ANTECEDENTS OF NATURE OF SCIENCE TEACHING INTENTION: TESTING THE APPLICABILITY OF THE THEORY OF PLANNED BEHAVIOR

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I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

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ABSTRACT

ANTECEDENTS OF NATURE OF SCIENCE TEACHING INTENTION: TESTING THE APPLICABILITY OF THE THEORY OF PLANNED BEHAVIOR

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This study tested the applicability of the Theory of Planned Behavior (TPB) in explaining pre-service science teachers' intentions to integrate NOS into their science instruction. Data were collected from 1172 senior pre-service science teachers through administration of Intention to Integrate NOS Questionnaire. On the basis of TPB, a model was proposed suggesting that intention to integrate NOS into science instruction is determined by attitude toward behavior, subjective norm (SN), and perceived behavioral control (PBC). Attitude, SN and PBC are assumed to be based on interactions between behavioral belief strength (BBS) and outcome evaluation (OE), between normative belief strength (NBS) and motivation to comply (MC), and between control belief strength (CBS) and power of control factor (PCF), respectively. The proposed model which included latent interactions was assessed by unconstrained approach based on double-mean-centering strategy. Findings revealed that participants' intention was significantly associated with attitude and PBC but not with SN. Also, although both BBS and OE were significantly linked to attitude, the interaction between BBS and OE was not linked to attitude. Additionally, SN was significantly related to NBS, MC and the interaction between NBS and MC. Besides, while PBC was significantly associated with only CBS, it was not associated with PCF and the interaction between CBS and PCF. Overall, the model explained 16.9 percent of the variance in the intention. These findings suggested the presence of other potential factors in explaining pre-service science teachers' intentions to integrate NOS into their science instruction such as personal norm, self-identity, and NOS knowledge.

Keywords: Nature of Science, Intention, Theory of Planned Behavior, Unconstrained Approach based on Double-Mean-Centering Strategy

ÖZ

BİLİMİN DOĞASI ÖĞRETİMİ NİYETİNİ BELİRLEYEN FAKTÖRLER: PLANLANMIŞ DAVRANIŞ TEORİSİNİN UYGULANABİLİRLİĞİNİN SINANMASI

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Bu çalışma, fen bilimleri öğretmen adaylarının fen derslerindeki konulara bilimin doğasını entegre etme niyetlerini açıklamada Planlanmış Davranış Teorisi'nin (PDT) uygulanabilirliğini sınamıştır. Veriler, 1172 son sınıf fen bilimleri öğretmen adayından bilimin doğasını entegre etme niyeti anketi kullanılarak toplanmıştır. PDT'ye dayanarak öne sürülen modele göre fen derslerine bilimin doğasını entegre etme niyeti, davranışa yönelik tutum, öznel norm (ÖN) ve algılanan davranış kontrolü (ADK) tarafından belirlenmektedir. Tutum, ÖN ve ADK'nin ise sırasıyla, davranış inanç gücü (DİG) ile sonuç değerlendirme (SD) arasındaki, normatif inanç gücü (NİG) ile motivasyon arasındaki ve kontrol inanç gücü (KİG) ile kontrol faktörü gücü (KFG) arasındaki etkileşimlere dayandıkları düşünülmektedir. Gizil değişkenler arasında etkileşimler içeren, öne sürülen model çift ortalama merkezleme stratejisine dayalı kısıtsız yaklaşım kullanılarak değerlendirilmiştir. Çalışmanın bulgularına göre katılımcıların niyeti, tutum ve ADK ile istatistiksel olarak anlamlı bir şekilde ilişkilidir fakat ÖN ile değildir. Ayrıca, DİG ve SD, tutuma istatistiksel olarak anlamlı bir şekilde bağlıyken, DİG ile SD arasındaki etkileşim tutuma bağlı değildir. Ek olarak, ÖN, NİG, motivasyon ve NİG ve motivasyon arasındaki etkileşimle istatistiksel olarak anlamlı bir şekilde ilgilidir. Bunun yanısıra, ADK yalnızca KİG ile istatistiksel olarak anlamlı bir şekilde ilişkili iken KFG ve KİG ile KFG arasındaki etkileşimle ilişkili değildir. Genel olarak, model niyetteki varyansın % 16.9'unu açıklamıştır. Bu bulgular fen bilimleri öğretmen adaylarının fen derslerindeki konulara bilimin doğasını entegre etme niyetlerini açıklayan diğer potansiyel faktörlerin varlığını öne sürmüştür, örneğin kişisel norm, öz-kimlik, ve bilimin doğası bilgisi.

Anahtar Kelimeler: Bilimin Doğası, Niyet, Planlanmış Davranış Teorisi, Çift Ortalama Merkezleme Stratejisine Dayalı Kısıtsız Yaklaşım

To myself and to my family

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LIST OF ABBREVIATIONS

NOS	Nature of Science
AASS	American Association for the Advancement of Science
NRC	National Research Council
MoNE	Ministry of National Education
PCK	Pedagogical Content Knowledge
I	Intention
A	Attitude
SN	Subjective Norm
PBC	Perceived Behavioral Control
BBS	Behavioral Belief Strength
OE	Outcome Evaluation
NBS	Normative Belief Strength
MC	Motivation to Comply
CBS	Control Belief Strength
PCF	Power of Control Factor

CHAPTER I

INTRODUCTION

Nature of science (NOS), a significant component of scientific literacy, has been highly emphasized by science education reform documents (e.g., American Association for the Advancement of Science [AAAS], 1990, 1993; National Research Council [NRC], 1996). In parallel with the international trend, achieving a certain level of scientific literacy has been stated as the vision of Turkish national elementary science curriculum (Ministry of National Education [MoNE], 2006, 2013) and an understanding of NOS is among the requirements of achieving this vision not only in national but also in international settings (see MoNE, 2013; NRC, 1996). However, related studies have revealed that NOS has not been given adequate attention during instructional planning and/or practices (e.g. Abd-El-Khalick, Bell, & Lederman, 1998; Aslan & Tasar, 2013; Bell, Lederman & Abd-El-Khalick, 2000; Lederman, 1999). For example, working with fourteen pre-service secondary science teachers, Abd-El-Khalick et al. (1998) reported that participants rarely include references to NOS in their lesson plans. In these references, NOS was out of focus and treated as a separate theme and in general one aspect of NOS was addressed. Similar to the situation in lesson plans, participants' instructions rarely involved explicit references to NOS. Besides, in few instances although participants stated that they had addressed NOS instructionally, in fact their instructions included only "doing science". In addition, according to the findings of Lederman's (1999) study, although all of the participant high school biology teachers held informed views on NOS, only the two most experienced teachers' instructional practices were consistent with their views. However, analyses of interviews and lesson plans showed that these two teachers did not purposely make an attempt to address NOS instructionally, in fact, these teachers did not specify students' understanding of NOS as an objective of instructions. Moreover, the study by Bell et al. (2000) revealed that a number of participanting pre-service secondary science teachers taught some NOS aspects in an explicit manner during their instructions. On the other hand, participants were not eager or were not able to address overt instructional objectives related to NOS, which in turn, they did not attempt to assess students' understanding of NOS. Furthermore, a recent research by Aslan and Tasar (2013) concluded that participant science teachers did not clearly and purposefully teach NOS during their classroom practices.

Related research dealing with effective NOS instruction identified a multitude of factors that impacted addressing NOS instructionally. These factors include teachers' intentions (Demirdogen, Hanuscin, Uzuntiryaki-Kondakci, & Koseoglu, 2015; Lederman, 1999; Lederman, Schwartz, Abd-El-Khalick, & Bell, 2001; Schwartz & Lederman, 2002), beliefs related to the importance of NOS (Abd-El-Khalick et al., 1998; Demirdogen et al., 2015; Herman, 2010; Schwartz & Lederman, 2002), perceptions about students' abilities to learn NOS (Lederman, 1999; Sweeney, 2010) and about connection between NOS and science subject matter (Schwartz & Lederman, 2002), sense of personal responsibility to employ NOS (Herman, 2010), and sense of self-confidence about their NOS conceptions (Abd-El-Khalick et al., 1998; Bell et al., 2000; Demirdogen et al., 2015), about their ability to teach NOS (Bell et al., 2000), and about their ability to evaluate students' NOS conceptions (Abd-El-Khalick et al., 1998). Another line of factors related to teachers' knowledge such as their NOS conceptions (Demirdogen et al., 2015; Lederman et al., 2001; Schwartz & Lederman, 2002; Wahbeh & Abd-El-Khalick, 2013), science subject matter knowledge (Lederman et al., 2001; Schwartz & Lederman, 2002; Wahbeh & Abd-El-Khalick, 2013), pedagogical knowledge (Herman, 2010; Lederman et al., 2001; Wahbeh & Abd-El-Khalick, 2013), and pedagogical content knowledge for NOS (Demirdogen et al., 2015; Schwartz & Lederman, 2002; Wahbeh & Abd-El-Khalick, 2013). Also, personal, contextual and situational factors including constraints particular to student teaching experience (e.g. pressure to cover the topic, assigned by cooperating teachers, within the time limit) (Abd-El-Khalick et al., 1998; Bell et al., 2000), constraints related to time (Abd-El-Khalick et al., 1998; Bell et al., 2000; Koehler, 2006), constraints related to the curriculum (Aslan & Tasar, 2013), classroom management (Abd-El-Khalick et al., 1998; Lederman, 1999; Lederman et al., 2001), availability of sources in order to teach and/or evaluate conceptions of the NOS (Abd-El-Khalick et al., 1998), expectations of parents, students, and school administrators (Aslan & Tasar, 2013), nation-wide or state-wide examinations (Aslan & Tasar, 2013; Koehler, 2006), and teachers' teaching experience (Abd-El-Khalick et al., 1998; Lederman, 1999), interest in students' prior NOS views (Wahbeh & Abd-El-Khalick, 2013), and concern about routine tasks (Abd-El-Khalick et al., 1998).

Considering aforementioned research studies, it is evident that there is a growing body of inquiries on the factors related to addressing NOS instructionally. However, researchers continue to be called to examine constraining or facilitating factors associated with translation of teachers' NOS views into instructional practices (see Abd-El-Khalick & Lederman, 2000; Lederman & Lederman, 2014). I agree with Lederman's (1999, p. 927) finding that "it was the teachers' instructional intentions that significantly affected what occurred in classroom practice" and therefore, believe that examination of possible factors explaining intention to address NOS instructionally would significantly contribute to efforts undertaken to develop effective NOS instruction. In the literature, even though research studies has supported the importance of teachers' intention to their instructional decisions regarding NOS (e.g., Demirdogen et al., 2015; Lederman, 1999; Lederman et al., 2001; Schwartz & Lederman, 2002), to the best of my knowledge, none of the investigations addressed the factors specifically explaining intentions. Considering the crucial role pre-service science teachers are going to play in teaching of NOS and equipping students with appropriate NOS conceptions in the future, this study interested in factors that could potentially explain pre-service science teachers' intentions to integrate NOS into their science instruction. By doing so, we may develop a better comprehension of the needs of pre-service teachers in terms of NOS teaching from factors associated with their instructional intentions, which in turn, necessary adjustments can be made that would enable pre-service teachers to integrate NOS into their science instruction when they will be in-service teachers.

In the present study, in order to examine factors that could potentially explain pre-service science teachers' intentions to integrate NOS into science instruction, the theory of planned behavior (TPB; Ajzen, 1985, 1991, 2005, 2012) was utilized as a theoretical framework. The TPB is currently among the most popular social psychological models in order for predicting behavior (Ajzen, 2011). It was extended from the theory of reasoned action (Ajzen & Fishbein, 1980; Fishbein & Ajzen, 1975) such that it allows dealing with actions over which persons do not possess complete volitional control (see Ajzen, 2005). A fundamental component of the TPB is the individual's *intention* to engage in a behavior which is supposed to grasp motivational features that impact the behavior; it shows the extent to which individuals are eager to try and are planning to make an effort to engage in the behavior (Ajzen, 1991). According to the theory (see Figure 1.1), behavioral *intention* is assumed to precede human social behavior and is itself affected by three factors: attitude toward behavior, subjective norm, and perceived behavioral control (Ajzen, 2012). In general, more positive attitude, stronger social pressure, and greater perceived behavioral control are associated with stronger *behavioral intention* (Ajzen, 2012). The relative significance of these three determinants on the intention can differ depending on behavior and population (Ajzen, 2011). On the other hand, attitude toward behavior, subjective norm, and perceived behavioral control are assumed to be functions of behavioral beliefs (i.e., beliefs regarding the behavior's probable consequences), normative beliefs (i.e., beliefs concerning others' normative expectations), and control beliefs (i.e., beliefs related to existence of factors that may ease or inhibit performing the behavior) (Ajzen, 2013) (Detailed information related the TPB is provided in second chapter of the dissertation, which is literature review)

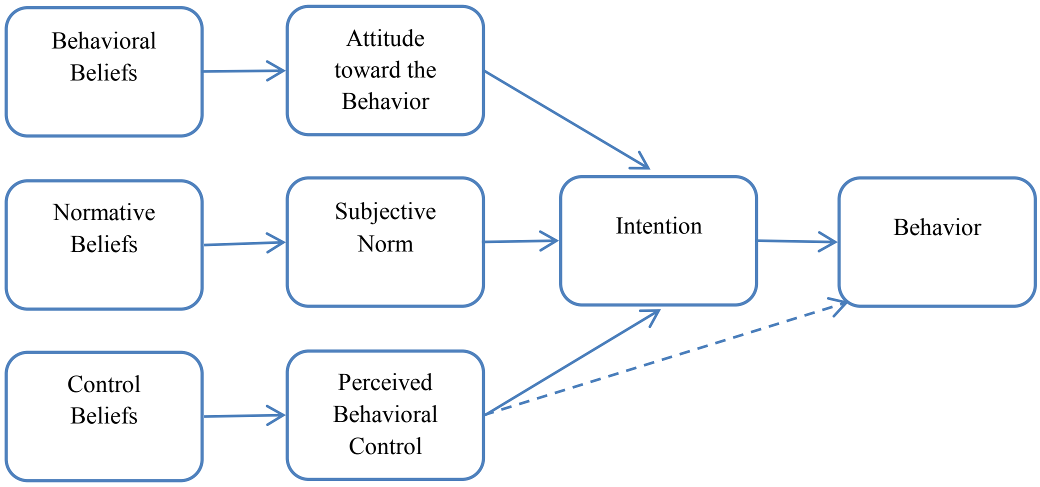

Figure 1.1 A schematic representation of the theory of planned behavior.
(Source: Adapted from Ajzen, 2005)

There are a number of reasons for utilizing the TPB as a theoretical framework. First, the TPB is currently among the most popular social psychological models in order for predicting behavior (Ajzen, 2011). Second, the TPB allows examination of causal antecedents of intentions to perform actions over which persons do not possess complete volitional control (see Ajzen, 2005). This is important for the present study since "integrating NOS into science instruction" is not under complete volitional control; it might depend on internal factors (e.g., pre-service science teachers' skills) and external factors (e.g., availability of resources for NOS instruction). Third, *behavioral intention* is considered as a central construct in the TPB (see Ajzen, 1991). Similarly, "intention to integrate NOS into science instruction" is central to the current study. Fourth, the TPB focuses on attitude toward the behavior, perceived social pressure with respect to the behavior, sense of self-efficacy or capability to engage in the behavior, and related beliefs in order to explain behavioral intentions.

On the other hand, research studies on NOS have supported that addressing NOS during instructional practices is related to components of the TPB including teachers' beliefsrelated to the significance of NOS, perceived social pressure to teach or not to teach NOS, sense of self-confidence about NOS conceptions, ability to teach NOS, and ability to evaluate students' NOS conceptions, and contextual and situational factors (e.g., availability of sources in order to teach and/or evaluate NOS conceptions, constraints related to the curriculum) (e.g., Abd-El-Khalick et al., 1998; Aslan & Tasar, 2013; Bell et al., 2000; Demirdogen et al., 2015; Herman, 2010; Lederman, 1999; Lederman et al., 2001; Schwartz & Lederman, 2002). Thus, it can be concluded that the TPB appears to be appropriate to shed light on the factors explaining pre-service science teachers' intentions to integrate NOS into science instruction.

1.1 Significance of the Study

In the literature, there is a growing body of investigations on the factors related to addressing NOS instructionally (Aslan & Tasar, 2013; Abd-El-Khalick et al., 1998; Bell et al., 2000; Demirdogen et al., 2015; Herman, 2010; Koehler, 2006; Lederman, 1999; Lederman et al., 2001; Schwartz & Lederman, 2002; Wahbeh & Abd-El-Khalick, 2013). However, researchers continue to be called to examine constraining or facilitating factors associated with translation of teachers' NOS views into instructional practices (see Abd-El-Khalick & Lederman, 2000; Lederman & Lederman, 2014).

I agree with the finding of Lederman's (1999) study that what happened in classroom practices were notably impacted by teachers' instructional intentions. Accordingly, in an attempt to facilitate reflection of NOS into instructional practices, it is vital to explore factors that underlie teachers' intentions to address NOS in their teaching. Hence, considering the crucial role pre-service teachers are going to play in teaching of NOS and equipping students with appropriate NOS conceptions in the future, the current study focused on factors that could potentially explain pre-service science teachers' intentions to integrate NOS into their science instruction. In the literature, although research has supported the significance of teachers' intention to their instructional decisions regarding NOS (e.g., Demirdogen et al., 2015; Lederman, 1999; Lederman et al., 2001; Schwartz & Lederman, 2002), to the best of my knowledge, none of the investigations addressed the factors specifically explaining intentions.

In the current study, in order to examine factors that could potentially explain pre-service science teachers' intentions to integrate NOS into science instruction, the TPB (Ajzen, 1985, 1991, 2005, 2012) was utilized as a theoretical framework. Even though TPB literature has provided ample evidence about the successful application of the theory in attempt to explain intentions and behaviors in many diverse domains (for a review of literature, see Armitage & Conner, 2001; Fishbein & Ajzen 2010), there are fewer research that employed the TPB as a theoretical framework in science education literature (e.g., Kilic, 2012; Kilic, Soran, & Graf, 2011; Lumpe, Czerniak, & Haney, 1998; Lumpe, Haney, & Czerniak, 1998; Ozcan, Tekkaya, & Cakiroglu, 2012). The present work can be seen as a first attempt to explore potential factors that explain pre-service science teachers' intentions to integrate NOS into science instruction based on the TPB. In this manner, this research provides empirical evidence about applicability of the TPB in explaining intentions to integrate NOS into science instruction and contributes to the related literature as a research study from a different cultural context like Turkey where NOS has been given a growing emphasis in the national science curriculum.

For the purpose of this study, intention to integrate nature of science questionnaire was developed utilizing the framework of TPB. Based on the present findings, the questionnaire appears to provide a reliable and valid measure of factors that could potentially explain pre-service science teachers' intentions to integrate NOS into their science instruction. In this manner, this research contributes to the related literature by providing a questionnaire that measures possible factors explaining intentions to integrate NOS into science instruction.

In this study, on the basis of TPB, a model was proposed suggesting that intention to integrate NOS into science instruction is determined by attitude toward integrating NOS into science instruction, subjective norm, and perceived behavioral control. Attitude toward behavior, subjective norm and perceived behavioral control are assumed to be based on interactions between behavioral belief strength and outcome evaluation, between normative belief strength and motivation to comply, and between control belief strength and power of control factor, respectively. In order to estimate the hypothesized model, which included latent interactions, was estimated by structural equation modeling (SEM). More specifically, an unconstrained approach based on double-mean-centering strategy (Lin, Wen, Marsh, & Lin, 2010), which is among approaches for the estimation of latent interactions, was adopted. It is noteworthy that even though estimation of interactions between variables is a significant issue in social and behavioral sciences, there have been limited research that employed SEM to estimation of interactions between latent variables (see Marsh, Wen, & Hau, 2004). This study contributes to related literature by employing unconstrained approach with double mean-centering strategy, which is among approaches for the estimation of SEM with latent interactions, in order to estimate interactions between variables that were hypothesized based on the TPB.

Related research on NOS identified a multitude of factors that impacted addressing NOS instructionally. It should be noted that a great majority of research studies are qualitative in nature. Although these qualitative investigations provide valuable information regarding factors associated with addressing NOS instructionally, they are limited to small sample size due to the nature of qualitative research and in these investigations it is difficult to detect relative effects of the factors. It is particularly important to have information of the related issue across a large sample and to identify relative impacts of the factors in an attempt to help more individuals develop effective NOS instruction. The present study is quantitative in nature and in order to gather data, intention to integrate nature of science questionnaire was administered to a large sample. Besides, SEM with latent interactions, which was used to analyze the gathered data, provided with information relative impacts of the factors in the hypothesized model.

1.2 Definition of Important Terms

Nature of science refers to “the epistemology of science, science as a way of knowing, or the values and beliefs inherent to the development of scientific knowledge” (Abd-El-Khalick et al., 1998, p. 418).

Pre-service science teachers refers to undergraduate students who are trained in a four-year elementary science education program to become elementary science teachers (Grades 6–8).

In the present study, *science instruction* refers to instructions related to science course at elementary schools

Behavioral intention refers to pre-service science teachers’ intention to integrate NOS into science instruction.

Attitude toward behavior refers to the degree to which a pre-service science teacher has a positive or negative evaluation of “integrating NOS into science instruction”

Subjective norm refers to social pressure perceived by pre-service science teachers to integrate NOS into science instruction.

Perceived behavioral control refers to perceived ease or difficulty of integrating NOS into science instruction.

Behavioral belief strength refers to pre-service science teachers’ estimation of the probability that integrating NOS into science instruction will yield each outcome in question (e.g., Students differentiate science [*physics, chemistry, biology*] from other disciplines [*e.g., history, philosophy*]).

Outcome evaluation refers to pre-service science teachers' evaluation of the importance of each outcome in question (e.g., that students differentiate science [*physics, chemistry, biology*] from other disciplines [*e.g., history, philosophy*]).

Normative belief strength refers to pre-service science teachers' estimation of the likelihood that a given referent person or institution (e.g., ministry of education, school administrators, parents, and students) will expect them to integrate NOS into their science instruction

Motivation to comply refers to pre-service science teachers' evaluation of the importance of each referent's expectation related to integrating NOS into science instruction

Control belief strength refers to pre-service science teachers' estimation of the likelihood that each factor (e.g., "Presence of a laboratory in the school") will be present

Power of control factor refers pre-service science teachers' evaluation of the extent to which presence of each factor will facilitate integrating NOS into science instruction

1.3 Research Questions

The current study was motivated by the following research questions:

1. What are pre-service science teachers' attitude toward integrating nature of science into science instruction, subjective norms, perceived behavioral control, behavioral beliefs, normative beliefs, control beliefs, and intention to integrate nature of science into science instruction?

2. How well can the theory of planned behavior account for pre-service science teachers' intention to integrate nature of science into their science instruction?

   2.1 How well can pre-service science teachers' intention to integrate nature of science into their science instruction be explained by attitude toward the behavior, subjective norm, and perceived behavioral control?

   2.2 How well can pre-service science teachers' attitude toward the behavior be explained by behavioral belief strength, outcome evaluation, and an interaction between behavioral belief strength and outcome evaluation?

   2.3 How well can pre-service science teachers' subjective norm be explained by normative belief strength, motivation to comply, and an interaction between normative belief strength and motivation to comply?

   2.4 How well can pre-service science teachers' perceived behavioral control be explained by control belief strength, power of control factor and an interaction between control belief strength and power of control factor?

1.4 Overview of the Proposed Model

The present study was interested in the applicability of the TPB in explaining pre-service science teachers' intentions to integrate NOS into their science instruction. On the basis of TPB, it was proposed a model suggesting that intention to integrate NOS into science instruction is determined by attitude toward integrating NOS into science instruction, subjective norm, and perceived behavioral control. Attitude toward behavior, subjective norm and perceived behavioral control are assumed to be based on interactions between behavioral belief strength and outcome evaluation, between normative belief strength and motivation to comply, and between control belief strength and power of control factor, respectively. In order to estimate the hypothesized model comprising latent interactions, both interacting latent variables (i.e., behavioral belief strength [BBS], outcome evaluation [OE], normative belief strength [NBS], motivation to comply [MC], control belief strength [CBS], and power of control factor [PCF]) and interaction latent variables (i.e. interactions of "behavioral belief strength and outcome evaluation" [BBS.OE], "normative belief strength and motivation to comply" [NBS.MC], and "control belief strength and power of control factor" [CBS.PCF]) were included in the model. Figure 1.2 shows the hypothesized model to be estimated in the analysis. Detailed information related to the analysis of latent interaction is provided in the third and fourth chapters of the dissertation.

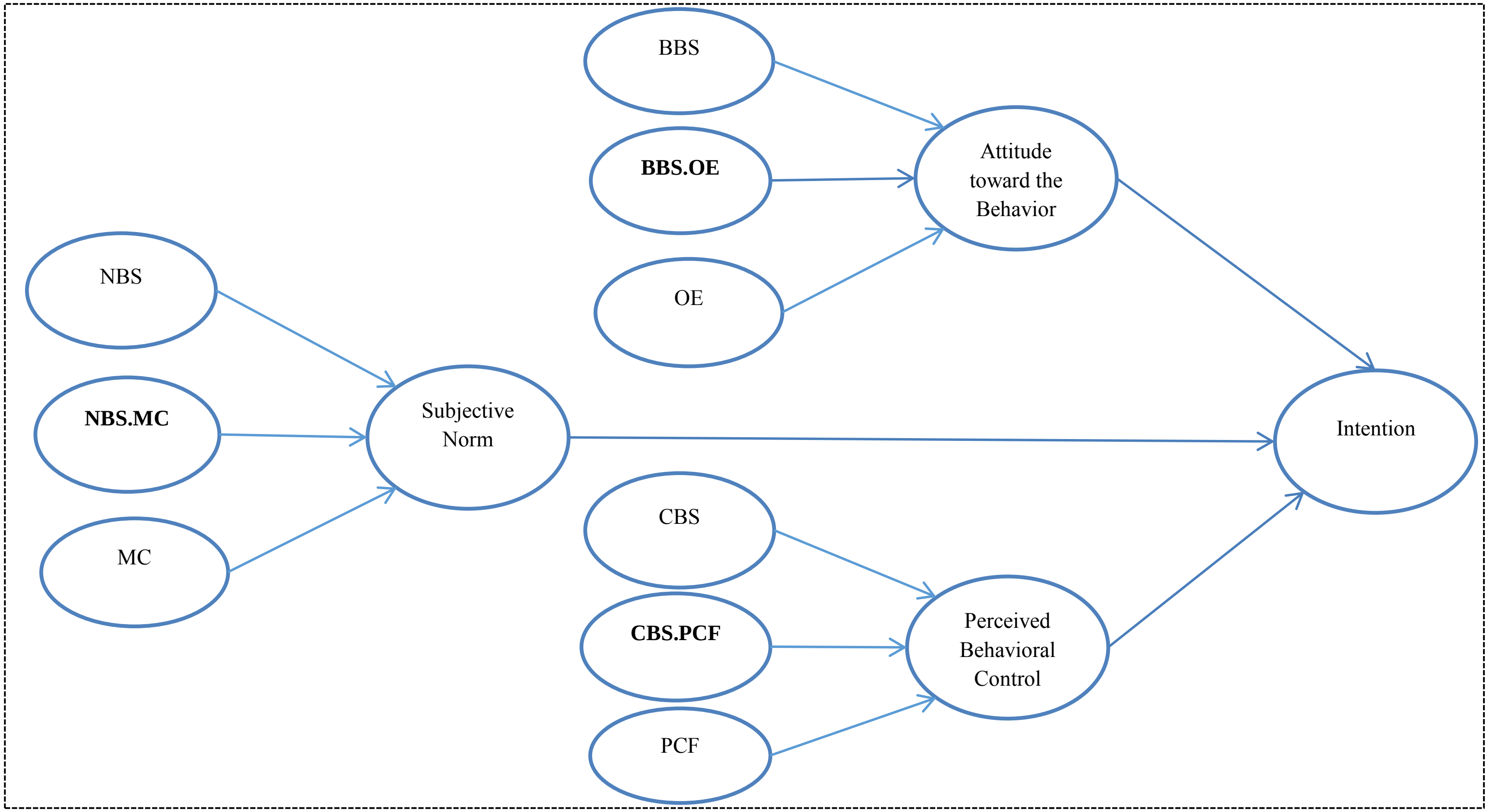

Figure 1.2 Hypothesized model to be estimated

CHAPTER II

LITERATURE REVIEW

The present study aimed to examine factors that could potentially predict pre-service science teachers' intentions to integrate NOS into science instruction in the framework of TPB. Therefore, this chapter comprises nature of science, factors impacting the translation of NOS conceptions into instructional practices, TPB, and use of TPB in science education. In NOS part, information about what NOS is and about literature on understanding of NOS and general approaches to NOS instructions is provided. In the second part, research studies related to factors impacting the translation of both pre-service and in-service science teachers' NOS conceptions into instructional practices are reviewed. In theory of planned behavior part, theoretical background is presented. Use of TPB in science education part includes research studies in science education that utilized TPB.

2.1 Nature of Science

The importance of nature of science (NOS) to pre-college science education has been recognized by science education reform documents (e.g., American Association for the Advancement of Science [AAAS], 1993, 1999; National Research Council [NRC], 1996). NOS has been generally utilized to refer to "the epistemology of science, science as a way of knowing, or the values and beliefs inherent to the development of scientific knowledge" (Abd-El-Khalick, Bell, & Lederman, 1998, p. 418). These definitions are, still, reasonably general and philosophers, historians, and educators of science are quick to be in disagreement on the particular NOS description (Abd-El -Khalick et al., 1998). However, Abd-El-Khalick and Lederman (2000b) believed that some significant NOS aspects do not arouse controversy and are accessible to pre-college students. These aspects included that "scientific knowledge is (a) tentative (subject to change); (b) empirically based (based on and/or derived from observations of the natural world); (c) subjective (theory-laden); (d) partly the product of human inference, imagination, and creativity (involves the invention of explanation); and (e) socially and culturally embedded" as well as that "distinction between observations and inferences, and the functions of, and relationships between scientific theories and laws" (Abd-El-Khalick & Lederman, 2000b, p.1063, see also Abd-El-Khalick et al., 1998; Lederman, 2007). Certainly, teachers play a significant role in conveying these NOS aspects to pre-college students. Yet, research has consistently reported the naïve conceptions of NOS held by both pre-service (e.g. Abd-El-Khalick & Akerson, 2004; Akerson, Abd-El-Khalick, & Lederman, 2000; Akerson, Morrison, & McDuffie, 2006; Erdogan, Cakiroglu, & Tekkaya, 2006; McDonald, 2010) and in-service teachers (e.g. Abd-El-Khalick & BouJaoude, 1997; Akerson & Hanuscin, 2007; Aslan & Tasar, 2013; Dogan & Abd-El-Khalick, 2008; Dogan, Cakiroglu, Bilican, & Cavus, 2013). There is no doubt that teachers cannot teach NOS in an efficient manner without understanding it (Schwartz & Lederman, 2002). For years, research has witnessed some attempts fostering appropriate views of NOS among science teachers, which would allow them to teach NOS in an effective manner (see Abd-El-Khalick & Lederman, 2000a). For example, in their review article, Abd-El-Khalick and Lederman (2000a) reported two general approaches to NOS instructions which were labeled as implicit and explicit. The implicit approach assumed that understanding of NOS would be developed as a "by-product" of participating in science-based activities without any discussion of NOS aspects whereas the explicit approach assumed that NOS views would be enhanced by means of making target aspects of NOS explicit (Abd-El-Khalick & Lederman, 2000a). The authors found these attempts generally unsuccessful; nevertheless the explicit approach was comparatively more efficient than the implicit approach. Subsequent research efforts included the phrase 'reflective' in the explicit approach and the explicit reflective approach has been started to be utilized by later studies to enhance NOS conceptions (e.g. Abd-El-Khalick & Akerson, 2004; Akerson, Abd-El-Khalick, & Lederman, 2000; Akerson & Hanuscin, 2007; Khishfe & Abd-El-Khalick, 2002).

As far as the relationship between teachers' NOS conceptions and their classroom practices is considered, findings of a number of studies (e.g. Abd-El-Khalick, Bell, & Lederman, 1998; Akerson & Abd-El-Khalick, 2003; Brickhouse, 1990; Bell, Lederman, & Abd-El-Khalick, 2000; Lederman, 1999; Lederman, Schwartz, Abd-El-Khalick, & Bell, 2001; Schwartz & Lederman, 2002; Herman, 2010) support the notion of Abd-El-Khalick and Lederman (2000a) that having adequate undertanding of NOS is required but not sufficient for teaching NOS effectively. Even teacher holding informed NOS conceptions may not translate those conceptions into classroom practices (e.g. Akerson & Abd-El-Khalick, 2003; Lederman, 1999). Hence, researchers started to investigate possible factors that impact the translation of teachers' NOS conceptions into instructional practices (e.g., Aslan & Tasar, 2013; Abd-El-Khalick et al., 1998; Bell et al., 2000; Demirdogen, Hanuscin, Uzuntiryaki-Kondakci, & Koseoglu, 2015; Herman, 2010; Koehler, 2006; Lederman, 1999; Lederman et al., 2001; Schwartz & Lederman, 2002; Sweeney, 2010; Wahbeh & Abd-El-Khalick, 2013). In the following sections, these research studies are reviewed in detail.

2.2 Factors impacting the translation of NOS conceptions into instructional practices

Research studies interested in factors that facilitate or impede the reflection of NOS views into instructional practices are inspected in two parts: research studies on (1) pre-service science teachers and (2) in-service science teachers.

2.2.1 Research on Pre-Service Science Teachers

In an attempt to gain insights about pre-service secondary science teachers' understanding of NOS and instructional practices and factors that influence translation of their NOS understanding into instructional practices, a series of research studies were conducted in the context of a fifth-year Master of Arts in Teaching (MAT) teacher preparation program at Oregon State University by Abd-El-Khalick, Bell, and Lederman (1998), Bell, Lederman, and Abd-El-Khalick (2000), and Lederman, Schwartz, Abd-El-Khalick, and Bell (2001). In each investigation, revisions were made based on the findings and recommendations of the previous one. Detailed information related to these investigations is provided in the following part.

In the first study, Abd-El-Khalick et al. (1998) worked with fourteen pre-service secondary science teachers (nine males and five females) enrolled in the teacher preparation program to outline the factors influencing the reflection of their views of NOS into planning and teaching. Data were collected by means of an open-ended questionnaire administered prior to pre-service teachers' student teaching to assess their views of NOS and by means of daily lesson plans, classroom videotapes, portfolios and supervisors' clinical observation notes gathered throughout participants' student teaching to examine for explicit references to NOS. Besides, semi structured interviews were conducted after participants' student teaching to validate their answers to the questionnaire and to detect the factors that influence reflection of their NOS views into teaching. Participants demonstrated to hold adequate understandings of several NOS aspects comprising empirical basis and tentativeness of science, subjectivity and creativity in science, and the distinction between observation and inference. But, findingsshowed that participants rarely include explicit references to NOS in their planning and instructional practices and they pronounced several factors for the inconsistency between NOS conceptions and instructional practices. The factors involved considering NOS as less important than other outcomes (e.g., science content and processes), concerns related to classroom management and routine tasks, feeling uncomfortable about NOS conceptions and ability to evaluate students' NOS conceptions, lack of sources and experience in order to teach NOS, constraints forced by cooperating teachers (e.g. pressure to cover the topic, assigned by cooperating teachers, within the time limit), and lack of time for planning instruction. The authors provided some recommendations for teacher education programs in order to facilitate reflection of pre-service teachers' NOS views into their classroom teaching. More specifically, teacher preparation programs should assist pre-service teachers to comprehend the logic behind and significance of emphasizing NOS in their classroom practices. Besides, pre-service teachers should be provided with further comprehensive experience in order to teach and assess the NOS. As well, teacher preparation programs should provide ways to assist supervising teachers to have adequate NOS conceptions and skills to teach the NOS. The authors also recommended temporally separating learning of NOS conceptions and learning how to address them in instructions and they pointed out a need for further study to examine the effectiveness of this approach.

Based on Abd-El-Khalick et al.'s (1998) recommendation, Bell, Lederman, and Abd-El-Khalick (2000) designed a study, in which teaching NOS was temporarily separated from teaching how to address NOS instructionally, to explore factors influencing the reflection of pre-service teachers' NOS views into their planning and student teaching. The sample of this study included thirteen pre-service secondary science teachers (8 males and 5 females) from the teacher preparation program. In the study, the following data sources were utilized: an open-ended questionnaire, which was administered prior to student teaching, to evaluate participants' understandings of NOS, daily lesson plans for 12-week internship, classroom videotapes, supervisors' weekly clinical observation notes, portfolios gathered during student teaching, and semi-structured interviews, which were conducted with participants after student teaching and analyzing data related to portfolios and instructional materials, to validate their answers to the questions in the open-ended questionnaire, to detect factors that influence the reflection of their NOS views into classroom practices, and clarify their pedagogical preferences for addressing NOS instructionally. Data revealed that participants held adequate conceptions related to some aspects of NOS. In addition, some participants addressed various aspects of NOS instructionally in an explicit manner. But, participants did not include instructional objectives related to NOS and did not attempt to assess students' NOS views. Participants pointed out several reasons of not giving importance to NOS during instructions. The first one that teaching NOS was perceived to conflict with teaching other science aspects (e.g. content and science process skills). Second, addressing NOS instructionally necessitated considerable time and this was considered as an inhibiting factor to keeping face with other teachers. Third, a lack of confidence related to NOS understandings. Fourth, restrictions of student teaching experience such as complying with topics that mentor teachers were addressing. Lastly, being so overwhelmed due to experience of student teaching. Overall, the authors concluded that results of temporarily separating teaching NOS from teaching how to teach NOS seemed to be promising. The authors suggested that more effort is necessary to provide pre-service teachers with including instructional objectives related to NOS. More specifically, pre-service teachers should be assigned to include objectives and assessments in their plans and to carry out their plans during student teaching.

The third in a series of research studies was done by Lederman et al. (2001). The authors were interested in the effectiveness of an intervention aimed to promote translating pre-service secondary science teachers' NOS understanding into their instructions. Specifically, position of NOS in the teacher preparation program was raised in an attempt to enhance pre-service teachers' understanding of NOS and to impact their beliefs related to significance of NOS as a learning outcome. The study comprised of two phases. In the first phase, NOS views of 15 pre-service secondary science teachers (8 females and 7 males) who enrolled in the teacher preparation program were inspected. Besides, to be included in the second phase, classroom-based phase, 7 of the fifteen participants were selected since they had adequate understanding of NOS, average or above average teaching abilities, a supervising teacher who would support NOS teaching or let participants include NOS in instructions, and an interest in NOS. The classroom-based phase aimed to follow the seven participants' attempts for explicit references to NOS in their planning and instruction during student teaching and detect facilitating factors to addressing NOS instructionally. In order to gather data, an open-ended Views of NOS questionnaire (VNOS-C), interviews, classroom observations, formal and informal discussions, and supervisors' field notes were utilized. Data showed that in this study, explicit references to NOS in planning, instructional practices, and instructional assessment enhanced compared to those in previous investigations, which are Abd-El-Khalick et al. (1998) and Bell et al. (2001). The most effective factors in participants' teaching attempts were specified as knowledge of NOS, subject matter, and pedagogy and intentions to address NOS instructionally. However, the authors emphasized that merely NOS knowledge, merely subject matter knowledge, or merely pedagogical knowledge will not be adequate and they stated that this study pointed out a necessity to describe and develop pedagogical content knowledge (PCK) for NOS. Considering that there were not continuities in attention given to NOS in the teacher preparation program: namely, NOS was given importance in specific courses, but not in others, the authors advised that NOS understanding, subject matter knowledge, and PCK for NOS are included all components of the program in a uniform and consistent manner.

Just recently, Demirdogen, Hanuscin, Uzuntiryaki-Kondakci, and Koseoglu (2015) were interested in the impact of an intervention on development of pre-service chemistry teachers' PCK for teaching NOS and on their instructional planning. The intervention took place within the context of two-semester elective course, that is, "Research in Chemistry Education". The course comprised of two instructional sections, which are (a) NOS instruction and (b) pedagogical instruction utilizing PCK as an organizing framework. Sample of the study involved thirty Turkish pre-service chemistry teachers (22 females and 8 males) who were registered for a course of research in science education. Data were gathered by means of open-ended instruments, observations, interviews, and artifacts (e.g. lesson plans and reflection papers). Gathered data indicated that all participants were able to reflect only knowledge of instructional strategies and science teaching orientation among PCK components into their lesson plans. Gathered data resulted in four main issues concerning pre-service chemistry teachers' PCK for NOS and nature of their teaching practices. More specifically, in order for participants to have an attempt to include NOS in instructions either in an implicit or explicit manner, they need to hold adequate conceptions of NOS and believe in the significance of their students' learning of NOS during chemistry instruction. Besides, all participants developed as a minimum some components of PCK for NOS and included this knowledge in their instructional plans to some level. Participants' PCK for NOS progressed from knowing about how to address NOS instructionally (knowledge level) to translating this knowledge into instructional plan (application level). In addition, participants who held more highly integrated PCK were more probably to integrate NOS in their instructional plans. As well, in order for teachers to teach NOS, they need to be comfortable about their conceptions of NOS. Finally, pre-service science teachers with well-sophisticated and well-integrated PCK for NOS was better able to design lessons to address NOS. Considering the finding that following NOS instruction, pedagogical instruction using PCK as an organizing framework was influential in encouraging pre-service chemistry teachers to include NOS in their instructions, it was recommended that focusing deliberately and purposefully on pre-service chemistry teachers' particular PCK components might be more efficient than methods that focused merely on how to address NOS instructionally. The authors also suggested that in order for teachers to develop PCK for NOS, it should be provided teachers with opportunities to develop an understanding of NOS and to study NOS from a teaching standpoint that can be actualized with using overt PCK framework in a course where NOS is integrated. In addition, it was suggested to reexamine PCK components to provide teachers with understanding how these components relate with each other in designing instruction.

2.2.2 Research on In-Service Science Teachers

In a multiple case study with five high school biology teachers (3 males and 2 females), Lederman (1999) investigated whether teachers' conceptions of NOS affect their classroom practices and what factors ease or inhibit the effect of their conceptions on classroom practices. Of the participating teachers, two were beginning teachers having teaching experiences of 2 and 4 years and three were experienced teachers having teaching experiences of 9, 14, and 15 years. Data were collected during one academic year by means of various data sources: semi-structured interviews conducted at the start and at the end of the investigation, an open-ended questionnaire to assess participants' conceptions of NOS, classroom observations, lesson plans, instructional materials for participants' all biology classes, an informal interview/discussion after each classroom observation, and weekly informal discussions about instruction. Besides, after collecting data from teachers, randomly selected students were also interviewed related to their conceptions of NOS. Findings of data analysis revealed that though teachers held conceptions of NOS consistent with those stated in varied reforms, their classroom practices were not directly affected by those conceptions. Teachers' teaching experience, intentions, and perceptions of students were found to be significant factors. More specifically, classroom practices of only the two most experienced teachers (teaching experiences of 14 and 15 years) were consistent with their views on NOS. However, analyses of interviews and lesson plans revealed that these two teachers did not intentionally attempt to teach NOS. In addition, data seemed to demonstrate that if teachers do not overtly intend to teach NOS and do not explicitly address NOS in their instructions, students will not develop contemporary understanding of NOS. One of the experienced teacher (a teaching experience of 9 years) did not teach NOS. According to her, NOS was too abstract for 10th grade students to master in an effective and functional manner. Furthermore, classroom management seemed to be a crucial concern for beginning teachers. The author recommended that pre-service and in-service science teacher education programs should help teachers develop understandings of NOS and skills and abilities to address those understandings instructionally. More specifically, as a first effort, teachers should be helped to consider NOS as a significant objective in each instructional unit, class, and activity. In addition, considering that classroom management was found to be concern of beginning teachers, they should be helped to develop various instructional routines and schemes making them be comfortable to organize and manage instructions. Lastly, the author emphasized the necessity of explicit NOS instruction.

In a separate study, Schwartz and Lederman (2002) focused on two beginning secondary science teachers' knowledge, intentions, and practices as they mastered NOS content and attempted to address NOS in their student teaching and first year of full-time teaching. These two participants were selected from a group of individuals enrolled in a Masters of Arts in Teaching (MAT) program since they varied in terms of experiences and level of NOS knowledge and science subject matter knowledge. Data were gathered by means of questionnaires, interviews, lesson plans, classroom observations, postlesson conferences, and informal discussions. More specifically, the form C of the Views of Nature of Science questionnaire (VNOS-C) was administered three times (at the beginning of the program and before and midway through student teaching) during the MAT program to evaluate participants' views on NOS. Participants were interviewed after second and third administration of the questionnaire to acquire further information concerning their NOS views. Lessons plans and classroom observations were used to evaluate participants' attempts to teach during their student teaching. The first author conducted a formal classroom observation during a participant's planning to address NOS instructionally. Following the formal classroom observation, a postlesson conference was conducted to provide participants with reflecting on their lessons and discussing facilitating and inhibiting factors to teaching of NOS. Following full-time student teaching, participants were interviewed to learn their views on NOS and instructional priorities related to addressing NOS, which are their intentions and explanations for achievement or failures during student teaching, and to learn their reflections on experiences of learning and addressing NOS instructionally during the MAT program. During the first year of full-time teaching, participants were communicated to learn their teaching positions, instructional attempts regarding NOS, sense of competence about and commitment to addressing NOS instructionally. Analysis of data suggested that strong NOS knowledge, strong science subject matter knowledge, and perceived connection between NOS and science subject matter influenced participants' learning and instructionally addressing of NOS. The teacher with extensive knowledge of subject matter, who also possessed more sophisticated views of NOS, was better able to teach NOS. This teacher's extensive subject matter knowledge allowed him to include varied examples to improve teaching of NOS. On the other hand, having relatively weak knowledge of subject matter and less sophisticated knowledge of NOS impede the other teacher's integration of NOS into science content instruction. In addition, the authors pointed out that participants had strong intentions and beliefs that NOS was a significant issue to address in their instructions and thus they could overcome some of the mostly identified restraints. In the study, the authors highlighted pedagogical content knowledge (PCK) for NOS that for teachers to teach NOS with success, development of knowledge of subject matter, NOS, and pedagogy, together with the interaction among these knowledge domains, which is PCK for NOS, should be paid attention. They recommended an emerging model for the necessities of addressing NOS instructionally that focused on teachers' PCK for NOS, intentions, and beliefs related to their abilities to address NOS instructionally in an effective manner and related students' abilities to master NOS.

In their study, Aslan and Tasar (2013) studied science teachers' conceptions of NOS and how these conceptions impacted their classroom practices. Five Turkish science teachers (3 females and 2 males) constituted the sample of the study. Participating five science teachers were selected from a larger cohort of 74 science teachers according to the following criteria: holding realistic views based on findings of Views on Science-Technology-Society (VOSTS) Questionnaire, being an experienced teacher, teaching to 6th graders, being available for being gathered qualitative data, and being a volunteer to participate in the study. Data sources included VOSTS Questionnaire, classroom observations, semi-structured interviews, and student artifacts (e.g. projects, homeworks, and examinations) were used. Gathered data indicated that participant science teachers had naïve ideas related to many NOS aspects and NOS was not addressed in participants' instructional practices. In the study, it was identified the following factors that had an influence on participant science teachers' NOS instructional decisions: (a) NOS was not addressed in the curriculum, (b) NOS views were not evaluated in nation-wide examinations, and (c) expectations of parents, students, and school administrators

The study by Wahbeh and Abd-El-Khalick (2013) examined the impact of integrated NOS intervention on middle and high school science teachers' views of NOS, retention of these views and instructional planning and teaching practices related to NOS. The study also investigated factors that have an effect on translating teachers' NOS views into teaching practices as well as certain characteristics of teachers' NOS views that impact, or interact with factors that impact, this translation. The study comprised of two phases. In the first phase, the intervention, which was described as explicit-reflective, metacognitive, content-embedded approach carried out in the framework of learning-as-conceptual-change, was implemented within the context of teacher professional development summer course. In the second phase, a subsample of participants was monitored as they made an attempt to include NOS in instructions. Nineteen middle and high school science teachers (9 females and 10 males) participated in the teacher professional development course and thus in the study and six teachers (4 females and 2 males) were drawn from participants who attained significant improvement in their NOS views by the conclusion of the course. Data were gathered through multiple sources: an open-ended questionnaire, semi-structured individual interviews, classroom observations, and artifacts, reflections papers, and logs which were generated by participants. The NOS-dedicated teacher professional development course was influential in facilitating informed views of NOS as well as retention of those views five months after the course. The course was also influential in providing teachers with successfully addressing NOS aspects including empirical, tentative, social and cultural embeddness, and to a lesser level inferential while the course was less influential in this respect related to NOS aspects of myth of the scientific method, nature of theories and laws, and theory-laden. More specifically, participants successfully addressed NOS aspects which they had comprehended and assimilated well through intervention and when the learning contexts matched well with the teaching contexts. The study enabled controlling for several mediating factors that influence translation of NOS views into classroom practices. These factors were concerns about classroom management and survival issues, beliefs related to significance of addressing NOS instructionally and related to students' interest in and skills about NOS, curricular primacies, teachers' interest related to mastering and addressing NOS instructionally, and presence of instructional resources related to NOS. On the other hand, the mediating factors drawn from the data were (a) depth of teachers' science content knowledge, (b) their pedagogical knowledge and abilities about implementing student-centered and inquiry teaching, (c) their interest in students' prior NOS views, (d) their skills of locating, adapting, and/or designing instructional resources related to NOS, and (e) nature and attributes of their very conceptions of NOS. The nature and attributes of teachers' NOS conceptions interacted with the rest of the mediating factors mentioned above and thus acquired priority over the rest of the mediating factors. The attributes of teachers' NOS conceptions included (a) situatedness of the NOS conceptions and (b) ahistoricity of knowledge related to scientific theories, constructs, and concepts. The authors pointed out that mediating factors drawn from the data of this study complied well with Schulman's model for pedagogical content knowledge (PCK), that is, a combination of subject matter knowledge, pedagogical knowledge, and knowledge related to learners and context and they built a model including sources of PCK for NOS.

To sum up, research studies on factors impacting the translation of NOS conceptions into instructional practices resulted in a multitude of factors which were as follows:

a. Teachers' intentions related to addressing NOS (Demirdogen et al., 2015; Lederman, 1999; Lederman et al., 2001; Schwartz & Lederman, 2002)
b. Teachers' beliefs related to the importance of NOS (Abd-El-Khalick et al., 1998; Demirdogen et al., 2015; Herman, 2010; Schwartz & Lederman, 2002)
c. Teachers' perceptions related to students' abilities to learn NOS (Lederman, 1999; Sweeney, 2010) and related to connection between NOS and science subject matter (Schwartz & Lederman, 2002)
d. Teachers' sense of personal responsibility to employ NOS (Herman, 2010),
e. Teachers' sense of self-confidence related to their NOS conceptions (Abd-El-Khalick et al., 1998; Bell et al., 2000; Demirdogen et al., 2015), capability to teach NOS (Bell et al., 2000), and ability to evaluate students' NOS conceptions (Abd-El-Khalick et al., 1998)
f. Teachers' conceptions of NOS (Demirdogen et al., 2015; Lederman et al., 2001; Schwartz & Lederman, 2002; Wahbeh & Abd-El-Khalick, 2013)
g. Teachers' science subject matter knowledge (Lederman et al., 2001; Schwartz & Lederman, 2002; Wahbeh & Abd-El-Khalick, 2013)
h. Teachers' pedagogical knowledge (Herman, 2010; Lederman et al., 2001; Wahbeh & Abd-El-Khalick, 2013)

i. Teachers' pedagogical content knowledge for NOS (Demirdogen et al., 2015; Schwartz & Lederman, 2002; Wahbeh & Abd-El-Khalick, 2013)
j. Teachers' interest in students' prior NOS views (Wahbeh & Abd-El-Khalick, 2013)
k. Constraints particular to student teaching experience (e.g. pressure to cover the topic, assigned by cooperating teachers, within the time limit) (Abd-El-Khalick et al., 1998; Bell et al., 2000)
l. Classroom management (Abd-El-Khalick et al., 1998; Lederman, 1999; Lederman et al., 2001)
m. Availability of sources in order to teach and/or evaluate NOS conceptions (Abd-El-Khalick et al., 1998)
n. Expectations of parents, students, and school administrators (Aslan & Tasar, 2013)
o. Teachers' teaching experience (Abd-El-Khalick et al., 1998; Lederman, 1999)
p. Characteristics of nation-wide or state-wide examinations (Aslan & Tasar, 2013; Koehler, 2006),
q. Constraints related to time (Abd-El-Khalick et al., 1998; Bell et al., 2000; Koehler, 2006)
r. Constraints related to the curriculum (Aslan & Tasar, 2013)

Considering the aforementioned studies, it is evident that there is a growing body of inquiries on the factors impacting the translation of NOS conceptions into instructional practices. However, researchers continue to be called to examine constraining or facilitating factors associated with translation of teachers' NOS views into instructional practices (see Abd-El-Khalick & Lederman, 2000a; Lederman & Lederman, 2014).

2.3 Theory of Planned Behavior

In the present study, in order to examine factors that could potentially predict pre-service science teachers' intentions to integrate NOS into science instruction, the theory of planned behavior (TPB; Ajzen, 1985, 1991, 2005, 2012) was utilized as a theoretical framework. Currently, the TPB is among the most popular social psychological models in order for predicting behavior (Ajzen, 2012). It was extended from the theory of reasoned action (Ajzen & Fishbein, 1980; Fishbein & Ajzen, 1975) such that it allows dealing with actions over which persons do not possess complete volitional control (see Ajzen, 2005). A fundamental component of the TPB is the individual's *intention* to engage in a behavior which is supposed to grasp motivational features that impact the behavior; it shows the extent to which individuals are eager to try and are planning to make an effort to engage in the behavior (Ajzen, 1991). According to the theory (see Figure 1.1), behavioral *intention* is assumed to precede human social behavior and is itself determined by three factors: attitude toward behavior, subjective norm, and perceived behavioral control (Ajzen, 2012). *Attitude toward behavior* is "the degree to which a person has a favorable or unfavorable evaluation or appraisal of the behavior in question" (Ajzen, 1991, p.188) and it is presumed to be based on beliefs related to possible consequences of a given behavior (*behavioral beliefs*) (Ajzen & Sheikh, 2013). More specifically, attitude toward behavior is expected to be brought out by a combination of an individual's beliefs of the possibility that performing the behavior will result in the consequences in question (i.e., *behavioral belief* or *behavioral belief strength*) and an individual's evaluations of the consequences (i.e., *outcome evaluation*) based on the expectancy-value model (see Ajzen, 1991, 2011, 2012). As indicated symbolically in Equation 1, belief of the possibility that performing the behavior will result in the consequence in question (b_i) is multiplied by evaluation of the consequence (e_i), and the resulting products are aggregated over all consequences which is, in turn, in direct proportion to an individual's attitude (A) (see Ajzen, 1991, 2012).

$$A \propto \sum b_i e_i \qquad (1)$$

Subjective *norm*, on the other hand, is "the perceived social pressure to perform or not to perform the behavior" (Ajzen, 1991, p.188) and it is assumed to be dependent on an individual's beliefs regarding normative referents' expectations and behaviors (*normative beliefs*) (Ajzen & Sheikh, 2013). In detail, as depicted in the expectancy

– value model (see Equation 2), the strength of each normative belief (n) is weighted by the individual's motivation to comply with the referent (m), and the resulting products are aggregated over all referents which is, in turn, in direct proportion to an individual's subjective norm (SN) (see Ajzen, 1991, 2012).

$$SN \propto \sum n_i m_i \quad (2)$$

Perceived behavioral control refers to "the perceived ease or difficulty of performing the behavior" (Ajzen, 1991, p.188) and it is presumed to be based on beliefs related to possible facilitating and impeding factors (*control beliefs*) (Ajzen & Sheikh, 2013). Specifically, as illustrated in the expectancy – value model (see Equation 3), the estimation of likelihood or belief related to presence of each facilitating or impeding factor (control factor) (c) is weighted by the power of the factor to ease or impede performing the behavior (p), and the resulting products are aggregated over all factors which is, in turn, in direct proportion to an individual's perceived behavioral control (PBC) (see Ajzen, 1991, 2012).

$$PBC \propto \sum c_i p_i \quad (3)$$

On the other side, in general, more positive attitude, stronger social pressure, and greater perceived behavioral control are associated with stronger *behavioral intention* (Ajzen, 2012). The relative significance of these three determinants on the intention can differ depending on behavior and population (Ajzen, 2011).

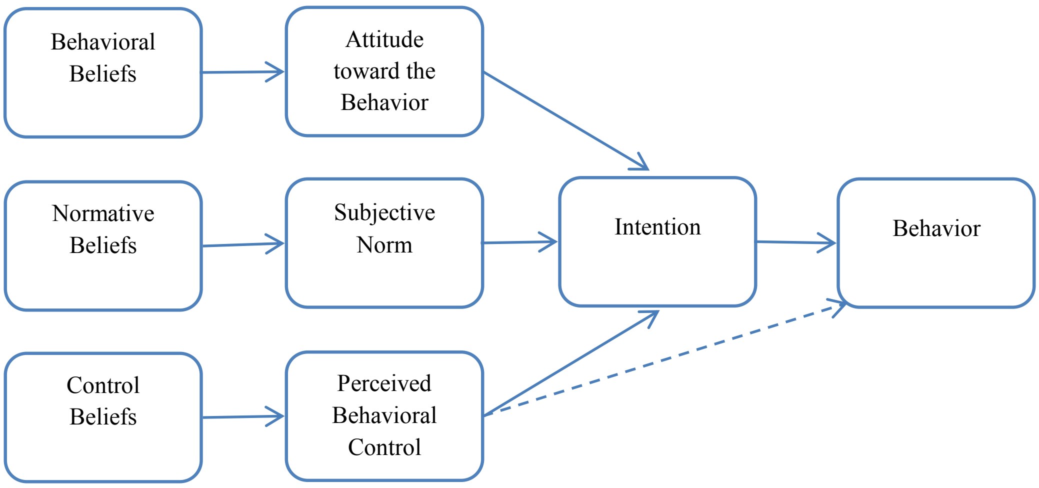

Figure 2.1 A schematic representation of the theory of planned behavior.
(Source: Adapted from Ajzen, 2005)

2.4 Use of TPB in Science Education

In science education literature, there are some research studies that employed the TPB as a theoretical framework. For instance, in their study, Lumpe, Haney, and Czerniak (1998) were interested in science teachers' beliefs and intentions to implement science-technology-society in their classroom by using the TPB. Two distinct cohorts of science teachers constituted the participants of the study. The first cohort included purposively selected fourteen K-12 science teachers (12 females and 2 males) varied in their backgrounds (e.g., type of school where they worked, teaching experience). In the first cohort, fourteen science teachers responded to open-ended questions aimed to identify teachers' beliefs with respect to implementing science-technology-society in the classroom, which in turn, were used to construct indirect measures in the TPB. The second cohort comprised of 117 K-12 science teachers and 72% of them were female. Participants' teaching experiences ranged from zero to 37 years with an average of 15 years. Sixty-four percent of the participant teachers had a bachelor's degree whereas other participants had a graduate degree. Of the teachers, 28% were primary grade teachers, 28% were intermediate grade teachers, 17% were middle school teachers, and 23% were high school teachers. In order to gather data, a questionnaire which was developed based on the TPB was utilized. There were also items to get information about participants' sex, teaching experience, grade level assignment, and the highest degree that they held. Findings indicated that participants' attitude toward behavior, subjective norm, and perceived behavioral control were significantly associated with their intentions to implement science-technology-society in the classroom. Among variables (i.e., attitude toward behavior, subjective norm, and perceived behavioral control), perceived behavioral control was found to be the best predictor of intention. These three variables explained 38% of the variation in participants' intentions to implement science-technology-society in their classroom. Inspection of associations between demographic variables (including sex, teaching experience, grade level assignment, highest degree that participants held) and theoretical constructs (including attitude, subjective norm, perceived behavioral control, and behavioral intentions) revealed that teachers' teaching experience was found to be negatively linked to variables comprising subjective norm, perceived behavioral control, and behavioral intentions. On the other hand, there were not significant associations between demographic variables, which were gender, grade level assignment, highest degree obtained, and theoretical constructs, which were attitude, subjective norm, and perceived behavioral control, and behavioral intentions. As a result, the study revealed that if teachers had intentions to implement STS in their classrooms, they held favorable attitudes toward STS and perceived that support from individuals and external factors were necessary. The authors recommended that teachers should be provided with professional development by focusing on particular beliefs that seem to impact intentions and behaviors in order to facilitate favorable beliefs toward implementing STS in the classroom. They pointed out the significance of providing teachers with opportunities to monitor and experience activities related to STS in their classrooms. They also emphasized the important role of curriculum materials in implementing STS.

Additionally, the authors had a suggestion for teacher education programs that STS should take place in teaching methods courses.

In another research, Lumpe, Czerniak and Haney (1998) studied factors affecting K-12 teachers' intentions to utilize cooperative learning in their science teaching. In order for the purpose of the study, the TPB was employed as a theoretical framework. The study comprised two distinct cohorts of teachers. Twenty-six purposively chosen K-12 teachers constituted the first cohort and they participated in first part of the study which is related to uncovering beliefs regarding use of cooperative learning in the classroom and developing a questionnaire to be used in the second part. The second cohort included 107 randomly selected K-12 teachers who participated in the second part of the study, related to testing the TPB. In the study, data collection instrument was the questionnaire that was developed based on the TPB in the first part of the study. Descriptive results showed that participating K-12 teachers had favorable attitudes toward employing cooperative learning during science instruction and sensed support from important referents with respect to using cooperative learning during science instruction. Still, they perceived that there might be lack of external supporting factors (e.g. sources for cooperative learning). On the other hand, multiple regression models revealed that attitude toward the behavior and perceived behavioral control were significantly related with intentions to employ cooperative learning during science instruction. However, subjective norm was found to be associated with intentions. Besides, it was found that there was a negative correlation between grade level and intention to utilize cooperative learning. That is, teachers who taught upper grades were less likely to intend to employ cooperative learning during science instruction.

Recently, Kilic, Soran and Graf (2011) investigated Turkish and German pre-service biology teachers' intentions to teach evolution and factors that influenced their intentions within the context of the TPB. Participants of the study included 116 Turkish pre-service biology teachers and 154 German pre-service biology teachers. Data were gathered through "Evolution teaching intention survey" which was developed based on the TPB and analyzed through structural equation modeling.

According to descriptive statistics, both Turkish and German pre-service biology teachers demonstrated fairly strong intentions to teach evolution and Turkish participants' intentions were stronger than those of German participants. Findings of structural equation modeling indicated that attitude and perceived behavioral control impacted Turkish pre-service biology teachers' intentions to teach evolution whereas attitude and subjective norm influenced German pre-service biology teachers' intentions. Attitude toward the behavior was found to be the most influential factor for both Turkish and German participants. Moreover, the theory accounted for 61% and 52% of the variance in intentions of Turkish and German pre-service biology teachers, respectively. Furthermore, underlying beliefs of Turkish participants' attitude differed to some extent from those of German participants' attitude. The authors attributed this to influential factors to difference in culture and education system. Considering the finding that subjective norm was not influential in Turkish participants' intentions, the authors pointed out two possible reasons. Specifically, Turkish pre-service teachers thought that they were expected to teach evolution and other individuals' expectations did not have an influence on their decisions. Related to finding that perceived behavioral control did not impact German participants' intentions, the authors reasoned that German pre-service biology teachers did not face with problems related to, for example, place of the evolution in the curriculum, time allocated for evolution, instructional materials so that they did not view presence of such facilities as a requirement to their decisions about teaching evolution Lastly, since the explained variance in German participants' intentions was smaller than those of Turkish participants' intentions, the authors pointed out the presence of other factors (e.g. evolution knowledge and personal norm) in German participants' intentions.

Another recent study by Kilic (2012) focused on Turkish and German biology teachers' intentions to teach evolution and factors related to their intentions. The TPB was utilized as a theoretical framework. The participants of the study included twenty-five Turkish and twelve German biology teachers with teaching experiences ranged from 2,5 to 30 years. Semi-structured interviews, based on the guidance of the

TPB, were conducted to collect data and qualitative content analysis was utilized to analyze the collected data. Findings revealed that intentions held by Turkish and German biology teachers and associated factors differed and the differences were thought to depend on values related to culture and religion. Results demonstrated that twenty of 25 Turkish biology teachers and all of the German biology teachers held positive attitudes toward teaching evolution and intentions to teach evolution. Remaining five Turkish biology teachers, who did not hold positive attitude, did not have intentions to teach evolution. In addition, eighteen Turkish biology teachers thought that throughout the society they were not wanted to teach evolution whereas German teachers considers teaching evolution a mission for them. Moreover, all German participants had high perceived control over teaching evolution, however, three Turkish participants stated that current conditions were not convention for teaching evolution.

In a separate study, Gokcen, Tekkaya, and Cakiroglu (2012) investigated early childhood teachers' science teaching intentions by utilizing the theory of planned behavior. In order for the purpose of the study, a cohort of early childhood teachers were interviewed by means of interviews questions prepared according to the theory. Findings revealed that participating teachers had positive attitudes toward teaching science. For example, they thought that "science teaching develops children's environmental awareness, psychomotor and affective skills". Moreover, they stated that kids, parents of kids, inspectors, and school principals expected them to teach science. Furthermore, they conveyed that although lesson plans, classroom materials, appropriate classroom settings, education that teachers received at the university were facilitating factors to teach science, deficiency of content knowledge and materials, constraints related to time, financial issues, vague curriculum, negative classroom environment and their reluctance were inhibiting factors.

Aforementioned research studies provided evidence for the applicability of the TPB in science education. In the present study, the applicability of the TPB in explaining pre-service science teachers' intentions to integrate NOS into their science instruction was tested.

CHAPTER III

METHOD

This chapter describes research methodology of the present study. Particularly, design of the research, population and sampling, instruments, data collection procedure, data analysis procedure, and assumptions and limitations of the study.

3.1 Design of the Study

The current study aimed to examine factors that could potentially explain pre-service science teachers' intentions to integrate NOS into science instruction in the framework of TPB. More specifically, on the basis of TPB, it was proposed a model suggesting that intention to integrate NOS into science instruction is determined by attitude toward integrating NOS into science instruction, subjective norm, and perceived behavioral control. Attitude toward behavior, subjective norm and perceived behavioral control are assumed to be based on interactions between behavioral belief strength and outcome evaluation, between normative belief strength and motivation to comply, and between control belief strength and power of control factor, respectively. Relating to primary research objective, this study could be classified as explanatory research (see Johnson, 2001) since a theory was tested to identify causal factors that produce change in pre-service science teachers' intentions to integrate NOS into their science instruction. More specifically, it was tested the applicability of the TPB in explaining pre-service science teachers' intentions to integrate NOS into their science instruction.

A questionnaire that included 10 theoretical constructs (intention, attitude toward behavior, subjective norm, perceived behavioral control, behavioral belief strength, outcome evaluation, normative belief strength, motivation to comply, control belief strength, and power of control factor) was developed based on the TPB. In the pilot study, it was administered to 408 pre-service science teachers to evaluate its psychometric properties. The final form of the questionnaire was administered to 1172 pre-service science teachers in the main study. The hypothesized model on the basis of TPB, which included latent interactions, was estimated by structural equation modeling (SEM). More specifically, an unconstrained approach based on double mean-centering strategy (Lin, Wen, Marsh, & Lin, 2010), which is among approaches for the estimation of latent interactions was adopted. With respect to time dimension, the present study could be classified as cross-sectional research since data were gathered from pre-service science teachers at a single point in time (see Johnson, 2001). Considering Johnson's classification of nonexperimental quantitative research based on a combination of primary research objective and time dimension, it could be stated that the present study is a cross-sectional, explanatory research study. The steps of the research design used in this study are shown in Figure 3.1.

3.2 Population and Sampling

The target population of the study was all senior pre-service science teachers in Turkey. Considering the fact that this study focused on nature of science, seniors were selected purposively since they completed a course related to nature of science. More specifically, the Council of Higher Education suggests a course related to nature and history of science in science teacher education programs. Accordingly, nature and history of science course is a required course in science teacher education programs in the participant universities except for two universities. In these two universities, nature of science is integrated into other courses (e.g. science methods courses). During the time of data collection, 2013-2014 academic year, there were 57 public universities which senior pre-service science teachers were enrolled in. While deciding about universities to be included in the sample, Turkish Statistical Institute's (Türkiye İstatistik Kurumu [TUIK], 2005) statistical regional unit classification was taken into account. More specifically, according to this classification, Turkey has 12 regions which were identified based on economic, social, cultural and geographical characteristics and population size of cities. Table 3.1 gives detailed information related to regions, cities in each region, number of universities in which senior

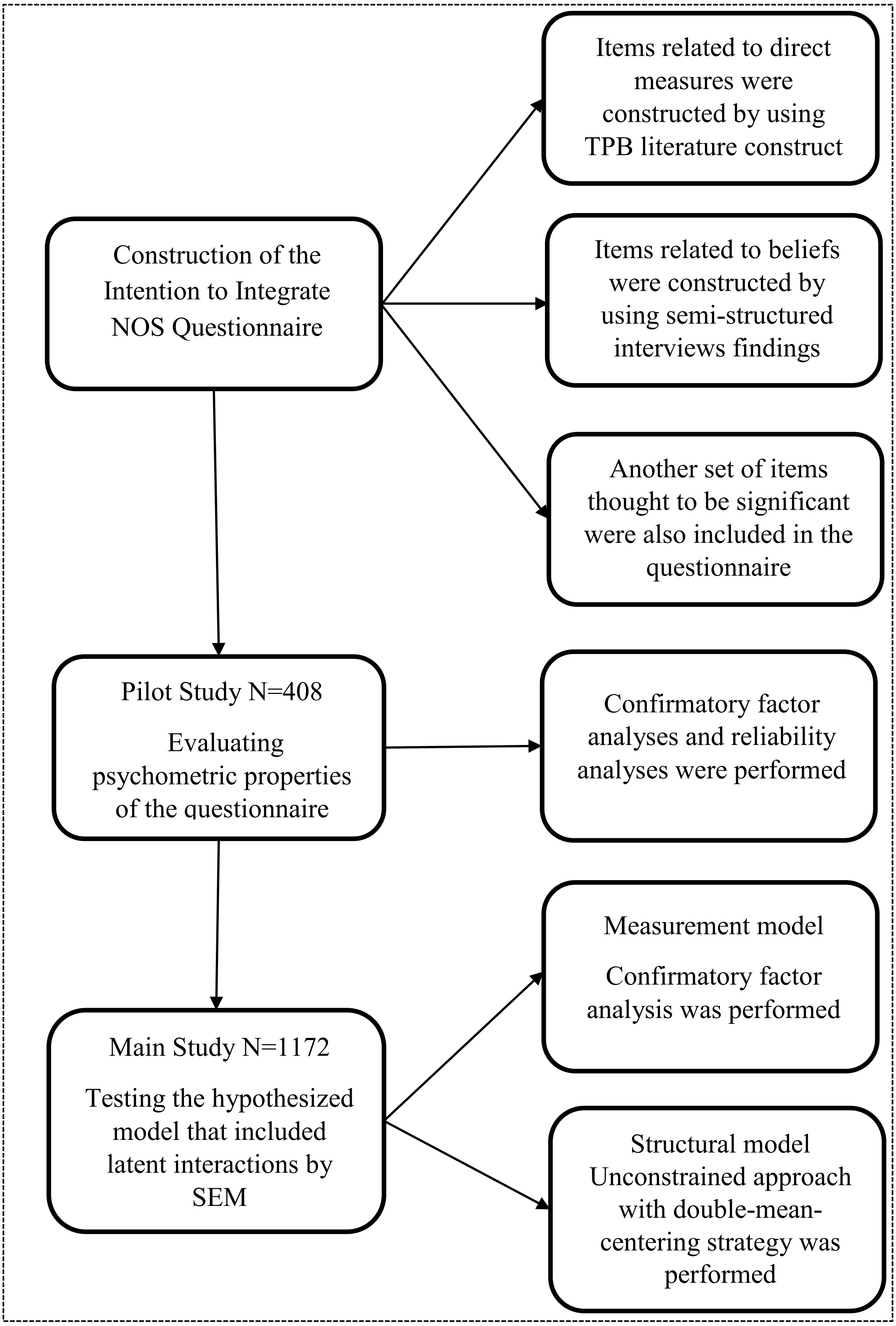

Figure 3.1 The steps of the research design used in the present study

pre-service science teachers were enrolled in each region, and expected population in each region. The information related to universities (e.g., universities that senior pre-service science teachers enrolled in, expected number of senior pre-service science teachers in each university, etc.) was acquired by utilizing Student Selection and Placement System's document, which is 2010-University Entrance Exam Placement: Higher Education Programs Guide. Twenty-two universities, out of 57, were selected so that number of senior pre-service science teachers to be included in the sample from each region was at least 10 percent of the region's population (see Table 3.1 for sample size from each region). It should be noted that universities from each region were selected by using convenience sampling due to constraints regarding time, cost, and travel.

Table 3.1

Turkish Statistical Institute's (2005) Statistical Regional Units Classification, Number of Universities in Which Senior Pre-Service Science Teachers were enrolled in Each Region, Number of Universities Included in the Study, Expected Population, and Sample

Region	City	# of universities that senior pre-service science teachers were enrolled	# of universities included in the study	Expected population	Sample
1. North East Anatolia	Erzurum, Erzincan, Bayburt, Ağrı, Kars, Iğdır, Ardahan	5	2	810	121
2. Central East Anatolia	Malatya, Elazığ, Bingöl, Tunceli, Van, Muş, Bitlis, Hakkari	5	1	455	74
3. South East Anatolia	Gaziantep, Adıyaman Kilis, Şanlıurfa, Diyarbakır, Mardin, Batman, Şırnak, Siirt	3	1	285	32
4. Istanbul	İstanbul	3	3	205	78
5. West Marmara	Tekirdağ, Edirne, Kırklareli, Balıkesir, Çanakkale	3	1	300	63
6. Aegean	İzmir, Aydın, Denizli, Muğla Manisa, Afyon, Kütahya, Uşak	8	3	985	121

Table 3.1 (continued)

Region	City	# of universities that senior pre-service science teachers were enrolled	# of universities included in the study	Expected population	Sample
7. East Marmara	Bursa, Eskişehir, Bilecik, Kocaeli, Sakarya, Düzce, Bolu, Yalova	5	3	480	123
8. West Anatolia	Ankara, Konya, Karaman	4	2	495	112
9. Mediterranean	Antalya, Isparta, Burdur, Adana, Mersin, Hatay, Kahramanmaraş, Osmaniye	5	1	485	81
10. Central Anatolia	Kırıkkale, Aksaray, Niğde, Nevşehir, Kırşehir, Kayseri, Sivas, Yozgat	6	2	745	99
11. West Black See	Zonguldak, Karabük, Bartın, Kastamonu, Çankırı, Sinop, Samsun, Tokat, Çorum, Amasya	6	2	685	179
12. East Black See	Trabzon, Ordu, Giresun, Rize, Artvin, Gümüşhane	4	1	560	89
Total		57	22	6490	1172

In the selected 22 universities, 1172 senior pre-service science teachers (mean age = 22.98, *SD* = 1.48 years) involved in the study. Of the sample, 74.3% (n = 871) were female, 25.5% (n = 299) were male, and 0.2% (n =2) did not provide gender information. Participants' mean cumulative Grade Point Average was 2.71/4.00 (*SD* = 0.38; range = 1.40 to 4.00). Majority of participants' fathers were employed (69.1%) and a considerable percentage of them were retired (25.9%) whereas majority of mothers were unemployed (82%). In terms of educational level, a small percentage (.7%) of fathers and a considerable percentage (7.2%) of mothers were illiterate while 2.8% of fathers and 7.6% of mothers were literate but did not graduate from primary school. In addition, 25% of fathers and 43.1% of mothers had primary school degree while about the same percentage of fathers (18.2%) and mothers (16.2%) had secondary school degree. Furthermore, 52.2% of fathers and 25.3% of mothers graduated from high school and above. In relation to family income, participants rated monthly income of their families as follows: Less than 750 Turkish Liras [TL] (2.8%), between 750 TL and 1000 TL (10.4%), between 1001 TL and 1500 TL (24%), between 1501 TL and 2000 TL (12.1%), between 2001 TL and 2500 TL (21.8%), between 2501 TL and 3000 TL (12%), and more than 3000 TL (15.1%).

On the other hand, participants were requested to evaluate their level of interest in and knowledge about NOS. Most of the participants (59.4%) stated to have "moderate" interest in NOS and 29.2% reported to have "a lot" interest in NOS while 9.6% of them claimed to have "a little" interest in NOS. Of the participants, 71.1% reported to have "moderate" knowledge about NOS whereas few participants claimed to have "a little" (16.4%) and "a lot" (11.6%) knowledge about NOS. Besides, participants were asked to evaluate to what extent they had been taught NOS at university, 46.1% of them rated as "moderate" and relatively fewer (38.3%) rated as "a lot" while 13.9% claimed as "a little". Table 3.2 provides detailed information related to participants' gender, mother's employment status, father's employment status, mother's educational level, father's educational level, monthly income of family, level of interest in NOS, knowledge about NOS, and prior experience.

Table 3.2

Characteristics of the Participants

	Frequency	Percentage (%)
Gender		
Female	871	74.3
Male	299	25.5
Missing	2	.2
Mother employment status		
Employed	117	10
Unemployed	961	82
Retired	53	4.5
Missing	41	3.5
Father employment status		
Employed	810	69.1
Unemployed	4	.3
Retired	304	25.9
Missing	54	4.6
Mother education level		
Illiterate	84	7.2
Literate, but not primary school	89	7.6
Primary school	505	43.1
Secondary school	190	16.2
High school	228	19.5
University	65	5.5
Ms/PhD	4	.3
Missing	7	.6
Father education level		
Illiterate	8	.7
Literate, but not primary school	33	2.8
Primary school	293	25
Secondary school	213	18.2
High school	366	31.2
University	238	20.3
Ms/PhD	8	.7
Missing	13	1.1

Table 3.2 (continued)

	Frequency	Percentage (%)
Monthly income of the family		
Less than 750 Turkish Liras (TL)	33	2.8
750 TL – 1000 TL	122	10.4
1001 TL – 1500 TL	281	24
1501 TL – 2000 TL	142	12.1
2001 TL – 2500 TL	256	21.8
2501 TL – 3000 TL	141	12
More than 3000 TL	177	15.1
Missing	20	1.7
Interested in NOS		
Not at all	10	.9
A little	113	9.6
Moderate	696	59.4
A lot	342	29.2
Missing	11	.9
Knowledge about NOS		
Not at all	4	.3
A little	192	16.4
Moderate	833	71.1
A lot	136	11.6
Missing	7	.6
To what extent participants had been taught NOS at university		
Not at all	12	1
A little	163	13.9
Moderate	540	46.1
A lot	449	38.3
Missing	8	.7

3.3 Instruments

In the present study, two instruments were used to gather data from pre-service science teachers: Demographic Information Scale and Intention to Integrate Nature of Science Questionnaire.

3.3.1 Demographic Information Scale

Demographic Information Scale investigated participants' characteristics including gender, age, cumulative Grade Point Average, employment status of parents, educational level of parents, monthly income of family, level of interest in NOS, knowledge about NOS, and prior experience related to NOS.

3.3.2 Intention to Integrate Nature of Science Questionnaire

In order to explore variables that could potentially explain pre-service science teachers' intentions to integrate nature of science into their science instruction, a questionnaire was developed.

3.3.2.1 Construction of the Intention to Integrate Nature of Science Questionnaire

The development of the questionnaire was guided by the theory of planned behavior (TPB; Ajzen, 1985, 1991, 2005, 2012). Items assessing direct measures, (i.e., intention, attitude toward the behavior, subjective norm, and perceived behavioral control) and corresponding beliefs (i.e., behavioral beliefs, normative beliefs, and control beliefs) were formulated. The TPB literature and semi-structured interviews with pre-service science teachers (see below) were drawn on to construct items related to direct measures and beliefs, respectively. In addition to the TPB literature and findings of the interviews, another set of items thought to be significant were included in the questionnaire.

The constructs included in the questionnaire and how related items were formulated were introduced as follows:

3.3.2.1.1 Construction of Items related to Direct Measures

The direct measures included behavioral intention, attitude toward the behavior, subjective norm, and perceived behavioral control. Items assessing direct measures were formulated by utilizing the TPB literature. Besides, a set of items thought to be significant were also included in the questionnaire. The appropriateness of the items were evaluated by three university professors in the area of science education who have expertise in NOS and/or TPB.

Behavioral intention: Four items were used to measure participants' intention to integrate NOS into their science instruction. Participants were asked to rate these statements (e.g. "I intend to integrate nature of science into science instruction") on a 7-point scale ranging from 1 (strongly disagree) to 7 (strongly agree). Three of the items were adapted from the TPB literature while one item was developed for this study. Table 3.3 displays the items and the related literature where the items were adapted. The items were not taken directly from the cited literature: Necessary revisions were made in the statements to assess participants' behavioral intention to integrate NOS into their science instruction. Additionally, changes were made in the scale response format of some items. In this way, agreement scale (1 = strongly disagree and 7 = strongly agree) was used for all items.

Table 3.3 *Items related to the Behavioral Intention*

Item	Adapted from
I will try to integrate nature of science into science instruction	Davis, Ajzen, Saunders, & Williams (2002)
I plan to integrate nature of science into science instruction	Mummery & Wankel (1999)
I intend to integrate nature of science into science instruction	Davis et al. (2002)
I **do not** think of integrating nature of science into science instruction	Newly developed item

Attitude toward integrating NOS into science instruction: Eleven 7-point semantic differential scales were used to identify participants' attitude toward integrating NOS into science instruction. Participants were asked to rate the statement "For me, to integrate nature of science into science instruction" by using anchors: Useful-useless, fun-boring, effortless-troublesome, easy-difficult, important-unimportant, necessary-unnecessary, valuable-worthless, correct-incorrect, reasonable-unreasonable, worthwhile-a waste of time, and worth to pay effort-a waste of effort. Seven of the anchors were formed by drawing on the TPB literature whereas four anchors were developed for this study. Table 3.4 displays the anchors and the related literature where the anchors were adapted. The anchors were not taken directly from the cited literature: a scale response format was changed to 7-point scale for some items so that a 7-point semantic differential scale format was used for all items.

Table 3.4

Items related to Attitude

Anchors	Adapted from
For me, to integrate nature of science into science instruction is ...	
Useful - Useless	Davis et al. (2002)
Fun - Boring	Mummery & Wankel (1999)
Effortless - Troublesome	Newly developed anchors
Easy - Difficult	Fishbein & Ajzen (2010)
Important - Unimportant	Mummery & Wankel (1999)
Necessary - Unnecessary	Conner, Norman, & Bell (2002)
Valuable - Worthless	Mummery & Wankel (1999)
Correct - Incorrect	Cheung, Chan, & Wong (1999)
Reasonable – Unreasonable	Newly developed anchors
Worthwhile - A waste of time	Newly developed anchors
Worth to pay effort - A waste of effort	Newly developed anchors

Subjective norm: Four items were used to assess participants' perceived social pressure with respect to integrating NOS into science instruction. Participants were asked to rate these statements (e.g. "Most people who are important to me will be disappointed if I do not integrate nature of science into science instruction") on a 7-point scale ranging from 1 (strongly disagree) to 7 (strongly agree). Table 3.5 displays the items and the related literature where the items were adapted. The items were not taken directly from the cited literature: necessary revisions were made in the statements to assess participants' perceived social pressure concerning integrating NOS into science instruction. Additionally, wording of the items was modified and/or extended to clarify and/or reflect the context of the study. As well, scale response format was changed to 7-point agreement scale (1 = strongly disagree and 7 = strongly agree) for all items.

Table 3.5

Items related to Subjective Norm

Item	Adapted from
People/Institutions whose opinions I value expect me to integrate nature of science into science instruction	Davis et al. (2002), Fishbein & Ajzen (2010)
Most of the people/institutions that I think to be important to my teaching career expect me to integrate nature of science into science instruction	Davis et al. (2002)
Most of the science teachers integrate nature of science into their science instruction	Fishbein & Ajzen (2010)
Most people who are important to me will be disappointed if I **do not** integrate nature of science into science instruction	Davis et al. (2002)

Perceived behavioral control: Six items were used to assess participants' perceived control over integrating nature of science into science instruction. Participants were asked to rate these statements (e.g. "I can overcome any problems that could prevent me from integrating nature of science into science instruction if I want to") on a 7-point scale ranging from 1 (strongly disagree) to 7 (strongly agree). Table 3.6 displays the items and the related literature where the items were adapted. The items were not taken directly from the cited literature: necessary revisions were made in the statements to assess participants' perceived control over integrating nature of science into science instruction. Wording of the items was also modified to clarify the statements. Additionally, scale response format was changed to 7-point agreement scale (1 = strongly disagree and 7 = strongly agree) for all items.

Table 3.6

Items related to Perceived Behavioral Control

Item	Adapted from
If I want to, I can integrate nature of science into science instruction	Cheung et al. (1999)
For me to integrate nature of science into science instruction is possible	Ajzen (2006)
For me to integrate nature of science into science instruction is easy	Davis et al. (2002)
To integrate nature of science into science instruction is up to me	Fishbein & Ajzen (2010)
I can overcome any problems that could prevent me from integrating nature of science into science instruction if I want to	Davis et al. (2002)
I have complete control over integrating nature of science into science instruction	Davis et al. (2002)

3.3.2.1.2 Construction of Items related to Beliefs

In the context of this study, the beliefs included behavioral beliefs, normative beliefs, and control beliefs. To construct belief items, semi-structured interviews were conducted with 19 senior pre-service science teachers from two public universities of Ankara. The utilized open-ended interview questions were adapted and expanded from Fishbein and Ajzen's (2010) work. Table 3.7 gives the open-ended questions used during semi-structured interviews.

Table 3.7

The Open-Ended Questions

What do you think as the advantages of integrating nature of science into science instruction?
What do you think as the disadvantages of integrating nature of science into science instruction?
Who would expect you to integrate nature of science into science instruction?
Who would not expect you to integrate nature of science into science instruction?
Which institutions would expect you to integrate nature of science into science instruction?
Which institutions would not expect you to integrate nature of science into science instruction?
What factors or circumstances would facilitate integrating nature of science into science instruction?
What factors or circumstances would impede integrating nature of science into science instruction?

Participants’ responses were analyzed and utilized to construct items pertaining to behavioral beliefs, normative beliefs, and control beliefs. Besides, a set of items thought to be significant indicators of the beliefs were included in the questionnaire. An initial pool of items was examined by three professors in the area of science education who have expertise in NOS and/or TPB.

Behavioral beliefs: In order to formulate items related to behavioral beliefs, interviewees were asked: “What do you think as the disadvantages of integrating nature of science into science instruction?” and “What do you think as the advantages of integrating nature of science into science instruction?” Based on interviewees’ responses about the disadvantages and advantages of integrating NOS into science instruction, outcomes of the mentioned behavior were identified. In addition to findings of the interviews, a set of behavioral outcomes thought to be significant were included in the questionnaire. Three professors who have expertise in NOS and/or TPB examined the initial pool of outcomes and selected 22 behavioral outcomes [e.g. “Students distinguish between science and pseudoscience (e.g., *astrology, acupuncture*)”] to be included in the questionnaire (see Table 3.8). With respect to each behavioral outcome, two questions were asked to produce measures of *behavioral belief strength* and *outcome evaluation*. In order to measure participants’ behavioral belief strength, they were asked to estimate the probability that integrating nature of science into science instruction would yield each outcome on a 7-point scale ranging from 1 (strongly disagree) to 7 (strongly agree). To measure outcome evaluation, the participants were asked to evaluate each outcome on a 7-point scale ranging from 1 (not important at all) to 7 (very important).

Table 3.8

Behavioral Outcome

If I integrate nature of science into science instruction…
Students easily understand science topics
Students learn science topics better
Students like science topics
Students' interest in science instruction increases
Students are developed as scientifically literate individuals
Students understand the interaction among science, technology, society, and environment better*
Students are raised as critical thinkers
Students' decision making skills related to socio-scientific issues (*e.g., gene therapy, cloning*) develop*
Students learn characteristics of scientific knowledge
Students differentiate science (*physics, chemistry, biology*) from other disciplines (*e.g., history, philosophy*)*
Students distinguish between science and pseudoscience (*e.g., astrology, acupuncture*)*
Students' creative thinking skills develop
Students realize that science is part of everyday life
Students' misconceptions related to nature of science are eliminated
Students learn the source of scientific knowledge
Students realize that scientists are not different from other people
Students realize that they can be scientists in the future as well
Students start to critically evaluate scientific news in the media
Students realize that science can have limitations*
Science instruction become enjoyable
Science instruction become more interesting for students
I become professionally developed

* Items were developed for the current study

Normative beliefs: In order to formulate items related to normative beliefs, interviewees were asked: "Who would expect you to integrate nature of science into science instruction?", "Who would not expect you to integrate nature of science into science instruction?", "Which institutions would expect you to integrate nature of science into science instruction?", and "Which institutions would not expect you to integrate nature of science into science instruction?" Based on interviewees' responses about individuals or institutions that would/would not expect interviewees to integrate NOS into science instruction, normative referents were identified. Three university professors who have expertise in NOS and/or TPB examined the initial pool of normative referents and selected nine normative referents (e.g., Ministry of Education, school administrators, parents, and students) to be included in the questionnaire (see Table 3.9). With respect to each normative referent, two questions were asked to produce measures of *normative belief strength* and *motivation to comply*. In order to measure participants' normative belief strength, they were asked to estimate the likelihood that a given referent person or institution (e.g., Ministry of Education, school administrators, parents, and students) would expect them to integrate NOS into their science instruction on a 7-point scale ranging from 1 (strongly disagree) to 7 (strongly agree). Second, to assess participants' motivation to comply with the referent, they were asked to evaluate the importance of each referent's expectation related to integrating NOS into science instruction on a 7-point scale ranging from 1 (not important at all) to 7 (very important).

Table 3.9

Normative Referents

Normative referent
Ministry of Education
Board of Education
Curriculum developers
Faculty members

Table 3.9 (continued)

Normative referent
School administrators
Science teachers
Teachers in other disciplines
Parents
Students

Control beliefs: In order to formulate items related to control beliefs, interviewees were asked: "What factors or circumstances would facilitate integrating nature of science into science instruction?" and "What factors or circumstances would impede integrating nature of science into science instruction?" Based on interviewees' responses about factors or circumstances that would facilitate or impede integrating NOS into science instruction, control factors were identified. The professors who have expertise in the fields of NOS and/or TPB examined the initial pool of control factors and selected 14 control factors (e.g., "Presence of a laboratory in the school") to be included in the questionnaire (see Table 3.10). With respect to each control factor, two questions were asked to produce measures of *control belief strength* and *power of control factor*. In order to measure participants' control belief strength, they were asked to estimate the likelihood that each factor (e.g., "Presence of a laboratory in the school") would be present on a 7-point scale ranging from 1 (not possible at all) to 7 (certainly possible). To measure power of control factor, participants were asked to evaluate the extent to which presence of each factor would facilitate integrating NOS into science instruction on a 7-point scale ranging from 1 (strongly disagree) to 7 (strongly agree).

Table 3.10

Control Factors

Control factor
Lack of concern about covering all the contents in the curriculum
The sufficiency of time allocated for science instruction
Presence of adequate equipment and materials (*laboratory equipment, technological and visual materials, textbooks, activity books, etc.*)
Presence of a laboratory in the school
My having sufficient knowledge of nature of science
My having experience for integrating nature of science into science instruction
My being sufficient in integrating nature of science in science instruction
The appropriateness of class size for integrating nature of science
That students are **reluctant** to learn about nature of science due to exam-based education system in Turkey
My ability to use appropriate teaching strategies to effectively integrate nature of science
My ability to answer students' questions easily
My ability to manage classroom
The appropriateness of science topics for integrating nature of science
That students have prior knowledge about nature of science

3.3.2.2 Pilot Study

In the pilot study, which was carried out during 2012-2013 spring semester, in order to evaluate psychometric properties of the intention to integrate nature of science questionnaire, it was administered to 408 senior pre-service science teachers (mean age = 22.84, *SD* = 1.64 years) enrolled in 10 public universities located in different geographical regions of Turkey. Of the sample, 72.3% (n = 295) were female, 26.7% (n = 109) were male, and 1% (n =4) failed to provide their gender. Participants' mean cumulative Grade Point Average was 2.84/4.00 (*SD* = 0.38; range = 1.75 to 3.91). The 10 universities were selected by using convenience sampling due to constraints regarding time, cost, and travel. Considering the fact that this study focused on nature of science, seniors were selected purposively since they completed a course related to nature of science. More specifically, the Council of Higher Education suggests a course related to nature and history of science in science teacher education programs. Accordingly, nature and history of science course is a required course in science teacher education programs in the participant universities except for one university. In this university, nature of science is integrated into other courses (e.g. science methods courses).

Confirmatory factor analysis (CFA) was used to examine the hypothesized factor structure of the questionnaire. Prior to the CFA, data were assessed for missing values, outliers, and normality. The variables in the questionnaire had missing cases ranged from 0 % to 3.3% and to estimate the missing values, multiple imputation with expectation maximization algorithm (EM) was utilized. The variables were inspected for both univariate and multivariate outliers. Univariate outliers were checked through z scores and forty-eight cases which had standard scores of 4 or greater were identified as univariate outliers (see Hair, Black, Babin, & Anderson, 2010). Thus, those forty-eight cases were extracted from the data. Related to multivariate outliers, Hair et al. (2010) pointed out that observations with Mahalanobis D^2/df value larger than 2.5 in small samples and 3 or 4 in large samples can be identified as potential outliers. Accordingly, there were no multivariate outliers. Univariate normality of the variables was assessed through examination of skewness and kurtosis values. Skewness values ranged from -2.25 to .09 whereas kurtosis values ranged from -1.13 to 6.51. Multivariate normality was assessed by using Mardia's test and the test produced a significant result ($p < .0005$) which means that multivariate normality was violated. Therefore, models tested through CFAs were estimated by using robust maximum likelihood (ML). The robust ML estimator yields ML parameter estimates with standard errors and a Satorra–Bentler scaled χ^2

(SB χ^2; Satorra & Bentler, 1994) which are robust against violation of normality (Brown, 2006).

Based on the TPB, the questionnaire included 10 latent variables: Intention (4 items), attitude toward behavior (11 items), subjective norm (4 items), perceived behavioral control (6 items), behavioral belief strength (22 items), outcome evaluation (22 items), normative belief strength (9 items), motivation to comply (9 items), control belief strength (14 items), and power of control factor (14 items). It should be noted that behavioral belief strength and outcome evaluation share identical behavioral outcomes, normative belief strength and motivation to comply share identical normative referents, and control belief strength and power of control factor share identical control factors. The latent variable pairs (i.e., behavioral belief strength - outcome evaluation, normative belief strength - motivation to comply, and control belief strength - power of control factor) were multiplied according to expectancy-value model in further analysis. For this reason, these latent variable pairs should share identical behavioral outcomes, normative referents, and control factors.

Ten separate CFAs were conducted to assess each latent variable and its items individually to determine problematic items. Each latent variable related to beliefs also was modeled in conjunction with its counterpart (i.e., behavioral belief strength - outcome evaluation, normative belief strength - motivation to comply, and control belief strength - power of control factor). As a result, a total of 63 items were eliminated from the questionnaire (see Tables 3.11 – 3.15) on the bases of factor loadings, standardized residuals, and modification indices. It should be noted that since the latent variable pairs related to beliefs (i.e. behavioral belief strength - outcome evaluation, normative belief strength - motivation to comply, and control belief strength - power of control factor) should share identical behavioral outcomes, normative referents, and control factors, when items were eliminated from one of the pairs, the identical items in the other pair were also eliminated. In detail, standardized factor loadings suggested elimination of eleven items (A3, A4, SN3, MC9, CBS1, CBS2, CBS3, CBS4, CBS9, CBS14, and PCF9) due to their poor loadings (see Table 3.10). Eliminated items, CBS1, CBS2, CBS3, CBS4, and CBS14, belonged to control belief strength that is one of control belief strength - power of control factor pair. Since control belief strength and power of control factor should share identical control factors, identical items (PCF1, PCF2, PCF3, PCF4, and PCF14) in the power of control factor were also eliminated. As a result, a total of sixteen items were removed from the questionnaire based on poor factor loadings. Examination of standardized residuals and modification indices showed localized points of ill fit (e.g., largest modification index = 280.39, smallest standardized residual = - 36.29). Hence, other items were deleted on the bases of standardized residuals and modification indices. To illustrate, since there was a consistent pattern of large standardized residuals associated with BBS2 and other items including BBS19 (-36.29), BBS12 (-11.02), BBS1 (6.48), and BBS3 (4.33), BBS2 was dropped from the questionnaire. There was a pattern of high modification indices associated with PBC1 and other items including PBC2 (92.14), PBC4 (19.90), and PBC6 (17.04) and with PBC6 and other items including PBC4 (64.30), PBC2 (30.26), and PBC1 (17.04) and it was not reasonable to make changes based on these modification indices. Thus, both PBC1 and PBC6 were dropped from the questionnaire.

Table 3.11 *Retained and Deleted Items with Standardized Factor Loadings for Intention and Attitude*

Item	λ	Item status
Intention (I)		
I will try to integrate nature of science into science instruction (I1)	.89	Retained
I plan to integrate nature of science into science instruction (I2)	.92	Retained
I intend to integrate nature of science into science instruction (I3)	.88	Retained
I do not think of integrating nature of science into science instruction (I4)	.51	Deleted
Attitude (A)		
Useful – Useless (A1)	.72	Retained
Fun – Boring (A2)	.65	Deleted
Effortless – Troublesome (A3)	.09	Deleted
Easy – Difficult (A4)	.09	Deleted
Important – Unimportant (A5)	.82	Retained
Necessary – Unnecessary (A6)	.89	Deleted
Valuable – Worthless (A7)	.83	Retained
Correct – Incorrect (A8)	.81	Retained
Reasonable – Unreasonable (A9)	.83	Retained
Worthwhile – A waste of time (A10)	.58	Retained
Worth to pay effort - A waste of effort (A11)	.57	Deleted

Table 3.12

Retained and Deleted Items with Standardized Factor Loadings for Subjective Norm and Perceived Behavioral Control

Item	λ	Item status
Subjective norm (SN)		
People/Institutions whose opinions I value expect me to integrate nature of science into science instruction (SN1)	.84	Retained
Most of the people/institutions that I think to be important to my teaching career expect me to integrate nature of science into science instruction (SN2)	.89	Retained
Most of the science teachers integrate nature of science into their science instruction (SN3)	.24	Deleted
Most people who are important to me will be disappointed if I do not integrate nature of science into science instruction (SN4)	.52	Retained
Perceived behavioral control (PBC)		
If I want to, I can integrate nature of science into science instruction (PBC1)	.80	Deleted
For me to integrate nature of science into science instruction is possible (PBC2)	.81	Retained
For me to integrate nature of science into science instruction is easy (PBC3)	.72	Retained
To integrate nature of science into science instruction is up to me (PBC4)	.70	Retained
I can overcome any problems that could prevent me from integrating nature of science into science instruction if I want to (PBC5)	.75	Retained
I have complete control over integrating nature of science into science instruction (PBC6)	.61	Deleted

Table 3.13

Retained and Deleted Items with Standardized Factor Loadings for Behavioral Belief Strength and Outcome Evaluation

Item	λ		Item status
Behavioral Outcome	Behavioral belief strength (BBS)	Outcome evaluation (OE)	
Students easily understand science topics	.70 (BBS1)	.65 (OE1)	Retained
Students learn science topics better	.74 (BBS2)	.68 (OE2)	Deleted
Students like science topics	.75 (BBS3)	.70 (OE3)	Deleted
Students' interest in science instruction increases	.78 (BBS4)	.74 (OE4)	Deleted
Students are developed as scientifically literate individuals	.74 (BBS5)	.71 (OE5)	Deleted
Students understand the interaction among science, technology, society, and environment better	.81 (BBS6)	.76 (OE6)	Retained
Students are raised as critical thinkers	.78 (BBS7)	.72 (OE7)	Retained
Students' decision making skills related to socio-scientific issues (e.g., gene therapy, cloning) develop	.74 (BBS8)	.74 (OE8)	Deleted
Students learn characteristics of scientific knowledge	.77 (BBS9)	.74 (OE9)	Deleted
Students differentiate science (physics, chemistry, biology) from other disciplines (e.g., history, philosophy)	.72 (BBS10)	.66 (OE10)	Retained

Table 3.13 (continued)

Item	λ		Item status
Behavioral Outcome	Behavioral belief strength (BBS)	Outcome evaluation (OE)	
Students distinguish between science and pseudoscience (e.g., astrology, acupuncture)	.70 (BBS11)	.72 (OE11)	Retained
Students' creative thinking skills develop	.74 (BBS12)	.73 (OE12)	Deleted
Students realize that science is part of everyday life	.77 (BBS13)	.76 (OE13)	Retained
Students' misconceptions related to nature of science are eliminated	.73 (BBS14)	.72 (OE14)	Retained
Students learn the source of scientific knowledge	.77 (BBS15)	.74 (OE15)	Deleted
Students realize that scientists are not different from other people	.51 (BBS16)	.56 (OE16)	Retained
Students realize that they can be scientists in the future as well	.69 (BBS17)	.73 (OE17)	Deleted
Students start to critically evaluate scientific news in the media	.75 (BBS18)	.76 (OE18)	Retained
Students realize that science can have limitations	.62 (BBS19)	.60 (OE19)	Deleted
Science instruction become enjoyable	.76 (BBS20)	.72 (OE20)	Deleted
Science instruction become more interesting for students	.75 (BBS21)	.71 (OE21)	Deleted
I become professionally developed	.70 (BBS22)	.63 (OE22)	Retained

Table 3.14

Retained and Deleted Items with Standardized Factor Loadings for Normative Belief Strength and Motivation to Comply

Item	λ		Item status
Normative referent	Normative belief strength (NBS)	Motivation to comply (MC)	
Ministry of Education	.71 (NBS1)	.81 (MC1)	Retained
Board of Education	.62 (NBS2)	.82 (MC2)	Deleted
Curriculum developers	.62 (NBS3)	.81 (MC3)	Deleted
Faculty members	.49 (NBS4)	.73 (MC4)	Retained
School administrators	.78 (NBS5)	.79 (MC5)	Retained
Science teachers	.66 (NBS6)	.70 (MC6)	Retained
Teachers in other disciplines	.65 (NBS7)	.60 (MC7)	Deleted
Parents	.59 (NBS8)	.51 (MC8)	Deleted
Students	.50 (NBS9)	.31 (MC9)	Deleted

Table 3.15

Retained and Deleted Items with Standardized Factor Loadings for Control Belief Strength and Power of Control Factor

Item	λ		Item status
Control factor	Control belief strength (CBS)	Power of control factor (PCF)	
Lack of concern about covering all the contents in the curriculum	.30 (CBS1)	.49 (PCF1)	Deleted
The sufficiency of time allocated for science instruction	.23 (CBS2)	.55 (PCF2)	Deleted
Presence of adequate equipment and materials (laboratory equipment, technological and visual materials, textbooks, activity books, etc.)	.34 (CBS3)	.65 (PCF3)	Deleted
Presence of a laboratory in the school	.25 (CBS4)	.69 (PCF4)	Deleted
My having sufficient knowledge of nature of science	.78 (CBS5)	.75 (PCF5)	Retained
My having experience for integrating nature of science into science instruction	.84 (CBS6)	.80 (PCF6)	Retained
My being sufficient in integrating nature of science in science instruction	.80 (CBS7)	.75 (PCF7)	Retained
The appropriateness of class size for integrating nature of science	.50 (CBS8)	.74 (PCF8)	Deleted
That students are reluctant to learn about nature of science due to exam-based education system in Turkey	.04 (CBS9)	.24 (PCF9)	Deleted

Table 3.15 (continued)

Item	λ	Item status	Item
Control factor	Control belief strength (CBS)	Power of control factor (PCF)	
My ability to use appropriate teaching strategies to effectively integrate nature of science	.75 (CBS10)	.77 (PCF10)	Retained
My ability to answer students' questions easily	.67 (CBS11)	.76 (PCF11)	Deleted
My ability to manage classroom	.52 (CBS12)	.68 (PCF12)	Deleted
The appropriateness of science topics for integrating nature of science	.47 (CBS13)	.69 (PCF13)	Deleted
That students have prior knowledge about nature of science	.38 (CBS14)	.56 (PCF14)	Deleted

Next, a ten-factor model with the remaining 52 items was assessed. The results supported the hypothesized model with reasonably strong measures of fit: Satorra–Bentler χ^2 (1229, N = 408) = 1659.43, p < .05, RMSEA = .029, CFI = .991, NNFI = .991, and SRMR = .055. However, since identical behavioral outcomes were used to infer both behavioral belief strength and outcome evaluation, identical normative referents were used to infer both normative belief strength and motivation to comply, and identical control factors were used to infer control belief strength and power of control factor, covariances were specified between errors of identical indicators (which are also named as ‘correlated errors’, ‘correlated uniquenesses’ or ‘correlated residuals’). As a result, 18 error covariances were specified and the ten-factor model was re-estimated: Satorra–Bentler χ^2 (1211, N = 408) = 1400.93, p < .05, RMSEA = .020, CFI = .996, NNFI = .996, SRMR = .052. Both models provided a good fit, but the model was significantly improved with the addition of error covariances, Satorra–Bentler $\chi^2_{\text{difference}}$ (18, N = 408) = 190.22, p < .05.

In the final model with error covariances (see Appendix C), all factor loadings between latent variables and respective indicators were statistically significant and standardized factor loading estimates ranged from .51 to .93, which provided evidence for construct validity (see Table 3.16). On the other hand, 42 out of 45 correlation between estimated latent variables were statistically significant and the correlations coefficients ranged from .05 to .70, which implied that intention, attitude toward behavior, subjective norm, perceived behavioral control, behavioral belief strength, outcome evaluation, normative belief strength, motivation to comply, control belief strength, and power of control factor are empirically distinct constructs (see Table 3.17). Consequently, discriminant validity was supported. Additionally, internal consistency estimates computed by Cronbach’s alpha were as follows: .92 for intention, .88 for attitude toward behavior, .77 for subjective norm, .83 for perceived behavioral control, .91 for behavioral belief strength, .90 for outcome evaluation, .75 for normative belief strength, .84 for motivation to comply, .88 for control belief strength and .88 for power of control factor, which suggested satisfactory reliability.

As a result, in the present study, the intention to integrate nature of science questionnaire was developed by utilizing the framework of TPB. After evaluation of three university professors in the area of science education who have expertise in NOS and/or TPB, the initial questionnaire was agreed as including 10 theoretical constructs (intention, attitude toward behavior, subjective norm, perceived behavioral control, behavioral belief strength, outcome evaluation, normative belief strength, motivation to comply, control belief strength, and power of control factor), which were measured by 115 items on a 7-point scale. The questionnaire was piloted with 408 pre-service science teachers to evaluate its psychometric properties. As a result of confirmatory factor analyses, 63 items were needed to be eliminated from the questionnaire on the bases of factor loadings, standardized residuals, and modification indices. Although eliminated items were excessive in number, it should be noted that the initial questionnaire included excessive number of items and the aim was to have the questionnaire including optimal number of items that measure theoretical constructs perfectly well. The pilot study provided initial evidence for ten-factor structure of the intention to integrate nature of science questionnaire that included 52 items. As well, the 10 theoretical constructs had satisfactory internal consistency estimates.

In the main study, the intention to integrate nature of science questionnaire was administered to a larger sample to provide further validity evidences and to test the hypothesized model based on the TPB.

Table 3.16 *Standardized Factor Loadings*

	I	A	SN	PBC	BBS	OE	NBS	MC	CBS	PCF
I1	.88									
I2	.93									
I3	.87									
A1		.73								
A5		.79								
A7		.83								
A8		.83								
A9		.84								
A10		.57								
SN1			.86							
SN2			.88							
SN4			.52							
PBC2				.81						
PBC3				.70						
PBC4				.68						
PBC5				.75						
BBS1					.69					
BBS6					.81					
BBS7					.77					
BBS10					.73					
BBS11					.70					
BBS13					.77					
BBS14					.72					
BBS16					.51					
BBS18					.74					
BBS22					.70					

Table 3.16 (continued)

	I	A	SN	PBC	BBS	OE	NBS	MC	CBS	PCF
OE1						.61				
OE6						.76				
OE7						.73				
OE10						.66				
OE11						.73				
OE13						.75				
OE14						.75				
OE16						.55				
OE18						.74				
OE22						.64				
NBS1							.72			
NBS4							.51			
NBS5							.78			
NBS6							.66			
MC1								.76		
MC4								.72		
MC5								.84		
MC6								.70		
CBS5									.75	
CBS6									.88	
CBS7									.83	
CBS10									.76	
PCF5										.82
PCF6										.88
PCF7										.80
PCF10										.70

Table 3.17

Correlations among Latent Variables

	I	A	SN	PBC	BBS	OE	NBS	MC	CBS	PCF
I	1.00									
A	.40*	1.00								
SN	.46*	.50*	1.00							
PBC	.49*	.53*	.53*	1.00						
BBS	.48*	.68*	.55*	.67*	1.00					
OE	.34*	.59*	.38*	.44*	.70*	1.00				
NBS	.27*	.27*	.57*	.27*	.29*	.17*	1.00			
MC	.13*	.27*	.41*	.14	.28*	.18*	.47*	1.00		
CBS	.48*	.49*	.38*	.67*	.49*	.39*	.25*	.20*	1.00	
PCF	.31*	.38*	.27*	.34*	.43*	.48*	.10	.05	.36*	1.00

*statistically significant at $p < .05$

3.4 Data Collection Procedure for the Main Study

After necessary permissions from METU Human Subjects Ethics Committee (HSEC) (see Appendix A) and selected twenty-two universities had been obtained, data collection took place during 2013-2014 academic year at twenty-two public universities located in twelve regions of Turkey. Turkish versions of Demographic Information Scale and Intention to Integrate Nature of Science Questionnaire were administered to 1172 volunteer senior pre-service science teachers by the researcher or by the help of instructors or research assistants who worked in the related universities. More specifically, instruments were administered at fifteen universities by the researcher and at seven universities by the help of instructors or research assistants. On average, the completion of the instruments took about 30 minutes.

3.5 Data Analysis Procedure for the Main Study

The present study was interested in factors that could potentially explain pre-service science teachers' intention to integrate NOS into science instruction utilizing the framework of TPB. On the basis of TPB, it was proposed a model suggesting that intention to integrate NOS into science instruction is determined by attitude toward integrating NOS into science instruction, subjective norm, and perceived behavioral control. Attitude toward behavior, subjective norm and perceived behavioral control are assumed to be based on interactions between behavioral belief strength and outcome evaluation, between normative belief strength and motivation to comply, and between control belief strength and power of control factor, respectively. In order to estimate the hypothesized model, which included latent interactions, structural equation modeling was utilized.

Prior to structural equation modeling, data related to theoretical constructs were assessed for missing values, outliers, and normality by using IBM SPSS Statistics 22 program. As well, in order to describe the sample, mean, standard deviation, minimum and maximum values, range, frequency, and percentages were utilized as descriptive statistics through IBM SPSS Statistics 22 program.

In the main study analysis, as a first step, the hypothesized ten-factor structure of the intention to integrate nature of science questionnaire was assessed by using confirmatory factor analysis (CFA) through LISREL 8.80 program. Next, the hypothesized model on the basis of TPB, which included latent interactions, was estimated by structural equation modeling through LISREL 8.80 program. More specifically, an unconstrained approach based on double mean-centering strategy (Lin, Wen, Marsh, & Lin, 2010), which is among approaches for the estimation of latent interactions was adopted. This approach takes place in a group of product-indicator approaches to estimate latent interactions in which indicators of the first latent factor are multiplied by indicators of the second latent factor to form multiple indicators of latent interaction factor by using different strategies for creating products (e.g. all possible products, matched pair products, and one pair) (see Marsh, Wen, Nagengast, & Hau, 2012). Forming product indicators seems to be in line with the TPB. In the theory, identical behavioral outcomes are used to infer both behavioral belief strength and outcome evaluation, identical normative referents are used to infer both normative belief strength and motivation to comply, and identical control factors are used to infer both control belief strength and power of control factor. These identical behavioral outcomes, normative referents, and control factors are multiplied according to expectancy-value model to determine attitude, subjective norm, and perceived behavioral control, respectively. On the other hand, unconstrained approach with double mean-centering strategy provides significant advantages. First, unconstrained approach does not require any complicated nonlinear constraints to describe relationships between product indicators and the latent interaction factor, however, nonlinear constraints are necessary for constrained approaches (Marsh, Wen & Hau, 2004; Marsh et al., 2012). Second, constraints derived from normality assumption of the latent variables are not imposed in the unconstrained approach so that this approach is less biased in terms of latent interaction effects than the constrained approach in a wide variety of nonnormal conditions (Marsh, Wen & Hau, 2006). Besides, the double-mean-centering strategy does not necessitate mean structure and two-stage estimation procedure which are needed for single-mean-centering strategy (Marsh, Wen & Hau, 2004, 2006) and orthogonalizing strategy (Little, Bovaird & Widaman, 2006; Marsh et al., 2007), respectively (Lin, Wen, Marsh & Lin, 2010).

3.6 Assumptions of the Study

The present study has the following assumptions:

1. Participating pre-service science teachers had the knowledge of nature of science.
2. Data collection instruments, which were demographic information scale and intention to integrate nature of science questionnaire, were administered under standard conditions.

3. Participating pre-service science teachers responded to items of demographic information scale and intention to integrate nature of science questionnaire sincerely.
4. There was no interaction among participating pre-service science teachers during the administration of the instruments.
5. Characteristics of participating pre-service science teachers represented the population.

3.7 Methodological Limitations

The present study has the following limitations which might have implications for further research studies:

1. In the pilot study, many items were needed to be eliminated from the questionnaire. Although both pilot and main study provided validity evidences for the intention to integrate nature of science questionnaire with the remaining items, this study should be replicated with more samples to provide further validity evidences.

2. Due to the nature of "intention" construct, data collected for "intention to integrate NOS into science instruction" relied on participants' self-reports so that this study might not capture participants' actual intentions. Accordingly, it is desirable for future studies to make use of additional methods such as inspection of lesson plans prepared by participants to verify the consistency and accuracy of self-reported data.

3. In this study, in order to formulate items related belief constructs (i.e., behavioral beliefs, normative beliefs, and control beliefs) semi-structured interviews were conducted with 19 senior pre-service science teachers from two public universities of Ankara. That is, items were limited to responses of

19 senior pre-service science teachers from two public universities of Ankara and these 19 participants' beliefs may not be representative of the population. Hence, semi-structured interviews should be conducted with diverse senior pre-service science teachers.

4. The sample of the pilot included 408 senior pre-service science teachers enrolled in 10 public universities located in different geographical regions of Turkey. On the other hand, the sample of the main study included 1172 senior pre-service science teachers enrolled in 22 universities located in 12 regions of Turkey which were identified based on economic, social, cultural and geographical characteristics and population size of cities. It should be noted that 22 universities, out of 57, were selected so that number of senior pre-service science teachers to be included in the sample from each region was at least 10 percent of the region's population. These efforts contributed to have a representative sample of the population. However, in both pilot and main study, universities to be included in the study were selected by using convenience sampling. Due to nature of convenience sampling characteristics of participants may not be representative of the population.

5. In the present study, unconstrained approach with double-mean-centering strategy, which is among the group of product-indicator approaches, was used for a number of reasons. First, forming product indicators seems to be in line with the TPB. Second, it provides significant advantages over other product-indicator approaches (e.g., constrained approach, unconstrained approach with single-mean-centering strategy): it is easier to perform and less biased in a wide variety of nonnormal conditions. However, there are alternative approaches for the estimation of latent interactions such as nonlinear structural equation mixture modeling (NSEMM) approach (Kelava, Nagengast, & Brandt, 2014), which is designed for nonnormally distributed latent predictor variables. It is suggested for future research to utilize alternative approaches to validate the present findings.

CHAPTER IV

RESULTS

This chapter includes the results of the current study with respect to data screening, descriptive statistics, and structural equation modeling with latent interactions. In data screening part, results related to assessment for missing values, outliers, and normality are presented. Descriptive statistics part addresses descriptive statistics such as mean, standard deviation, minimum and maximum values, range, frequency, and percentages to describe participants' attitude toward integrating NOS into science instruction, subjective norms, perceived behavioral control, behavioral beliefs, normative beliefs, control beliefs, and intention to integrate NOS into science instruction. Structural equation modeling with latent interactions part includes the findings of an unconstrained approach with double-mean-centering strategy, which is among approaches for the estimation of latent interactions.

4.1 Data Screening

Data related to theoretical constructs were assessed for missing values, outliers, and normality. The variables had missing cases ranged from 0 % to .9 % and to estimate the missing values, multiple imputation with expectation maximization algorithm (EM) was utilized. The variables were inspected for both univariate and multivariate outliers. Univariate outliers were checked through z scores and one hundred and nine cases which had standard scores of 4 or greater were identified as univariate outliers (see Hair, Black, Babin, & Anderson, 2010). Related to multivariate outliers, Hair et al. (2010) pointed out that observations with Mahalanobis D^2/df value larger than 2.5 in small samples and 3 or 4 in large samples can be identified as potential outliers. Accordingly, there were eighteen multivariate outliers. Seventeen of the 18 multivariate outliers were also designated as outliers in univariate analysis. Thus, one hundred and ten cases were extracted from the data. Univariate normality of the variables was assessed through inspection of skewness and kurtosis values. After deleting outliers, skewness values ranged from -2.18 to -.53 whereas kurtosis values ranged from -.39 to 4.77. Multivariate normality was assessed by using Mardia's test and the test produced a significant result ($p < .0005$) which means that multivariate normality was violated. Therefore, models were estimated by using robust maximum likelihood (ML).

4.2 Descriptive Statistics

In this section, descriptive results regarding pre-service science teachers' attitude toward integrating NOS into science instruction, subjective norm, perceived behavioral control, behavioral belief strength, outcome evaluation, normative belief strength, motivation to comply, control belief strength, and power of control factor, and intention to integrate NOS into science instruction are presented. As evident in Table 4.1, participating pre-service science teachers' mean scores on theoretical constructs ranged from 5.19 to 6.44. That is, participants scored higher than the midpoint of 4 in all theoretical constructs, demonstrating that they generally had high levels of scores on constructs. More specifically, participants the highest score on outcome evaluation (*M* = 6.44, *SD* = .57), followed by attitude toward integrating NOS (*M* = 6.29, *SD* = .76), and behavioral belief strength (*M* = 6.11, *SD* = .72). Power of control factor (*M* = 5.91, *SD* = 1.19), perceived behavioral control (*M* = 5.66, *SD* = .93), control belief strength (*M* = 5.48, *SD* = .95), intention to integrate NOS (*M* = 5.45, *SD* = 1.51), motivation to comply (*M* = 5.37, *SD* = 1.36), and subjective norm (*M* = 5.20, *SD* = 1.18) were the next. The lowest score was on normative belief strength (*M* = 5.19, *SD* = 1.29). It can be said that mentioned outcomes of integrating NOS into science instruction were highly valued by participating pre-service science teachers. Besides, participants had quite favorable attitude toward integrating NOS into science instruction and they strongly believed that integrating NOS into science instruction would produce the mentioned outcomes. On other hand, participants had moderately strong beliefs that mentioned normative referents expected them to integrate NOS into science instruction.

Table 4.1

Mean, Standard Deviation, Minimum, and Maximum Values for Theoretical Construct

Variables	Mean	St. D	Min.	Max.
Attitude toward integrating NOS	6.29	.76	3.33	7.00
Subjective norm	5.20	1.18	1.00	7.00
Perceived behavioral control	5.66	.93	2.00	7.00
Behavioral belief strength	6.11	.72	2.50	7.00
Outcome evaluation	6.44	.57	3.30	7.00
Normative belief strength	5.19	1.29	1.00	7.00
Motivation to comply	5.37	1.36	1.00	7.00
Control belief strength	5.48	.95	1.25	7.00
Power of control factor	5.91	1.19	1.00	7.00
Intention to integrate NOS	5.45	1.51	1.00	7.00

Note: St.D standard deviation, Min. minimum value, Max. maximum value

Descriptive results for each theoretical construct were reported in detail in the following sections.

4.2.1 Attitude toward Integrating NOS into Science Instruction

Pre-service science teachers' scores for attitude toward the behavior ranged from 3.33 to 7.00 with a mean of 6.29 (SD = .76); higher scores reflected more favorable attitude toward integrating NOS. Results revealed that participants had, on average, quite favorable attitude toward integrating NOS into science instruction. That is, pre-service science teachers evaluated "integrating NOS into science instruction" very positively. As evident in Table 4.2, great majority of participants thought that "integrating NOS into science instruction" is useful (96.8%), important (95.5%), valuable (92.6%), correct (94.6%), reasonable (94.9%), and worthwhile (92.6%). It should be noted that items used to measure attitude toward the behavior were scored on 7-point semantic differential scales. For the presentation of the data, responses for scores of 5, 6, and 7 were combined to provide proportions of participants who agreed with positive anchors.

Table 4.2

Frequency Distributions of Participants' Responses regarding Attitude, Item Means and Standard Deviations

Anchors	Percentages (%)								Mean	St.D
For me, to integrate nature of science into science classes is ...										
	7	6	5	4	3	2	1			
Useful	63.1	26.3	7.4	2.9	.3	0	0	Useless	6.49	.78
Important	56.6	27.6	11.3	3.8	.8	0	0	Unimportant	6.35	.88
Valuable	46.2	30.8	15.6	5.6	1.6	.2	0	Worthless	6.14	1.00
Correct	51.5	29.9	13.2	4.7	.5	.2	0	Incorrect	6.27	.92
Reasonable	53.9	29.5	11.5	3.8	1.2	.1	0	Unreasonable	6.31	.91
Worthwhile	52.3	26.7	13.6	5.8	1.3	.3	0	A waste of time	6.22	1.01

4.2.2 Subjective Norm

Pre-service science teachers' scores for subjective norm ranged from 1.00 to 7.00 with a mean of 5.20 (*SD* = 1.18); higher scores reflected stronger perceived social pressure to integrate NOS into science instruction. This finding implied that pre-service science teachers perceived moderate social pressure from important people and institutions to integrate NOS into science instruction. As evident in Table 4.3, frequency analyses indicated that most of the participants agreed with statements including "people/institutions whose opinions I value expect me to integrate nature of science into science instruction" (76.8%) and "most of the people/institutions that I think to be important to my teaching career expect me to integrate nature of science into science instruction" (80.5%). However, fewer participants agreed with that "most people who are important to me will be disappointed if I do not integrate nature of science into science instruction" (58.4%). It should be noted that items used to measure subjective norm were scored on a 7-point scale ranging from 1 (strongly disagree) to 7 (strongly agree). For the presentation of the data, responses for scores of 5, 6, and 7 were combined to provide proportions of participants who confirmed the statements.

Table 4.3

Frequency Distributions of Participants' Responses regarding Subjective Norm, Item Means, and Standard Deviations

	Percentages (%)								
To what extent do you agree with the following statements?	SD						SA		
	1	2	3	4	5	6	7	M	St.D
People/Institutions whose opinions I value expect me to integrate nature of science into science instruction	1	1.9	4	16.4	25.2	29.8	21.8	5.39	1.29

Table 4.3 (continued)

To what extent do you agree with the following statements?	Percentages (%) SD 1	2	3	4	5	6	SA 7	M	St.D
Most of the people/institutions that I think to be important to my teaching career expect me to integrate nature of science into science instruction	.8	1.6	3.5	13.7	25.7	32.5	22.3	5.49	1.24
Most people who are important to me will be disappointed if I do not integrate nature of science into science instruction	6.3	5.1	8.6	21.5	21.5	21.3	15.6	4.73	1.67

Note: SD strongly disagree, SA strongly agree, M mean, St.D standard deviation

4.2.3 Perceived Behavioral Control

Pre-service science teachers' scores for perceived behavioral control ranged from 2.00 and 7.00 with a mean of 5.66 (*SD* = .93); higher scores reflected greater perceived control over integrating NOS into science instruction. Pre-service science teachers, on average, believed that they had moderately high control over integrating NOS into science instruction. It could be implied that participants seemed to perceive "integrating NOS into science instruction" as not difficult. As shown in Table 4.4, a majority of participants believed that integrating NOS into science instruction is possible (90.6%), easy (78.2%), and up to them (86.4%), and they can overcome any problems that could prevent them from integrating NOS into science instruction if they want to (82,9%). It should be noted that items used to measure perceived behavioral control were scored on a 7-point scale ranging from 1 (strongly disagree) to 7 (strongly agree). For the presentation of the data, responses for scores of 5, 6, and 7 were combined to provide proportions of participants who confirmed the statements.

Table 4.4

Frequency Distributions of Participants' Responses regarding Perceived Behavioral Control, Item Means, and Standard Deviations

To what extent do you agree with the following statements?	Percentages (%)								
	SD						SA		
	1	2	3	4	5	6	7	M	St.D
For me to integrate nature of science into science instruction is possible	0	.4	1.4	7.5	20.3	39.8	30.5	5.89	.99
For me to integrate nature of science into science instruction is easy	.5	1.1	3.8	16.3	29.4	30.6	18.2	5.38	1.18
To integrate nature of science into science instruction is up to me	.5	.9	2.8	9.4	21.1	34.4	30.9	5.76	1.17
I can overcome any problems that could prevent me from integrating nature of science into science instruction if I want to	.5	1.1	2.3	13.2	21.8	36.4	24.7	5.63	1.17

Note: SD strongly disagree, SA strongly agree, M mean, St.D standard deviation

4.2.4 Behavioral Belief Strength

Pre-service science teachers' scores for behavioral belief strength ranged from 2.50 to 7.00 with a mean of 6.11 (*SD* = .72); higher scores reflected more favorable beliefs about outcomes of integrating NOS into science instruction. Results revealed that participants had highly favorable beliefs related to outcomes of integrating NOS into science instruction. That is, they strongly believed that integrating NOS into science instruction would yield the outcomes in the question (e.g. that I become professionally developed). As shown in Table 4.5, a great majority of participants believed that if they integrate NOS into science instruction, students easily understand science topics (91.1%), students understand the interaction among science, technology, society, and environment better (95.2%), students are raised as critical thinkers (94.1%), students differentiate science (*physics, chemistry, biology*) from other disciplines (*e.g., history, philosophy*) (91.7%), students distinguish between science and pseudoscience (*e.g., astrology, acupuncture*) (90.1%), students realize that science is part of everyday life (95.5%), students' misconceptions related to nature of science are eliminated (92.5%), students realize that scientists are not different from other people (87.1%), students start to critically evaluate scientific news in the media (92.9%), and they become professionally developed (95%). It should be noted that items used to measure behavioral belief strength were scored on a 7-point scale ranging from 1 (strongly disagree) to 7 (strongly agree). For the presentation of the data, responses for scores of 5, 6, and 7 were combined to provide proportions of participants who confirmed the statements.

Table 4.5

Frequency Distributions of Participants' Responses regarding Behavioral Belief Strength, Item Means, and Standard Deviations

If I integrate nature of science into science instruction:	Percentages (%)							M	St.D
	SD						SA		
	1	2	3	4	5	6	7		
Students easily understand science topics	.5	.5	1.7	6.1	15.2	33.2	42.7	6.06	1.09
Students understand the interaction among science, technology, society, and environment better	0	.3	1.3	3.3	13.1	33.8	48.3	6.24	.92
Students are raised as critical thinkers	0	.2	.9	4.9	13.4	35.2	45.5	6.19	.93
Students differentiate science (*physics, chemistry, biology*) from other disciplines (*e.g., history, philosophy*)	.3	.6	1.7	5.6	16	34.7	41	6.05	1.05
Students distinguish between science and pseudoscience (*e.g., astrology, acupuncture*)	.3	.4	1.8	7.3	17.6	33.1	39.4	5.98	1.09
Students realize that science is part of everyday life	0	.3	1.1	3.2	11.8	33.4	50.3	6.28	.90

Table 4.5 (continued)

	Percentages (%)								
If I integrate nature of science into science instruction:	SD						SA		
	1	2	3	4	5	6	7	M	St.D
Students' misconceptions related to nature of science are eliminated	0	.3	1.5	5.8	18.9	34.4	39.2	6.03	1.00
Students realize that scientists are not different from other people	1.2	1.7	3.4	6.7	16.5	30.3	40.3	5.87	1.30
Students start to critically evaluate scientific news in the media	0	.4	1.5	5.1	16.6	35.4	40.9	6.08	1.00
I become professionally developed	0	.3	1	3.7	8.4	30.5	56.1	6.36	.90

Note: SD strongly disagree, SA strongly agree, M mean, St.D standard deviation

4.2.5 Outcome Evaluation

Pre-service science teachers' scores for outcome evaluation ranged from 3.33 to 7.00 with a mean of 6.44 (*SD* = .57); higher scores revealed more favorable beliefs about importance of behavioral outcomes. Participants in general, believed that all of the mentioned outcomes of integrating NOS into science instruction were quite important. As evident in Table 4.6, a great majority of participants believed that following outcomes were important: That students easily understand science topics (97.7%), that students understand the interaction among science, technology, society, and environment better (97.9%), development of students as critical thinkers (98%), that students differentiate science (*physics, chemistry, biology*) from other disciplines (*e.g., history, philosophy*) (95.7%), that students distinguish between science and pseudoscience (*e.g., astrology, acupuncture*) (93.9%), that students realize that science is part of everyday life (97.9%), eliminating students' misconceptions related to nature of science (97.2%), that students realize that scientists are not different from other people (93.6%), that students start to critically evaluate scientific news in the media (96.6%), and developing themselves professionally (97.9%). It should be noted that items used to measure behavioral outcome were scored on a 7-point scale ranging from 1 (not important at all) to 7 (very important). For the presentation of the data, responses for scores of 5, 6, and 7 were combined to provide proportions of participants who found the statements important.

Table 4.6

Frequency Distributions of Participants' Responses regarding Outcome Evaluation, Item Means, and Standard Deviations

How important to you are the following situations?	Percentages (%)							M	St.D
	NI						VI		
	1	2	3	4	5	6	7		
That students easily understand science topics	0	0	.3	2	8.4	20.4	68.9	6.56	.75
That students understand the interaction among science, technology, society, and environment better	0	0	.3	1.8	6.2	26.8	64.9	6.54	.72
Development of students as critical thinkers	0	0	.2	1.9	7.2	23.6	67.2	6.56	.72

Table 4.6 (continued)

How important to you are the following situations?	Percentages (%) NI 1	2	3	4	5	6	VI 7	M	St.D
That students differentiate science (*physics, chemistry, biology*) from other disciplines (*e.g., history, philosophy*)	0	.2	.5	3.7	12.9	32.5	50.3	6.28	.88
That students distinguish between science and pseudoscience (*e.g., astrology, acupuncture*)	0	.5	.8	4.8	14.8	31.7	47.4	6.19	.96
That students realize that science is part of everyday life	0	0	.5	1.6	6.7	26.7	64.5	6.53	.74
Eliminating students' misconceptions related to nature of science	0	0	.3	2.6	9.4	26.2	61.6	6.46	.79
That students realize that scientists are not different from other people	0	.6	1.4	4.4	13.1	30.8	49.7	6.21	.99
That students start to critically evaluate scientific news in the media	0	0	.8	2.7	10.7	29.2	56.7	6.38	.84
Developing myself professionally	0	0	.3	1.8	5.8	17.2	74.9	6.65	.69

Note: NI Not important at all, VI very important, M mean, St.D standard deviation

4.2.6 Normative Belief Strength

Pre-service science teachers' scores for normative belief strength ranged from 1.00 to 7.00 with a mean of 5.19 (*SD* = 1.29); higher scores reflected stronger beliefs that given normative referents expect participants to integrate NOS into science instruction. According to findings of the present study, participants had moderately strong beliefs that normative referents including ministry of education, faculty members, school administrators, and science teachers expected them to integrate NOS into science instruction. As shown in Table 4.7, most of the participants agreed that ministry of education (64.5%), faculty members (77.4%), school administrators (59.3%), and science teachers (70.9%) expected them to integrate NOS into their science instruction. It should be noted that items used to measure normative belief strength were scored on a 7-point scale ranging from 1 (strongly disagree) to 7 (strongly agree). For the presentation of the data, responses for scores of 5, 6, and 7 were combined to provide proportions of participants who confirmed the statements.

Table 4.7

Frequency Distributions of Participants' Responses regarding Normative Belief Strength, Item Means, and Standard Deviations

The following people/institutions expect me to integrate nature of science into science instruction:	Percentages (%)								
	SD						SA		
	1	2	3	4	5	6	7	M	St.D
Ministry of Education	5.1	4.6	7.2	18.6	15.2	21.4	27.9	5.10	1.74
Faculty members	2.3	2.8	4.2	13.4	14.7	26.9	35.8	5.59	1.51
School administrators	5	5.6	8.4	21.6	21.2	20.3	17.8	4.81	1.66
Science teachers	2.4	3.5	6.7	16.5	19.5	25.5	25.9	5.27	1.53

Note: SD strongly disagree, SA strongly agree, M mean, St.D standard deviation

4.2.7 Motivation to Comply

Pre-service science teachers' scores for motivation to comply ranged from 1.00 to 7.00 with a mean of 5.37 (*SD* = 1.36); higher scores reflected stronger beliefs that normative referents' expectations with respect to integrating NOS into science instruction are important for participating pre-service science teachers. Results indicated that participants had, on average, moderately strong beliefs that expectations of normative referents including ministry of education, faculty members, school administrators, and science teachers related to integrating NOS into science instruction were important. As illustrated in Table 4.8, most of the participants believed that following referents' expectations with respect to integrating NOS into science instruction were important: Ministry of Education (73.1%), faculty members (76%), school administrators (72.3%), and science teachers (78.4%). It should be noted that items used to measure motivation to comply were scored on a 7-point scale ranging from 1 (not important at all) to 7 (very important). For the presentation of the data, responses for scores of 5, 6, and 7 were combined to provide proportions of participants who found the normative referents' expectations important.

Table 4.8

Frequency Distributions of Participants' Responses regarding Motivation to Comply, Item Means, and Standard Deviations

How important are expectations of people or institutions related to your integration of nature of science into your science instruction for you?	Percentages (%)								
	NI						VI		
	1	2	3	4	5	6	7	M	St.D
Ministry of Education	5.5	4.7	4.2	12.5	16.7	24.7	31.7	5.31	1.74

Table 4.8 (continued)

How important are expectations of people or institutions related to your integration of nature of science into your science instruction for you?	Percentages (%)								
	NI						VI		
	1	2	3	4	5	6	7	M	St.D
Faculty members	4.4	2.8	4.3	12.5	17.4	25.3	33.3	5.45	1.63
School administrators	4.4	3.2	4.7	15.4	21	26.4	24.9	5.24	1.59
Science teachers	3.1	2.2	3.9	12.4	20.2	27.5	30.7	5.50	1.49

Note: NI Not important at all, VI very important, M mean, St.D standard deviation

4.2.8 Control Belief Strength

Pre-service science teachers' scores for control belief strength ranged from 1.25 to 7.00 with a mean of 5.48 (*SD* = .95); higher scores reflected stronger beliefs that the control factors will be present during participants' in-service teaching career. Results indicated that participants had a moderate sense of beliefs that control factors would be present. More specifically, they believed that it was somewhat possible that control factors including having sufficient knowledge of NOS, having experience for integrating NOS into science instruction, being sufficient in integrating NOS into science instruction), and being able to use appropriate teaching strategies to effectively integrate NOS into science instruction would be present during their in-service teaching career. As shown in Table 4.9, majority of the participants thought that they would have sufficient knowledge of NOS (81.6%), they would have experience for integrating NOS into science classes (83.5%), they would be sufficient in integrating NOS in science instruction (79.8%), and they would be able to use appropriate teaching strategies to effectively integrate NOS into science instruction

(82.7%) during their in-service teaching career. It should be noted that items used to measure control belief strength were scored on a 7-point scale ranging from 1 (not possible at all) to 7 (certainly possible). For the presentation of the data, responses for scores of 5, 6, and 7 were combined to provide proportions of participants who confirmed the statements.

Table 4.9

Frequency Distributions of Participants' Responses regarding Control Belief Strength, Item Means, and Standard Deviations

During your in-service teaching career, to what extent do you expect the following factors will be present?	Percentages (%)								
	NP						CP		
	1	2	3	4	5	6	7	M	St.D
I will have sufficient knowledge of nature of science	.3	1.1	4.1	12.9	27.5	34.6	19.5	5.48	1.16
I will have experience for integrating nature of science into science instruction	.2	.7	3.5	12.1	25.9	36.9	20.7	5.56	1.11
I will be sufficient in integrating nature of science into science instruction	.2	1	4	15	29.3	35.8	14.7	5.38	1.11
I will be able to use appropriate teaching strategies to effectively integrate nature of science into science instruction	.3	.8	3.3	12.9	28.3	37	17.4	5.49	1.10

Note: NP not possible at all, CP certainly possible, M mean, St.D standard deviation

4.2.9 Power of Control Factor

Pre-service science teachers' scores for power of control factor ranged from 1.00 to 7.00 with a mean of 5.91 (*SD* = 1.19); higher scores reflected more favorable beliefs about each factor's power to facilitate integrating NOS into science instruction. According to findings of this study, participants had moderately strong beliefs that control factors, which are having sufficient knowledge of NOS, having experience for integrating NOS into science instruction, being sufficient in integrating NOS into science instruction, would facilitate their integrating NOS into science instruction. As shown in Table 4.10, majority of the participants thought that their having sufficient knowledge of NOS (87.4%), their having experience for integrating NOS into science instruction (86.6%), their being sufficient in integrating NOS into science instruction (85.7%), their ability to use appropriate teaching strategies to effectively integrate NOS (89.2%) would facilitate their integrating NOS into science instruction. It should be noted that items used to measure control belief strength were scored on a 7-point scale ranging from 1 (strongly disagree) to 7 (strongly agree). For the presentation of the data, responses for scores of 5, 6, and 7 were combined to provide proportions of participants who confirmed the statements.

Table 4.10

Frequency Distributions of Participants' Responses regarding Power of Control Factor, Item Means, and Standard Deviations

The presence of the following factors will facilitate integrating nature of science into science instruction:	Percentages (%)								
	SD						SA		
	1	2	3	4	5	6	7	M	St.D
My having sufficient knowledge of nature of science	1.9	1.5	3.1	6.2	12.5	30.5	44.4	5.95	1.34

Table 4.10 (continued)

The presence of the following factors will facilitate integrating nature of science into science instruction:	Percentages (%)								
	SD						SA		
	1	2	3	4	5	6	7	M	St.D
My having experience for integrating nature of science into science instruction	2	2.3	2.6	6.5	13.7	30.9	42	5.88	1.38
My being sufficient in integrating nature of science into science instruction	1.7	2.5	2.9	7.3	15.1	30.3	40.3	5.84	1.38
My ability to use appropriate teaching strategies to effectively integrate nature of science	.6	1.4	1.6	7.2	16	33.5	39.7	5.96	1.16

Note: SD strongly disagree, SA strongly agree, M mean, St.D standard deviation

4.2.10 Intention to Integrate NOS

Pre-service science teachers' scores for intention to integrate NOS ranged from 1.00 to 7.00 with a mean of 5.45 (*SD* = 1.51); higher scores reflected stronger intentions to integrate NOS. Results revealed that participants had moderately strong intentions to integrate NOS into their science instruction. That is, they seemed to be willing to integrate NOS into their science instruction during their teaching. As seen in Table 4.11, most of the participants expressed their agreement on items including "I will try to integrate nature of science into science instruction" (75.9%), "I plan to integrate nature of science into science instruction" (73.3%), and "I intend to integrate nature of science into science instruction" (78%). It should be noted that items used to measure intention were scored on a 7-point scale ranging from 1 (strongly disagree) to 7 (strongly agree). For the presentation of the data, responses for scores of 5, 6, and 7 were combined to provide proportions of participants who confirmed the statements.

Table 4.11

Frequency Distributions of Participants' Responses regarding Intention, Item Means, and Standard Deviations

Considering your own teaching, to what extent do you agree with the following statements?	Percentages (%)								
	SD						SA		
	1	2	3	4	5	6	7	M	St.D
I will try to integrate nature of science into science instruction	3.9	2.6	5.7	11.8	18.4	21.5	36	5.47	1.63
I plan to integrate nature of science into science instruction	2.9	3.8	6.2	12.8	17.8	25.9	30.5	5.38	1.59
I intend to integrate nature of science into science instruction	3.8	2.6	4.5	11	18.2	27	32.8	5.49	1.58

Note: SD strongly disagree, SA strongly agree, M mean, St.D standard deviation

4.3 Structural Equation Modeling With Latent Interactions

The present study was interested in factors that could potentially explain pre-service science teachers' intention to integrate NOS into science instruction utilizing the framework of TPB. On the basis of TPB, it was proposed a model suggesting that intention to integrate NOS into science instruction is determined by attitude toward integrating NOS into science instruction, subjective norm, and perceived behavioral control. Attitude toward behavior, subjective norm and perceived behavioral control are assumed to be based on interactions between behavioral belief strength and outcome evaluations, between normative belief strength and motivation to comply, and between control belief strength and power of control factor, respectively. The hypothesized model on the basis of TPB, which included latent interactions, was estimated by structural equation modeling (SEM). More specifically, an unconstrained approach based on double mean-centering strategy (Lin, Wen, Marsh, & Lin, 2010), which is among approaches for the estimation of latent interactions was used.

The structural equation modeling analysis for estimation of latent interactions comprises of two steps. The first step is assessing measurement model by performing a confirmatory factor analysis. Then, the second step is assessing structural model by an unconstrained approach with double mean-centering strategy. These two steps are described in detail in the following sections.

In the main study analysis, as a first step, the hypothesized ten-factor structure of the intention to integrate nature of science questionnaire was assessed by using confirmatory factor analysis (CFA) through LISREL 8.80 program. Next, the hypothesized model on the basis of TPB, which included latent interactions, was estimated by structural equation modeling through LISREL 8.80 program.

4.3.1 Measurement Model

Prior to estimation of latent interactions, a measurement model was assessed by performing a confirmatory factor analysis (CFA). It should be noted that a measurement model does not include latent interaction variables (see Foldnes & Hagtvet, 2014; Jonsson, 1998). Accordingly, latent variables included in the CFA were intention (3 items), attitude toward behavior (6 items), subjective norm (3 items), perceived behavioral control (4 items), behavioral belief strength (10 items), outcome evaluations (10 items), normative belief strength (4 items), motivation to comply (4 items), control belief strength (4 items), and power of control factor (4 items) (see Appendix B for the questionnaire that was used in the main study). The latent variables were hypothesized to covary with each other. The ten-factor model tested through CFA was estimated by robust maximum likelihood (ML) due to significant departures from univariate and multivariate normality. The robust ML estimator yields ML parameter estimates with standard errors and a Satorra–Bentler scaled $\chi 2$ (SB $\chi 2$; Satorra & Bentler, 1994) which are robust against violation of normality (Brown, 2006).

Results supported the hypothesized model with reasonably strong measures of fit: Satorra–Bentler $\chi 2$ (1229, N = 1172) = 3083.05, $p < .05$, RMSEA = .036, CFI = .985, NNFI = .984, and SRMR = .042. On the other hand, since identical behavioral outcomes were used to infer both behavioral belief strength and outcome evaluation, identical normative referents were used to infer both normative belief strength and motivation to comply, and identical control factors were used to infer control belief strength and power of control factor, covariances were specified between errors of identical indicators. As a result, 18 error covariances were specified and the ten-factor model was re-estimated: Satorra–Bentler $\chi 2$ (1211, N = 1172) = 2264.03, $p < .05$, RMSEA = .027, CFI = .992, NNFI = .991, and SRMR = .04.

Both models provided a good fit, but the model was significantly improved with addition of error covariances, Satorra–Bentler $\chi^2_{\text{difference}}$ (18, N = 1172) = 673.15, $p < .05$. In the final model with error covariances (see Appendix D), all factor loadings between latent variables and respective indicators were statistically significant and standardized factor loading estimates ranged from .54 to .94, which provided evidence for construct validity (see Table 4.12). On the other hand, all of 45 correlation coefficients between estimated latent variables were statistically significant and the correlation coefficients ranged from .10 to .68 providing evidence for discriminant validity (see Table 4.13).

Additionally, internal consistency estimates computed by Cronbach's alpha were as follows: .94 for intention, .91 for attitude toward behavior, .78 for subjective norm,

.85 for perceived behavioral control, .89 for behavioral belief strength, .89 for outcome evaluation, .81 for normative belief strength, .86 for motivation to comply, .87 for control belief strength and .92 for power of control factor, which suggested satisfactory reliability.

Table 4.12

Standardized Factor Loadings

	I	A	SN	PBC	BBS	OE	NBS	MC	CBS	PCF
I1	.89									
I2	.93									
I3	.91									
A1		.73								
A2		.81								
A3		.83								
A4		.86								
A5		.85								
A6		.72								
SN1			.84							
SN2			.88							
SN3			.57							
PBC1				.78						
PBC2				.77						
PBC3				.73						
PBC4				.77						

Table 4.12 (continued)

	I	A	SN	PBC	BBS	OE	NBS	MC	CBS	PCF
BBS1					.59					
BBS2					.77					
BBS3					.73					
BBS4					.63					
BBS5					.65					
BBS6					.79					
BBS7					.73					
BBS8					.54					
BBS9					.72					
BBS10					.65					
OE1						.56				
OE2						.71				
OE3						.73				
OE4						.63				
OE5						.65				
OE6						.76				
OE7						.71				
OE8						.58				
OE9						.72				
OE10						.62				

Table 4.12 (continued)

	I	A	SN	PBC	BBS	OE	NBS	MC	CBS	PCF
NBS1							.76			
NBS2							.60			
NBS3							.86			
NBS4							.71			
MC1								.82		
MC2								.71		
MC3								.87		
MC4								.71		
CBS1									.80	
CBS2									.84	
CBS3									.83	
CBS4									.68	
PCF1										.86
PCF2										.94
PCF3										.90
PCF4										.77

Table 4.13

Correlations among Latent Variables

	I	A	SN	PBC	BBS	OE	NBS	MC	CBS	PCF
I	1.00									
A	.38	1.00								
SN	.29	.47	1.00							
PBC	.38	.53	.51	1.00						
BBS	.39	.60	.42	.54	1.00					
OE	.32	.52	.35	.45	.68	1.00				
NBS	.11	.28	.45	.32	.24	.22	1.00			
MC	.10	.25	.31	.25	.25	.24	.49	1.00		
CBS	.41	.45	.35	.51	.52	.38	.24	.20	1.00	
PCF	.27	.28	.24	.21	.42	.38	.14	.13	.40	1.00

Note: All of the correlations are statistically significant at $p < .05$

4.3.2 Structural Model

In order to estimate the hypothesized model, unconstrained approach based on double-mean-centering strategy was used. First, double-mean-centering strategy was applied to the data: indicators of the latent variables except for intention were mean-centered and then, identical indicators of latent variable pairs (i.e., behavioral belief strength - outcome evaluation, normative belief strength - motivation to comply, and control belief strength - power of control factor) were multiplied to form indicators of latent interaction variables. To illustrate, the first indicator (BBS1) of behavioral belief strength (BBS) was multiplied by the first indicator (OE1: counterpart of BBS1) of outcome evaluation (OE) to form first the indicator (BBS1OE1) of latent interaction variable (which is denoted as BBS.OE in this study) and, similarly, all identical behavioral outcomes from behavioral belief strength and outcome evaluation, all identical normative referents from normative belief strength and motivation to comply, and all identical control factors from control belief strength and power of control factor were multiplied to form indicators of the latent interaction variables which were denoted as BBS.OE, NBS.MC, and CBS.PCF, respectively in the present study. Then, the matched product indicators were mean-centered again, that is double-mean-centering (for a guideline of double-mean-centering strategy see Lin et al., 2010).

On the other hand, since indicators were non-normally distributed and indicators from interacting latent variable and their related product indicators from interaction latent variable share common indicators, error covariances were specified between indicators and their related product indicators (see Kelava & Brandt, 2009). To illustrate, BBS1OE1 and BBS1 shared a constituent indicator, which is BBS1 and BBS1OE1 and OE1 shared a constituent indicator, which is OE1. Therefore, error covariances were specified between BBS1OE1 and BBS1 and between BBS1OE1 and OE1 and, similarly, error covariances were specified between all indicators from interacting latent variables and their related product indicators from interaction latent variables. Consequently, 36 error covariances were specified and the model was estimated: Satorra–Bentler $\chi 2$ (2258, N = 1172) = 4446.63, $p < .05$, RMSEA = .029, CFI = .985, NNFI = .984, and SRMR = .069.

In addition to error covariances between indicators from interacting latent variables and their related product indicators from interaction latent variables, covariances were also specified between errors of identical indicators (i.e., identical behavioral outcomes, identical normative referents, and identical control factors). Totally, 54 error covariances (including 36 error covariances between indicators and their related product indicators and 18 error covariances between identical indicators) were specified and the model re-estimated: Satorra–Bentler $\chi 2$ (2240, N = 1172) = 3691.60, $p < .05$, RMSEA = .024, CFI = .99, NNFI = .99, and SRMR = .067. Both models provided a good fit, but the model was significantly improved with the addition of error covariances between identical items, Satorra–Bentler $\chi^2_{difference}$ (18, N = 1172) = 711.54 $p < .05$. Besides, it should be noted the path coefficient from "motivation to comply” to “subjective norm” became significant with the addition of error covariances between identical items. The final model including 54 error covariances is provided in Appendix E. It should be noted that in order to calculate appropriate standardized estimates of interactions effects, Equation 4.1 suggested by Wen, Marsh, and Hau (2010; see also Marsh et al., 2012) was utilized. In the equation, γ'' represents appropriate standardized coefficient of interaction effect, γ' represents standardized coefficient of interaction effect provided by LISREL output, and Φ_{11}, Φ_{22}, and Φ_{33} represent variances of two interacting latent variables and an interaction latent variable, respectively which are from unstandardized solutions.

$$\gamma'' = \gamma' \frac{\sqrt{\Phi 11\ \Phi 22}}{\sqrt{\Phi 33}} \quad (4.1)$$

On the other hand, in order to calculate the z-values of the appropriate standardized estimates, bootstrap method was utilized (see Marsh et al., 2012 for the bootstrap method). As suggested by Marsh et al, since there were ignorable differences between z-values from original estimates and those from the bootstrap method, in this study z-values provided by original estimates were employed. It should be noted that in this study z-values were based on robust standard errors. Figure 4.1 represents standardized path coefficients and respective standard errors of the final model with 54 error covariances. For the sake of simplicity, indicators of latent variables were omitted from the figure: All factor loadings between latent variables and respective indicators were statistically significant and standardized factor loading estimates ranged from .32 to .94 (see Table 4.14). As shown in the table, only one of the standardized factor loading estimates was .32. Remaining loadings were all above .40. Thus, these findings, in general, suggested that indicators loaded on their expected constructs.

Table 4.14

Standardized Factor Loadings

	I	A	SN	PBC	BBS	OE	BBS. OE	NBS	MC	NBS. MC	CBS	PCF	CBS. PCF
I1	.89												
I2	.93												
I3	.91												
A1		.72											
A2		.80											
A3		.81											
A4		.85											
A5		.83											
A6		.70											
SN1			.83										
SN2			.87										
SN3			.56										

Table 4.14 (continued)

	I	A	SN	PBC	BBS	OE	BBS. OE	NBS	MC	NBS. MC	CBS	PCF	CBS. PCF
PBC1				.77									
PBC2				.76									
PBC3				.71									
PBC4				.75									
BBS1					.59								
BBS2					.77								
BBS3					.74								
BBS4					.63								
BBS5					.65								
BBS6					.78								
BBS7					.73								
BBS8					.55								
BBS9					.72								
BBS10					.65								

Table 4.14 (continued)

	I	A	SN	PBC	BBS	OE	BBS. OE	NBS	MC	NBS. MC	CBS	PCF	CBS. PCF
OE1						.56							
OE2						.72							
OE3						.73							
OE4						.63							
OE5						.65							
OE6						.76							
OE7						.72							
OE8						.58							
OE9						.72							
OE10						.62							

Table 4.14 (continued)

	I	A	SN	PBC	BBS	OE	BBS. OE	NBS	MC	NBS. MC	CBS	PCF	CBS. PCF
BBS1OE1							.48						
BBS2OE2							.79						
BBS3OE3							.58						
BBS4OE4							.41						
BBS5OE5							.44						
BBS6OE6							.71						
BBS7OE7							.62						
BBS8OE8							.32						
BBS9OE9							.53						
BBS10OE10							.52						
NBS1								.75					
NBS2								.59					
NBS3								.86					
NBS4								.71					

Table 4.14 (continued)

	I	A	SN	PBC	BBS	OE	BBS. OE	NBS	MC	NBS. MC	CBS	PCF	CBS. PCF
MC1									.82				
MC2									.71				
MC3									.87				
MC4									.71				
NBS1MC1										.69			
NBS2MC2										.60			
NBS3MC3										.72			
NBS4MC4										.55			
CBS1											.80		
CBS2											.84		
CBS3											.83		
CBS4											.68		

Table 4.14 (continued)

	I	A	SN	PBC	BBS	OE	BBS. OE	NBS	MC	NBS. MC	CBS	PCF	CBS. PCF
PCF1												.86	
PCF2												.94	
PCF3												.90	
PCF4												.77	
CBS1PCF1													.65
CBS2PCF2													.80
CBS3PCF3													.75
CBS4PCF4													.41

Overall, the findings revealed that pre-service science teachers' intention to integrate nature of science into science instruction was positively linked to attitude toward the behavior ($\beta = .24$, $p < .05$) and perceived behavioral control ($\beta = .25$, $p < .05$). Though, subjective norm was not found to be related to the intention ($\beta = .04$, $p > .05$). These findings implied that intention to integrate nature of science into science instruction was significantly linked to attitude toward integrating NOS into science instruction and perceived control over integrating NOS into science instruction. More specifically, pre-service science teachers who had more positive attitude toward integrating NOS into science instruction and greater perceived control over integrating NOS into science instruction were more likely to have stronger intentions to integrate NOS. On the other hand, behavioral belief strength ($\gamma = .41$, $p < .05$) and outcome evaluation ($\gamma = .28$, $p < .05$) were significantly related to attitude toward the behavior whereas there was not a significant interaction effect of behavioral belief strength and outcome evaluation on attitude ($\gamma = .09$, $p > .05$). That is, participants' attitude toward integrating NOS into science instruction was significantly determined by strength of their beliefs that integrating NOS into science instruction would yield given outcomes and their evaluation of the outcomes.

In addition, subjective norm was significantly associated with normative belief strength ($\gamma = .36$, $p < .05$), motivation to comply ($\gamma = .12$, $p < .05$) and the interaction between normative belief strength and motivation to comply ($\gamma = .08$, $p < .05$). That is, pre-service science teachers who had stronger beliefs related to normative referents' (e.g., ministry of education, school administrators, etc.) expectations and higher motivation to comply with the referents were more likely to perceive stronger social pressure to integrate NOS into science instruction. Besides, positive effect of beliefs related to normative referents' expectations on perceived social pressure is more substantial for pre-service teachers with higher motivation to comply with the referents. Equivalently, positive effect of motivation to comply with the referents on perceived social pressure is more substantial for pre-service teachers with stronger beliefs related to normative referents' expectations.

Furthermore, perceived behavioral control was significantly related to control belief strength ($\gamma = .49$, $p < .05$), but not to power of control factor ($\gamma = .00$, $p > .05$). Besides, there was not a significant interaction effect of control belief strength and power of control factor on perceived behavioral control ($\gamma = .05$, $p > .05$). These findings implied that participants' perceived control over integrating NOS into science instruction was significantly linked to their beliefs that given factor would be present during their in-service teaching career.

Overall, findings from squared multiple correlations for structural equations suggested that the model was able to explain 16.9 percent of the variation in the intention.

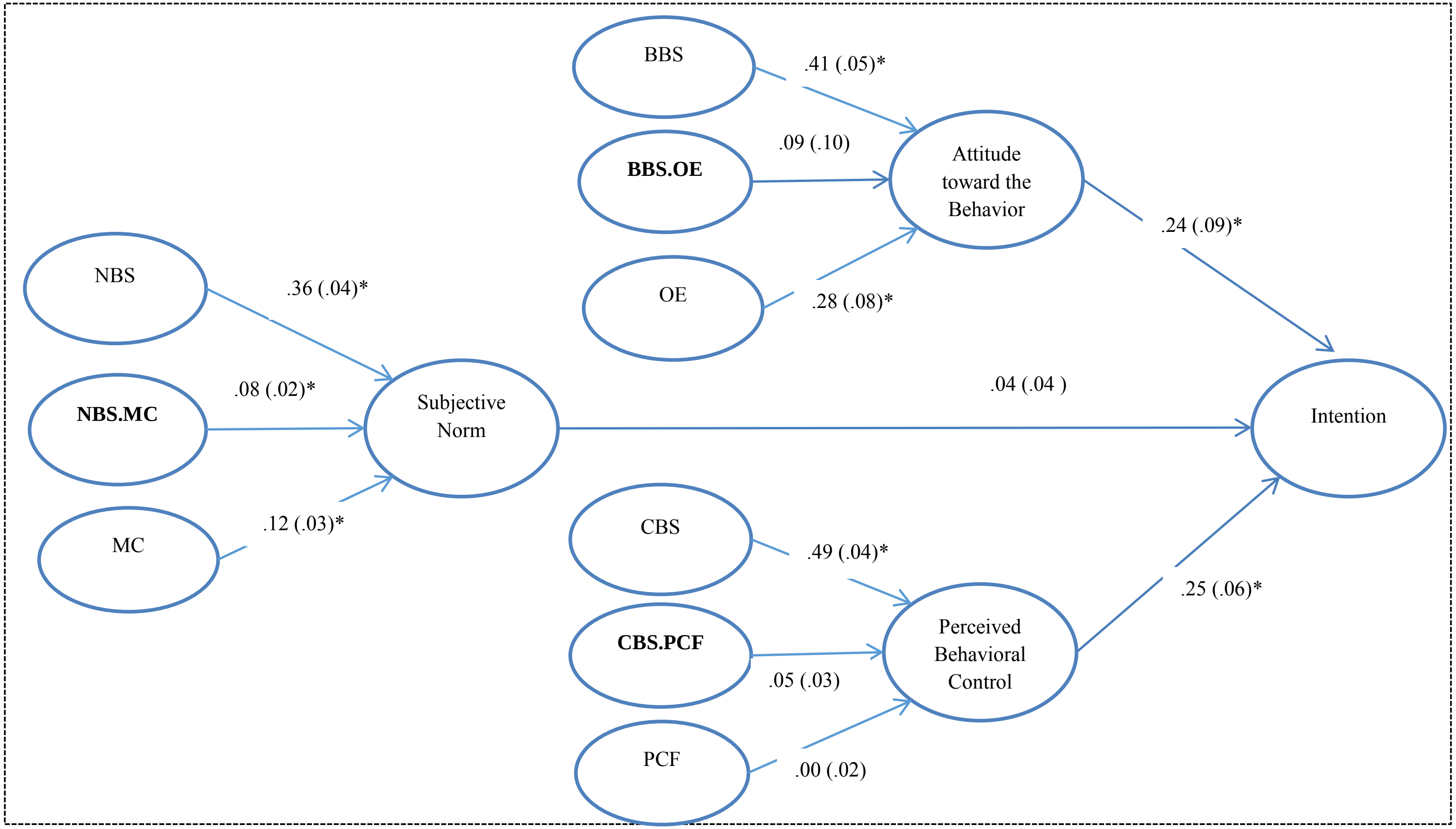

Figure 4.1 The final model with standardized path coefficients and respective standard errors in parentheses
*statistically significant at $p < .05$

4.4 Summary of the Results

The results of the present study can be summarized as follows:

1. Participating pre-service science teachers had quite favorable attitude toward integrating NOS into science instruction, perceived moderate social pressure from important people and institutions to integrate NOS into science instruction, had moderately high control over integrating NOS into science instruction, and had moderately strong intentions to integrate NOS into their science instruction.
2. Participants strongly believed that integrating NOS into science instruction would yield the outcomes mentioned in the question and they believed that all of the mentioned outcomes of integrating NOS into science instruction were quite important.
3. Participants had moderately strong beliefs that normative referents including ministry of education, faculty members, school administrators, and science teachers expected them to integrate NOS into science instruction and that these normative referents' expectations with respect to integrating NOS into science instruction were important.
4. Participants believed that it was somewhat possible that control factors, which are having sufficient knowledge of NOS, having experience for integrating NOS into science instruction, being sufficient in integrating NOS into science instruction), and being able to use appropriate teaching strategies to effectively integrate NOS into science instruction, would be present during their in-service teaching career and they had moderately strong beliefs that the abovementioned control factors would facilitate their integrating NOS into science instruction.
5. Pre-service science teachers' intention to integrate nature of science into science instruction was positively explained by attitude toward the behavior and perceived behavioral control. Though, subjective norm did not significantly explain the intention.

6. Behavioral belief strength and outcome evaluation were significantly related to attitude toward the behavior whereas there was not a significant interaction effect of behavioral belief strength and outcome evaluation on attitude.
7. Subjective norm was significantly explained by normative belief strength, motivation to comply, and the interaction effect between normative belief strength and motivation to comply.
8. Perceived behavioral control was significantly related to control belief strength, but not to power of control factor. Besides, there was not a significant interaction effect of control belief strength and power of control factor on perceived behavioral control.
9. The proposed model based on the TPB was able to explain 16.9 percent of the variation in the intention.

CHAPTER V

DISCUSSION

This chapter comprises of discussions, implications of the results, and limitations and recommendations. More specifically, at first, results of the study are discussed. Then, implications are introduced to provide with recommendations for science teacher education programs and for effective NOS instruction. And then, implications for further research are given to provide with recommendations for further research.

5.1 Discussion of Results

Nature of science (NOS), a significant component of scientific literacy, has taken place in Turkish national elementary science curriculum (MoNE, 2013). Certainly, teachers play a significant role in translating the recommendations outlined in the curriculum into instructional practices. Toward this end, considering the importance of teachers' intentions to their instructional decisions regarding NOS (e.g., Demirdogen et al., 2015; Lederman, 1999; Lederman et al., 2001; Schwartz & Lederman, 2002), it is vital to explore factors that underlie teachers' intentions to address NOS in their teaching. Accordingly, the present study was interested in factors that could potentially explain pre-service science teachers' intention to integrate NOS into science instruction utilizing the framework of TPB. On the basis of TPB, it was proposed a model suggesting that intention to integrate NOS into science instruction is determined by attitude toward integrating NOS into science instruction, subjective norm, and perceived behavioral control. Attitude toward behavior, subjective norm and perceived behavioral control are assumed to be based on interactions between behavioral belief strength and outcome evaluation, between normative belief strength and motivation to comply, and between control belief strength and power of control factor, respectively.

Investigating factors that could potentially explain pre-service science teachers' intentions to integrate NOS into science instruction within the framework of TPB appeared to be informative. Structural equation modeling (SEM) with latent interactions revealed that the model based on the TPB accounted for considerable variation (16.9 %) in pre-service science teachers' intention to integrate NOS into science instruction.

Overall, analysis findings showed that pre-service science teachers' intention to integrate NOS into science instruction was positively linked to attitude toward the behavior (β = .24, $p < .05$) and perceived behavioral control (β = .25, $p < .05$); path coefficient associated with attitude toward the behavior was much the same with that associated with perceived behavioral control. Though, subjective norm was not significantly related to participants' intention (β = .04, $p >.05$). These findings implied that pre-service science teachers who had more positive attitude toward integrating NOS into science instruction and greater perceived control over integrating NOS into science instruction were more likely to have stronger intentions to integrate NOS. However, perceived social pressure to integrate NOS made no practical contribution to participants' intention to integrate NOS into their science instruction. On the other hand, effects of behavioral belief strength (γ = .41, $p < .05$) and outcome evaluation (γ = .28, $p < .05$) on attitude toward the behavior were statistically significant, however, interaction effect of behavioral belief strength and outcome evaluation on attitude (γ = .09, $p >.05$) was not found to be significant. That is, participants' attitude toward integrating NOS into science instruction was more positive when strength of behavioral beliefs was higher and when evaluation of the outcomes were more positive. In addition, effects of normative belief strength (γ = .36, $p < .05$), motivation to comply (γ = .12, $p < .05$), and the interaction between normative belief strength and motivation to comply (γ = .08, $p < .05$) on subjective norm were found to be significant. That is, perceived social pressure to integrate NOS into science instruction was higher when strength of normative belief was higher and when motivation to comply with the referents was higher. Also, positive effect of normative belief strength on perceived social pressure was more substantial for participants with higher motivation to comply with the referents. Equivalently, positive effect of motivation to comply with the referents on perceived social pressure was more substantial for participants with higher normative belief strength. Furthermore, while the effect of control belief strength ($\gamma = .49$, $p < .05$) on perceived behavioral control was significant, effects of power of control factor ($\gamma = .00$, $p > .05$) and the interaction between control belief strength and power of control factor ($\gamma = .05$, $p > .05$) on perceived behavioral control were not found to be significant. That is, participants' perceived control over integrating NOS into science instruction was greater when strength of control belief was higher.

More specifically, abovementioned results revealed that pre-service science teachers with more positive attitude toward integrating NOS into science instruction were more likely to have stronger intentions to integrate NOS into their science instruction. This is an expected finding because considering the items utilized to measure attitude, participants with positive attitude toward integrating NOS thought that "integrating NOS into science instruction" is (a) useful, (b) important, (c) valuable, (d) correct, (e) reasonable and (e) worthwhile. Accordingly, it is reasonable to assume that favorable attitude toward integrating NOS can facilitate strong intention to integrate NOS into science instruction. Considering the importance of teachers' intentions to their instructional decisions regarding NOS (e.g., Demirdogen et al., 2015; Lederman, 1999; Lederman et al., 2001; Schwartz & Lederman, 2002), it can be said that several research studies in the literature provided a partial support for the present study (e.g., Abd-El-Khalick et al., 1998; Demirdogen et al., 2015; Herman, 2010; Schwartz & Lederman, 2002). More specifically, according to the study by Abd-El-Khalick et al. (1998), viewing NOS as less important than other outcomes (e.g., science content and processes) was among factors that pre-service secondary science teachers pronounced for lack of attention to the NOS in their planning and instruction. Hence, the authors recommended that teacher preparation programs should assist pre-service teachers to comprehend the logic behind and significance of emphasizing NOS in their classroom practices. In addition, Schwartz and Lederman (2002) reported that unless an individual views NOS as significant, appropriate, and achievable by students, s/he is unlikely to address NOS instructionally. Considering the participants in their study, the authors elaborated that participating teachers strongly intended to teach NOS, strongly believed that NOS was a significant issue to address instructionally, and during the first year of teaching, continually stated their commitment to addressing NOS instructionally, and therefore, they could overcome some of the frequently specified restraints that have impeded many individuals. Moreover, in the study of Demirdogen et al. (2015), believing in the significance of students' learning of NOS during chemistry instruction was reported to be among necessary factors in order for participants to have an attempt to include NOS in instructions either in an implicit or explicit manner. Furthermore, Herman (2010) stated that in order to implement NOS, teachers need to view it as important, however, this condition may still not be sufficient. On the other hand, the present finding is consistent with investigations, which employed TPB as a theoretical framework in science education literature, pointed out a significant association between attitude and behavioral intention (e.g., Kilic, Soran, & Graf, 2011; Lumpe, Haney, & Czerniak, 1998). Specifically, Kilic et al.'s (2011) study demonstrated that Turkish and German pre-service biology teachers' attitude toward teaching evolution was found to be the most influential factor in their intentions to teach evolution. Based on this finding, the authors suggested that providing pre-service teachers with importance and necessity of evolution, which in turn positive attitude, is an important step for effective evolution instruction. In addition, working with K-12 science teachers, Lumpe et al. (1998) found a significant association between teachers' attitude and intention to implement Science-Technology-Society in their classrooms. In order for promoting positive attitudes related to science-technology-society, the authors stated that teachers might be provided with tangible and positive experiences with authentic science-technology-society subjects, authentic scientific research in which science-technology-society subjects are examined, and chances to describe science-technology-society operationally.

With respect to the effect of interaction between behavioral belief strength and outcome evaluation on attitude toward behavior, findings revealed that behavioral belief strength and outcome evaluation were significantly related to attitude toward the behavior whereas there was not a significant interaction effect of behavioral belief strength and outcome evaluation on attitude. That is, pre-service science teachers' attitude toward integrating NOS into science instruction was more positive when strength of behavioral beliefs was higher and when evaluation of the outcomes were more positive. These implied that participants who strongly believed that integrating NOS into science instruction yielded the outcomes in the question (e.g., "students easily understand science topics") and evaluated these outcomes positively were more likely to have positive attitudes toward integrating NOS into science instruction. This finding is also expected because it is sensible to assume that favorable beliefs about consequences of integrating NOS into science instruction can foster positive attitude toward integrating NOS into science instruction. On the other hand, the present finding that interaction between behavioral belief strength and outcome evaluation did not significantly influence attitude toward integrating NOS into science instruction is not consistent with the TPB. It should be noted that analysis in the present study differs from that generally reported in the TPB literature. More specifically, in this study, the effect of interaction between behavioral belief strength and outcome evaluation on attitude toward behavior was examined through SEM with latent interactions by including three latent variables: behavioral belief strength, outcome evaluation and latent interaction variable (product of behavioral belief strength and outcome evaluation) based on the guide related to interaction effect analyses (see Kline, 2011; Marsh et al., 2006; Schumacker & Lomax, 2010). In their study, Blanton and Jaccard (2006) warned that "it is only when the component parts of the product term are included in the regression equation that the regression coefficient associated with the product term takes on the interaction meaning that typically embraced in psychology" (p. 158). However, in TPB literature (for a review of literature see Fishbein & Ajzen 2010), in general, behavioral belief strength and outcome evaluation were multiplied and resulting products were summed in order to obtain belief-based measure, that is, an estimate of attitude toward the behavior based on behavioral beliefs. Then, the correlation between attitude and belief-based measure was examined. Considering the guide related to interaction analysis (see

Blanton & Jaccard, 2006; Kline, 2011; Marsh et al., 2006; Schumacker & Lomax, 2010), it can be said that the present analysis seems to be an appropriate methodological approach in order to examine interaction effects. Thus, results of the current analysis pointed out that although both behavioral belief strength and outcome evaluation individually were related to attitude toward integrating NOS into science classes, there was not an interaction effect between behavioral belief strength and outcome evaluation on attitude.

In addition, findings also indicated that high perceived control over integrating NOS into science instruction was related to stronger intentions to integrate NOS into science instruction. Considering the items used in the domain of "perceived behavioral control", participants with high perceived control over integrating NOS into science instruction thought that integrating NOS into science instruction was possible, easy and up to them, and they could overcome any problems that could prevent them from integrating NOS into science instruction if they wanted to. Accordingly, it can be inferred that participants with high perceived control over were more likely to believe that they are capable of integrating NOS into science instruction (see Ajzen, 2011). Thus, it is reasonable to expect that pre-service science teachers with high perceived control over integrating NOS were more likely to intend to integrate NOS into science instruction. Several investigations supported the present finding partially (e.g., Abd-El-Khalick et al., 1998; Bell et al., 2000; Demirdogen et al., 2015). After finding that greater majority of participating pre-service chemistry teachers preferred to incorporate NOS aspects, on which they held contemporary conceptions, in their lesson plans, Demirdogen et al. (2015) concluded that in order to teach NOS, pre-service chemistry teachers need to be comfortable in their understanding of the NOS. In addition, Abd-El-Khalick et al. (1998) found that pre-service secondary science teachers' discomfort about their own NOS understanding was one of the factors for lack of attention to the NOS in their planning and instruction. Furthermore, studying with pre-service secondary science teachers, Bell et al. (2000) showed that lack of confidence in understanding and ability to teach NOS was among the constraining factors to addressing NOS instructionally. On the other hand, the current finding concurs with that indicated by research utilized TPB as a theoretical framework in science education literature that perceived behavioral control is associated with behavioral intention (e.g., Kilic, Soran, & Graf, 2011; Lumpe, Haney, & Czerniak, 1998). More specifically, Lumpe, Haney and Czerniak (1998) found that science teachers' perceived behavioral control has the strongest effect on their intentions to implement science-technology-society in the classroom. Accordingly, the authors concluded that when there is no support, teachers might not be eager to implement science-technology-society in the classroom. In addition, in their study, Kilic, Soran and Graf (2011) reported that although perceived behavioral control impacted Turkish pre-service biology teachers' intentions to teach evolution, it did not have an influence on German pre-service biology teachers' intentions. Considering this finding, the authors reasoned that German pre-service biology teachers did not face with problems related to, for example, place of the evolution in the curriculum, time allocated for evolution, instructional materials so that they did not view presence of such facilities as a requirement to their decisions about teaching evolution.

In relation to the impact of interaction between control belief strength and power of control factor on perceived behavioral control, the present findings showed that perceived behavioral control was significantly linked to control belief strength but not to power of control factor and to an interaction between control belief strength and power of control factor. That is, participants who strongly believed that (a) they would have sufficient knowledge of NOS, (b) they would have experience for integrating NOS into science instruction, (c) they would be sufficient in integrating NOS into science instruction, and (d) they would be able to use appropriate teaching strategies to effectively integrate NOS into science instruction during their in-service teaching career were more likely to have perceived control over integrating NOS into science instruction. However, although participants had moderately strong beliefs that having sufficient knowledge of NOS, having experience for integrating NOS into science instruction, being sufficient in integrating NOS into science instruction, and having ability to use appropriate teaching strategies to effectively integrate NOS would facilitate their integrating NOS into science instruction, these beliefs did not significantly estimate their perceived control over integrating NOS. Similarly, the interaction between control belief strength and power of control factor did not significantly impact participants' perceived control over integrating NOS into science instruction, either. It seemed that the control factors identified in the present study failed to capture significant views on perceived behavioral control. It should be noted that in the present study, in order to measure "power of control factor", items related to only possible facilitating factors were utilized, items related to impeding factors were not included in the study. This may influence the relationship between power of control factor and perceived behavioral control and thus influence the interaction effect between control belief strength and power of control factor on perceived behavioral control. Therefore, this study points out a necessity for further research to identify control factors that capture pre-service science teachers' perceived behavioral control well.

On the other hand, subjective norm was not found to be related to participants' intention to integrate NOS into science instruction. That is, participants who perceived social pressure from important others and institutions to integrate NOS did not necessarily intend to integrate NOS into their science instruction. It can inferred that expectations of important individuals and institutions with respect to integrating NOS into were not influential enough to foster pre-service science teachers' intention to integrate NOS into science instruction. Actually, this finding is not surprising considering descriptive results demonstrating that pre-service science teachers perceived moderate social pressure from important people and institutions to integrate NOS into science instruction. On the other hand, Ajzen (2005) signified that contribution of attitude, subjective norm, and perceived behavioral control to the explanation of intentions varies depending on the intention under consideration. Specifically, only one or two of the determinants including attitude, subjective norm, and perceived behavioral control are necessary in explaining some intentions whereas all of the determinants are significant in others. Supporting Ajzen's (2005) assertion, in the TPB literature while some studies reported the importance of subjective norm to behavioral intentions, others did not (see Beck & Ajzen, 1991; Davis et al., 2002; Hrubes, Ajzen, & Daigle, 2001; Kilic et al. 2011; Latimer & Martin Ginis, 2005; Lumpe et al., 1998; Zemore & Ajzen, 2014).

In relation to the impact of interaction between normative belief strength and motivation to comply on subjective norm, the present findings indicated that subjective norm was significantly linked to normative belief strength, motivation to comply and the interaction between normative belief strength and motivation to comply. That is, perceived social pressure to integrate NOS into science instruction was higher when strength of normative belief was higher and when motivation to comply with the referents was higher. Also, positive effect of normative belief strength on perceived social pressure was more substantial for participants with higher motivation to comply with the referents. Equivalently, positive effect of motivation to comply with the referents on perceived social pressure was more substantial for participants with higher normative belief strength. More specifically, pre-service science teachers who had stronger beliefs related to normative referents' (including ministry of education, faculty members, school administrators, and science teachers) expectations and who had stronger beliefs about the importance of normative referents' expectations were more likely to perceive stronger social pressure to integrate NOS into science instruction. Besides, positive effect of beliefs related to normative referents' expectations on perceived social pressure is more substantial for pre-service teachers with stronger beliefs about the importance of normative referents' expectations. Equivalently, positive effect of beliefs about the importance of normative referents' expectations on perceived social pressure is more substantial for pre-service teachers with stronger beliefs related to normative referents' expectations. It can be concluded that items related to normative belief strength and motivation to comply were able to capture significant considerations on perceived social pressure and this finding was consistent with the TPB.

SEM with latent interactions demonstrated that the model based on the TPB explained 16.9 % in pre-service science teachers' intention to integrate NOS into science instruction. Although the variance explained in intention was considerable, it was somewhat low compared to findings of other studies (e.g. see also Armitage & Conner, 2001; Kilic et al., 2011; Fishbein & Ajzen 2010). However, this finding is not surprising considering that integrating NOS into science instruction is not a simple behavior, as delineated by Abd-El-Khalick and Lederman (2000a), teaching NOS in an effective manner necessities NOS knowledge, pedagogical knowledge, and pedagogical content knowledge (PCK). Pedagogical knowledge includes "knowledge of generic pedagogical principles, the characteristics of the learner, and classroom management skills" whereas PCK related to NOS comprises

> …in addition to an adequate understanding of various aspects of NOS, knowledge of a wide range of related examples, activities, illustrations, explanations, demonstrations, and historical episodes. These components would enable the teacher to organize, represent, and present the topic for instruction in a manner that makes target aspects of NOS accessible to precollege students. Moreover, knowledge of alternative ways of representing aspects of NOS would enable the teacher to adapt those aspects to the diverse interests and abilities of learners (Abd-El-Khalick & Lederman, 2000a, p. 692),

Accordingly, it can be said that this study suggested the presence of other potential factors (e.g., NOS knowledge, PCK for NOS) in explaining pre-service science teachers' intentions to integrate NOS into their science instruction.

5.2 Implications of the Study

This study investigated factors that could potentially explain pre-service science teachers' intention to integrate NOS into science instruction utilizing the framework of TPB. It was found that pre-service science teachers' attitude toward integrating NOS into science instruction and perceived behavioral control were significant in explaining their intentions to integrate NOS into science instruction. Considering the vital role of teacher education programs in training qualified teachers, the current study has recommendations for teacher education programs. Firstly, it is suggested that teacher education programs should provide pre-service science teachers with development of positive attitudes toward integrating NOS into science instruction. This can be done by Abd-El-Khalick et al.'s (1998) recommendation that teacher preparation programs should provide pre-service teachers with comprehending the logic behind and significance of emphasizing NOS in their classroom practices. Toward this end, possible outcomes of integrating NOS into science instruction, which were uncovered in this study, can be made use of. In the present study, anticipated outcomes of integrating NOS into science instruction were identified as:

(a) Students easily understand science topics
(b) Students understand the interaction among science, technology, society, and environment better
(c) Students are raised as critical thinkers
(d) Students differentiate science (*physics, chemistry, biology*) from other disciplines (e.g., *history, philosophy*)
(e) Students distinguish between science and pseudoscience (e.g., *astrology, acupuncture*)
(f) Students realize that science is part of everyday life
(g) Students' misconceptions related to nature of science are eliminated
(h) Students realize that scientists are not different from other people
(i) Students start to critically evaluate scientific news in the media
(j) I become professionally developed

Aforementioned outcomes can be emphasized in related courses offered in pre-service education programs by addressing related findings of investigations and by inviting individuals having expertise on NOS. As well, pre-service science teachers can be asked to address NOS in their lesson plans and their teaching so that they can experience consequences of addressing NOS.

In addition, considering the significant role perceived behavioral control plays in explaining participants' intentions to integrate NOS into science instruction, it is suggested that teacher education programs should help pre-service science teachers to have a sense of confidence in their knowledge and capabilities to teach NOS effectively. Such a sense of confidence could be fostered through facilitating pedagogical content knowledge (PCK) related to NOS among pre-service science teachers. PCK for NOS provides pre-service teachers with “adequate understanding of various aspects of NOS, knowledge of a wide range of related examples, activities, illustrations, explanations, demonstrations, and historical episodes”, and “knowledge of alternative ways of representing aspects of NOS” (Abd-El-Khalick & Lederman, 2000a, p. 692). Accordingly, it is reasonable to expect that PCK for NOS fosters a sense of confidence in knowledge and abilities to address NOS instructionally. Thus, this study recommended that teacher education programs can be designed to provide pre-service science teachers with education to promote PCK related to NOS.

On the other hand, based on the findings of the study, the questionnaire developed in this study appears to provide a reliable and valid measure of factors that could potentially explain pre-service science teachers’ intentions to integrate NOS into their science instruction. This questionnaire can also be used as a tool in an attempt to foster NOS teaching. More specifically, by means of the questionnaire, constraining and facilitating factors can be identified, which in turn, would significantly contribute to efforts undertaken to facilitate NOS integration into science instruction.

5.3 Limitations and Recommendations

The current study has provided with a reliable and valid instrument to measure factors that could potentially explain pre-service science teachers’ intentions to integrate NOS into their science instruction within the framework of the TPB and with insights about relative contribution of each factor to the intentions to integrate NOS into science instruction. Nevertheless, this study also has a number of limitations that future research can address. First, in the pilot study, many items were needed to be eliminated from the questionnaire. Although both pilot and main study provided validity evidences for the intention to integrate nature of science questionnaire with the remaining items, this study should be replicated with more samples to provide further validity evidences. Second, due to the nature of “intention” construct, data collected for "intention to integrate NOS into science instruction" relied on participants' self-reports so that this study might not capture participants' actual intentions. Accordingly, it is desirable for future studies to make use of additional methods such as inspection of lesson plans prepared by participants to verify the consistency and accuracy of self-reported data. Third, in this study, in order to formulate items related belief constructs (i.e., behavioral beliefs, normative beliefs, and control beliefs) semi-structured interviews were conducted with 19 senior pre-service science teachers from two public universities of Ankara. That is, items were limited to responses of 19 senior pre-service science teachers from two public universities of Ankara and these 19 participants' beliefs may not be representative of the population. Hence, semi-structured interviews should be conducted with diverse senior pre-service science teachers. Fourth, according to analysis results, it seemed that the control factors identified in the present study failed to capture significant views on perceived behavioral control. It should be noted that in the present study, in order to measure "power of control factor", items related to only possible facilitating factors were utilized, items related to impeding factors were not included in the study. This may influence the relationship between power of control factor and perceived behavioral control and thus influence the interaction effect between control belief strength and power of control factor on perceived behavioral control. Therefore, this study points out a necessity for further research to identify control factors that capture pre-service science teachers' perceived behavioral control well. Fifth, the sample of the pilot included 408 senior pre-service science teachers enrolled in 10 public universities located in different geographical regions of Turkey. On the other hand, the sample of the main study included 1172 senior pre-service science teachers enrolled in 22 universities located in 12 regions of Turkey which were identified based on economic, social, cultural and geographical characteristics and population size of cities. It should be noted that 22 universities, out of 57, were selected so that number of senior pre-service science teachers to be included in the sample from each region was at least 10 percent of the region's population. These efforts contributed to have a representative sample of the population. However, in both pilot and main study, universities to be included in the study were selected by using convenience sampling. Due to nature of convenience sampling characteristics of participants may not be representative of the population. Sixth, in the present study, unconstrained approach with double-mean-centering strategy, which is among the group of product-indicator approaches, was used for a number of reasons. First, forming product indicators seems to be in line with the TPB. Second, it provides significant advantages over other product-indicator approaches (e.g., constrained approach, unconstrained approach with single-mean-centering strategy): it is easier to perform and less biased in a wide variety of nonnormal conditions. However, there are alternative approaches for the estimation of latent interactions such as nonlinear structural equation mixture modeling (NSEMM) approach (Kelava, Nagengast, & Brandt, 2014), which is designed for nonnormally distributed latent predictor variables. It is suggested for future research to utilize alternative approaches to validate the present findings. Seventh, in the current study, the proposed model based on the TPB accounted for 16.9 % in pre-service science teachers' intention to integrate NOS into science instruction. Although the variance explained in intention was considerable, it was somewhat low compared to findings of other studies (e.g. see also Armitage & Conner, 2001; Kilic et al., 2011; Fishbein & Ajzen 2010). Thus, this study suggested the presence of other potential factors (e.g., NOS knowledge, PCK for NOS) in explaining pre-service science teachers' intentions to integrate NOS into their science instruction. Accordingly, future studies can include other potential factors (e.g., NOS knowledge, PCK for NOS, personal norm, self-identity) in the proposed model in order for a more informed model related to factors explaining pre-service science teachers' intentions to integrate NOS into their science instruction

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APPENDICES

APPENDIX A

PERMISSIONS OBTAINED FROM METU HUMAN SUBJECTS ETHICS COMMITTEE

UYGULAMALI ETİK ARAŞTIRMA MERKEZİ
APPLIED ETHICS RESEARCH CENTER

ORTA DOĞU TEKNİK ÜNİVERSİTESİ
MIDDLE EAST TECHNICAL UNIVERSIT

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Sayı: 28620816/252-727

19.09 2013

Gönderilen : Prof. Dr. Ceren Öztekin
İlköğretim Bölümü

Gönderen : Prof. Dr. Canan Özgen
IAK Başkanı

İlgi : Etik Onayı

Danışmanlığını yapmış olduğunuz İlköğretim Bölümü Doktora öğrencisi Gülsüm Akyol'un "Bilimin doğası öğretimi niyetini belirleyen faktörlerin planlanmış davranış teorisi çerçevesinde açıklanması" isimli araştırması "İnsan Araştırmaları Komitesi" tarafından uygun görülerek gerekli onay verilmiştir.

Bilgilerinize saygılarımla sunarım.

Etik Komite Onayı

Uygundur

19/09/2013

Prof.Dr. Canan Özgen
Uygulamalı Etik Araştırma Merkezi
(UEAM) Başkanı
ODTÜ 06531 ANKARA

APPENDIX B

INTENTION TO INTEGRATE NATURE OF SCIENCE QUESTIONNAIRE

Dear Teacher Candidates;

This study intends to determine your views on "**integrating nature of science into science instruction**". Please read each sentence carefully, and then tick the appropriate option. Some questions in this questionnaire are similar to others, do not worry about it. **Thank you in advance for your contribution**.

Items related to Intention:

Considering your own teaching, to what extent do you agree with the following statements?	Strongly Disagree 1	2	3	4	5	6	Strongly Agree 7
1. I will try to integrate nature of science into science instruction	☐	☐	☐	☐	☐	☐	☐
2. I plan to integrate nature of science into science instruction	☐	☐	☐	☐	☐	☐	☐
3. I intend to integrate nature of science into science instruction	☐	☐	☐	☐	☐	☐	☐

Items related to Attitude:

For me, to integrate nature of science into science instruction is ...								
	7	6	5	4	3	2	1	
Useful	☐	☐	☐	☐	☐	☐	☐	Useless
Important	☐	☐	☐	☐	☐	☐	☐	Unimportant
Valuable	☐	☐	☐	☐	☐	☐	☐	Worthless
Correct	☐	☐	☐	☐	☐	☐	☐	Incorrect
Reasonable	☐	☐	☐	☐	☐	☐	☐	Unreasonable
Worthwhile	☐	☐	☐	☐	☐	☐	☐	A waste of time

Items related to behavioral belief strength:

If I integrate nature of science into science instruction:	Strongly Disagree 1	2	3	4	5	6	Strongly Agree 7
1. Students easily understand science topics	☐	☐	☐	☐	☐	☐	☐
2. Students understand the interaction among science, technology, society, and environment better	☐	☐	☐	☐	☐	☐	☐
3. Students are raised as critical thinkers	☐	☐	☐	☐	☐	☐	☐
4. Students differentiate science (*physics, chemistry, biology*) from other disciplines (*e.g., history, philosophy*)	☐	☐	☐	☐	☐	☐	☐
5. Students distinguish between science and pseudoscience (*e.g., astrology, acupuncture*)	☐	☐	☐	☐	☐	☐	☐
6. Students realize that science is part of everyday life	☐	☐	☐	☐	☐	☐	☐
7. Students' misconceptions related to nature of science are eliminated	☐	☐	☐	☐	☐	☐	☐
8. Students realize that scientists are not different from other people	☐	☐	☐	☐	☐	☐	☐
9. Students start to critically evaluate scientific news in the media	☐	☐	☐	☐	☐	☐	☐
10. I become professionally developed	☐	☐	☐	☐	☐	☐	☐

Items related to outcome evaluation:

How important to you are the following situations?	Not important at all 1	2	3	4	5	6	Very important 7
1. That students easily understand science topics	☐	☐	☐	☐	☐	☐	☐
2. That students understand the interaction among science, technology, society, and environment better	☐	☐	☐	☐	☐	☐	☐
3. Development of students as critical thinkers	☐	☐	☐	☐	☐	☐	☐
4. That students differentiate science (*physics, chemistry, biology*) from other disciplines (*e.g., history, philosophy*)	☐	☐	☐	☐	☐	☐	☐
5. That students distinguish between science and pseudoscience (*e.g., astrology, acupuncture*)	☐	☐	☐	☐	☐	☐	☐
6. That students realize that science is part of everyday life	☐	☐	☐	☐	☐	☐	☐
7. Eliminating students' misconceptions related to nature of science	☐	☐	☐	☐	☐	☐	☐
8. That students realize scientists are not different from other people	☐	☐	☐	☐	☐	☐	☐
9. That students start to critically evaluate scientific news in the media	☐	☐	☐	☐	☐	☐	☐
10. Developing myself professionally	☐	☐	☐	☐	☐	☐	☐

Items related to Subjective Norm:

To what extent do you agree with the following statements?	Strongly Disagree 1	2	3	4	5	6	Strongly Agree 7
1. People/Institutions whose opinions I value expect me to integrate nature of science into science instruction	☐	☐	☐	☐	☐	☐	☐
2. Most of the people/institutions that I think to be important to my teaching career expect me to integrate nature of science into science instruction	☐	☐	☐	☐	☐	☐	☐
3. Most people who are important to me will be disappointed if I **do not** integrate nature of science into science instruction	☐	☐	☐	☐	☐	☐	☐

Items related to Normative Belief Strength:

The following people/institution expect me to integrate nature of science into science instruction:	Strongly Disagree 1	2	3	4	5	6	Strongly Agree 7
1. Ministry of Education	☐	☐	☐	☐	☐	☐	☐
2. Faculty members	☐	☐	☐	☐	☐	☐	☐
3. School administrators	☐	☐	☐	☐	☐	☐	☐
4. Science teachers	☐	☐	☐	☐	☐	☐	☐

Items related to motivation to comply:

How important are expectations of people or institution related to your integration of nature of science into your science instruction for you?	Not important at all 1	2	3	4	5	6	Very important 7
1. Ministry of Education	☐	☐	☐	☐	☐	☐	☐
2. Faculty members	☐	☐	☐	☐	☐	☐	☐
3. School administrators	☐	☐	☐	☐	☐	☐	☐
4. Science teachers	☐	☐	☐	☐	☐	☐	☐

Items related to perceived behavioral control:

To what extent do you agree with the following statements?	Strongly Disagree 1	2	3	4	5	6	Strongly Agree 7
1. For me to integrate nature of science into science instruction is possible	☐	☐	☐	☐	☐	☐	☐
2. For me to integrate nature of science into science instruction is easy	☐	☐	☐	☐	☐	☐	☐
3. To integrate nature of science into science instruction is up to me	☐	☐	☐	☐	☐	☐	☐
4. I can overcome any problems that could prevent me from integrating nature of science into science instruction if I want to	☐	☐	☐	☐	☐	☐	☐

Items related to control belief strength:

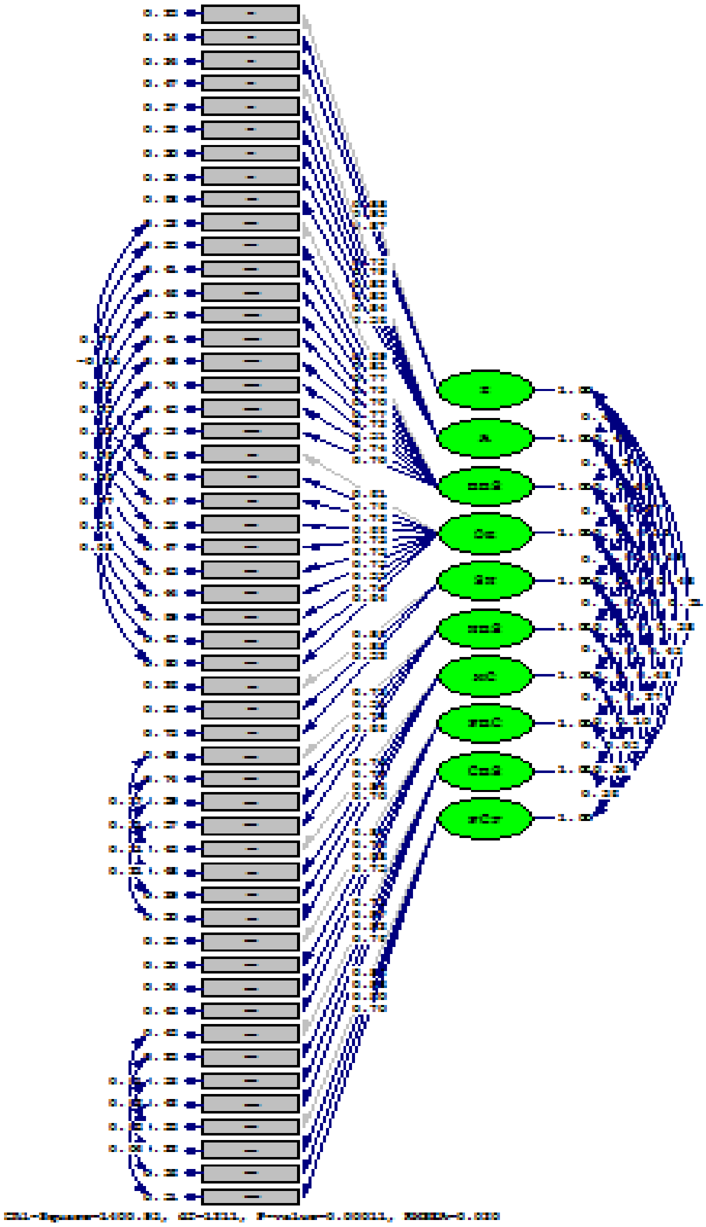
During your in-service teaching career, to what extent do you expect the following factors will be present?	Not possible at all 1	2	3	4	5	6	Certainly possible 7
1. I will have sufficient knowledge of nature of science	☐	☐	☐	☐	☐	☐	☐
2. I will have experience for integrating nature of science into science instruction	☐	☐	☐	☐	☐	☐	☐
3. I will be sufficient in integrating nature of science in science instruction	☐	☐	☐	☐	☐	☐	☐
4. I will be able to use appropriate teaching strategies to effectively integrate nature of science into science instruction	☐	☐	☐	☐	☐	☐	☐

Items related to power of control factor:

The presence of the following factors will facilitate integrating nature of science into science instruction:	Strongly Disagree 1	2	3	4	5	6	Strongly Agree 7
1. My having sufficient knowledge of nature of science	☐	☐	☐	☐	☐	☐	☐
2. My having experience for integrating nature of science into science instruction	☐	☐	☐	☐	☐	☐	☐
3. My being sufficient in integrating nature of science in science instruction	☐	☐	☐	☐	☐	☐	☐
4. My ability to use appropriate teaching strategies to effectively integrate nature of science	☐	☐	☐	☐	☐	☐	☐

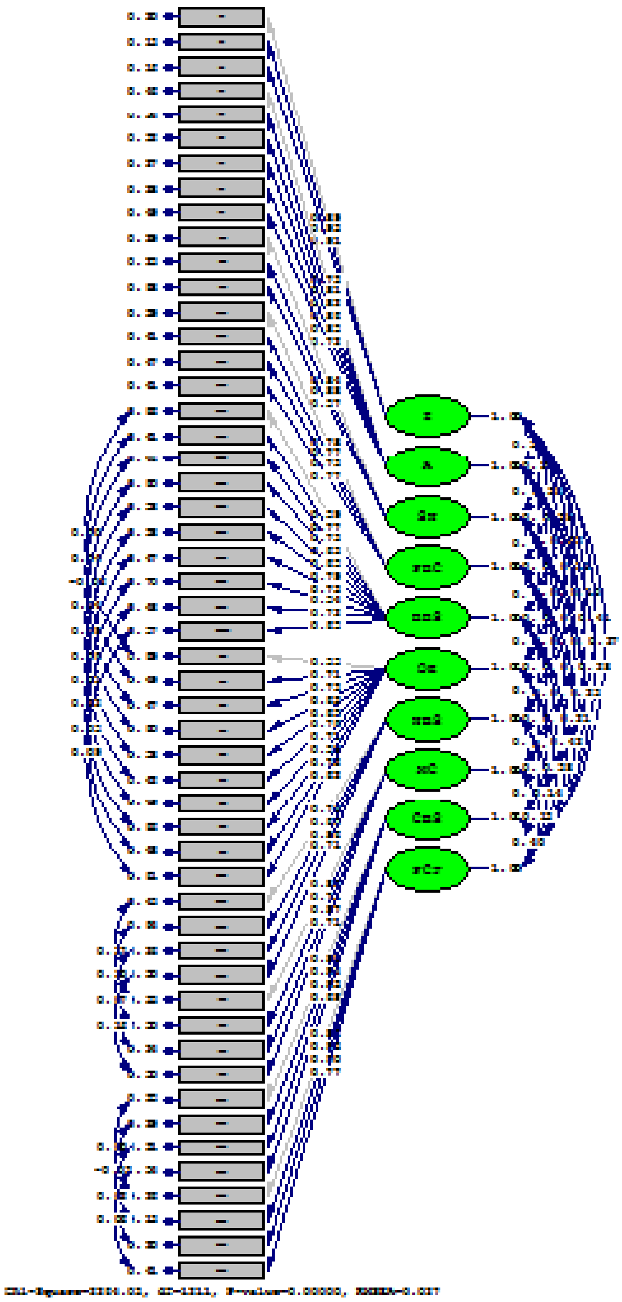
APPENDIX C

MEASUREMENT MODEL OF THE PILOT STUDY



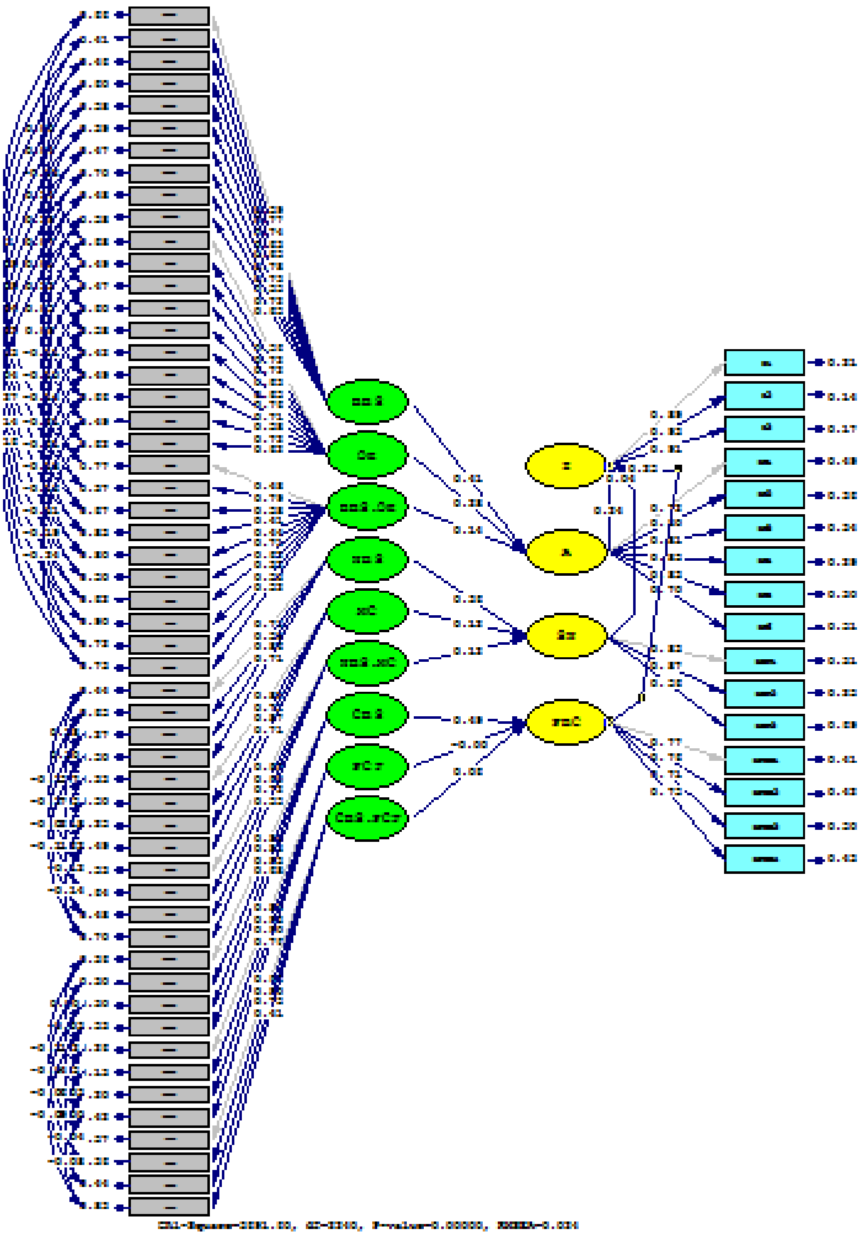
APPENDIX D

MEASUREMENT MODEL OF THE MAIN STUDY



APPENDIX E

STRUCTURAL MODEL OF THE MAIN STUDY



APPENDIX F

CURRICULUM VITAE

PERSONAL INFORMATION

Surname, Name: Akyol, Gülsüm
Nationality: Turkish (TC)
Marital Status: Single
Phone: +90 312 210 75 08
Fax: +90 312 210 79 84
email: glsmakyl@gmail.com

EDUCATION

Degree	Institution	Year of Graduation
MS	METU Science and Mathematics Education	2009
BS	METU Elementary Science Education	2006
High School	Erdoğan Akdağ Anatolian Teacher High School, Yozgat	2001

VISITING SCHOLAR

August 2014 – July 2015	University of Illinois at Urbana-Champaign	College of Education

WORK EXPERIENCE

Year	**Place**	**Enrollment**
2010- present	METU Department of Elementary Education	Research Assistant

Assistant of:

ELE 225 Measurement and Assessment

ELE 240 Probability and Statistics

ELE 331 Laboratory Applications in Science I

ELE 332 Laboratory Applications in Science II

ELE 411 Environmental Sciences

ELE 420 Practice Teaching in Elementary Education

ESME 506 Quantitative Data Analysis in Education

ELE 603 Advanced Educational Research

PUBLICATIONS

Journal Article

1. **Akyol G.,** Sungur S. and Tekkaya C. "The contribution of cognitive and metacognitive strategy use to students' science achievement", Educational Research and Evaluation, 16, 1-21 (2010)

2. **Akyol G**., Tekkaya C., Sungur S., and Traynor A. "Modeling the interrelationships among pre-service science teachers' understanding and acceptance of evolution, their views on nature of science and self-efficacy beliefs regarding teaching evolution", Journal of Science Teacher Education, 23(8), 937-957 (2012)

3. Tekkaya C., **Akyol, G**. and Sungur, S. "Relationships among teachers' knowledge and beliefs regarding the teaching of evolution: A case for Turkey", Evolution: Education and Outreach, 5(3), 477-493 (2012)

International Conference Presentations - Proceedings

1. **Akyol G**., Tekkaya C. and Sungur S. "The contribution of understandings of evolutionary theory and nature of science to pre-service science teachers' acceptance of evolutionary theory", Procedia Social and Behavioral Sciences, 9, 1889-1893 (2010)

2. **Akyol G.,** Tekkaya C., and Sungur S. "Examination of pre-service science teachers' perceptions and understanding of evolution in relation to socio-demographic variables", Procedia - Social and Behavioral Sciences, 31, 167-172 (2012)

3. Tekkaya C., Sungur S. and **Akyol G**. "Turkish pre-service science teachers' understanding of natural selection: Some preliminary findings", Western Anatolia Journal of Educational Science (Selected Issue: Selected papers presented at World Conference on New Trends in Science Education) ISSN 1308 – 8971, 485-490 (2011)

National and International Conference Presentations

1. **Akyol, G**., Tekkaya, C., & Sungur, S.- *Determinants of pre-service science teachers' intention of teaching nature of science: Theory of planned behavior perspective*. Poster presented at the meeting of Applied Education Congress, Ankara, Turkey, (2012, September).

2. Tekkaya, C., **Akyol, G**., & Sungur, S. Evrim teorisini kabul etmeye etki eden faktorler: Evrim bilgisinin ve bilimsel bilginin dogasi ile ilgili goruslerin incelenmesi [Factors affecting acceptance of evolutionary theory: Examination of understandings of evolutionary theory and nature of scientific knowledge]. Poster presented at the meeting of IX. Ulusal Fen Bilimleri ve Matematik Egitimi Kongresi, Izmir, Turkey, (2010, September).

3. Tekkaya, C., Sungur, S., & **Akyol, G.** - *Examination of pre-service science teachers' understanding and acceptance of evolution in relation to gender*. Paper presented at the meeting of World Conference on New Trends in Science Education (WCNTSE), Kuşadası, Turkey, (2011, September).

FOREIGN LANGUAGES

English

HOBBIES

Jogging, watching movies, and reading books

APPENDIX G

TURKISH SUMMARY

BİLİMİN DOĞASI ÖĞRETİMİ NİYETİNİ BELİRLEYEN FAKTÖRLER: PLANLANMIŞ DAVRANIŞ TEORİSİNİN UYGULANABİLİRLİĞİNİN SINANMASI

Giriş

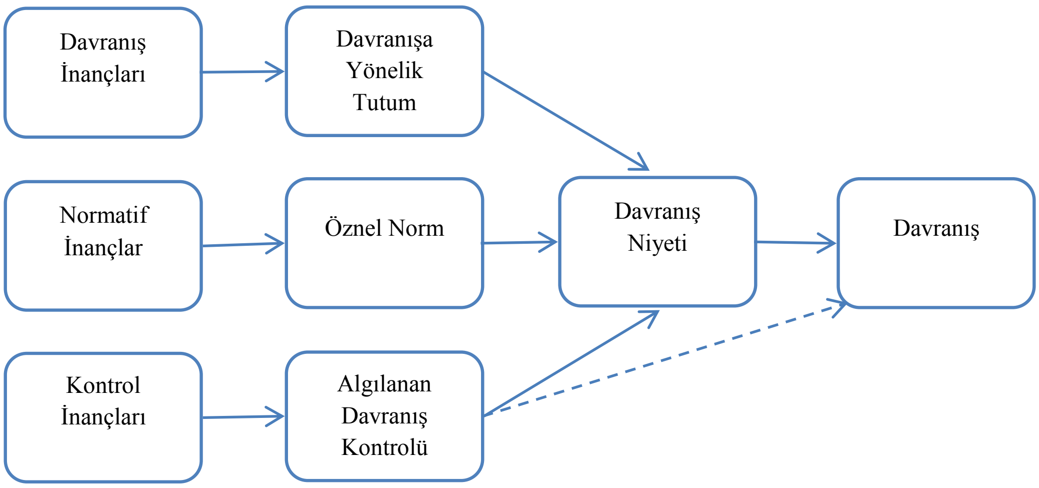
Bilimin doğası, bilimsel okuryazarlığın önemli bir bileşeni olarak, başlıca bilim eğitimi reform dökümanlarında vurgulanmıştır (e.g., American Association for the Advancement of Science [AAAS], 1990, 1993; National Research Council [NRC], 1996). Uluslararası eğilime paralel olarak, belirli bir düzeyde bilimsel okuryazarlığı sağlamak ilköğretim fen öğretim programının vizyonu olarak belirtilmiş (Milli Eğitim Bakanlığı [MEB], 2006, 2013) ve bu vizyonu gerçekleştirmek için belirlenen amaçlardan biri de bilimin doğasını anlamak olarak yer almaktadır (bk. MEB, 2013; NRC, 1996). Ancak, yapılan çalışmalar, ders planlarında ve sınıf içi uygulamalarda bilimin doğasına yeteri kadar önem verilmediğini göstermektedir (ör. Abd-El-Khalick, Bell, ve Lederman, 1998; Aslan ve Tasar, 2013; Bell, Lederman ve Abd-El-Khalick, 2000; Lederman, 1999). Örneğin, Abd-El-Khalick ve ark. (1998), 14 ortaöğretim fen öğretmeniyle yaptığı çalışmasında katılımcıların ders planlarında bilimin doğasına seyreklikle yer verdiğini belirtmişlerdir. Bu yer vermelerde, bilimin doğasına odaklanılmamış, bilimin doğası ayrı bir konu olarak davranılmış ve genellikle bilimin doğasının bir boyutu kullanılmıştır. Bazı durumlarda ise, katılımcılar bilimin doğasına yer verdiklerini belirtmelerine rağmen, aslında derslerinde yalnızca “bilim yapmaya” yer verdikleri gözlenmiştir. Ayrıca, Lederman'ın (1999) çalışmasına göre, biyoloji öğretmenlerinden oluşan bütün katılımcılar, bilimin doğası ile ilgili yeterli seviyede bilgi sahibi olmalarına rağmen, yalnızca en deneyimli iki öğretmenin sınıf içi uygulamasıyla bilim doğası bilgileri tutarlıdır. Fakat, yapılan görüşmelerin ve ders planlarının analizlerinin sonuçları, bu iki öğretmenin bilimin doğasına maksatlı olarak yer vermediğini göstermiştir, aslında bu öğretmenler, öğrencilerin bilimin doğasını anlamalarıyla ilgili bir kazanım belirtmemişlerdir. Bunun yanı sıra, Bell ve ark. (2000) çalışmalarında bazı katılımcıların ders anlatımlarında doğrudan yaklaşımla (explicit manner) bilimin doğasına yer verdiklerini göstermişlerdir. Ancak, araştırmacılar, katılımcıların bilimin doğası ile ilgili açık bir kazanım yazma konusunda ya isteksiz olduklarını ya da yapamadıklarını belirtmişler, bunun sonucunda da katılımcılar öğrencilerin bilimin doğası bilgilerini değerlendirmek için bir girişimde bulunmamışlardır. Aslan ve Tasar (2013) tarafından çalışma ise araştırmaya katılan fen öğretmenlerinin açık ve maksatlı bir biçimde bilimin doğasını öğretmediklerini göstermiştir.

Bilimin doğasını etkili bir şekilde öğretilmesini etkileyen faktörlerle ilgili yapılan çalışmalar, birçok faktörü ortaya çıkarmıştır. Bu faktörler, öğretmenlerin veya öğretmen adaylarının: Niyetleri (Demirdogen, Hanuscin, Uzuntiryaki-Kondakci, ve Koseoglu, 2015; Lederman, 1999; Lederman, Schwartz, Abd-El-Khalick, ve Bell, 2001; Schwartz ve Lederman, 2002), bilimin doğasının önemi ile ilgili inançları, (Abd-El-Khalick ve ark., 1998; Demirdogen ve ark., 2015; Herman, 2010; Schwartz ve Lederman, 2002), öğrencilerin bilimin doğasını öğrenme yetenekleriyle ilgili algıları (Lederman, 1999; Sweeney, 2010), bilimin doğası ile fen alan bilgisi arasındaki bağlantı ile ilgili algıları (Schwartz ve Lederman, 2002), bilimin doğasına yer vermekle ilgili kişisel sorumluluk duyguları (Herman, 2010), ve bilimin doğası bilgileriyle ilgili özgüven duyguları (Abd-El-Khalick ve ark., 1998; Bell ve ark., 2000; Demirdogen ve ark., 2015), bilimin doğasını öğretme yetenekleriyle ilgili özgüven duyguları (Bell ve ark., 2000), öğrencilerin bilimin doğası bilgilerini değerlendirme yetenekleriyle ilgili özgüven duyguları (Abd-El-Khalick ve ark., 1998). Bunların yanısıra öğretmenlerin veya öğretmen adaylarının bilgileriyle ilgili faktörler bulunmakta, bunlar: Bilimin doğası ile ilgili bilgileri (Demirdogen ve ark., 2015; Lederman ve ark., 2001; Schwartz ve Lederman, 2002; Wahbeh ve Abd-El-Khalick, 2013), fen alan bilgileri (Lederman ve ark., 2001; Schwartz ve Lederman, 2002; Wahbeh ve Abd-El-Khalick, 2013), pedagoji bilgileri (Herman, 2010; Lederman ve ark., 2001; Wahbeh ve Abd-El-Khalick, 2013), and bilimin doğası ile ilgili pedagojik alan bilgileri (Demirdogen ve ark., 2015; Schwartz ve Lederman, 2002; Wahbeh ve Abd-El-Khalick, 2013). Ayrıca, kişisel, bağlamsal ve durumsal faktörler şunlardır: öğrenci öğretim deneyimi ile ilgili kıstlamalar (ör. staj sırasında sorumlu olduğun öğretmenin verdiği konuyu belirli bir zaman diliminde anlatma) (Abd-El-Khalick ve ark., 1998; Bell ve ark., 2000), zamanla ilgili kısıtlamalar (Abd-El-Khalick ve ark., 1998; Bell ve ark., 2000; Koehler, 2006), müfredatla ilgili kısıtlamalar (Aslan ve Tasar, 2013), sınıf yönetimi (Abd-El-Khalick ve ark., 1998; Lederman, 1999; Lederman ve ark., 2001), bilimin doğasını öğretmek ve/veya değerlendirmek için kaynakların bulunması (Abd-El-Khalick ve ark., 1998), velilerin, öğrencilerin, ve okul yöneticilerinin beklentileri (Aslan ve Tasar, 2013), ülke çapında veya eyalet çapında yapılan sınavlar (Aslan ve Tasar, 2013; Koehler, 2006), ve öğretme deneyimi (Abd-El-Khalick ve ark., 1998; Lederman, 1999), öğrencilerin önceki bilgileriyle ilgilenilmesi (Wahbeh ve Abd-El-Khalick, 2013), ve rutin işlerle meşgul olma (Abd-El-Khalick ve ark., 1998).

Yukarıda belirtilen çalışmalar gözönüne alındığında, bilimin doğasının öğretilmesiyle ilgili faktörler üzerine araştırma yapan birçok çalışmanın olduğu açıktır. Fakat, araştırmacıların bilimin doğası ile ilgili görüşlerin sınıf içi uygulamalarına yansıtılmasını etkiyen kısıtlayıcı ve kolaylaştırıcı faktörleri incelemeleri yönünde çağrı yapılmaya devam edilmektedir (bk. Abd-El-Khalick ve Lederman, 2000; Lederman ve Lederman, 2014). Lederman' nın (1999), çalışmasının sonucunda da belirttiği gibi sınıf uygulamasını önemli ölçüde etkileyen faktör öğretmenlerin öğretim niyetleridir. Buna bağlı olarak, bilimin doğası öğretimini geliştirmek için, öğretmenlerin bilimin doğasını öğretme niyetlerini etkileyen faktörleri belirlemek önemlidir. Literatürde, öğretmenlerin veya öğretmen adaylarının niyetlerinin bilim doğasının öğretilmesi kararındaki önemini destekleyen çalışmalar bulunmasına rağmen (ör. Demirdogen ve ark., 2015; Lederman, 1999;

Lederman ve ark., 2001; Schwartz & Lederman, 2002), bildiğim kadarıyla, özellikle bilimin doğasını öğretme niyetini etkiyen faktörleri inceleyen araştırma bulunmamaktadır. Öğretmen adaylarının gelecekte bilimin doğası öğretilmesinde ve öğrencilerin uygun bilimin doğası görüşleriyle donatılmasındaki önemi de gözönüne alınarak, bu çalışmada fen bilimleri öğretmen adaylarının fen derslerindeki konulara bilimin doğasını entegre etme niyetlerini açıklayabilen faktörler incelenecektir. Böylelikle, öğretmen adaylarının entegre etme niyetlerini etkileyen faktörlere bakarak bilimin doğasının öğretilmesiyle ilgili ihtiyaçlarını daha iyi anlayabilir, öğretmen olduklarında fen derslerine bilimin doğasını entegre edebilmeleri için gerekli düzenlemeler yapılabilir.

Bu çalışmada, fen bilimleri öğretmen adaylarının fen derslerindeki konulara bilimin doğasını entegre etme niyetlerini açıklayan faktörler, planlanmış davranış teorisi kullanılarak incelenmiştir (PDT; Ajzen, 1985, 1991, 2005, 2012). Günümüzde, planlanmış davranış teorisi, davranışları tahmin etmek için en çok bilinen sosyal psikolojik modeller arasında yer almaktadir (Ajzen, 2011). Planlanmış davranış teorisi, gerekçeli eylem teorisinin (theory of reasoned action; Ajzen & Fishbein, 1980; Fishbein & Ajzen, 1975) genişletilmiş hali olup, böylelikle tamamen isteğe bağlı olmayan davranışların incelenmesine izin verir (bk. Ajzen, 2005). Planlanmış davranış teorisinin temel bileşeni, bireylerin davranışı gerçekleştirme niyetleridir, niyetler bireyin davaranışı gerçekleştirmek için istekli bir şekilde deneyeceğini ve ne kadar çaba sarfetmeyi planladığını gösterir (Ajzen, 1991). Teoriye göre (bk. Şekil 1) davranış niyetinin, bireyin sosyal davranışından önce geldiği varsayılırken, davranış niyetini üç faktör açıklamaktadir, bunlar: davranışa yönelik tutum, öznel norm ve algılanan davranış kontrolüdür (Ajzen, 2012). Genel olarak, davranışa yönelik daha pozitif tutum, daha güçlü sosyal baskı, ve daha güçlü algılanan davranış kontrolü, daha güçlü davranış niyeti ile ilişkilendirilir (Ajzen, 2012). Bu üç faktörün, yani davranışa yönelik tutum, öznel norm ve algılanan davranış kontrolünün, davranış niyetindeki önemi davranışa ve populasyona göre değişiklik gösterebilir (Ajzen, 2011). Öte yandan, davranışa yönelik tutum, öznel norm ve algılanan davranış kontrolünün de sırasıyla davranış inançları, normatif inançlar, ve kontrol inançları sonucunda oluştuğu düşünülmektedir (Ajzen, 2013).



Şekil 1 Planlanmış davranış teorisinin şematik gösterimi
(Kaynak: Ajzen, 2005' den adapte edilmiştir)

Bu çalışmada teorik çerçeve olarak planlanmış davranış teorisin seçilmesini birçok nedeni var.

Birincisi, günümüzde, planlanmış davranış teorisi, davranışları tahmin etmek için en çok bilinen sosyal psikolojik modeller arasında yer almaktadir (Ajzen, 2011). İkincisi, planlanmış davranış teorisi tamamen isteğe bağlı olmayan davranışların incelenmesine izin vermektedir (bk. Ajzen, 2005). Bu durum, bu çalışma için önemlidir, "fen derslerindeki konulara bilimin doğasını engtere etmek" tamamen isteğe bağlı bir davranış değildir; bu davranış içsel (ör. Fen bilimleri öğretmen adaylarının becerileri) ve dışsal faktörlere (ör. Bilimin doğası öğretimi için kaynakların olması) bağlı olabilir. Üçüncüsü, davranış niyetinin, planlanmış davranış teorisindeki merkezi yapı olmasıdır. Benzer bir şekilde "fen derslerindeki konulara bilimin doğasını entegre etme niyeti" de bu çalışmanın merkezindedir. Dördüncüsü, planlanmış davranış teorisi, davranış niyetlerini açıklamak için davranışa yönelik tutum, davranışa yönelik sosyal baskı, öz yeterlik veya davranışı yapabilme duygusuna, ve ilgili inançlara odaklanmıştır. Öte yandan, bilimin doğası ile ilgili çalışmalar, derslerde bilimin doğasına yer vermenin planlanmış davranış teorisinde bulunan yapılarla ilgili olduğunu desteklemektedir, bunlar: bilimin doğasının önemiyle ilgili inançlar, bilimin doğasını öğretmek veya öğretmemekle ilgili sosyal baskı, bilimin doğası bilgisiyle ilgili özgüven duygusu, bilimin doğasını öğretme yeteneğiyle ilgili özgüven duygusu, öğrencilerin bilimin doğası bilgilerini değerlendirme yetenekleriyle ilgili özgüven duyguları, bağlamsal ve durumsal faktörler (ör. Bilimin doğasını öğretmek ve/veya değerlendirmek için kaynakların bulunması) (ör. Abd-El-Khalick ve ark., 1998; Aslan ve Tasar, 2013; Bell ve ark., 2000; Demirdogen ve ark., 2015; Herman, 2010; Lederman, 1999; Lederman ve ark., 2001; Schwartz ve Lederman, 2002). Yani, fen bilimleri öğretmen adaylarının fen derslerindeki konulara bilimin doğasını entegre etme niyetlerini açıklayabilen faktörleri incelemek için planlanmış davranış teorisi uygun bir teoridir sonucuna varılabilir.

Çalışmanın Önemi

Literatürde, derslerde bilimin doğasına yer vermeye etki eden faktörleri araştıran giderek artan çalışmalar bulunmaktadır (Abd-El-Khalick ve ark., 1998; Aslan ve Tasar, 2013; Bell ve ark., 2000; Demirdogen ve ark., 2015; Herman, 2010; Koehler, 2006; Lederman, 1999; Lederman ve ark., 2001; Schwartz ve Lederman, 2002; Wahbeh ve Abd-El-Khalick, 2013). Fakat, araştırmacıların bilimin doğası ile ilgili görüşlerin sınıf içi uygulamalarına yansıtılmasını etkiyen kısıtlayıcı ve kolaylaştırıcı faktörleri incelemeleri yönünde çağrı yapılmaya devam edilmektedir (bk. Abd-El-Khalick ve Lederman, 2000; Lederman ve Lederman, 2014).

Lederman' nın (1999), çalışmasının sonucunda da belirttiği gibi sınıf uygulamasını önemli ölçüde etkileyen faktör öğretmenlerin öğretim niyetleridir. Buna bağlı olarak, bilimin doğası öğretimini geliştirmek için, öğretmenlerin bilimin doğasını öğretme niyetlerini etkileyen faktörleri belirlemek önemlidir. Öğretmen adaylarının gelecekte bilimin doğası öğretilmesinde ve öğrencilerin uygun bilimin doğası görüşleriyle donatılmasındaki önemi de gözönüne alınarak, bu çalışmada fen bilimleri öğretmen adaylarının fen derslerindeki konulara bilimin doğasını entegre etme niyetlerini açıklayabilen faktörler incelenecektir. Literatürde, öğretmenlerin veya öğretmen adaylarının niyetlerinin bilim doğasının öğretilmesi kararındaki önemini destekleyen çalışmalar bulunmasına rağmen (ör. Demirdogen ve ark., 2015; Lederman, 1999; Lederman ve ark., 2001; Schwartz & Lederman, 2002), bildiğim kadarıyla, özellikle bilimin doğasını öğretme niyetini etkiyen faktörleri inceleyen araştırma bulunmamaktadır.

Bu çalışmada, fen bilgisi öğretmen adaylarının fen derslerindeki konulara bilimin doğasını entegre etme niyetlerini açıklayan faktörleri incelemek için teorik çerçeve olarak planlanmış davranış teorisi kullanılmıştır (Ajzen, 1985, 1991, 2005, 2012). Planlanmış davranış terorisi literatürü, çok çeşitli alanlarda davranışları ve davranış niyetlerini açıklamak için teorinin başarılı uygulanmasıyla ilgili yeterli kanıt sunmasına rağmen, (literatür için bk. Armitage ve Conner, 2001; Fishbein ve Ajzen 2010), planlanmış davranış teorisinin, fen eğitimi alanında uygulanmasına yönelik daha az çalışma bulunmaktadır (e.g., Kilic, 2012; Kilic, Soran, ve Graf, 2011; Lumpe, Czerniak, ve Haney, 1998; Lumpe, Haney, ve Czerniak, 1998; Ozcan, Tekkaya, ve Cakiroglu, 2012).

Bu çalışma, fen bilgisi öğretmen adaylarının fen derslerindeki konulara bilimin doğasını entegre etme niyetlerini açıklayan faktörleri planlanmış davranış teorisi kullanılarak inceleyen ilk çalışma olarak görülebilir. Bu bağlamda, bu çalışma fen derslerindeki konulara bilimin doğasını entegre etme niyetlerini açıklamak için planlanmış davranış teorisini uygulabilirliği ile ilgili ampirik kanıtlar sağlayacaktır. Ayrıca, ilgili literatüre Türkiye gibi, fen bilimleri müfredatında bilimin doğasına giderek artan bir önem veren farkli bir kültürel ortamdan katkıda bulunur.

Bu çalışmada, planlanmış davranış teorisi kullanılarak bilimin doğasını entegre etme niyeti anketi geliştirilmiştir. Çalışma sonuçlarına bakıldığında, geliştirilen anket fen bilimleri öğretmen adaylarının fen derslerindeki konulara bilimin doğasını entegre etme niyetlerini açıklayabilen faktörlerle ilgili güvenilir ve geçerli ölçüm verdiği görülmektedir. Bu bağlamda, bu çalışma ilgili literatüre fen bilimleri öğretmen adaylarının fen derslerindeki konulara bilimin doğasını entegre etme niyetlerini açıklayabilen faktörleri ölçen bir anketle katkı sağlamıştır.

Bu çalışmada, planlanmış davranış teorisi temelinde bir model öne sürülmüştür. Bu modele göre fen derslerindeki konulara bilimin doğasını entegre etme niyeti, davranışa yönelik tutum, öznel norm ve algılanan davranış kontrolü tarafından belirlenmektedir. Davranışa yönelik tutum, öznel norm ve algılanan davranış kontrolünün ise sırasıyla, davranış inanç gücü ile sonuç değerlendirme arasındaki, normatif inanç gücü ile motivasyon arasındaki ve kontrol inanç gücü ile kontrol faktörü gücü arasındaki etkileşimlere dayandıkları düşünülmektedir. Gizil değişkenler arasında etkileşimler içeren, öne sürülen model yapısal eşitlik modellemesi kullanılarak analiz edilmiştir. Daha detaylı olarak, gizil değişkenler arasında etkileşimleri analiz etmek için kullanılan yaklaşımlar arasında bulunan çift ortalama merkezleme stratejisine dayalı kısıtsız yaklaşım (unconstrained approach based on double-mean-centering strategy) (Lin, Wen, Marsh, ve Lin, 2010) kullanılmıştır. Şunu belirtmekte fayda var: sosyal ve davranış bilimlerinde değişkenler arasındaki etkileşimleri test etmek önemli bir konu iken, sınırlı sayıda çalışma gizil değişkenler arasındaki etkileşimi test etmek için yapısal eşitlik modellemesi kullanmıştır (bk. Marsh, Wen, ve Hau, 2004). Bu çalışma, literatüre gizil değişkenler arasındaki etkileşimleri test etmek için çift ortalama merkezleme stratejisine dayalı kısıtsız yaklaşımı kullanarak katkıda bulunmaktadır.

Bilimin doğası öğretilmesini etkileyen faktörlerle ilgili yapılan çalışmalar, birçok faktörü ortaya çıkarmıştır. Ancak bu çalışmaların büyük çoğunluğu nitel çalışmalardır. Nitel çalışmalar, bilimin doğasını öğretilmesini etkileyen faktörlerle ilgili önemli bilgiler sağlamasına karşın, nitel çalışmalarda araştırmaya katılan katılımcı sayısı sınırlıdır ve bu çalışmalarda faktörlerin göreli etkilerini belirlemek zordur. Konuyla ilgili büyük bir örneklemden bilgi sahibi olmak ve faktörlerin göreli etkilerini belirlemek özellikle önemlidir. Bu çalışma, nicel bir çalışma olup bilimin doğasını entegre etme niyeti anketi kullanılarak büyük bir örneklemden veri toplanmıştır. Toplanan verilerin analizi için gizil değişkenler arasında etkileşim içeren yapısal eşitlik modellemesi kullanılarak, öne sürülen modelde faktörlerin göreli etkileriyle ilgili bilgi verilmiştir.

Araştırma Soruları

Bu çalışmada aşağıdaki çalışma sorularına cevap aranmıştır:

1. Fen bilimleri öğretmen adaylarının fen derslerindeki konulara bilimin doğasını entegre etmeye yönelik tutumları, öznel normları, algılanan davranış kontrolleri, davranış inançları, normatif inançları, kontrol inançları, ve fen derslerindeki konulara bilimin doğasını entegre etme niyetleri nelerdir?
2. Planlanmış davranış teorisi, fen bilimleri öğretmen adaylarının fen derslerindeki konulara bilimin doğasını entegre etme niyetleri ne kadar iyi açıklayabilir?

2.1 Fen bilimleri öğretmen adaylarının fen derslerindeki konulara bilimin doğasını entegre etme niyeti, davranışa yönelik tutum, öznel norm, algılanan davranış kontrolü tarafından ne kadar iyi açıklanabilir?

2.2 Fen bilimleri öğretmen adaylarının davranışa yönelik tutumu, davranış inanç gücü, sonuç değerlendirme, ve davranış inanç gücü ile sonuç değerlendirme arasındaki etkileşim tarafından ne kadar iyi açıklanabilir?

2.3 Fen bilimleri öğretmen adaylarının öznel normu, normatif inanç gücü, motivasyon, ve normatif inanç gücü ile motivasyon arasındaki etkileşim tarafından ne kadar iyi açıklanabilir?

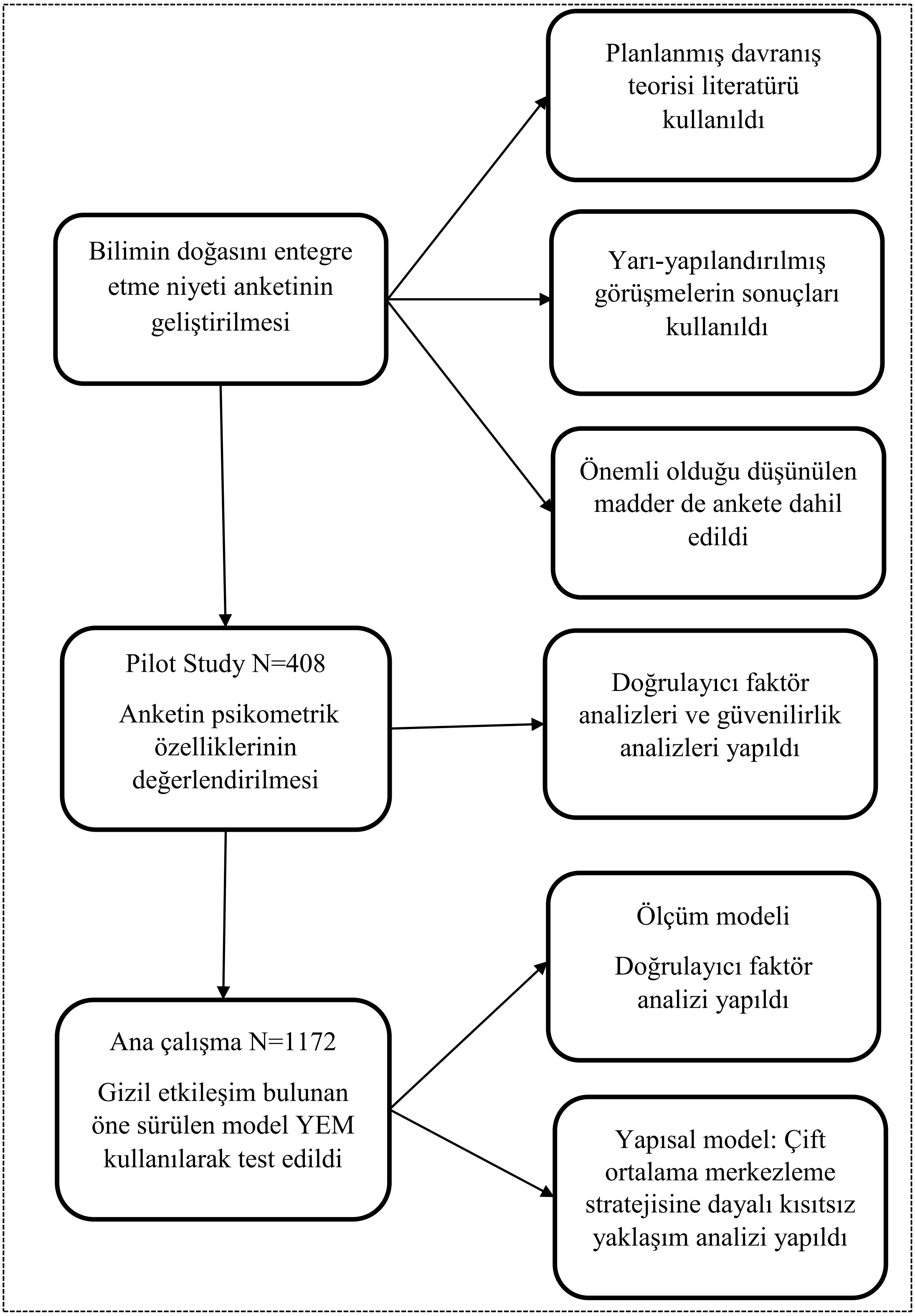
2.4 Fen bilimleri öğretmen adaylarının algılanan davranış kontrolü, kontrol inanç gücü, kontrol faktörü gücü, ve kontrol inanç gücü ile kontrol faktörü gücü arasındaki etkileşim tarafından ne kadar iyi açıklanabilir?

Yöntem

Bu araştırmanın dizaynı Şekil 2' de verilmiştir.

Evren ve Örneklem

Çalışmanın evrenini Türkiye'deki üniversitelerde öğrenim gören 4. sınıf fen bilimleri öğretmen adayları oluşturmaktadır. Çalışmanın amacı göz önüne alındığında, bilimin doğasıyla ilgili ders almış olduklarından dolayı dördüncü sınıf fen bilimleri öğretmen adayları maksatlı olarak seçilmiştir. Detaylı olarak, çalışmanın yapıldığı 2 üniversitede bilimin doğası diğer derslerin içeriklerine entegre edilirken, diğer katılımcı üniversitelerde bilimin doğası ve bilim tarihi dersi, fen bilgisi öğretmenliği programında alınması gereken dersler arasında yer almakatadır. Türkiye'de, 2013-2014 eğitim öğretim yılında, 57 devlet üniversitesinde 4. sınıf fen bilimleri öğretmen adayları öğrenim görmektedir. Çalışmaya katılacak üniversiteler belirlenirken Türkiye İstatistik Kurumu'nun (TÜİK) 2005 yılına ait İstatistiki Bölge Birimleri Sınıflandırması gözönüne alınmıştır. Bu sınıflandırmaya göre, illerin ekonomik, sosyal, kültürel, coğrafi ve nüfus büyüklüğü gözönüne alındığında Türkiye 12 bölgeden oluşmaktadır. Tablo 1'de bölgeler, bölgelerde bulunan iller, herbir bölgedeki 4. sınıf fen bilimleri öğretmen adaylarının öğrenim gördüğü üniversite sayısı, ve herbir bölgedeki evren büyüklüğü verilmiştir. Herbir bölgede bulunan dördüncü sınıf fen bilimleri öğretmen adaylarının en az %10'unun çalışmaya katılabilmesi için, 57 üniversite arasında 22 üniversite çalışmaya katılması için seçilmiştir. Seyahat, zaman ve maliyet sınırlamaları nedeniyle, seçilen 22 üniversite uygun örnekleme yöntemiyle seçilmiştir. Herbir bölgedeki çalışmaya dahil edilen üniversite sayısı ve örneklem büyüklüğü Tablo 1'de verilmiştir. Seçilen 22 üniversiteden çalışmaya toplamda 1172 dördüncü sınıf fen bilimleri öğretmen adayı katılmıştır (yaş ortalaması = 22.98, SS = 1.48 yıl). Çalışmaya katılan fen bilimleri öğretmen adaylarının cinsiyet, anne ve babanın çalışma durumu, anne ve babanın eğitim düzeyi, ailenin aylık geliri, bilimin doğasına ne kadar ilgili oldukları, bilimin doğası ile ne kadar bilgili oldukları üniversite eğitimleri sırasında bilimin doğası konusuna ne kadar değinildiği ile ilgili bilgiler Tablo 2' de sunulmuştur.



Şekil 2 Araştırma dizaynı

Tablo 1

Türkiye İstatistik Kurumu'nun (TÜİK) 2005 yılına ait İstatistiki Bölge Birimleri Sınıflandırması, 4. sınıf fen bilimleri öğretmen adayı bulunduran üniversite sayısı, çalışmaya dahil edilen üniversite sayısı, beklenen populasyon büyüklüğü ve örneklem büyüküğü

Bölge	Şehir	4. sınıf fen bilimleri öğretmen adayı bulunduran üniv. sayısı	Çalışmaya dahil edilen üniversite sayısı	Beklenen populasyon büyüklüğü	Örneklem büyüküğü
1. Kuzeydoğu Anadolu	Erzurum, Erzincan, Bayburt, Ağrı, Kars, Iğdır, Ardahan	5	2	810	121
2. Ortadoğu Anadolu	Malatya, Elazığ, Bingöl, Tunceli, Van, Muş, Bitlis, Hakkari	5	1	455	74
3. Güneydoğu Anadolu	Gaziantep, Adıyaman Kilis, Şanlıurfa, Diyarbakır, Mardin, Batman, Şırnak, Siirt	3	1	285	32
4. İstanbul	İstanbul	3	3	205	78
5. Batı Marmara	Tekirdağ, Edirne, Kırklareli, Balıkesir, Çanakkale	3	1	300	63
6. Ege	İzmir, Aydın, Denizli, Muğla Manisa, Afyon, Kütahya, Uşak	8	3	985	121

Tablo 1 (devamı)

Bölge	Şehir	4. sınıf fen bilimleri öğretmen adayı bulunduran üniv. sayısı	Çalışmaya dahil edilen üniversite sayısı	Beklenen populasyon büyüklüğü	Örneklem büyüküğü
7. Doğu Marmara	Bursa, Eskişehir, Bilecik, Kocaeli, Sakarya, Düzce, Bolu, Yalova	5	3	480	123
8. Batı Anadolu	Ankara, Konya, Karaman	4	2	495	112
9. Akdeniz	Antalya, Isparta, Burdur, Adana, Mersin, Hatay, Kahramanmaraş, Osmaniye	5	1	485	81
10. Orta Anadolu	Kırıkkale, Aksaray, Niğde, Nevşehir, Kırşehir, Kayseri, Sivas, Yozgat	6	2	745	99
11. Batı Karadeniz	Zonguldak, Karabük, Bartın, Kastamonu, Çankırı, Sinop, Samsun, Tokat, Çorum, Amasya	6	2	685	179
12. Doğu Karadeniz	Trabzon, Ordu, Giresun, Rize, Artvin, Gümüşhane	4	1	560	89
Toplam		57	22	6490	1172

Tablo 2

Katılımcıların özellikleri

	Frekans	Yüzde (%)
Cinsiyet		
Kadın	871	74.3
Erkek	299	25.5
Cevapsız	2	.2
Anne çalışma durumu		
Çalışıyor	117	10
İşsiz	961	82
Emekli	53	4.5
Cevapsız	41	3.5
Baba çalışma durumu		
Çalışıyor	810	69.1
İşsiz	4	.3
Emekli	304	25.9
Cevapsız	54	4.6
Anne eğitim düzeyi		
Okuma yazma bilmiyor	84	7.2
İlkokul mezunu değil ama okuma yazma biliyor	89	7.6
İlkokul mezunu	505	43.1
Ortaokul mezunu	190	16.2
Lise mezunu	228	19.5
Üniversite mezunu	65	5.5
Yüksek lisans/doktora mezunu	4	.3
Cevapsız	7	.6
Baba eğitim düzeyi		
Okuma yazma bilmiyor	8	.7
İlkokul mezunu değil ama okuma yazma biliyor	33	2.8
İlkokul mezunu	293	25
Ortaokul mezunu	213	18.2
Lise mezunu	366	31.2
Üniversite mezunu	238	20.3
Yüksek lisans/doktora mezunu	8	.7
Cevapsız	13	1.1

Tablo 2 (devamı)

	Frekans	Percentage (%)
Ailenin aylık gelir durumu		
750 TL’ den az	33	2.8
750 TL – 1000 TL	122	10.4
1001 TL – 1500 TL	281	24
1501 TL – 2000 TL	142	12.1
2001 TL – 2500 TL	256	21.8
2501 TL – 3000 TL	141	12
3000 TL’ den fazla	177	15.1
Cevapsız	20	1.7
Bilimin doğasına ilgi		
Hiç	10	.9
Biraz	113	9.6
Orta	696	59.4
Çok	342	29.2
Cevapsız	11	.9
Bilimin doğası ile ilgili bilgi		
Hiç	4	.3
Biraz	192	16.4
Orta	833	71.1
Çok	136	11.6
Cevapsız	7	.6
Üniversite eğitimi sırasında bilimin doğası konusuna ne kadar değinildiği		
Hiç	12	1
Biraz	163	13.9
Orta	540	46.1
Çok	449	38.3
Cevapsız	8	.7

Veri toplama araçları

Bu çalışmada veriler “Demografik Bilgi Ölçeği” ve “Bilimin Doğasını Entegre Etme Niyeti Anketi” kullanılarak toplanmıştır.

Demografik Bilgi Ölçeği

Demografik bilgi ölçeğinde fen bilimleri öğretmen adaylarının cinsiyeti, anne ve babanın çalışma durumu, anne ve babanın eğitim düzeyi, ailenin aylık geliri, bilimin doğasına ne kadar ilgili oldukları, bilimin doğası hakkında ne kadar bilgili oldukları, üniversite eğitimleri sırasında bilimin doğası konusuna ne kadar değinildiği ile ilgili sorular sorulmuştur.

Bilimin Doğasını Entegre Etme Niyeti Anketi

Fen bilimleri öğretmen adaylarının fen derslerine bilimin doğasını entegre etme niyetlerini açıklayabilen faktörleri incelemek için Bilimin Doğasını Entegre Etme Niyeti anketi kullanılmıştır.

Bilimin Doğasını Entegre Etme Niyeti Anketinin Oluşturulması

Bilimin Doğasını Entegre Etme Niyeti anketi, planlanmış davranış teorisi rehberliğinde geliştirilmiştir (PDT; Ajzen, 1985, 1991, 2005, 2012). Doğrudan ölçümlerle ilgili (davranış niyeti, davranışa yönelik tutum, öznel norm ve algılanan davranış kontrolü) ve ilgili inançlarla ilgili maddeler, sırasıyla planlanmış davranış teorisi literatürü ve fen bilimleri öğretmen adayları ile yapılan yarı-yapılandırılmış görüşmeler oluşturulmuştur. Planlanmış davranış teorisi literatürüne ve fen bilimleri öğretmen adayları ile yapılan yarı-yapılandırılmış görüşmelere ek olarak, önemli olduğu düşünülen maddeler de ankete eklenmiştir. Anketteki yapılar ve ilgili maddeler hakkında bilgiler aşağıda verilmiştir.

Doğrudan ölçümlerle ilgili maddelerin oluşturulması

Doğrudan ölçümlerle ilgili, yani davranış niyeti, davranışa yönelik tutum, öznel norm ve algılanan davranış kontrolü ile ilgili maddeler, planlanmış davranış teorisi literatürü kullanılarak oluşturulmuştur. Aynı zamanda, önemli olduğu düşünülen maddeler de ankete eklenmiştir. Maddelerin uygunluğu, bilimin doğası ve/veya planlanmış davranış teorisi konularında uzman olan üç üniversite öğretim üyesi tarafından değerlendirilmiştir.

Davranış niyeti: Fen bilimleri öğretmen adaylarının fen derslerindeki konulara bilimin doğasını entegre etme niyetlerini ölçmek için dört madde kullanılmıştır. Katılımcılar, 1’ den (1 = kesinlikle katılmıyorum) 7’ ye kadar olan (7 = kesinlikle katılıyorum) 7'li derecendirmeli ifadeleri (ör. Fen dersindeki konulara bilimin doğasını entegre etme niyetindeyim) değerlendirmişlerdir.

Davranışa yönelik tutum: Fen bilimleri öğretmen adaylarının bilimin doğasını fen derslerindeki konulara entegre etmeye yönelik tutumları, onbir 7'li derecendirmeli semantik diferansiyel ölçek kullanılarak belirlenmiştir. Katılımcılar, "Benim için Fen dersindeki konulara bilimin doğasını entegre etmek..." cümlesini, birbirine zıt karşılıklı ifadeleri (ör. Faydalıdır-faydasızdır) kullanarak değerlendirmiştir.

Öznel norm: Fen bilimleri öğretmen adaylarının öznel normlarını değerlendirmek için dört madde kullanılmıştır. Katılımcılar, 1' den (1 = kesinlikle katılmıyorum) 7' ye kadar olan (7 = kesinlikle katılıyorum) 7'li derecendirmeli ifadeleri (ör. Fen dersindeki konulara bilimin doğasını entegre etmezsem, benim için önemli olan çoğu kişi hayal kırıklığına uğrar) değerlendirmişlerdir.

Algılanan davranış kontrolü: Fen bilimleri öğretmen adaylarının algılanan davranış kontrolleri değerlendirmek için altı madde kullanılmıştır. Katılımcılar, 1' den (1 = kesinlikle katılmıyorum) 7' ye kadar olan (7 = kesinlikle katılıyorum) 7'li derecendirmeli ifadeleri (ör. İstediğim takdirde, fen dersindeki konulara bilimin doğasını entegre etmeme engel olabilecek sorunların üstesinden gelebilirim) değerlendirmişlerdir.

İnaçlarla ilgili maddelerin oluşturulması

İnaçlarla, yani davranış inançları, normatif inançlar, ve kontrol inançlarıyla ilgili maddeleri oluşturmak için, Ankara'da bulunan iki devlet üniversitesinden 19 dördüncü sınıf fen bilimleri öğretmen adayı ile yarı-yapılandırılmış görüşmeler yapılmıştır. Yarı-yapılandırılmış görüşmelerde kullanılan açık uçlu sorular, Fishbein ve Ajzen'ın (2010) çalışmasından adapte edilmiş ve genişletilmiştir.

Davranış İnançları: Davranış inaçlarıyla ilgili maddeleri oluşturmak için, yarı-yapılandırılmış görüşmelerde görüşülen kişilere şu sorular sorulmuştur: "Fen derslerindeki konulara bilimin doğasını entegre etmenin avantajlarının neler olduğunu düşünüyorsun?" ve "Fen derslerindeki konulara bilimin doğasını entegre etmenin dezavantajlarının neler olduğunu düşünüyorsun?” Görüşülen kişilerin cevapları gözönüne alınarak, davranış sonuçları belirlenmiştir. Yarı-yapılandırılmış görüşme sonuçlarının yanı sıra, önemli olduğu düşünülen davranış sonuçları da eklenmiştir. Belirlenen davranış sonuçları, bilimin doğası ve/veya planlanmış davranış teorisi konularında uzman olan üç üniversite öğretim üyesi tarafından değerlendirilmiştir ve ankette 22 davranış sonucuna [ör. “Öğrenciler, fen bilimleri (fizik, kimya, biyoloji) ile diğer disiplinler (örn; tarih, felsefe) arasındaki farkı ayırt eder”] yer verilmesine karar verilmiştir. Herbir davranış sonucuna, *davranış inanç gücü* ve *sonuç değerlendirme* boyutlarını oluşturmak için iki soru sorulmuştur. Davranış inanç gücünü ölçmek için katılımcılardan “fen derslerindeki konulara bilimin doğasını entegre etmenin”, verilen herbir davranış sonucunu oluşturma olasılığını 1’ den (1 = kesinlikle katılmıyorum) 7’ ye kadar olan (7 = kesinlikle katılıyorum) 7’li derecendirmeli ölçekte değerlendirmeleri istenmiştir. Sonuç değerlendirme boyutunu ölçmek için ise, katılımcılardan herbir davranış sonucu 1’ den (1 = hiç önemli değil) 7’ ye kadar olan (7 = çok önemli) 7’li derecendirmeli ölçekte değerlendirmeleri istenmiştir.

Normatif İnançlar: Normatif inaçlarla ilgili maddeleri oluşturmak için, yarı-yapılandırılmış görüşmelerde görüşülen kişilere şu sorular sorulmuştur: “Fen derslerindeki konulara bilimin doğasını entegre etmeni kimler bekler?”, “Fen derslerindeki konulara bilimin doğasını entegre etmeni kimler beklemez?”, “Fen derslerindeki konulara bilimin doğasını entegre etmeni hangi kurumlar bekler?” ve “Fen derslerindeki konulara bilimin doğasını entegre etmeni hangi kurumlar beklemez?” Görüşülen kişilerin cevapları gözönüne alınarak, normatif kişiler ve kurumlar (normative referents) belirlenmiştir. Belirlenen kişiler ve kurumlar, bilimin doğası ve/veya planlanmış davranış teorisi konularında uzman olan üç üniversite öğretim üyesi tarafından değerlendirilmiştir ve ankette toplam 9 kişi ve kurumun (ör. Öğretim üyeleri) bulunmasına karar verilmiştir. *Normatif inanç gücü* ve *motivasyon* boyutlarını ölçmek için herbir kişiye yada kuruma iki soru sorulmuştur. Normatif inanç gücünü ölçmek için katılımcılardan, fen derslerindeki konulara bilimin doğasını entegre etmelerini, verilen herbir kişinin yada kurumun bekleme olasılığını

1’ den (1 = kesinlikle katılmıyorum) 7’ ye kadar olan (7 = kesinlikle katılıyorum) 7’li derecendirmeli ölçekte değerlendirmeleri istenmiştir. Motivasyon boyutunu ölçmek için ise katılımcılardan herbir kişinin yada kurumun beklentilerinin önemini 1’ den (1 = hiç önemli değil) 7’ ye kadar olan (7 = çok önemli) 7’li derecendirmeli ölçekte değerlendirmeleri istenmiştir.

Kontrol İnançlar: Kontrol inaçlarla ilgili maddeleri oluşturmak için, yarı-yapılandırılmış görüşmelerde görüşülen kişilere şu sorular sorulmuştur: “Hangi faktörler yada koşullar fen derslerindeki konulara bilimin doğasını entegre etmeni kolaylaştırır?” ve “Hangi faktörler yada koşullar fen derslerindeki konulara bilimin doğasını entegre etmeni zorlaştırır?” Görüşülen kişilerin cevapları gözönüne alınarak, kontrol faktörler belirlenmiştir. Belirlenen kontrol faktörler, bilimin doğası ve/veya planlanmış davranış teorisi konularında uzman olan üç üniversite öğretim üyesi tarafından değerlendirilmiştir ve ankette toplam 14 kontrol faktörünün (ör. “Bilimin doğası ile ilgili yeterli bilgiye sahip olmam”) bulunmasına karar verilmiştir. *Kontrol inanç gücü* ve *kontrol faktörü gücü* boyutlarını ölçmek için herbir kontrol faktöre iki soru sorulmuştur. Kontrol inanç gücü ölçmek için, katılımcılardan öğretmenlik hizmeti sırasında, verilen kontrol faktörlerinin bulunması olasılığını 1’ den (1 = hiç mümkün değil) 7’ ye kadar olan (7 = kesinlikle mümkün) 7’li derecendirmeli ölçekte değerlendirmeleri istenmiştir. Kontrol faktörü gücü boyutunu ölçmek için ise, katılımcılardan herbir faktörün fen derslerindeki konulara bilimin doğasını entegre etmeyi ne ölçüde kolaylaştırdığını 1’ den (1 = kesinlikle katılmıyorum) 7’ ye kadar olan (7 = kesinlikle katılıyorum) 7’li derecendirmeli ölçekte değerlendirmeleri istenmiştir.

Pilot Çalışma

Pilot çalışma, bilimin doğasını entegre etme niyeti anketinin psikometrik özelliklerinin değerlendirilmesi amacıyla 2012-2013 yılı bahar döneminde gerçekleştirilmiştir. Geliştirilen anket, Türkiye’ nin farklı bölgelerinde bulunan 10 devlet üniversitesinde öğrenim 408 dördüncü sınıf fen bilimleri öğretmen adayına (yaş ortalaması = 22.84, *SS* = 1.64 years) uygulanmıştır. Katılımcıların, % 72.3’ sini (n = 295) kadınlar, % 26.7’ sını (n = 109) erkekler oluşturmaktadır. Katılımcıların % 1’ i (n =4) ise cinsiyetle ilgili soruya cevap vermemiştir. Bahsedilen 10 üniversite, seyahat, zaman ve maliyet sınırlamaları nedeniyle, uygun örnekleme yöntemiyle seçilmiştir. Çalışmanın amacı göz önüne alındığında, bilimin doğasıyla ilgili ders almış olduklarından dolayı dördüncü sınıf fen bilimleri öğretmen adayları maksatlı olarak seçilmiştir. Detaylı olarak, çalışmanın yapıldığı 1 üniversitede bilimin doğası diğer derslerin içeriklerine entegre edilirken, diğer katılımcı üniversitelerde bilimin doğası ve bilim tarihi dersi, fen bilgisi öğretmenliği programında alınması gereken dersler arasında yer almaktadır.

Bilimin doğasını entegre etme niyeti anketinin varsayılan faktör yapısını incelemek için doğrulayıcı faktör analizleri yapılmıştır. Çalışmadaki değişkenler normal dağılım göstermediği için modeller test edilirken sağlam çoklu benzerlik yöntemi (robust maximum likelihood estimation) kullanılmıştır. Faktör analizleri sonucunda, faktör yükleri, standartlaştırılmış artıklar ve modifikasyon indeksleri incelenerek toplamda 63 madde anketten çıkarılmıştır. Daha sonra, 10 faktörlü ve geriye kalan 52 maddeden oluşan model değerlendirilmiş ve elde edilen uyum indeksleri modelin uyumunun oldukça iyi olduğunu göstermiştir: Satorra–Bentler χ^2 (1229, N = 408) = 1659.43, $p < .05$, RMSEA = .029, CFI = .991, NNFI = .991, ve SRMR = .055.

Fakat, bu çalışmada, davranış inanç gücü ve sonuç değerlendirme boyutları için aynı davranış sonuçları, normatif inanç gücü ve motivasyon boyutları için aynı kişiler ve kurum (normative referents), ve kontrol inanç gücü ve kontrol faktörü gücü için aynı kontrol faktörleri kullanıldığı için aynı maddelere ait hatalar ilişkilendirilip model tekrar test edilmiştir. Sonuç olarak, 18 hata kovaryansı bulunan 10 faktörlü modelin uyum indeksleri şu şekildedir: Satorra–Bentler χ^2 (1211, N = 408) = 1400.93, $p < .05$, RMSEA = .020, CFI = .996, NNFI = .996, SRMR = .052. Her iki modelin de uyumları iyi olmasına rağmen, hata kovaryansların eklenmesiyle model istatistiksel olarak anlamlı bir şekilde gelişmiştir: Satorra–Bentler χ^2_{fark} (18, N = 408) = 190.22, $p < .05$.

On-sekiz hata kovaryansı içeren 10 faktör yapılı modelde, gizil değişkenler ile ilgili göstergeler arasındaki bütün faktör yükleri anlamlıdır ve standart faktör yükleri .51

ile .93 arasında değişmektedir. Öte yandan, gizil değişkenler arasındaki 45 korelasyondan 42' si istatistiksel olarak anlamlıdır ve korelasyon katsayıları .05 ile .70 arasında değişmektedir. Bunlara ek olarak, güvenirlik için cronbach alfa katsayıları hesaplanmıştır ve değerler şu şekildedir: davranış niyeti için .92, tutum için .88, öznel norm için .77, algılanan davranış kontrolü için .83, davranış inanç gücü için .91, sonuç değerlendirme için .90, normatif inanç gücü için .75, motivasyon için .84, kontrol inanç gücü için .88 ve kontrol faktörü gücü için .88.

Sonuçlar

Bu çalışmada, fen bilimleri öğretmen adaylarının fen derslerindeki konulara bilimin doğasını entegre etme niyetlerini açıklayan faktörler planlanmış davranış teorisi kullanılarak incelenmiştir. Çalışmada, planlanmış davranış teorisi temelinde bir model öne sürülmüştür. Bu modele göre fen derslerindeki konulara bilimin doğasını entegre etme niyeti, davranışa yönelik tutum, öznel norm ve algılanan davranış kontrolü tarafından belirlenmektedir. Davranışa yönelik tutum, öznel norm ve algılanan davranış kontrolünün ise sırasıyla, davranış inanç gücü ile sonuç değerlendirme arasındaki, normatif inanç gücü ile motivasyon arasındaki ve kontrol inanç gücü ile kontrol faktörü gücü arasındaki etkileşimlere dayandıkları düşünülmektedir. Gizil değişkenler arasında etkileşimler içeren öne sürülen model, yapısal eşitlik modellemesi kullanılarak analiz edilmiştir. Daha detaylı olarak, gizil değişkenler arasında etkileşimleri analiz etmek için kullanılan yaklaşımlar arasında bulunan çift ortalama merkezleme stratejisine dayalı kısıtsız yaklaşım (unconstrained approach based on double-mean-centering strategy) (Lin, Wen, Marsh, ve Lin, 2010) kullanılmıştır.

Analiz kısmı iki aşamadan oluşmaktadır: Birincisi, ölçüm modelinin doğrulayıcı faktör analizi ile değerlendirilmesi. İkincisi ise, yapısal modelin çift ortalama merkezleme stratejisine dayalı kısıtsız yaklaşım kullanılarak analiz edilmesidir.

Ölçüm modeli

Ölçüm modeli doğrulayıcı faktör analizi ile kullanılarak değerlendirilmiştir. On faktörlü modelde bulunan gizil değişkenler ve göstergeleri şu şekildedir: Davranış niyeti (3 madde), davranışa yönelik tutum (6 madde), öznel norm (3 madde), algılanan davranış kontrolü (4 madde), davranış inanç gücü (10 madde), sonuç değerlendirme (10 madde), normatif inanç gücü (4 madde), motivasyon (4 madde), kontrol inanç gücü (4 madde), ve kontrol faktörü gücü (4 madde). Çalışmada değişkenler normal dağılım göstermediği için modeller test edilirken sağlam çoklu benzerlik yöntemi (robust maximum likelihood estimation) kullanılmıştır.

Doğrulayıcı faktör analizi sonucu, modelin uyumunun oldukça iyi olduğunu göstermiştir: Satorra–Bentler $\chi 2$ (1229, N = 1172) = 3083.05, $p < .05$, RMSEA = .036, CFI = .985, NNFI = .984, ve SRMR = .042. Öte yandan, bu çalışmada, davranış inanç gücü ve sonuç değerlendirme boyutları için aynı davranış sonuçları, normatif inanç gücü ve motivasyon boyutları için aynı kişiler ve kurum (normative referents), ve kontrol inanç gücü ve kontrol faktörü gücü için aynı kontrol faktörleri kullanıldığı için aynı maddelere ait hatalar ilişkilendirilip model tekrar test edilmiştir. Sonuç olarak, 18 hata kovaryansı bulunan 10 faktörlü modelin uyum indeksleri şu şekildedir: Satorra–Bentler $\chi 2$ (1211, N = 1172) = 2264.03, $p < .05$, RMSEA = .027, CFI = .992, NNFI = .991, ve SRMR = .04. Her iki modelin de uyumları iyi olmasına rağmen, hata kovaryansların eklenmesiyle model anlamlı bir şekilde gelişmiştir: Satorra–Bentler χ^2_{fark} (18, N = 1172) = 673.15, $p < .05$.

On-sekiz hata kovaryansı içeren 10 faktörlü modelde, gizil değişkenler ile ilgili göstergeler arasındaki bütün faktör yükleri istatistiksel olarak anlamlıdır ve standart faktör yükleri .54 ile .94 arasında değişmektedir. Öte yandan, gizil değişkenler arasındaki 45 korelasyonların tamamı istatistiksel olarak anlamlıdır ve korelasyon katsayıları .10 ile .68 arasında değişmektedir.

Yapısal model

Planlanmış davranış teorisine dayanılarak öne sürülen modeli test etmek için çift ortalama merkezleme stratejisine dayalı kısıtsız yaklaşım kullanılmıştır. Öncelikle, çift ortalama merkezleme stratejisi uygulanmıştır: Davranış niyeti boyutu hariç, bütün gizil değişkenlerin göstergeleri ortalama etrafında merkezileştirilmiştir (mean-centering). Daha sonra, gizil değişken çiftlerinin (davranış inanç gücü - sonuç değerlendirme, normatif inanç gücü - motivasyon ve kontrol inanç gücü - kontrol faktörü gücü) aynı göstergeleri, gizil etkileşim değişkenlerinin (latent interaction variables) göstergelerini oluşturmak için çarpılmıştır. Örneğin, davranış inanç gücü boyutunun göstergesi, sonuç değerlendirme boyutundaki kendiyle benzer göstergeyle çarpılarak gizil etkileşim değişkenin bir göstergesini oluşturulur. Bu uygulama, diğer bütün ilgili göstergelere uygulanarak gizil etkileşim değişkenlerinin göstergeleri elde edilir. Çarpılarak oluşturulmuş gizil etkileşim değişkenlerinin göstergeleri, yeniden ortalama etrafında merkezileştirilir ve uygulama çift ortalama merkezleme olarak adlandırılır (double-mean-centering) (çift ortalama merkezleme stratejisi için bk. Lin et al., 2010).

Öte yandan, bu çalışmada değişkenler normal dağılım göstermediği için ve gizil değişkenlerin göstergeleri ile ilgili gizil etkileşim değişkenlerinin göstergeleri ortak göstergeleri paylaştıkları için, gizil değişkenlerin göstergeleri ile ilgili gizil etkileşim değişkenlerinin göstergeleri arasına hata kovaryansı eklenip model test edilmiştir. Sonuç olarak, modelde 36 hata kovaryansı belirlenen 13 faktörlü model test edilmiştir: Satorra–Bentler $\chi 2$ (2258, N = 1172) = 4446.63, $p < .05$, RMSEA = .029, CFI = .985, NNFI = .984, ve SRMR = .069.

Daha sonra, gizil değişkenlerin göstergeleri ile ilgili gizil etkileşim değişkenlerinin göstergeleri arasına konulan hata kovaryanslarının yanı sıra, davranış inanç gücü ve sonuç değerlendirme boyutları için aynı davranış sonuçları, normatif inanç gücü ve motivasyon boyutları için aynı kişiler ve kurum (normative referents), ve kontrol inanç gücü ve kontrol faktörü gücü için aynı kontrol faktörleri kullanıldığı için aynı maddelere ait hatalar model tekrar test edilmiştir. Toplamda, 54 hata kovaryansı bulunan modelin bulunan uyum indeksleri şu şekildedir: Satorra–Bentler $\chi 2$ (2240, N = 1172) = 3691.60, $p < .05$, RMSEA = .024, CFI = .99, NNFI = .99, ve SRMR = .067. Her iki modelin de uyumları iyi olmasına rağmen, aynı maddeler arasına konulan hata kovaryansların eklenmesiyle model istatistiksel olarak anlamlı bir şekilde gelişmiştir: Satorra–Bentler χ^2_{fark} (18, N = 1172) = 711.54, $p < .05$. Bunun yanı sıra, "motivasyon" dan öznel norma giden path katsayısı, aynı maddeler arasına konulan hata kovaryansların eklenmesiyle istatistiksel olarak anlamlı hale gelmiştir. Öte yandan, 54 hata kovaryansı bulunan modelde, gizil değişkenler ile ilgili göstergeler arasındaki bütün faktör yükleri anlamlıdır ve standart faktör yükleri .32 ile .94 arasında değişmektedir.

Çalışmanın bulgularına göre fen bilimleri öğretmen adaylarının fen derslerindeki konulara bilimin doğasını entegre etme niyetleri, davranışa yönelik tutum (β = .24, $p < .05$) ve algılanan davranış kontrolü (β = .25, $p < .05$) ile istatistiksel olarak anlamlı bir şekilde ilişkili olmasına rağmen öznel norm (β = .04, p >.05) ile değildir. Yani, fen derslerindeki konulara bilimin doğasını entegre etmeyle ilgili daha olumlu tutuma ve daha güçlü algılanan davranış kontrolüne sahip olan katılımcıların bilimin doğasını entegre etmeyle ilgili daha güçlü niyetleri olmuştur. Öte yandan, davranış inanç gücü (γ = .41, $p < .05$) ve sonuç değerlendirme (γ = .28, $p < .05$) tutuma istatistiksel olarak anlamlı bir şekilde bağlıyken, davranış inanç gücü ile sonuç değerlendirme arasındaki etkileşim tutuma bağlı değildir (γ = .09, p >.05). Yani, katılımcıların fen derslerindeki konulara bilimin doğasını entegre etme davranışına yönelik tutumları, davranışın sonuçlarıyla ilgili inançların gücü ve davranış sonuçlarının değerlendirilmesiyle belirlenmiştir. Ek olarak, normatif inanç gücü (γ = .36, $p < .05$), motivasyon (γ = .12, $p < .05$) ve normatif inanç gücü ile motivasyon arasındaki etkileşimle (γ = .08, $p < .05$) istatistiksel olarak anlamlı bir şekilde ilgilidir. Yani, normatif kişilerin veya kurumun fen derslerindeki konulara bilimin doğasını entegre etme konusunda beklentileriyle ilgili güçlü inançlara sahip olan ve bahsedilen kişilerin veya kurumun beklentilerinin önemli olduğunu düşünen katılımcılar, fen derslerindeki konulara bilimin doğasını entegre etme konusunda daha güçlü sosyal baskı algılamışlardır. Bunun yanı sıra, normatif kişilerin veya kurumun fen derslerindeki konulara bilimin doğasını entegre etme konusunda beklentileriyle ilgili inançların algılanan sosyal baskı üstündeki olumlu etkisi, kişilerin veya kurumun beklentilerinin önemi ile ilgili daha güçlü inançlara sahip olan katılımcılarda daha belirgindir. Aynı şekilde, kişilerin veya kurumun beklentilerinin önemi ile ilgili daha güçlü inançların algılanan sosyal baskı üstündeki olumlu etkisi, normatif kişilerin veya kurumun fen derslerindeki konulara bilimin doğasını entegre etme konusunda beklentileriyle ilgili daha güçlü inançlara sahip olan katılımcılarda daha belirgindir. Ayrıca, algılanan davranış kontrolü yalnızca kontrol inanç gücü ($\gamma = .49$, $p < .05$) ile istatistiksel olarak anlamlı bir şekilde ilişkili iken kontrol faktörü gücü ($\gamma = .00$, $p > .05$) ve kontrol inanç gücü ile kontrol faktörü gücü arasındaki etkileşimle ($\gamma = .05$, $p > .05$) ilişkili değildir. Yani, katılımcıların fen derslerindeki konulara bilimin doğasını entegre etme davranışı üzerindeki algıladıkları kontrol, öğretmen olduklarında verilen kontrol faktörlerin olacağı ile ilgili inançlarıyla anlamlı bir şekilde ilişkili çıkmıştır. Genel olarak, planlanmış davranış teorisi gözönüne alınarak ileri sürülmüş model, fen derslerindeki konulara bilimin doğasını entegre etme niyetindeki varyansın % 16.9'unu açıklamıştır. Bu bulgular fen bilimleri öğretmen adaylarının fen derslerindeki konulara bilimin doğasını entegre etme niyetlerini açıklayan diğer potansiyel faktörlerin varlığını öne sürmüştür, örneğin kişisel norm, öz-kimlik, ve bilimin doğası bilgisi.

APPENDIX G

TEZ FOTOKOPİSİ İZİN FORMU

ENSTİTÜ

Fen Bilimleri Enstitüsü ☐

Sosyal Bilimler Enstitüsü ■

Uygulamalı Matematik Enstitüsü ☐

Enformatik Enstitüsü ☐

Deniz Bilimleri Enstitüsü ☐

YAZARIN

Soyadı : Akyol
Adı : Gülsüm
Bölümü : İlköğretim

TEZİN ADI (İngilizce) : Antecedents of nature of science teaching intention: Testing the applicability of the theory of planned behavior

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: