.49	1.36	5.00
GDO'lu gıdalar konunun öğretimine yönelik genel öğretim stratejileri	3.68	0.57	1.78	5.00
GDO'lu gıdaların öğretimi sonuç beklentisi inançları	3.56	0.58	1.00	5.00

Kişisel Epistemolojik İnançlar. Tablo N.8'de de gösterildiği üzere, elde edilen en yüksek ortalama değer "Öğrenme yeteneği doğuştandır" boyutunda olmuştur. Bu sonuç, katılımcıların sahip olduğu en gelişmemiş epistemolojik inancın "Öğrenme yeteneği doğuştandır" boyutuna ait olduğunu ortaya koymaktadır. Öte yandan, çalışmaya katılan fen bilgisi öğretmen adaylarının "Öğrenme hemen gerçekleşir ve Bilgi kesindir" alt boyutu hakkındaki inançlarına ait ortalama değerin en düşük ortalama değer olduğu görülmüştür. Bu sonuç göstermiştir ki, bu çalışmanın katılımcıların "Öğrenme hemen gerçekleşir ve Bilgi kesindir" alt boyutuna dair inançları, diğer epistemolojik inançlara nazaran daha gelişmiştir.

Table N.8

Kişisel Epistemolojik İnançlar Betimsel Analiz Sonuçları

Boyutlar	*M*	*SD*	*Min*	*Max*
Öğrenme hemen gerçekleşir ve Bilgi kesindir	2.12	0.60	1.00	4.50
Öğrenme yeteneği doğuştandır	3.34	0.65	1.00	5.00
Bilgi basittir	3.30	0.68	1.00	5.00

GDO'lu gıdalar risk ve fayda algısı. Tablo N.9'da gösterildiği üzere, betimsel analiz sonuçlarına göre, çalışmaya katılan fen bilgisi öğretmen adaylarının fayda algısı maddelerine verdikleri cevapların ortalaması 2.56 olarak hesaplanmıştır. Risk algısına ait ortalama değer ise 3.83'tür. Elde edilen sonuçlara göre, katılımcılar GDO'lu gıdalar hakkında yüksek risk algısına sahipken, nispeten yüksek bir düzeyde de fayda algısına sahiptirler.

Table N.9

GDO'lu Gıdalar Risk ve Fayda Algısı Betimsel Analiz Sonuçları

Boyutlar	*M*	*SD*	*Min*	*Max*
GDO'lu gıdalar fayda algısı	2.56	0.66	1.00	5.00
GDO'lu gıdalar risk algısı	3.83	0.71	1.00	5.00

GDO'lu Gıdalar Bilgi Düzeyi. Katılımcıların GDO'lu gıdalar bilgi ölçeğine verdiği her bir doğru cevap 1, yanlış ve bilmiyorum cevapları ise 0 olarak kodlandığı için, bir katılımcının bu ölçekten alabileceği toplam puan en fazla 17'dir. Bu durum gözetildiğinde, betimsel analizlerin sonuçları, katılımcıların ortalama bilgi düzeyinin 17 üzerinden 9.73 olduğunu ortaya çıkarmıştır. Bu sonuca göre, bu çalışmaya katılan fen bilgisi öğretmen adaylarının GDO'lu gıdalar hakkında ortalama düzeyde bilgiye sahip oldukları söylenebilir. Tablo N.10'da katılımcıların her bir bilgi maddesine verdiği cevapların ortalama ve standart sapma değerleri gösterilmiştir.

Table N.10

GDO'lu Gıdalar Bilgi Düzeyi Betimsel Analiz Sonuçları

Madde		Yüzde oranı (%)	
		Yanlış	Doğru
1	Tarımsal ürünler, kalıtsal yapıları değiştirilerek bazı hastalık ve salgınlara karşı dirençli hale getirilebilirler.	17.6	82.4
2	Genetiği değiştirilmiş bazı bakteriler petrol kirliliği olan plajları temizleme yeteneğine sahiptir.	45.4	54.6
3	Genetik modifikasyonlar tıpta kullanılmaz.	31.8	68.2
4	GDO'lu gıdalar gen içerirken, geleneksel tarım yoluyla elde edilen gıdalar gen içermez.	30.1	69.9
5	Hayvansal özellikler hiçbir yolla bitkilere aktarılamaz.	36.6	63.4
6	Besinlerde bulunan bakterilerin tümü zararlıdır.	9.7	90.3
7	"Doğal", her zaman sağlıklı anlamına gelmez.	29.1	70.9
8	İşlenmiş gıdaların tümü genetiği değiştirilmiş ürünler kullanılarak elde edilir.	45.3	54.7
9	Dünyada, gen teknolojileri kullanılarak gıda üretilmesi konusunda herhangi bir yasa veya yönetmelik yoktur.	51.0	49.0
10	Genetiği değiştirilmiş gıdalar sindirilemez.	23.5	76.5
11	Bir bitkinin genlerini değiştirmek için o bitkinin hücrelerini öldürmek gerekir.	37.0	63.0
12	Bitkilerin tarım ilacı ihtiyacı, genetik yapıları değiştirilerek azaltılabilir.	34.9	65.1
13	Türkiye'de, gen teknolojileri kullanılarak gıda üretilmesi konusunda herhangi bir yasa veya yönetmelik yoktur.	60.1	39.9
14	GDO'lu gıdalarla beslenmek insanların genlerinde değişikliğe yol açabilir.	83.3	16.7

Tabl0 N.10 (Devamı)

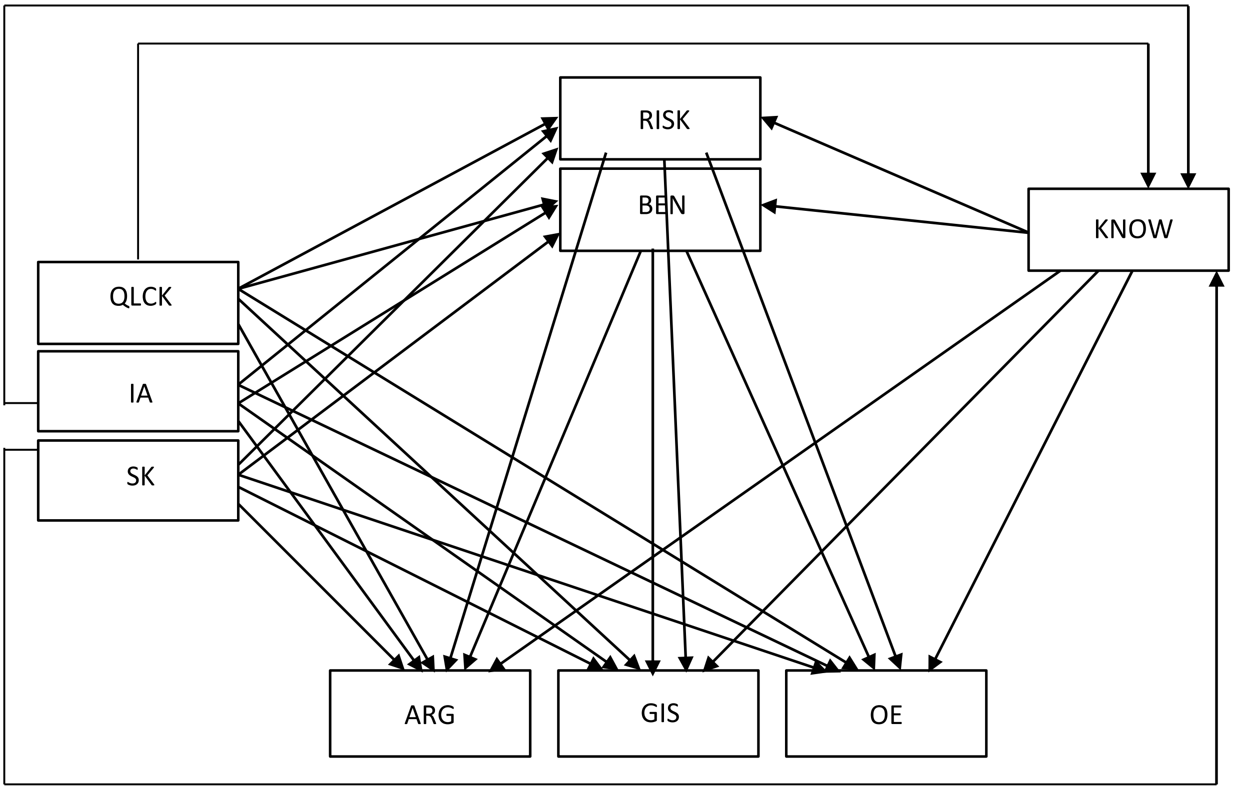
Madde		Yüzde oranı (%) Yanlış	Doğru
15	Genetiği değiştirilmiş hayvanlar diğer hayvanlara göre her zaman daha büyüktür.	55.4	44.6
16	Türkiye'de GDO'lu tohumla tarım yapmak yasaktır.	89.0	11.0
17	Türkiye'de, mısır ve soya gibi GDO'lu bazı ithal ürünlerin hayvan yemi olarak kullanımına yasal olarak izin verilmektedir.	47.2	52.7

Öne Sürülen Modele Dair Analizler

Modelin Belirlenmesi. Öne sürülen modelin değerlendirilmesi amacıyla öncelikle nicel analizler yapılmış, sonrasında da modele dair daha detaylı bilgiler elde etmek amacıyla görüşmeler yapılarak nitel veriler elde edilmiştir. Görüşme sorularının analizi sonucu dört ana tema ortaya çıkmıştır: GDO'lu gıdaların öğretimi öz-yeterlik inancı, GDO'lu gıdaların öğretimi öz-yeterlik inancı ve kişisel epistemolojik inançlar, GDO'lu gıdaların öğretimi öz-yeterlik inancı ve GDO'lu gıdalar bilgi düzeyi, GDO'lu gıdaların öğretimi öz-yeterlik inancı ve GDO'lu gıdalar risk ve fayda algısı.

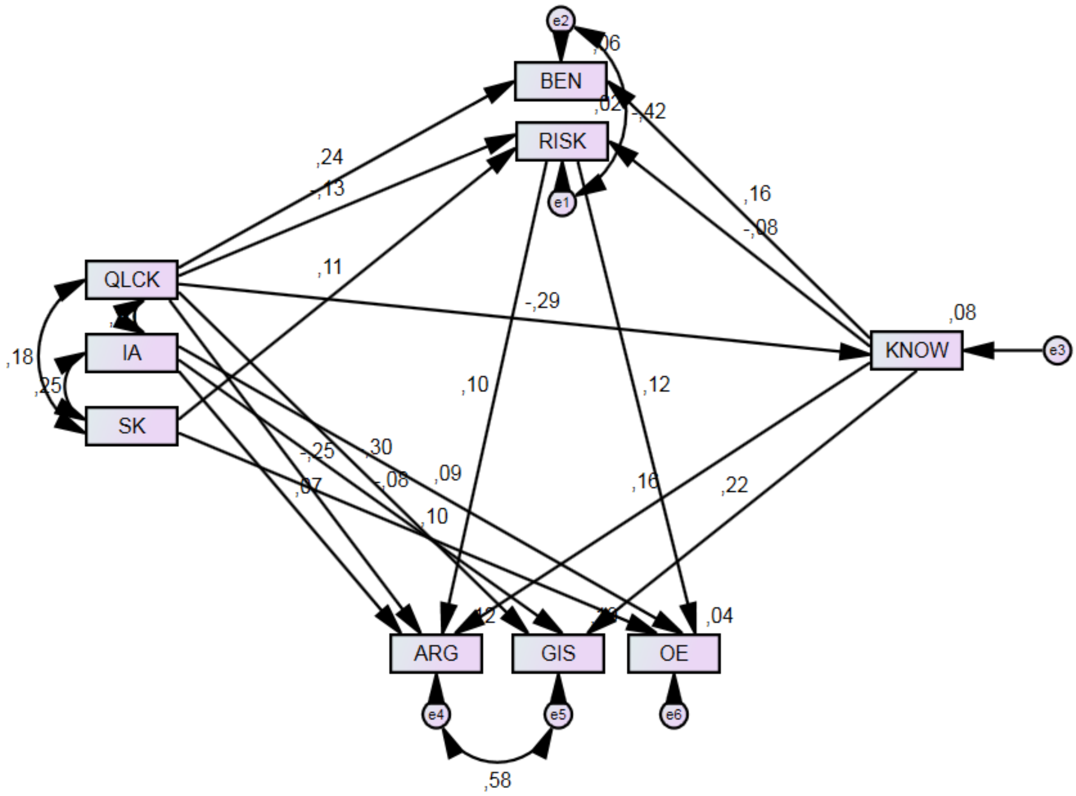
Öne sürülen modelin nicel analizi için yol analizinden faydalanılmıştır. Figür N.2'de gösterildiği üzere, modelde yer alan dış değişkenler (exogenous variables); kişisel epistemolojik inançlara ait üç alt boyut (Öğrenme hemen gerçekleşir ve Bilgi kesindir (QLCK), Öğrenme yeteneği doğuştandır (IA), ve Bilgi basittir (SK)), GDO'lu gıdalar risk algısı (RISK), GDO'lu gıdalar fayda algısı (BEN), ve GDO'lu gıdalar bilgi düzeyidir (KNOW). İç değişkenler (endogenous variables) ise, GDO'lu gıdaların öğretimi öz-yeterlik inancı değişkenine ait boyutlar olan GDO'lu gıdalar konunun öğretimine yönelik genel öğretim stratejileri (GIS), GDO'lu gıdaların öğretimi sonuç beklentisi inançları (OE) ve GDO'lu gıdalar ile ilgili argümantasyon ve karar vermenin teşvik edilmesine dair inançlardır (ARG).

Modelin belirlenme sürecinde izlenmesi gereken tüm basamaklar takip edilmiştir (Kline, 2011) ve yol analizi öncesi gerekli tüm ön analizler yapılmıştır. Öne sürülen ilişkilere göre, kişisel epistemolojik inançlara ait üç alt boyut (Öğrenme hemen gerçekleşir ve Bilgi kesindir (QLCK), Öğrenme yeteneği doğuştandır (IA), ve Bilgi basittir (SK)), GDO'lu gıdalar risk algısı (RISK), GDO'lu gıdalar fayda algısı (BEN), ve GDO'lu gıdalar bilgi düzeyi (KNOW) değişkenleri katılımcıların GDO'lu gıdaların öğretimi öz-yeterlik inancı ile doğrudan ilişkilidir. Ayrıca, modelde yer alan kişisel epistemolojik inançlar (QLCK, IA ve SK) ve GDO'lu gıdalar bilgi düzeyi değişkenlerinin GDO'lu gıdalar risk algısı (RISK), ve GDO'lu gıdalar fayda algısı (BEN) ile doğrudan ilişkili olduğu öne sürülmüştür. Son olarak ise, kişisel epistemolojik inançlar (QLCK, IA ve SK) değişkenine ait boyutların katılımcıların GDO'lu gıdalar bilgi düzeyi ile doğrudan ilişkili olduğu öne sürülmüştür.



Figür N.2 Modelde yer alan değişkenler ve öne sürülen ilişkiler.

Model belirlendikten hemen sonra AMOS programı aracılığıyla yol analizi yapılmış ve öne sürülen ilişkiler test edilmiştir. Yapılan ilk analiz sonucu, öne sürülen modelin iyi uyum göstermediği ortaya çıkmıştır. Bu nedenle, birtakım modifikasyon yapılmış ve yeni model ortaya çıkarılmıştır. Bu amaçla, modele yeni yollar eklenmiş ve anlamlı olmayan yollar modelden çıkarılmıştır (Kelloway, 1998; Kline, 2011). Elde edilen son modelin analizi sonucu ortaya çıkan uyum indeksleri şöyledir: $\chi^2 = 81.97$, df = 15, $\chi^2/df = 5.06$, GFI = .98, AGFI = .95, CFI = .95, RMSEA = .06, SRMR = .03. Elde edilen uyum indeksleri model iyi bir uyum gösterdiğini ortaya çıkarmıştır. Ayrıca, ki-kare değeri hariç ($\chi^2 = 81.97$, p = 0.00) tüm değerlerin önerilen aralıklarda olduğu görülmüştür. Ki-kare değerinin anlamlı çıkması geniş örneklemlerde sıkça rastlanılan bir durum olduğundan (Kline, 2011; Schumacker & Lomax, 1996), bu çalışma kapsamında da kabul edilebilir görülmüştür. Revize edilen modelin son hali ve standart yol katsayıları Figür N.3'te gösterilmiştir.



Figür N.3 Revize edilen modeldeki anlamlı ilişkiler ve standart katsayılar

GDO'lu Gıdalar Konusunun Öğretimi Öz-yeterlik İnancı ve Modelde Yer Alan Diğer Üç Değişken ile İlişkisi. Katılımcıların GDO'lu gıdalar konusunun öğretimine yönelik öz-yeterlik inançları ve kişisel epistemolojik inançları arasındaki ilişkiyi ortaya çıkarmak amacıyla öncelikle yol analizi yapılmış, sonrasında ise görüşmeler aracılığıyla nitel veriler elde edilerek katılımcılara bu ilişkilere dair daha detaylı sorular sorulmuştur. Tablo N.11'de gösterildiği üzere, katılımcıların bilginin basit olduğuna dair inançları ile GDO'lu gıdalar konusunun öğretimi öz-yeterlik inancı değişkeninin yalnızca GDO'lu gıdaların öğretimi sonuç beklentisi inançları (OE) boyutu arasında anlamlı bir ilişki vardır. Bunun yanı sıra, analizlerin sonuçlarına göre, kişisel epistemolojik inancın bir boyutu olan öğrenme yeteneği doğuştandır (IA) boyutu ile GDO'lu gıdalar konusunun öğretimi öz-yeterlik inancı değişkeninin tüm boyutları (ARG, OE, GIS) arasında anlamlı bir ilişki vardır. Ayrica, kişisel epistemolojik inançlar değişkeninin Öğrenme hemen gerçekleşir ve Bilgi kesindir

(QLCK) ile Öğrenme yeteneği doğuştandır (IA) boyutları ile GDO'lu gıdalar ile ilgili argümantasyon ve karar vermenin teşvik edilmesine dair inançlardır (ARG) arasında sırasıyla negatif ve pozitif anlamlı bir ilişki bulunmuştur. GDO'lu gıdaların öğretimi öz-yeterlik inancı değişkenine ait boyutlardan biri olan GDO'lu gıdalar konunun öğretimine yönelik genel öğretim stratejileri (GIS) boyutu ile kişisel epistemolojik inançlar arasındaki ilişkiler incelendiğinde ise, GIS değişkeninin QLCK ve IA değişkenleri ile anlamlı ilişkiye sahip olduğu görülmektedir.

Tablo N.11

Kişisel Epistemolojik İnançlar ile GDO'lu Gıdaların Öğretimi Öz-yeterlik İnancı Arasındaki Anlamlı ve Direkt İlişkiler

İç değişken	Dış değişken	β	Estimate	SE	CR	p
ARG	Öğrenme hemen gerçekleşir ve Bilgi kesindir	-.25	-.36	.04	-8.21	.00
	Öğrenme yeteneği doğuştandır	.06	.09	.04	2.31	.02
GIS	Öğrenme hemen gerçekleşir ve Bilgi kesindir	-.30	-.42	.04	-10.29	.00
	Öğrenme yeteneği doğuştandır	-.08	-.11	.03	-3.05	.00
OE	Öğrenme yeteneği doğuştandır	.09	.09	.03	2.89	.00
	Bilgi basittir	.10	.14	.04	3.09	.00

Nicel veri analizi sonuçlarının yanı sıra, kişisel epistemolojik inançlar ve GDO'lu gıdaların öğretimi öz-yeterlik inancı arasındaki ilişkiye dair daha detaylı bilgiler elde etmek amacıyla nicel veriler de elde edilmiştir. Görüşme sorularından elde edilen bu nitel veriler, öne sürülen modeldeki ilişkileri açıklamak için kullanılmıştır. Bu ilişkilere dair nitel veri analizi sonucu ortaya çıkan kategoriler şöyledir: Bilginin basitliği ve GDO'lu gıdaların öğretimi öz-yeterlik inancı, Bilginin kesinliği ve GDO'lu gıdaların öğretimi öz-yeterlik inancı, Öğrenme yeteneğinin doğuştan geldiğine dair inanç ve GDO'lu gıdaların öğretimi öz-yeterlik inancı, Bilginin kaynağının otorite olduğuna dair inanç ve GDO'lu gıdaların öğretimi öz-yeterlik inancı, Öğrenmenin hemen gerçekleştiğine dair inanç ve GDO'lu gıdaların öğretimi öz-yeterlik inancı.

Bu çalışmada, katılımcıların GDO'lu gıdaların öğretimi öz-yeterlik inancı ile GDO'lu gıdalar risk ve fayda algıları arasındaki ilişkiyi incelemek amacıyla nicel ve nitel verilerden faydalanılmıştır. Bu bağlamda elde edilen verilere göre, GDO'lu gıdalar risk algısının GDO'lu gıdaların öğretimi öz-yeterlik inancı boyutlarından olan ARG ve OE ile pozitif ve anlamlı bir ilişkiye sahip olduğu ortaya çıkmıştır (Bkz. Tablo N.12). Buna karşılık, GDO'lu gıdalar fayda algısının, GDO'lu gıdaların öğretimi öz-yeterlik inancı boyutlarından herhangi biri ile anlamlı bir ilişki içinde olmadığı ortaya çıkmıştır. Nicel veri analizinin yanı sıra, katılımcılarla yapılan görüşmeler sonucu nitel veriler de elde edilmiştir. Katılımcıların GDO'lu gıdaların öğretimi öz-yeterlik inançları ile GDO'lu gıdalar risk ve fayda algıları arasındaki ilişkiye dair görüşmelerin analizi sonucu ortaya çıkan kategoriler şunlardır: GDO'lu gıdalar risk algısı ve GDO'lu gıdaların öğretimi öz-yeterlik inancı, GDO'lu gıdalar fayda algısı ve GDO'lu gıdaların öğretimi öz-yeterlik inancı.

Tablo N.12

GDO'lu Gıdalar Risk ve Fayda Algısı ile GDO'lu Gıdaların Öğretimi Öz-yeterlik İnancı Arasındaki Anlamlı ve Direkt İlişkiler

İç değişken	Dış değişken	β	Estimate	SE	CR	p
ARG	GDO'lu gıdalar fayda algısı	.10	.15	.03	4.37	.00
OE	GDO'lu gıdalar risk algısı	.12	.13	.03	4.02	.00

Katılımcıların GDO'lu gıdaların öğretimi öz-yeterlik inancı ile GDO'lu gıdalar hakkındaki bilgi düzeyi arasındaki ilişki incelendiğinde, bilgi düzeyinin GDO'lu gıdalar ile ilgili argümantasyon ve karar vermenin teşvik edilmesine dair inançlar (ARG) ve GDO'lu gıdalar konunun öğretimine yönelik genel öğretim stratejileri (GIS) boyutları ile pozitif ve anlamlı bir ilişki içinde olduğu ortaya çıkmıştır (Bkz. Tablo N.13). Buna karşın, çalışmaya katılan fen bilgisi öğretmen adaylarının GDO'lu gıdalar konusundaki bilgi düzeyi ile onların GDO'lu gıdaların öğretimi sonuç beklentisi inançları (OE) arasında anlamlı bir ilişki bulunamamıştır. Katılımcıların sahip olduğu GDO'lu gıdalar bilgi düzeyi ile GDO'lu gıdaların öğretimi öz-yeterlik inancı arasındaki ilişkiye dair nitel verilerin analizi sonucu şu kategori ortaya çıkmıştır: GDO'lu gıdalar bilgi düzeyi ve GDO'lu gıdaların öğretimi öz-yeterlik inancı.

Tablo N.13

GDO'lu Gıdalar Bilgi Düzeyi ile GDO'lu Gıdaların Öğretimi Öz-yeterlik İnancı Arasındaki Anlamlı ve Direkt İlişkiler

İç değişken	Dış değişken	β	Estimate	SE	CR	p
ARG	GDO'lu gıdalar bilgi düzeyi	.16	.30	.05	5.50	.00
GIS	GDO'lu gıdalar bilgi düzeyi	.22	.40	.05	7.89	.00

Kişisel Epistemolojik İnançlar, GDO'lu Gıdalar Risk ve Fayda Algısı ve GDO'lu Gıdalar Bilgi Düzeyi Arasındaki İlişki.

Bu çalışmada, yol analizi iki temel amaç için kullanılmıştır; katılımcıların GDO'lu gıdaların öğretimi öz-yeterlik inancı ve modelde yer alan diğer üç değişken (kişisel epistemolojik inançlar, GDO'lu gıdalar risk ve fayda algısı, GDO'lu gıdalar bilgi düzeyi) arasındaki ilişkiyi incelemek ve ikinci olarak, kişisel epistemolojik inançlar, GDO'lu gıdalar risk ve fayda algısı ve GDO'lu gıdalar bilgi düzeyi arasındaki ilişkiyi incelemek. Bahsedilen ikinci amaç kapsamında, belirtilen üç değişken arasındaki ilişkiler ile ilgili olarak, kişisel epistemolojik inançların, GDO'lu gıdalar risk ve fayda algısı ile doğrudan ilişkili olduğu öne sürülmüştür. Bunun yanı sıra, GDO'lu gıdalar bilgi düzeyinin GDO'lu gıdalar risk ve fayda algısı ile doğrudan ilişkili olduğu öne sürülmüştür.

Yol analizi sonuçlarına göre, Tablo N.14'te gösterildiği üzere, QLCK boyutu hariç, kişisel epistemolojik inançlara ait boyutlar ile GDO'lu gıdalar fayda algısı arasında anlamlı bir ilişki bulunamamıştır. Bunun yanı sıra, GDO'lu gıdalar bilgi düzeyi ile GDO'lu gıdalar fayda algısı arasında pozitif ve anlamlı bir ilişki ortaya çıkmıştır. Ayrıca, yol analizi sonuçlarına göre, IA boyutu haricindeki tüm kişisel epistemolojik inançlar boyutları ve GDO'lu gıdalar risk algısı arasında anlamlı bir ilişkinin olduğu ortaya çıkmıştır. Son olarak, GDO'lu gıdalar bilgi düzeyi ile GDO'lu gıdalar risk algısı arasında anlamlı ve negatif bir ilişki olduğu görülmektedir.

Tablo N.14

Kişisel Epistemolojik İnançlar ve GDO'lu Gıdalar Bilgi Düzeyi Değişkenleri ile GDO'lu Gıdalar Risk ve Fayda Algısı Arasındaki Anlamlı ve Direkt İlişkiler

İç değişken	Dış değişken	β	Estimate	SE	CR	p	R^2
BEN	Öğrenme hemen gerçekleşir ve Bilgi kesindir	.24	.40	.05	7.84	.00	.06
	GDO'lu gıdalar bilgi düzeyi	.16	.32	.06	5.13	.00	
RISK	Öğrenme hemen gerçekleşir ve Bilgi kesindir	-.13	-.12	.03	-3.99	.00	.02
	Bilgi basittir	.11	.14	.03	3.85	.00	
	GDO'lu gıdalar bilgi düzeyi	-.08	-.10	.03	-2.63	.00	

Modelde yer alan değişkenler kişisel epistemolojik inançlar ve GDO'lu gıdalar bilgi düzeyi arasındaki ilişkiye dair elde edilen sonuçlara göre, Tablo N.15'te de gösterildiği üzere, kişisel epistemolojik inançların QLCK boyutu ile GDO'lu gıdalar bilgi düzeyi arasında anlamlı bir ilişki olduğu ortaya çıkmıştır. Öte yandan, kişisel epistemolojik inançlar boyutları IA ve SK ile GDO'lu gıdalar bilgi düzeyi arasında herhangi bir anlamlı ilişki bulunamamıştır.

Tablo N.15

Kişisel Epistemolojik İnançlar ve GDO'lu Gıdalar Bilgi Düzeyi Arasındaki Anlamlı ve Direkt İlişkiler

İç değişken	Dış değişken	β	Estimate	SE	CR	p	R^2
KNOW	Öğrenme hemen gerçekleşir ve Bilgi kesindir	-.29	-.23	.02	-9.84	.00	.08

Tartışma

Bu bölümde, çalışmadan elde edilen bulguların tartışmaları yer alacaktır. Öncelikle, GDO'lu gıdaların öğretimi öz-yeterlik inancı, kişisel epistemolojik inançlar, GDO'lu gıdalar risk ve fayda algısı ve GDO'lu gıdalar bilgi düzeyi değişkenlerine ait betimsel analiz sonuçları, sonrasında ise öne sürülen modele dair nicel ve nitel analiz bulguları tartışılacaktır.

Bu çalışmada, diğer değişkenlerden farklı olarak, katılımcıların GDO'lu gıdaların öğretimi öz-yeterlik inancı ile ilgili hem nicel hem de nitel veriler toplanmıştır. Elde edilen nicel bulgulara göre, çalışmaya katılan fen bilgisi öğretmen adaylarının nispeten yüksek öz-yeterlik inancına sahip oldukları görülmüştür. Elde edilen bu sonuç katılımcıların bugüne dek aldıkları dersler ile açıklanabilir (Schoon & Boone, 1998; Watters & Ginns, 2000). Çalışmanın katılımcıları üçüncü ve dördüncü sınıf öğrencileri oldukları için bu güne dek birçok sayıda pedagoji dersi almışlardır. Buna rağmen, Hoy ve Spero'ya (2005) göre, öğretmen adayları henüz profesyonel öğretmenlik hayatına başlamadıkları için onların öz-yeterlik inançları ile ilgili yorum yaparken dikkatli olunmalıdır. Bu bakış açısından hareketle, bu çalışmadaki öğretmen adaylarının da SBK konularının öğretiminin karmaşıklığını azımsamış olma ihtimali mevcuttur. Bu sebeple, bu çalışmada nicel veri analizinin yanı sıra, katılımcıların GDO'lu gıdaların öğretimi öz-yeterlik inançları görüşme soruları ile de incelenmiştir.

Görüşme soruları aracılığı ile katılımcılardan öncelikli olarak GDO'lu gıdalar gibi tartışmalı konuların öğretimine yönelik sahip oldukları öz-yeterlik inançlarını derecelendirmeleri istenmiştir. Katılımcıların büyük çoğunluğu bu konudaki inançlarını 5 üzerinden 4 olarak derecelendirse de, bir kısım fen bilgisi öğretmen adayı bu konuda sahip oldukları inancın 3 düzeyinde olduğunu belirtmişlerdir. Nitel veri sonuçlarından elde edilen GDO'lu gıdaların öğretimi öz-yeterlik inancının kaynakları ve engelleri kategorisinin altında, fen bilgisi öğretmen adaylarının kaynak olarak en çok deneyim yetersizliği ve öğrencinin hazırbulunuşluğunu, engel olarak ise üniversitede aldıkları dersler ile staj okullarında edindikleri deneyimleri belirtmişlerdir. Öz-yeterlik inançlarının kaynak ve engellerinin yanı sıra, görüşme soruları, katılımcıların SBK öğreniminin değerlendirilmesi, SBK tartışma ortamlarının oluşturulması, SBK'nın doğasının öğretimi ve SBK derslerinde sınıf ve zaman yönetimi gibi hususlarda da aydınlatıcı olmuştur. Bunların yanı sıra, görüşme soruları, fen bilgisi öğretmen adaylarının SBK'nın öğretilmesi sürecinde öğretmen telkini ve SBK ve SBK'nın öğretimi ile ilgili sahip olunan yanlış bilgiler hakkında da bilgiler elde edilmesini sağlamıştır. Görüşme sorularının analiz sonuçlarına göre, fen bilgisi öğretmen adayları etkili SBK öğretimi için gerekli yolları biliyor olsa da, SBK öğretiminin yapıldığı bir sınıfta sınıf ve zaman yönetimi konusunda zorlanacaklarını belirtmişlerdir. Bu durum, literatür ile örtüşen niteliktedir (Ingersoll, 2001; Turnuklu ve Galton, 2001). Öğretmen telkini kategorisinde ortaya çıkan sonuçlara göre, katılımcıların büyük çoğunluğu SBK ile ilgili bir derste tartışılan konu ile ilgili fikirlerini paylaşmayacaklarını bildirmiş, bu durumun öğrenciyi negatif yönde etkileyeceğini belirtmişlerdir. Katılımcıların bu görüşünün tersine, yapılan araştırmalar öğretmenlerin sınıf içinde bilimsel olarak gerekçelendirdiği sürece kendi fikirlerini paylaşması gerektiğini ortaya koymuştur (Cross & Price, 1996; Oulton, Dillon, & Grace, 2004; Sadler ve diğerleri, 2006). Son olarak, nitel veriler sayesinde katılımcıların SBK ve SBK öğretimi ile ilgili bazı yanlış bilgilere sahip oldukları ortaya çıkarılmıştır.

GDO'lu gıdaların öğretimi öz-yeterlik inancı ile ilgili elde edilen bulgular birtakım çıkarımlarda bulunmamıza olanak sağlamıştır. Daha önce de bahsedildiği gibi bu çalışmada, nicel veriler SBK konusunda hazırlanmış herhangi bir ders almamış olan geniş bir gruptan toplanmış iken, nitel veri toplama araçlarının katılımcıları SBK ve SBK'nın öğretimi ile ilgili hazırlanmış bir dersi almış olan ve görüşme için özellikle seçilmiş dördüncü sınıf fen bilgisi öğretmen adaylarıdır. Görüldüğü gibi, katılımcıların GDO'lu gıdaların öğretimi öz-yeterlik inancı nicel analiz sonuçlarına göre yüksek iken, görüşme soruları öğretmen adaylarının bu konudaki öz-yeterlik inançlarının çok da yüksek olmadığını, özellikle sınıf ve zaman yönetiminde birçok sorunların olabileceğini ortaya koymuştur. Bu bulgulardan hareketle, Bandura'nın teorisinden farklı olarak öğretmen adaylarının deneyimlerinin artmasıyla SBK'nın öğretimine dair olan öz-yeterlik inançlarının düştüğünü görmekteyiz. Bu durum, Hoy ve Spero'nun (2005) çalışması ile de ortaya koyulmuştur. Hoy ve Spero'nun çalışmasında, öğretmenlik mesleğinin ilk yılında olan katılımcıların öğretime yönelik öz-yeterlik algılarının hizmet öncesi yıllara göre belirgin bir biçimde düştüğü gözlemlenmiştir.

GDO'lu gıdaların öğretimi öz-yeterlik inancının yanı sıra, betimsel analizler katılımcıların kişisel epistemolojik inançlarını da ortaya çıkarmıştır. Faktör analizi sonuçları, Schommer'in (1990, 1994) çalışmalarını destekler niteliktedir ve kişisel epistemolojik inançların çok boyutlu olduğunu göstermiştir. Bunun yanı sıra, katılımcıların, öğrenme yeteneğinin doğuştan olmasına dair inançları diğer inançlara göre daha sofistikedir. Buna karşılık, katılımcıların sahip olduğu en gelişmemiş inancın Öğrenme hemen gerçekleşir ve bilgi kesindir boyutuna dair olduğu görülmektedir. Genel olarak bakıldığında ise, çalışmanın katılımcılarının gelişmemiş bir epistemolojik inanca sahip oldukları ortaya çıkmıştır. Çalışmanın katılımcılarının gelişmemiş epistemolojik inançlara sahip olmalarının nedeni Türkiye'deki eğitim sistemi olarak düşünülebilir. Bu çalışmanın katılımcılarının büyük çoğunluğunun ortaokul ve lise yıllarında geleneksel öğretim stratejilerine maruz kaldıkları söylenebilir (Yilmaz-Tuzun & Topcu, 2008). Türkiye'de yapılandırmacı yaklaşımın benimsenmesinin üzerinden yıllar geçmesine rağmen, yetersiz sayı ve nitelikteki hizmetiçi eğitim programları sebebiyle, hala yadsınamayacak sayıda yapılandırmacı öğretim stratejilerini benimsemeye direnen öğretmenler vardır (Aydin & Cakiroglu, 2010). Bu sebeple, öğrenmenin zaman içinde dereceli olarak gerçekleştiği fikrinin üzerine kurulan yapılandırmacı yaklaşımdan ziyade (Ramos, 1999; Tucker & Batchelder, 2000), çalışmanın katılımcıları geleneksel öğretim stratejilerine dair ve ezberci eğitime daha aşinadır.

Nicel veri analizi sonuçlarına göre, katılımcıların GDO'lu gıdalar konusundaki bilgi seviyesi orta düzeydedir. Lewis ve Leach'e (2006) göre, tartışmalı konularla ilgili tartışmalara dahil olabilmek için bu konularda bilgili olmak gerekmektedir. Fen bilgisi öğretmenlerinin bu konularda tartışma ortamı yürüteceği göz önünde bulundurulduğunda, tartışmalı bir konu olan GDO'lu gıdalar hakkında bilgi sahibi olmaları gerektiği aşikardır. Son olarak, nicel bulgular göstermiştir ki, katılımcıların GDO'lu gıdalarla ilgili yüksek düzeyde risk algıları varken, nispeten yüksek düzeyde de fayda algıları vardır. Bu durumun pekçok sebebi olabilir. Örneğin, katılımcılar GDO'lu gıdaların uzun vadedeki sonuçları ile ilgili risk algılarına sahip olabilirler. Yapılan araştırmalar, GDO'lu gıdalarla beslenmenin uzun vadede hayvanlarda negatif bazı sonuçlarının olabileceğine dikkat çekmişlerdir (e.g. Malatesta, Biggiogera, Manuali, & Rocchi, 2003; Malatesta ve diğerleri, 2008; Sissener, Sanden, Bakke, Krogdahl, & Hemre, 2009; Trabalza-Marinucci, 2008). GDO'lu gıdalarla ilgili yapılan çalışmalar bireylerin bu konudaki risk ve fayda algısının birbirinden farklı olabileceğini ortaya koysa da, dünyanın farklı yerlerinde yaşayan insanlar GDO'lu gıdalar konusuna temkinli yaklaşmaktadır. Örneğin, İngiltere, Avustralya ve Japonya gibi gelişmiş ülkelerdeki insanların birçoğu GDO'lu gıdaları riskli bulmaktadır (Curtis, McCluskey, & Wahl, 2004). Bu çalışmanın sonuçları da benzer bir durumu ortaya koymaktadır.

Daha önce de belirtildiği üzere, modelde yer alan her bir değişken ile ilgili betimsel bulgulara ulaşılmasının yanı sıra, bu çalışmada, modelde yer alan değişkenler arasındaki ilişkilerle ilgili de bulgulara varılmıştır. GDO'lu gıdaların öğretimi öz-yeterlik inancı ve bu değişkenin modelde yer alan diğer üç değişken (kişisel epistemolojik inançlar, GDO'lu gıdalar risk ve fayda algısı, GDO'lu gıdalar bilgi düzeyi) ile ilişkisi ayrı ayrı incelenmiştir. Bu amaçla hem nicel hem de nitel veri toplanmıştır. Bunun yanı sıra, kişisel epistemolojik inançlar, GDO'lu gıdalar risk ve fayda algısı, GDO'lu gıdalar bilgi düzeyi değişkenleri arasındaki ilişki de incelenmiş ve bu amaçla nicel veriler analiz edilmiştir.

Çalışmaya katılan fen bilgisi öğretmen adaylarının GDO'lu gıdaların öğretimi öz-yeterlik inançları ile onların kişisel epistemolojik inançları arasında birtakım ilişkiler elde edilmiştir. Nicel veri sonuçlarına göre, katılımcıların öğrenme yeteneğinin doğuştan olduğuna dair inançları ile öz-yeterlik inancının her bir boyutu arasında anlamlı bir ilişki vardır. Bu ilişki GDO'lu gıdalar konunun öğretimine yönelik genel öğretim stratejileri (GIS) boyutu için pozitif iken diğer iki boyut için negatif bulunmuştur. Negatif bulunan ilişkiler iki şekilde açıklanabilir. Öncelikle, katılımcıların öğrenme yeteneğinin doğuştan olduğuna dair inançlarının gelişmemiş olduğu göz önünde bulundurulmalıdır. İkinci olarak, Kember'ın da (1997) belirttiği gibi, öğretmen adaylarının inançları ve öğretim yaklaşımları arasında her zaman tutarlı bir ilişki olmayabilir. Öğretmen adaylarının bu tür çelişkiler yaşamasının yetersiz zaman, tecrübesizlik veya programı yetiştirme telaşı olduğu söylenebilir. Brownlee, Purdie ve Boulton-Lewis'e (2001) göre bu durumun bir başka nedeni de öğretmen adaylarının epistemolojik inançlar konusunda tam bir geçiş evresinde olmaları ve epistemolojik inançları ile öğretim yaklaşımlarını yansıtmada zorluk yaşama ihtimalleridir. Bu düşüncelerle paralel olarak, bu çalışmada, fen bilgisi öğretmen adaylarının öğrenme yeteneğinin doğuştan olduğuna dair inançları onların SBK'ların öğretiminin kompleks olduğu düşüncelerini daha da kuvvetlendirmiş olabilir. Başka bir deyişle, katılımcıların SBK'ların öğretimi konusunda yeterince deneyime sahip olmaması, SBK öğreniminin etkili öğretim stratejileri ile geliştirilebileceği düşüncesi onların güvensiz hissetmesine neden olmuş olabilir. Bu konuda elde edilen nicel veriler de bu düşünceyi destekler niteliktedir.

GDO'lu gıdaların öğretimi öz-yeterlik inancı ve GDO'lu gıdalar bilgi düzeyi değişkenleri arasındaki ilişkiye bakıldığında, nicel veriler, bilgi düzeyi ile GDO'lu gıdalar ile ilgili argümantasyon ve karar vermenin teşvik edilmesine dair inançlar (ARG) ve GDO'lu gıdalar konunun öğretimine yönelik genel öğretim stratejileri (GIS) arasında pozitif ve anlamlı bir ilişki olduğunu fakat GDO'lu gıdaların öğretimi sonuç beklentisi inançları (OE) ile anlamlı bir ilişki olmadığını ortaya koymuştur. Öz-yeterlik inancı ile bilgi düzeyi arasında anlamlı ve pozitif bir ilişkinin bulunması ilgili literatüre de paralel bir bulgudur (Kilinc ve diğerleri, 2013, Menon & Sadler, 2016). Öte yandan, GDO'lu gıdaların öğretimi sonuç beklentisi inançları ile bilgi düzeyi arasında ortaya çıkan negatif ilişki katılımcıların görüşme sorularına verdikleri cevaplar ile açıklanabilir. Görüşmeye katılan bazı öğretmen adaylarına göre, bilgi düzeyinin artması öğretmen adaylarının sonuç beklentisi inançları ile her zaman doğru orantılı bir ilişkide olmayabilir. Başka deyişle, bir öğretmen adayı GDO'lu gıdalar hakkında yeterli bilgiye sahip olsa dahi, yeterli sınıf ortamı deneyimine sahip olmadığı için, öğrencilerin GDO'lu gıdalar konusunu öğrenmesinin etkili öğretim yolları ile ilişkili olduğu inancına sahip olmayabilir. Swars ve Dooley'nin (2010) çalışmaları bu düşünceyi destekler niteliktedir. Swars ve Dooley (2010) öğretmen adayları ile metot dersi kapsamında gerçekleştirdiği çalışmasında, katılımcıların içerik bilgisinin ve fen öğretimi kişisel inançlarının arttığını; fakat sonuç beklentisi inançlarında bir değişmenin olmadığını ortaya koymuştur. Bunun yanı sıra, katılımcılar, yapılan görüşmelerde yüksek olmayan kişisel öz-yeterlik inançlarının sebebi olarak yüksek olmayan bilgi düzeylerini göstermişlerdir.

Kişisel epistemolojik inançlar ve bilgi düzeyinin yanı sıra, bu çalışmada, GDO'lu gıdaların öğretimi öz-yeterlik inancı ve GDO'lu gıdalar risk ve fayda algısı arasındaki ilişki de incelenmiştir. Nicel veri sonuçlarına göre, GDO'lu gıdalar risk algısı ile GDO'lu gıdalar ile ilgili argümantasyon ve karar vermenin teşvik edilmesine dair inançlar (ARG) ve GDO'lu gıdaların öğretimi sonuç beklentisi inançları (OE) arasında pozitif bir ilişki olduğu ortaya çıkmıştır. Öte yandan, öz-yeterlik inancı ve fayda algısı arasında herhangi bir ilişki bulunamamıştır. Görüşme sorularına verilen cevaplar, risk algısı ve öz-yeterlik inancı arasındaki pozitif ilişkiyi destekler niteliktedir. Katılımcılara göre, öğretmenlerin bir konuyu riskli olarak algılaması onları bu konuda daha dikkatli ve hassas bir duruma getirmiş olabilir. Dolayısıyla katılımcılara göre bu öğretmenler etkili öğretim yapma konusunda daha istekli olabilir ve bu tür konulara daha çok zaman ayırabilirler. Öne sürülen bu fikir, Cross ve Price (1996) tarafından yapılan çalışmada da desteklenmektedir. Cross ve Price'a (1996) göre, tartışmalı konuların öğretimi konusunda istekli olan öğretmenler gelecek nesilleri karar verme becerileri ile yetiştirme istediğinde olan ve sosyal adaletin gelişmesine katkı sağlamak isteyen öğretmenlerdir.

Modelde yer alan değişkenler; kişisel epistemolojik inançlar, GDO'lu gıdalar risk ve fayda algısı ve GDO'lu gıdalar bilgi düzeyi arasındaki ilişkiler hakkında elde edilen bulgulara bakıldığında, GDO'lu gıdalar fayda algısının katılımcıların epistemolojik inançların Öğrenme hemen gerçekleşir ve Bilgi kesindir boyutuna dair inançlarla anlamlı ve negatif bir ilişki içinde olduğu, öte yandan GDO'lu gıdalar risk algılarının bu boyuta dair inançlarla pozitif ve anlamlı bir ilişki içinde olduğu ortaya çıkmıştır. Bu durum, Schommer (1994) ve Schommer-Aikins ve Hutter'ın (2002) öne sürdüğü şekilde, bireylerin epistemolojik inançlarının gelişmesi ile birlikte tartışmalı konulara birden çok perspektiften bakabilmesi ve bu konuları faydalı kabul etmek konusunda daha temkinli yaklaştıkları ile açıklanabilir. Bunun yanı sıra, risk algısının katılımcıların Bilgi basittir boyutuna dair inançlarıyla negatif ve anlamlı bir ilişkisi olduğu görülmüştür. Bunun nedeni, bilginin basit bir yapıdan ziyade interdisipliner olduğunu düşünen bireylerin, tartışmalı konuların doğasını daha iyi anlaması, böylelikle bu konuların riskli taraflarıyla ilgili daha kolay ikna olması gösterilebilir.

Katilimcilarin GDO'lu gıdalar risk ve fayda algıları ile bu konudaki bilgi düzeyleri arasındaki ilişkiye bakıldığında, fayda algısının anlamlı ve pozitif yönde, risk algısının ise anlamlı ve negative yönde bilgi düzeyi ile ilişkili olduğu ortaya çıkmıştır. Bu bulgulara göre, bilginin artması ile risk algısı azalmaktadır. Sjöberg (2008) de çalışmasında benzer sonuçlara ulaşmış ve GDO'lu gıdalarla ilgili bilginin artması ile bu konudaki risk algısının azaldığını söylemiştir. Ayrıca, ilgili literatürde de benzer sonuçlara ulaşılmıştır (Chen & Li, 2007; Mielby, Sandøe, & Lassen, 2013; Verdurme & Viane, 2003). Son olarak, analizler, katılımcıların GDO'lu gıdalarla ilgili bilgi düzeylerinin onların Öğrenme hemen gerçekleşir ve Bilgi kesindir boyutuna dair inançlarıyla anlamlı ve pozitif bir ilişki içinde olduğunu ortaya çıkarmıştır. Bu bulgu iki şekilde açıklanabilir: Öncelikle, yapılan çalışmalarda gösterildiği gibi (örn. May &

Etkina, 2002; Schommer, 1990; Schommer, Crouse, Rhodes, 1992; Qian & Alvermann, 2000), epistemolojik inançların gelişmesi bireylerin kavramsal anlamaları olumlu yönde etkilenmektedir. Bunun yanı sıra, bireylerin gelişmiş epistemolojik inançlara sahip olması onların tartışmalı konuları daha etraflıca düşünmesini ve dolayısı ile daha iyi anlamasını sağlamaktadır (Kardash & Scholes, 1996; Mason & Boscolo, 2004).

APPENDIX O

CURRICULUM VITAE

PERSONAL INFORMATION

Surname, Name: ÖZTÜRK, Nilay
Nationality: Turkish (TC)
Date and Place of Birth: 29 June 1987, İstanbul
Marital Status: Single
email: nilayozzturk@gmail.com

EDUCATION

2011-2016	PhD Middle East Technical University, Ankara, Turkey Elementary Education – Science Education
2009-2011	MS Middle East Technical University, Ankara, Turkey Elementary Science and Mathematics Education
2005-2009	BS Middle East Technical University, Ankara, Turkey Elementary Science Education
2001-2005	High School Beyoğlu Anatolian High School (English High School for Girls), İstanbul, Turkey

ACADEMIC AND PROFESSIONAL EXPERIENCE

2009-Present	Research Assistant Department of Elementary Science Education Middle East Technical University, Turkey
08/2015-01/2016	Visiting Scholar Department of Learning, Teaching, and Curriculum ReSTEM Institute University of Missouri, USA
08/2010	Summer School Utrecht University, Utrecht-Netherlands

FOREIGN LANGUAGE

Fluent English, Basic French

RESEARCH INTEREST

Socioscientific issues, Teaching self-efficacy beliefs, Epistemological beliefs

MEMBERSHIP

National Association of Research in Science Teaching (NARST)

European Science Education Research Association (ESERA)

Fen Eğitimi ve Araştırmaları Derneği (FEAD)

INTERNATIONAL JOURNAL PUBLICATIONS

Ozturk, N., & Yılmaz-Tuzun, O. (2016). Pre-Service Science Teachers' Epistemological Beliefs and Informal Reasoning Regarding Socioscientific Issues. *Research in Science Education.* doi: 10.1007/s11165-016-9548-4

Ozturk, N., & Teksoz, G. (2016). The impact of affective constraints on shaping environmental literacy: Model testing using mediator and moderator variables. *International Electronic Journal of Environmental Education*, *6*(2), 54–75.

Dal, B., **Ozturk, N**., Alper, U., Sonmez, D., & Cokelez, A. (2015). An analysis of teachers' climate change awareness. *Athens Journal of Education, 2*(2), 111-122.

Dal, B., Alper, U., Ozdem-Yilmaz, Y., **Ozturk, N**., & Sonmez, D. (2015): A model for pre-service teachers' climate change awareness and willingness to act for pro-climate change friendly behavior: adaptation of awareness to climate change questionnaire. *International Research in Geographical and Environmental Education*, *24*(3), 184–200. doi:10.1080/10382046.2015.1034456

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CONFERENCE PAPERS

Ozturk, N., & Yılmaz-Tuzun, O. (2016, September). *Fen bilgisi öğretmen adaylarının epistemolojik dünya görüşleri ve değer yönelimleri.* Paper presented at the 12th National Science and Mathematics Education Congress, Trabzon, Turkey.

Yilmaz-Tuzun, O., Cakir, B., & **Ozturk, N**. (2015, June). *STEM Integration into a Laboratory Course: A Case Study*. Poster presented at ISER 2015 World Conference of Education, İstanbul, Turkey.

Ozturk, N., & Yılmaz-Tuzun, O. (2015, April). *Relationships among pre-service science teachers' epistemological beliefs and epistemological world views.* Paper presented at the meeting of II. IOSTE Eurasian Regional Symposium & Brokerage Event Horizon 2020, İstanbul, Turkey.

Ozturk, N., & Yılmaz-Tuzun, O. (2013, April). *Pre-service science teachers' informal reasoning in the context of nuclear power plant construction.* Paper presented at the meeting of NARST Annual Conference, Puerto Rico, USA.

Ozturk, N., & Yılmaz-Tuzun, O. (2012, September). *Investigating gender differences regarding informal reasoning on socioscientific issues, epistemological beliefs and metacognition.* Paper presented at the meeting of Applied Education Congress, Ankara, Turkey.

Savas, M., Elmas, R., & **Ozturk, N**. (2011, September). *A curriculum reflection: New science and technology curriculum in Turkey.* Paper presented at the meeting of ESERA Conference, Lyon, France.

Ozturk, N., Elmas, R., & Savas, M. (2011, April). *Private school elementary science teachers' reflections on new science and technology curriculum.* Paper presented at the meeting of 2nd International Conference on New Trends in Education and Their Implications (ICONTE), Antalya, Turkey.

Savas, M., **Ozturk, N**., & Yılmaz-Tuzun, O. (2010, Eylül). *Fen bilgisi öğretmen adaylarının fen eğitiminde teknoloji kullanımı ile ilgili görüşleri ile ilişkili olan faktörlerin belirlenmesi.* Paper presented at the 9th National Science and Mathematics Education Congress, İzmir, Turkey.

Savas, M., **Ozturk, N**., & Yılmaz-Tuzun, O. (2010, Eylül). *Fen bilgisi öğretmen adaylarının teknolojik pedagojik alan bilgisinin incelenmesi.* Paper presented at the 12th National Science and Mathematics Education Congress, İzmir, Turkey.

TEACHING EXPERIENCE

Instructional Principles and Methods

Probability and Statistics

Laboratory Applications in Science I and II

School Experience I and II

Advanced Educational Research

Educational Inquiry

Environmental Sciences

Education and Awareness for Sustainability

Community Service

APPENDIX P

TEZ FOTOKOPİSİ İZİN FORMU

ENSTİTÜ

Fen Bilimleri Enstitüsü ☐
Sosyal Bilimler Enstitüsü ■
Uygulamalı Matematik Enstitüsü ☐
Enformatik Enstitüsü ☐
Deniz Bilimleri Enstitüsü ☐

YAZARIN

Soyadı : ÖZTÜRK
Adı : Nilay
Bölümü : İlköğretim

TEZİN ADI (İngilizce): Preservice Science Teachers’ SSI Teaching Self-efficacy Beliefs and Their Relations to Knowledge, Risk and Benefit Perceptions, and Personal Epistemological Beliefs

TEZİN TÜRÜ: Yüksek Lisans ☐ Doktora ■

1. Tezimin tamamından kaynak gösterilmek şartıyla fotokopi alınabilir. ☐
2. Tezimin içindekiler sayfası, özet, indeks sayfalarından ve/veya bir bölümünden kaynak gösterilmek şartıyla fotokopi alınabilir. ☐
3. Tezimden bir bir (1) yıl süreyle fotokopi alınamaz. ■

TEZİN KÜTÜPHANEYE TESLİM TARİHİ: