STUDENTS NATURE OF SCIENCE VIEWS REGARDING GENDER, GRADE LEVEL AND LEARNING ENVIRONMENT PERCEPTIONS

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I certify that this thesis satisfies all the requirements as a thesis for the degree of Master of Science.

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ABSTRACT

STUDENTS NATURE OF SCIENCE VIEWS REGARDING GENDER, GRADE LEVEL AND LEARNING ENVIRONMENT PERCEPTIONS

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The purpose of this study was to assess middle school students' Nature of Science (NOS) views in relation to gender, grade level, and learning environment perceptions in science classes. The sample included 608 middle school students (289 boys and 319 girls) from Grade 7 (n = 286) and Grade at (n =322) attending public schools located in Yenimahalle and Sincan districts in Ankara. The Background Characteristics Survey, The Students' Views of Nature of Science (SVNOS) and "What is Happening in this Class (WIHIC)" instruments were administered to the students. A two-way multivariate analysis of variance (MANOVA) was performed to examine gender and grade level differences in students' views on different tenets of NOS. Findings revealed that there were no significant gender and grade level differences in students' nature of science views. Additionally, a canonical correlation analysis was conducted between a set of learning environment perception variables as measured by the WIHIC and a set of NOS tenets as measured by the SVNOS. Findings showed that all learning environment perception variables (i.e., cohesiveness, teacher support, investigation, involvement, task orientation, cooperation and equity) were positively related to the students' views on all NOS tenets except for changing/tentative nature of science.

Keywords: Nature of science, classroom learning environment, middle school students, student gender, grade-level

ÖZ

ÖĞRENCİLERİN CİNSİYET, SINIF SEVİYESİ VE SINIF ORTAMI ALGISINA GÖRE BİLİMİN DOĞASINA YÖNELİK GÖRÜŞLERİ

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Bu çalışmanın amacı, fen bilimleri dersinde ortaokul öğrencilerinin, bilimin doğası hakkındaki görüşlerini cinsiyet, sınıf düzeyi ve sınıf ortamı algılarıyla ilişkili olarak incelemektir. Çalışmanın örneklemini Ankara'nın Yenimahalle ve Sincan ilçelerinde öğrenim gören 608 (289 erkek, 319 kız) 7. ve 8. Sınıf ortaokul öğrencisi oluşturmaktadır. Öğrencilere kişisel bilgiler anketi, Bilimin Doğasına Yönelik Görüş Ölçeği ve "Bu Sınıfta Neler Oluyor? ölçeği uygulanmıştır. Öğrencilerin cinsiyet ve sınıf düzeyinin bilimin doğasına yönelik farklı alt boyutlardaki etkisi iki yönlü MANOVA analizi kullanılarak araştırılmıştır. Sonuçlar, öğrencilerin cinsiyet ve sınıf düzeylerinin öğrencilerin bilimin doğasına yönelik görüşlerinde anlamlı bir etkisinin olmadığını ortaya koymuştur. Ayrıca, öğrenme ortamı algısına yönelik değişkenler ve bilimin doğasına yönelik görüşlerle ilgili değişkenler arasındaki ilişki kanonik korelasyon analizi ile irdelenmiştir. Sonuçlar; öğrencilerin öğrenme ortamına yönelik algılarına yönelik tüm değişkenlerin (öğrenci yaklaşımı, öğretmen desteği, katılım, araştırma/ inceleme, ödevler, işbirliği ve eşitlik) bilimsel bilginin değişebilirliği hariç, bilimin doğasına yönelik görüşleriyle pozitif ilişkili olduğunu göstermiştir.

Anahtar Kelimeler: Bilimin doğası, öğrenme ortamı, ortaokul öğrencileri, cinsiyet, sınıf düzeyi

To my beloved family who make life meaningful.

Words fail to describe their significance in my life

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LIST OF SYMBOLS/ ABBREVIATIONS

AAAS: American Association for the Advancement of Science

CCQ: Classroom Climate Questionnaire

CES: Classroom Environment Scale

CFA: Confirmatory Factor Analysis

CFI: Comperative Fit Index

CLES: Constructivist Learning Environment Survey

COST: Conceptions of Scientific Theories Test

E-NOS: Nature of Science Questionnaire for Elementary Level

GFI: Goodness of Fit Index

ICEQ: Individualized Classroom Environment Questionnaire

K-12: Kindergarten through Grade 12

LEI: Learning Environment Inventory

LISREL: Linear Structural Relationships

M: mean score

MANOVA: Multivariate Analysis of Variance

MoNE: Ministry of National Education

MCI: My Class Inventory

METU: Middle East Technical University

NFI: Normed Fit Index

NNFI: Non-normed Fit Index

NOS: Nature of science

NOSI: Nature of science instruments

NOSS: Nature of Science Scale

NOST: Nature of Science Test

NRC: National Research Council

NSKS: Nature of Scientific Knowledge Scale

NSTA: National Science Teachers Association

PNSS: Pupils' Nature of Science Scale

QTI: Questionnaire on Teacher Interaction

RMSEA: Root Mean Squared Error of Approximation

SD: Standart Deviation

SEBS: Scientific Epistemological Beliefs Survey

SEVs: Scientific Epistemological Views

SINOS: Students' Ideas about Nature of Science

SLEI: Science Laboratory Environment Inventory

SPI: Science Process Inventory

SUSSI: Student Understanding of Science and Scientific Inquiry

SVNOS: Students' Views of Nature of Science

TOUS: Test on Understanding Science

TROFLEI: Technology-Rich Outcomes Focused Learning Environment Inventory

VNOS: Views of Nature of Science

VNOS-C: The Views of Nature of Science Questionnaire Form C

VNOS-E: Views of Nature of Science Elementary School Version

VOSE: Views on Science and Education Questionnaire

VOST: Views of Science Test

VOSTS: Views on Science-Technology-Society

WIHIC: WhatIs Happening In this Class

WISP: Wisconsin Inventory of Science Processes

α: Significans Level

n: Number of sample

CHAPTER 1

INTRODUCTION

Positivists argue that there is a single objective reality independent of values, attitudes, or perspectives. What is expected from scientists is to access this external reality in an objective manner (Sim & Wright, 2000). Thus, according to this view, the natural world and the relationships in it already exist and the task of scientists is just to 'discover' it. Accordingly, science is an objective activity not affected by cultural, political, social or philosophical influences and biases (Allen & Baker, 2017) in the context of justification (Okasha, 2002). It is cumulative and progresses toward the truth (Allen & Baker, 2017; Okasha, 2002). Holding an empiricist view of science, positivists also maintain that experience provides the only valid basis for knowledge. Accordingly, scientific research requires the data collected through senses. The concepts, propositions or any statements which could not be observed or otherwise experienced are meaningless. Their research methodology is mainly inductive which leads to the development of general propositions or laws from actual observations. Positivists also claim that there is one scientific method which can be utilized to study both the physical world and the social world (Sim & Wright, 2000).

According to some philosophers and historians, however, the positivist view of science is naive, and does not provide an actual representation of how science works (Allen & Baker, 2017). For example, Popper (2002) argued that scientists use their imaginings and creativeness to develop remarkable theories with important and wide-ranging implications. Popper further claimed that true scientists expose theories to the risk of falsification rather than trying to obtain supporting evidences (i.e. inductive proof). Thus, the community of scientists is aware of uncertainty of their knowledge (O'Hear, 1989). Additionally, Kuhn (1996) maintained that the data obtained by scientists was theory-laden. According to him, obtaining theory-neutral data free from scientists' background beliefs or theoretical commitments was not possible. Kuhn provided instances from history of science, also noted that science was not always cumulative, that is to say progressing in a linear fashion. Sometimes, old paradigms (i.e. assumptions, ideas, and methodologies prevalent in any field of science) can be replaced with new ones leading to new conceptualizations. Kuhn also pointed out the role of social context in the practice of science. He viewed science as an intrinsically social activity (Kuhn, 1996; Okasha, 2002). Considering all these views, post-positivist researchers' propositions appear to provide a more realistic picture of how scientific ideas change and how science works (Allen & Baker, 2017).

Contemporary science education researchers advocating the nature of science (NOS) as a crucial aspect of scientific literacy identified some key tenets of NOS (Lederman, Abd-El-Khalick, Bell, & Schwartz, 2002; McComas, 2014) benefiting from these post-positivist approaches. Thus, a consensus has been reached to some extent by science educators (Deng, Chen, Tsai, & Chai, 2011). For instance, according to Lederman et al. (2002), there are seven key tenets of NOS: "(a) the empirical nature of scientific knowledge, (b) scientific theories and laws, (c) the creative and imaginative nature of scientific knowledge, (d) the theory-laden nature of scientific knowledge, (e) the social and cultural embeddedness of scientific knowledge, (f) myth of scientific method, and (g) tentative nature of scientific knowledge". Among these tenets, the *"empirical nature of scientific knowledge"* involves that scientific knowledge is at least to some extent derived from the observation of natural world (Lederman, 1999). Nevertheless, scientists do not have access to natural phenomena directly every time. Instead they make some inferences. Accordingly, students with sophisticated views on "empirical nature of science" are expected to discriminate observation from inference. Such discrimination enables them to better comprehend theoretical or inferential entities (Lederman et al., 2002). In addition, the second tenet of the NOS involves that students distinguish between *"scientific theories and laws"* and understand that they are dissimilar types of knowledge: *Laws* are portrayals about the relationships among observable phenomena, whereas *theories* provide inferred explanations for large sets of apparently distinct observations in different fields of investigation (Lederman et al., 2002). According to the third tenet of NOS, *"creativity and imagination"* are also important to generation of scientific knowledge. Indeed, science requires development of explanations and theoretical entities, both of which involve scientists' creativity (Lederman et al., 2002). For example, Kepler went far beyond the existing data and theorized underlying map of the heavens boldly using only inadequate or limited data. Thus, his work did not progress by simple gathering and organization of presuppositionless data (O'Hear, 1989). While this exemplified third tenet is about the role of creativeness and imagination in the development of scientific knowledge, the fourth tenet, emphasizes *"the theory-laden nature of scientific knowledge".* According to this tenet, scientists' prior experiences, knowledge, theoretical commitments affects their work. Thus, their observations and how they interpret these observations may be shaped by their background beliefs and experiences (Lederman et al., 2002; Okasha, 2002). For example, for an Aristotelian scientist, a falling stone can be interpreted as an example for a natural motion, however for a scientist with a commitment to Newton's physics; this fall can be interpreted in terms of gravitation. Additionally, the fifth tenet emphasizes *"the social and cultural embeddedness of scientific knowledge"*. In fact, scientific knowledge is generated in tin a larger cultural context and scientists grow up within this culture. So, science is not independent of place and time which are culturally situated and affected. In general, according to this tenet, science influences and influenced by various factors including social, political, and economical factors (Allen & Baker, 2017; Lederman et al., 2002). The sixth tenet of NOS, on the other hand, is about the *"myth of scientific method".* There is a commonly held misconception that there is just one scientific method followed by all scientists resulting in the development of infallible knowledge. However, there is no single method such as inductive method to be followed step by step by scientist (Lederman et al., 2002). For instance, Galileo did not induce laws of pendulum motion by making systematic observations of several pendulums and then making generalizations (Matthews, 2015). Rather, he used the language of mathematics. Actually, according to him, mathematics could be utilized to describe the behavior of objects in the material world. He also gave emphasis on the experimental testing of the hypotheses (Okasha, 2002). Finally, the last tenet of NOS suggested by Lederman et al., (2002), involves *"tentative nature of scientific knowledge".* As it has been mentioned by Lederman et al., (2002), even though the scientific knowledge, including theories and laws, is reliable and durable, it can change as new evidences are obtained. For example, Newtonian physics was considered as basically correct by scientist for a long time. However, in the initial years of the 20th century, two revolutionary developments namely, relativity theory and quantum mechanics demonstrated that Newtonian mechanics do not apply to all objects (Okasha, 2002).

McComas (2014) also suggested similar tenets of NOS comprising tentativeness, subjectivity, creativity, historical, cultural, and social influences. The tenets identified by the science education researchers are considered to be the most beneficial and relevant dimensions of NOS for K-12 science teaching and learning (Deng et al., 2011; Lin, Goh, Chai, & Tsai, 2013). Accordingly, researchers attempted to develop instruments to assess students' views on these core tenets of NOS: These instruments include "Nature of Scientific Knowledge Scale" (NSKS) (Rubba & Anderson, 1978), "Views of Nature of Science" (VNOS) (Lederman et al., 2002), "The Pupil's Nature of Science Scale" (PNSS) (Huang, Tsai, & Chang, 2005), "Student Understanding of Science and Scientific Inquiry" (SUSSI) (Liang et al., 2008), "Views on Science and Education Questionnaire" (VOSE) (Chen, 2006), "Scientific Epistemological Beliefs Survey" (SEBS) (Conley, Pintrich, Vekiri, & Harrison, 2004), "Scientific Epistemological Views" (SEVs) (Tsai & Liu, 2005), and "Students' Views of Nature of Science" (SVNOS) (Lin et al., 2013). Some of these instruments consist of open-ended questions (e.g. VNOS), so they can be used only with small samples. In the literature, they are commonly used in experimental designs and they are not appropriate for inferential statistical analyses (Martin-Dunlop, 2013). Thus, in order to obtain students' views on NOS on a larger scale and conduct inferential statistical analyses to be able to make some generalizations, Likert-type instruments are more appropriate. Accordingly, in the current study, middle school students' views on NOS were aimed to be determined using a Likert-type instrument. Among the available instruments, Students' Views of Nature of

Science (SVNOS) (Lin et al., 2013) was chosen because the instrument was developed using the sub-scales or items from existing instruments targeting the main tenets of NOS including cultural impact, theory-laden nature, creative nature, non-objective nature, tentative nature, social negotiation, and justification. Reliability and confirmatory factor analyses results indicated it was a valid and reliable instrument to assess middle school students' NOS views on these key tenets.

In the literature, using available instruments, some researchers examined the difference in students' views of nature of science according to grade level and gender (Solomon et al., 1996; Hofer, 2001; Kang et al., 2005; Chai et al. 2010). However, the results were inconclusive: according to some research findings, there were significant gender and grade level differences concerning certain NOS dimensons (Huang, Tsai, & Chang, 2005; Lin et al., 2013) whereas other studies revealed that there was no gender difference (Hacıeminoglu, et al., 2014) or grade level differences may not be consistent across grade levels (Özdem, et al., 2010). In addition, relevant literature suggests that students' learning experiences including specific instructional activities and behaviors implemented in a classroom has great influence on students' NOS views (Hofer, 2001; Lederman, 1992) Thus, it appears that examining students' NOS views in relation to learning environment perceptions may have important educational implications with an ultimate aim of developing adequate NOS views. Accordingly, this study aimed to examine Turkish middle school students' views of NOS as measured by the SVNOS according to gender, grade level, and learning environment perceptions proposing some hypotheses considering available literature and context of the study. The literature on students' NOS views measured with respect to gender, grade level, and learning environment perceptions were presented in the following section.

1.1.Students' NOS views regarding Gender, Grade Level, and Learning Environment Perceptions

Relevant research demonstrated that students' learning experiences play an important role in the development of NOS views (Hofer, 2001; Solomon, Scott, &

Duveen, 1996). According to Lederman and Druger (1985), students are likely to develop sophisticated views on NOS in the classroom environments where they engage in the learning process actively with emphasis on inquiry oriented questions and problems. Teacher support also emerged as an important factor contributing to the development of sophisticated views. Supporting this finding, Martin-Dunlop (2013) reported that there were significant, positive bivariate correlations between students' understanding of NOS and their perceptions of classroom learning environments regarding instructor support, student cohesiveness, investigation, cooperation, open-endedness, and presence of adequate material. Supporting these quantitative findings, qualitative results also revealed that laboratory activities requiring an open-ended divergent approach during experimentation and cooperative relations among students were related to better understanding of NOS. In line with these findings, the author suggested that in order to help students develop sophisticated views on science, science teachers should be supportive acting as a facilitator and encourage cooperation among students. The teachers should provide their students with inquiry-oriented open-ended activities. Similarly, Solomon et al., (1996), suggested that encouraging students to design experiments, collect and analyze data can promote students' NOS views. Accordingly, in the present study, using self-report instruments, the relation between students' learning environment perceptions and their NOS views was examined. Students' learning environment perceptions were explored in the seven dimensions: "student cohesiveness, teacher support, involvement, investigation, task orientation, cooperation, and equity" using "What is Happening in This Class Questionnaire" (WIHIC) (Aldridge & Fraser, 2000). *Student cohesiveness* involves the interactions among the students concerning how responsive and helpful they are to each other. *Teacher support* concerns the extent to which teachers are cooperative and supportive to their students. *Involvement* focuses on students' interest, enjoyment, and participation in classroom activities. *Investigation* involves the extent to which students use the skills and inquiry during an investigation and problem solving. *Task orientation* focuses on whether students pay attention to planned activities and tasks, as well as remain on tasks and being aware of what was expected from them. *Cooperation* concerns to what extent students cooperate with each other while doing classroom projects or assignments. And *equity* involves the extent to which teachers provide students with equal opportunities to contribute to classroom activities or to receive encouragement or praise (Waldrip, Fisher, & Dorman, 2009).

Waldrip et al., (2009), suggested that the WIHIC was useful for predicting various student outcomes. Actually, it is a widely used instrument to measure learning environment perceptions of middle school students (Dorman, 2003; den Brok et al., 2006b; Wolf & Fraser, 2008). It was validated to be used in many countries such as Australia (Aldridge et al., 1999), Korea (Kim et al., 2000), Taiwan (Aldridge et al., 1999), Singapore (Chionh & Fraser, 1998), and Canada (Raanflaub & Fraser, 2002). In addition, the instrument is easy to use: It does not take much time to administer and scoring is easy Accordingly, in the present study, the WIHIC was utilized to examine students' learning environment perceptions. Based on the aforementioned literature, in the present study, it was hypothesized that all the dimension of the learning environment perceptions as measured by the WIHIC are positively related to students' views on all NOS dimensions.

In the current study, grade level differences in students' NOS views were also examined. Related literature suggested that age related trend in students' NOS views may not always be positive depending on the learning environment that they experience (Chai, Deng, & Tsai, 2012). Thus, if students experienced learning environments emphasizing rote memorization and activities and problems with single solutions which did not require thinking in multiple directions, students' NOS views could remain naive. Thus, grade level differences, if found, could give some clues about students' learning experiences. Concerning gender difference, researchers in science education have suggested that more emphasis should be given to the exploration of gender differences in students' NOS views (Wen, Kuo, Chang, & Tsai, 2010). When the relevant literature was reviewed, it was found that research on both gender and grade level differences were inconclusive (Deng et al., 2011). For example, the study conducted by Huang, Tsai, and Chang (2005) demonstrated that males hold more sophisticated views on tentative nature and role of social negation tenets of NOS. In addition, fifth grade students were found to have more sophisticated views related to changing nature of scientific knowledge compared to sixth grade students. In another study, Hacıeminoglu, Yılmaz-Tüzün, and Ertepınar (2014) found that there was no gender difference with respect to NOS views. However, significant differences were found among sixth, seventh, and eight grade students concerning observation and inference tenet. Regarding the tentative nature of NOS, seventh grade students' responses were found to be significantly different from that of sixth and eighth grade students. No difference was found among different grade levels with respect to imagination and creativity. Thus, based on the available literature it appears that grade level differences are not consistent across different tenet of NOS. In addition, the research examining gender difference was found to produce mixed results. However, concerning gender difference, in current study, it was hypothesized that students' NOS views do not differ across gender because, as pointed out by Pintrich (2002) when (scientific) epistemological beliefs are investigated in terms of specific dimensions rather than considering it as general, holistic ways of thinking, gender differences may not appear. Supporting this idea Conley et al. (2004) found no gender difference in their study in which they examined students' (scientific) epistemological beliefs with respect to some dimensions. However considering the fact that there are also studies which revealed no gender difference in terms of NOS dimensions (e.g. Hacıeminoglu, Yılmaz-Tüzün, and Ertepınar, 2014), more research is needed in order to clarify the students' NOS views in relation to gender comparing and contrasting the available studies. Concerning grade level difference, in the current study, it was also hypothesized that there is no grade level difference with respect to students' NOS views considering the available literature and context of the study. As indicated before, students' learning experiences are important in the development of NOS views. Accordingly, there may not be always a positive trend in students' NOS views across grade levels depending on the learning environment that they experience (Chai, Deng, & Tsai, 2012). The related studies revealed that teachers tend to hold inadequate NOS views (Akerson et al., 2000; Akerson & Hanuscin, 2007). In a study in Turkey, for instance, Köksal and Çakiroğlu (2010) stated that science teachers had inadequate understanding on some NOS tenets including relationship between theory and law, but they had more sophisticated understanding on creativity and imagination aspect. According to related literature, however, even teachers with sophisticated NOS views may not translate their views into classroom practices effectively (e.g. Lederman, 1999; Akerson & Abd-El-Khalick, 2003). Moreover, available national literature suggest that science teachers tend to use lecture method to convey instruction rather than creating learning environments which involve active student participation in Turkey (Dindar & Yangın 2007; Gökçe, 2006). Because, open-ended activities requiring active students participation are likely to enhance students' NOS views (Martin-Dunlop, 2013), in the present study, considering the context, it is expected that grade level dos not make a difference in students' NOS views. It is also expected that their NOS views are not highly sophisticated.

Conducting studies on students' NOS views is important because studies in the relevant literature demonstrated that students' views on NOS play an important role in their knowledge acquisition, their approaches to learning science and their reasoning and argumentation (Deng et al., 2011; Lederman, 1992; Sadler, Chambers, & Zeidler, 2004). More specifically, according to results, students with sophisticated views on NOS were likely to use learning strategies leading to meaningful learning and have favorable attitude toward science (Tsai & Liu, 2005). Thus, in order to improve students' science learning and performance as well as science education in general, there is a need for determining students' NOS views and how these views are related to their demographics and learning environment perceptions. Accordingly, current study aims at examining middle school students' NOS views in relation to their gender, grade level, and learning environment perceptions. More specifically, this study addresses following research questions:

1) Are there gender and grade level differences with respect to middle school students' NOS views?

2) Are there relationships between middle school students' classroom environment perceptions and their NOS views?

1.2.Significance of the Study

In the literature there are many studies which examine the effective way of teaching NOS (e.g., Akerson & Hanuscin, 2007; Koksal & Çakıroğlu, 2010). Similarly, there are some examples of designing lesson to facilitate understating of intended aspect of NOS. (e.g., Abd-El-Khalick & Lederman, 2000; Khishfe & Abl-El Khalick, 2002; McComas, 2003; Clough, 2006; Akerson & Hanuscin, 2007; Izci, 2017). Most of the studies focus on students' and teachers' misconceptions (e.g., Lederman, 2007; Bell et al., 2011; Concannon et al., 2013) and various interventions to enhance understanding of NOS (e.g., Abd-El-Khalick & Akerson, 2004; Bilican, 2014) and also most of the studies assess students' and teachers' understanding of NOS (e. g., Lederman et al., 2002; Akerson & Abd-El-Khalick, 2005; Kılıç et al., 2005; Çelikdemir, 2006; Bora, et al., 2006; Dogan & Abd-El-Khalick, 2008; Ozgelen & Yılmaz-Tüzün, 2010; Schwartz et al., 2010; Donelly & Argyle, 2011). However, a few studies explore students' understanding nature of science with association of science learning environment (e.g., Walberg & Anderson, 1968; Martin-Dunlop, 2013; Sontay & Karamustafaoglu, 2018). Currently, there is a lack of research that particularly analyzes interrelation of middle school students' understanding of NOS and their learning environment perceptions using a cross-sectional and correlational research design in Turkey. However, as pointed out by Ormerod and Duckworth (1975) childhood years (8 to 14) are critically important years for developing behaviors about science. Thus, it is important to examine the NOS views of students in this age period in relation to various variables including classroom environment perceptions with an ultimate aim of improving their NOS views. Accordingly, this study has potential to provide new perspectives for science teachers and nature of science researchers to help students develop adequate NOS views. In addition, as stated in the previous section, according to the relevant literature research on gender and grade level differences is inconclusive. Discussion of the findings considering the context of the study, can lead to a better understanding of the mixed-results in the available literature. Furthermore, results can lead to further research to examine whether there are gender biases in science classes or whether there are changes in classroom practices across grade levels differentially affecting students’ NOS views.

CHAPTER 2

LITERATURE REVIEW

In this chapter, a literature review relevant to the current study was presented. More specifically, firstly, several definitions of nature of science in science education literature was provided and how this study defined the conceptualization nature of science. Secondly, the research related to the role of grade level and gender in students' NOS views was reviewed. Finally, the literature concerning the students' NOS views in relation to classroom environment was presented.

2.1.Nature of Science

There are many debates going among science sociologists, science historians and science philosophers about the specific and accurate definition of NOS. Lederman (1992) stated that the phrase "nature of science" typically refers to "the epistemology of science, science as a way of knowing, or the values and beliefs inherent to the development of scientific knowledge" (p.331). Nevertheless, there is no complete definition of this term. More broadly, Clough (2006) suggested that the phrase "nature of science" (NOS) refers to what science is, how scientists use scientific knowledge, how science works, what is the impact of society on scientific knowledge and also what is the impact of scientific knowledge on society. Moreover, Walls (2012) stated that NOS includes how scientific knowledge is constructed, who generates scientific knowledge, who uses science, and where scientific knowledge comes from. Similarly, Osborne et al. (2003) noticed that NOS concern how scientific community works, how scientists operate scientific enterprise. According to McComas (2008), NOS associate with history, sociology, psychology and philosophy of science. Thus, it appears that historians, philosophers and sociologists of science did not have an agreement on a specific definition of NOS leading to existence of various meaning of NOS. While there is no universal conceptualization of the nature of science (Kang, Scharmann, & Noh, 2005), as pointed out by Lederman (1992) the development of an adequate understanding of nature of science is an ultimate science education goal. Indeed, a sophisticated NOS understanding is suggested to be essential for students to enhance their general understanding of science (National Research Council, 1996). Many science educators accepted that understanding nature of science is the important part of science education. For example, Lederman (2007) said that first objective of science educations help students to improve conception of nature of science (NOS). Developing adequate understanding of NOS is accepted as a desired outcome of science education by most scientists, science educators, and science education organizations (Abd-El-Khalick, Bell, & Lederman, 1998). Thus, critical part of science instruction is the development of students' NOS understanding.

According to NSTA (1982), developing an adequate understanding of NOS requires not only knowing the role of theory in that scientific information but also analyzing the investigation of scientific information. Furthermore, Science for All Americans (AAAS, 1990) characterized three components for an acceptable understanding of NOS. According to the first component, science cannot provide answers to all questions. The second component stresses that scientific inquiry depends not only on logic and empirical evidence but also contains imagination. The third component, on the other hand, concerns political and social aspects of science.

Considering all the debates about different conceptions about nature of science, science education researchers attempted to identify some core tenets of NOS that are deemed to be the most useful and appropriate dimensions for classroom practices (e.g. Deng et al., 2011; McComas, 2005; 2008). For example, in early attempts, The Center of Unified Science Education at Ohio State University (1974) defined NOS aspects as "tentative, public, replicable, probabilistic, humanistic, unique, holistic and empirical". Also, Rubba and Anderson (1978) reported 6 aspects of NOS such as "amoral, creative, developmental, parsimonious, testable and unified". Moreover The National Science Education Standards (NRC, 1996) characterized NOS aspects like "historical, tentative, empirical, rational and confirmative". Abd-El-Khalick, Lederman and Bell (1998) characterized 7 tenets of NOS which "tentative, theory-laden, empirical, partly product of human inference, imagination and creativity, and socially culturally embedded, the relationship between theory and laws and distinction between observation and inference". Some documents (AAAS, 1993; NRC, 1996; 2012) also support these tenets. The general aspects that create an agreement among historians, philosophers, and science educators and that have been emphasized in many reforms and empirical studies were proposed by Lederman et al. (2002). According to this consensus views on nature of science; "scientific knowledge is tentative, empirically based, subjective (theory-laden), and involves human imagination and creativity". This view also emphasizes that science is affected by society and culture (socially and culturally embedded), there is distinction between scientific laws and theories, observations are different from inferences and there is a lack of universal method for doing science. Furthermore, Abd-El-Khalick et al., (2008), described ten tenets of NOS which include "empirical, inferential, creative, theory-driven, tentative aspects of science, the myth of the scientific method, scientific theories, scientific laws, social dimension of science and social and cultural embeddedness of science". McComas (2014) also suggested similar tenets of NOS including "tentativeness, subjectivity, creativity, historical, cultural and social influences". These tenets identified by the science education researchers are considered to be the most useful and relevant dimensions of NOS for K-12 science teaching and learning (Deng et al., 2011; Lin, Goh, Chai, & Tsai, 2013). Thus, considering aforementioned literature, although there is not specific agreed upon aspects of NOS, current study focused on the following NOS tenets, (1) "the cultural impacts on science", (2) "the theory-laden notion of scientific exploration", (3) "the creative nature of science", (4) "the non-objective nature of science", (5) "the changing/tentative nature of science knowledge", (6) "the role of social negotiation" and (7) "the justification in the development of scientific knowledge". Among these tenets, "*cultural impact on science"* stresses that science and culture, which includes and arts, habits, customs, religions, politics, moral values, are interrelated to each other. In science, knowledge production shares many prevalent factors and shared habits of mind and norms and scientific researchers are influenced by cultural factors. As a result, there is no doubt that science is a part of culture (Maurizio, 2003). So culture inevitably affects scientific studies.

"Theory-laden nature of science" involves that scientist' theoretical background, prior knowledge, beliefs, skills, values and training influence their scientific work. These factors affect scientific methods and investigation styles employed by the researchers. As a result, scientists' background influences how they do science (Lederman, 2007).

"Creative nature of science" is essential part of NOS and scientists use their creativity to make inferences about natural phenomena. National Science Education Standards indicated that "Science is a human enterprise, and the work of science relies on human qualities such as creativity, skills" (NRC, 1996, p.170). Scientists require imagination and creativity to make inferential explanation about what they observe. Scientific knowledge involves scientists' imagination and creativity. In other words, scientists use their imagination and creativity to interpret data and construct experiments because it is not totally rational (Akerson et al., 2010).

"Non-objective nature of science" emphasizes that even though scientists use the same data they can make different inferences because it depends on scientists' logical reasoning. Scientific knowledge is influenced by subjectivity of scientists. According to Deng et al., (2014), specified that scientific knowledge and scientists' observations are not independent of human subjectivity. Thus, non-objective is also unavoidable. How and what scientist conduct their work are influenced by personal values and prior experiences. Human subjectivity is a part of scientific knowledge (Lederman, 2007). Scientists have different experiences and biases that lead to different interpretations of the same data. In addition, it is not possible to make absolutely objective interpretations without any bias (Parker, 2010). Subjectivity plays a role when scientists' interpretations of data shaped the theoretical perspectives.

According to "*changing/tentative nature of science"*, scientific knowledge can change over time in the light of new evidence. In other words, scientific knowledge is subject to change with new evidence is gathered. According to Lederman et al., (2002), "Scientific knowledge, although reliable and durable, is never absolute or certain. Scientific knowledge including facts, theories and laws is subject to change" (p.502). New observations and explanations cause changes in existing scientific knowledge. Scientific knowledge is never concrete.

The tenets of NOS related to "*social negotiation"* stress the role of communication in the development of scientific knowledge. According to these tenets, scientific knowledge is produced as a result of a complex social activity as highlighted by Hodson (1991). According to Chen et al., (2013), social and cultural values construct scientific investigation and observation. Thus, socio-cultural participation affects interpretation, conduction and improvement of science. Also, scientific knowledge is influenced culture and society in which scientist belong to. In addition, social and cultural elements influence the direction and production of science.

Finally, "*justification tenets of nature of science"* involves that scientific claims are derived from observations of natural phenomena and observations are accessible to senses and justification requires to consider cause and effect relationship to produce statements (Lederman, 2007). In other words, this tenet emphasizes the role of experimentation and the utilization of data to support claims. Thus, according to this tenet, scientific knowledge is based on thinking, reasoning, and experimentation (Conley, et al., 2004).

Although developing an adequate understating of NOS in relation to these main tenets is a central goal of science education, the studies in the field have revealed that students hold naive view about the tenets including empirical, tentative, inferential, creative and imaginative nature of science (e.g. Mackay, 1971; Rubba, 1977; Horner & Rubba, 1978; Lederman & O'Malley, 1990; Larochelle & Desautels, 1991; Griffiths & Barman, 1995; Abd-El-Khalick & Lederman, 2000; Shiang & Lederman, 2002; Saddler, Chambers, & Zeidler, 2004; Kılıç, Sungur, Cakiroglu, & Tekkaya, 2005; Dogan & Abd-El-Khalick, 2008; Ibrahim et al., 2009; Yenice & Saydam, 2010; Akerson & Donnelly, 2010; Akerson, Buck, Donnelly, Nargund-Joshi, & Weiland, 2011; Dogan, 2011; Aydeniz, Baksa, & Skinner, 2011; Walls, 2012; Cil & Cepni, 2012; Abd-El-Khalick, 2012; Cakmakci, 2012; Akerson, Nargund-Joshi, Weiland, Pongnason, & Avsar, 2013). For instance, some studies (e.g. BouJaoude, 1996; Meichtry, 1992; Smith et al., 2000) demonstrated that most of the elementary and middle school students believe that scientific knowledge does not change and scientist do not use their imagination or creativity during their scientific investigations. In addition, in an early study, Mackay (1971) assessed Australian secondary students' understanding of nature of science and its tenets. Researcher figured out that students had insufficient knowledge in the role of creativity.

Also, studying with high school students in Canada Griffiths and Barry (1993) founded that students thought laws and facts were absolute although theories were subject to change. The findings showed that students had inadequate understanding of theories and laws because students were not aware of different function of theories and laws. In a similar study, Brickhouse, Dagher, Letts and Shipman (2000) studied with college students to determine their understanding of nature of science. The study showed that students thought that hypothesis are subject to change whereas facts and laws are absolute. Similarly, in a national study, Bora (2005) assessed 10th grade math-science students' views of NOS in terms of the relationship between hypothesis, theories and laws and the results indicated that students had traditional views (naive) on the aspect of hypothesis, theories and laws. Moreover, concerning other aspects of NOS, studying with Korean 6th, 8th, 10th grade students , Kang, Scharmann and Noh (2005) reported that most of Korean students possessed inadequate understanding of NOS and tentativeness of science. In addition, Khishfe and Lederman (2006) founded that majority of the 9th,10th and 11th grade high school students in their sample presented an inadequate understanding about nature of science tenets such as "tentativeness, empirical evidence, distinction between observation and inference, creative and imaginative science and subjectivity". In another study, Das et al., (2018), investigated 9th grade

Bhutanese students' views of nature of science (NOS) in 7 aspects of NOS which were "tentativeness, empirical basis, imagination, creativity, methods of scientific investigation, distinction between observation and inference, and distinction between law and theory". The findings revealed that students had inadequate views on all the targeted aspects of NOS. Furthermore, in a national study, Hacıeminoglu et al., (2014), assessed middle school students NOS aspects in terms of "tentative, imagination and creativity, empirical and observation and inference". Researchers founded that the students' NOS views in tentative NOS and imagination and creativity were inadequate whereas their NOS views in empirical nature of scientific knowledge was adequate.

In conclusion, the aforementioned studies related to students' NOS views in various aspects indicated that students hold naive views on most of the aspects and, accordingly, students understanding of NOS aren't at desired levels.

2.2.The Instruments Developed for Measuring Students NOS Views

Improving NOS views of students has been the most important goal of science education for kindergarten through Grade 12 (K-12) and helping K-12 students and science teachers develop informed conceptions of NOS are the central part of science education since the beginning 1960s (Lederman et al., 2002). For this purpose, science educators develop various scales to assess students' understanding of nature of science knowledge. Many instruments have been documented in the literature to evaluate the participants' views of NOS (Chen, 2006; Lederman et al., 2002; Liang et al., 2009). In this part, various assessment instruments developed to assess NOS understanding have been specified and summarized. Some of the NOS instruments include open- ended questions: "The versions of the Views of Nature of Science" (VNOS) instrument, for example, including "VNOS-A", (Lederman & O'Malley, 1990); "VNOS-B", (Abd-El-Khalick, Bell, & Lederman, 1998); "VNOS-C" (Abd-El-Khalick & Lederman, 2000); "VNOS-D" (Lederman & Khishfe, 2002); and "VNOS-E" (Lederman & Ko, 2004) all consist of open ended questions to assess individuals' understanding on different NOS aspects. Among these versions, “VNOS-A” consists of seven open-ended items. However, some defects were identified in the wording of some items. Then, originating from “VNOS-A”, “VNOS-B” and “VNOS-C” were constructed. But, it was found that these two versions are too long and it is difficult for participants to complete them in a regular class hour. Thus, these two versions were revised and “VNOS-D” and “VNOS-E”, which take less time to administer and lead to the same results with the longer versions, were prepared (Lederman, Bartos, & Lederman, 2014). In the VNOS instruments, more than one item is used to target specific NOS aspects. Accordingly, students’ NOS views are determined considering their overall responses to the items rather than focusing on one-to-one correspondence between an item and a specific NOS aspect. However, the instruments with open-ended items to assess NOS views can be used only with small samples. In fact, in the related literature, they are usually utilized in experimental research designs. Such instruments are not appropriate for inferential statistical analyses (Martin- Dunlop, 2013).

Regarding the assessment of NOS views quantitatively, the initial attempts were made in the early 1960s. These instruments are composed of agree/disagree, Likert-type, or multiple choice items which makes them easy to administer to larger samples. The examples for these initial instruments include “Test on Understanding Science” (TOUS), (Colley & Klopfer, 1961); “Winconsin Inventory of Science Processes” (WISP), (Scientific Literacy Research Center, 1967); “Science Process Inventory” (SPI), (Welch, 1966); “Nature of Science Scale” (NOSS), (Kimball, 1968); “Nature of Science Test” (NOST), (Billeh & Hasan, 1975); “Views of Science Test” (VOST), (Hillis, 1975); “Nature of Scientific Knowledge Scale” (NSKS), (Rubba, 1976); “Conceptions of Scientific Theories Test” (COST), (Cotham & Smith, 1981); “Views on Science-Technology-Society” (VOSTS), (Aikenhead et al., 1987); “Students’ Ideas about Nature of Science” (SINOS), (Chen et al., 2013); “Students’ Views of Nature of Science” (SVNOS), (Lin et al., 2013).

Among these instruments, “Test on Understanding Science” (TOUS; Colley & Klopfer, 1961) is a 60 item multiple-choice instrument with four-alternatives used to figure out students’ NOS views in three subscales, which are “the scientific enterprise, the scientist and the methods and aims for science". Another multiple-choice instrument, "Nature of Science Test" (NOST) (Billeh & Hasan, 1975) also consists of 60 multiple choice items to assess students' knowledge of science in 4 aspects which are "assumptions of science, products of science, and processes of science and ethics of science". Additionally, "The Views on Science-Technology-Society" (VOSTS) questionnaire includes 114 multiple-choice items to examine students' views of "nature of scientific knowledge, interaction of technology and society" (Aikenhead et al., 1987). On the other hand, "Science Process Inventory" (SPI, 1966) contains 135 items with agree/disagree choices. The items target NOS aspects which involve understanding of the methods and processes of scientific knowledge.

Remaining available instruments developed to assess NOS views are mainly Likert-type instruments. For example, "Nature of Science Scale" (NOSS, 1968) consists of 29 Likert- type items with 3 choices including agree, disagree, neutral. The instrument was originally used to determine science teachers' views of science. "Views of Science Test" (VOST) (Hillis, 1975) which has 40 Likert-type items with 5 choices was developed to assess high school students' nature of science views on the aspect of the tentativeness. Furthermore, the "Nature of Scientific Knowledge Scale" (NKSK) (Rubba, 1976); consists of 48 Likert-type items with 5 choices. The instrument was developed originally for high school students to measure the "tentative, replicable, probabilistic, humanistic, historic, unique, holistic and empirical" aspects of NOS. Also, "Conceptions of Scientific Theories Test" (COST) (Cotham & Smith, 1981) consists of 40 Likert-scale items which was used to assess college students' NOS understanding.

In addition, "Wisconsin Inventory of Science Processes" (WISP) (Scientific Literacy Research Center, 1967) questionnaire consisted of 93 statements with three-choice-response, namely "accurate", "inaccurate" and "not understood" and the instrument was used for high school students to assess their knowledge of science. Moreover, "Students' Ideas about Nature of Science" (SINOS; Chen et al., 2013) which consists of 47 likert-scale items was used to evaluate Taiwanese younger students'

NOS views in terms of "theory-leadenness, coherence-objectivity, creativity-imagination, tentativeness, durability, science for girls and science for boys". Furthermore, "Students' Views of Nature of Science" (SVNOS), (Lin et al., 2013) which consists of 33 Likert- scale items was used to assess middle school students understanding of NOS in seven aspects of "cultural impact, theory-laden, creative nature, non-objective nature, changing/tentative nature, social negotiation and justification".

As shown above, in the literature, there are many instruments developed to assess individuals' views of NOS (e.g. Chen, 2006; Lederman et al., 2002; Liang et al., 2009). Some of the instruments such as VNOS contain of open-ended questions. Such instruments can be utilized only with small samples. In the related literature, they appear to be used in experimental research and they are not suitable for research designs involving inferential statistical analyses (Martin-Dunlop, 2013). Accordingly, in the present study, to get students' NOS views on a larger scale and to be able to make some generalizations about the findings, instruments appropriate for inferential statistical analyses and targeting core tenets of NOS were decided to be used. Thus, during the instrument selection process, "TOUS", "SPI", "WISP", "NOSS" instruments were discarded because these instruments were thought to be insufficient for the characteristics of NOS according to Abd-El-Khalick et al., (1998), and Lederman, Wade, Bell (1998). As a result, those instruments were not convenient for the purpose of the study. Even though "VOST", "NKSK" and "COST" included characteristics of NOS; they were originally developed for high school and college students. For this reason, in the current study, among the available instruments, "Students' Views of Nature of Science" (SVNOS) (Lin et al., 2013) was decided to be used because the instrument contains Likert-type items developed using the sub-scales or items from existing instruments targeting the main tenets of NOS including "cultural impact" (n=4, e.g. "The value of scientific knowledge is different for people from different cultures"), "theory-laden nature" (n=6, e.g. "Scientists' research activities will be affected by their existing theories"), "creative nature" (n=4, e.g. "Some accepted scientific knowledge originated from human imagination and hunches"), "non-objective nature" (n=5, e.g. "All questions in science have one right answer”), “tentative nature” (n=3, e.g. “The ideas in science books sometimes change”), “social negotiation” (n=5, e.g. “New scientific knowledge becomes widely accepted through the recognition of many scientists in the field”), and “justification” (n=6, e.g. “Ideas about science experiments come from being curious and thinking about how things work”). Reliability and confirmatory factor analyses results indicated it was a valid and reliable instrument to assess middle school students’ NOS views on these key tenets.

In the current study, the SVNOS was translated and adapted to Turkish to examine middle school students’ NOS views in relation to gender, grade level, and learning environment perceptions.

2.3.Students’ NOS views regarding Gender and Grade Level

Related literature suggested that emphasis should be given to the investigation of gender differences in students’ NOS views (Wen, Kuo, Chang, & Tsai, 2010). Actually, when the relevant literature examined, it was found that research on gender as well as grade level differences were inconclusive (Deng et al., 2011). In addition, students’ learning experiences appear to play an important role in the development of NOS views (Hofer, 2001; Solomon, Scott, & Duveen, 1996). Accordingly, in the current study, students’ NOS views were aimed to be examined in relation to gender, grade level, and learning environment perceptions. In this sub-section, the studies related to gender and grade level were reviewed and firstly, national, then international literature were presented.

In a national recent study, Yenice, Hiğde and Özden (2017) assessed 641 middle school students’ (Grade 5, 6, 7 and 8) views of NOS. “NOSI” was used to determine views of NOS and the role of gender in students’ nature of science scores were tested in the study in the aspect of “tentative NOS, imagination and creativity, empirical NOS and observation and inference”. The researchers figured out that there was no gender effect on students’ NOS views. In other words, the difference in the scores of male and female students was not statistically significant in terms of NOS views. But, female students' average scores were higher than male students.

In another study, Cansız et al., (2017), examined middle school students' views of NOS. "Turkish version of Students' Ideas about Nature of Science" (SINOS) was used to evaluate some aspect of NOS in gender. The results revealed that girls possess contemporary views of NOS more than boys in the aspects of tentativeness and theory-laden. However, boys possess contemporary views of NOS than girls in the aspects of creativity-imagination and objectivity.

Furthermore, Hacıeminoglu, Tüzün-Yılmaz and Ertepınar (2014) assessed 6th, 7th, 8th grade students' nature of science in terms of varying grade levels and gender. "Nature of Science Instrument" (NOSI) was administered to the students in aspects of "tentative NOS, imagination and creativity, empirical NOS and observation and inference". Results indicated that although there were no significant differences between boys and girls' views of NOS, there were differences in grade level of students' NOS views. 7th grade students held more adequate NOS understanding in terms of tentative nature of NOS and empirical nature of NOS than 6th and 8th grade students. Also, 6th and 7th grade students possess more contemporary views in terms of imagination and creativity than 8th grade students. There were no significant differences between 6th and 7th grade students in NOS views in terms of imagination and creativity. However, there were no significant differences between 6th, 7th and 8th grade students in terms of observation and inferences.

In a similar study, Yenice and Saydam (2010) studied with 8th grade students. "Nature of Science Knowledge Scale" (NSKS) which covered three tenets was administered to evaluate students' understanding of NOS. In this research, the tenets examined were "closed scientific knowledge, justified scientific knowledge, and changeable scientific knowledge". The results revealed that there were significant differences in the students' perceptions of nature of science knowledge by gender. Female students had higher scores than male students in the closed tenet. Although, there was significant difference about closed tenets of NKSK, there were not any difference by gender in the other tenets which were justified and changeable tenets.

In addition, Çelikdemir (2006) examined elementary school students' NOS views. A total of 1949 Grade 6 and Grade 8 students included in the study and "Nature of Science Questionnaire for Elementary Level" (E-NOS) was used to evaluate students' views on seven aspect of NOS namely, "tentativeness, subjectivity and creativity of scientific knowledge, social and cultural embeddedness of science, the role of observations and inferences, theories and laws and uncertainty in developing science". The result revealed that most of the student had naive views on some tenets of nature of science. Especially most of the students were not aware of the distinction of "theories and laws" which are different kind of knowledge. Also many students thought that there is certain scientific method to improve scientific knowledge. Female students had more contemporary views on some aspect of NOS which were subjectivity and creativity of the nature of science than male students. In other words, gender was found to affect the views of NOS. Moreover, the results revealed that 8^{th} grade students possess contemporary views of NOS more than 6^{th} grade students considering tentative and subjective nature of sciences and the role of uncertainty in science. It was also founded that 6^{th} grade students possess sophisticated views of NOS considering the role of observation and inferences in science.

In another study, Kılıç, Sungur, Çakıroğlu, Tekkaya (2005) investigated the differences in students' understanding of 575 grade 9^{th} students' nature of scientific knowledge by gender. "Nature of Scientific Knowledge" (NSKS) was administered to the students to specify the students' perceptions of nature of scientific knowledge. NSKS covered 6 tenets which are "amoral, creative, developmental, parsimonious, testable, and unified". Findings of the study indicated a significant gender difference. The results showed that significant difference in gender was found in two tenets of NKSK such as unified and amoral. Girls had higher scores than boys in these tenets. However, there was not significant gender difference concerning creative, developmental, testable, parsimonious tenets of NSKS.

Overall, the above-mentioned national studies revealed mixed results concerning gender and grade level differences with respect to NOS views on various tenets.

In the international literature, Huang et al., (2005), examined fifth and sixth grade students' views of nature of science in Taiwan. "Pupils' Nature of Science Scale" (PNSS) was administered to students in tenets of "invented and changing nature of science, the role of social negotiation on science and cultural context on science". Gender and grade differences were analyzed in the study. The findings indicated that male students had more sophisticated understanding of NOS on the tentative nature of science and the role of social negotiation than female students. Moreover 6th graders had more sophisticated views of NOS in tentative nature of science than 5th graders.

In addition; Kang, Scharmann, and Noh (2005) examined the understandings of 1,702 Grade 6, 8, and 10 Korean students' views of NOS on five NOS tenets including, "purpose of science, definition of scientific theory, nature of models, tentativeness of scientific theory and origin of scientific theory". Researchers designed a large-scale survey which was administered to participants. Results showed that students in all grades held inadequate understanding of the tentative nature of scientific knowledge. According to the study, only a few students possessed concrete understanding of the tentativeness of scientific theories. In shortly, no differences were evident between the responses of students from the different participant grade levels.

Furthermore, Abd-El-Khalick (2006) assessed 153 undergraduate and graduate students' views of the "tentative, empirical, creative, and theory-laden nature of scientific knowledge; the role of social and cultural contexts in science". "The Views of Nature of Science Questionnaire Form C" (VNOS-C) (Abd-El-Khalick, 1998; Abd-El-Khalick, Lederman, Bell, & Schwartz, 2001) was administered to the participants. The result showed that there was no gender difference concerning NOS views.

In a similar study, Doğan and Abd-El-Khalick (2008) investigated 2,087 students and 378 science teachers' understanding of certain aspects of NOS. A view on "Science-Technology-Society" (VOSTS) was administered. The researchers reported that there were no gender difference in the responses of both students and teachers.

In addition, Parker (2010) assessed 153 sixth grade students' views of NOS understanding in the aspect of "imagination and creativity, empirical, tentative, distinction between observation and inferences and theory-laden". "VNOS-E" instrument was used to assess participants' understanding of the targeted NOS aspects at the beginning and in the end of the study. Participants divided into four sub-groups according to their gender and ethnicity; "White males", "White females", "other males" and "other females". Control groups and treatment groups had four sub-groups. Both control and treatment groups had naive views of these aspects of NOS pre-instruction. Treatment group took three science units such as "Climate Change", "Earth' Moon", "Solar System" with NOS activities whereas control group took these three science units with no-NOS activities. However, participants' post- instruction NOS views were changed. There were statistically significant differences between control and treatment groups in gender and ethnicity with respect to "subjective, creative/ imaginative and distinction between observation and inference". At the conclusion of the study white males had more informed views than white females in the treatment group. Although white females had no gains, white males a little gain in control groups. The finding of the study revealed that the understanding of the NOS was independent of gender in total group of students in the treatment group and control group. In other words, according to the results, gender did not appear to affect the students' views of NOS.

In another study, Lin et al., (2013), assessed Singaporean secondary school students' (seventh and eighth graders) views of NOS in seven scale of NOS namely; "the creative nature of science, the role of social negotiation, the theory-laden notion of scientific exploration, the cultural impacts on science the changing/ tentative nature of science knowledge, the non-objective nature of science and the justification of scientific ideas" using "Students' Views of Nature of Science" (SVNOS) instrument. The results revealed that there were significant differences in gender and grade level in some aspects of NOS. Male students had more sophisticated in all scales of SVNOS except the non-objective nature of science than female students. However, female students had more concrete understanding of non-objective nature of science than male students. Moreover, seventh grade students performed significantly better than eighth grade students on the cultural impacts on science, theory- laden notion of scientific exploration, the role of social negotiation whereas eighth grader students performed better than seventh grade students on the non-objective nature of science.

Additionally, Deng et al., (2014), investigated students' views on nature of science in Asian countries. VNOS was administered to the 10^{th} and 11^{th} grade students to determine NOS views in five aspects. These are "empirical, changing-tentative, subjective, imaginative and socially-culturally embedded nature of science aspects". The findings in the study indicated that there was no gender difference in the views of NOS. On the other hand, according to the results, there was statistically significant difference among 11^{th} and 10^{th} grade students considering the changing-tentative and empirical aspects. Although Grade 11 students tended to perform better on changing-tentative nature of science younger students tended to perform better on the empirical nature of science.

In a similar study, Adedoyin and Bello (2017) studied with 99 undergraduate pre-service biology teachers in Nigeria. "The Nature of Science Questionnaire" (NoSQ) was used to students' views of nature of science concepts. The researchers revealed that there was no gender difference according to the students' responses.

In addition, Penn, Ramnarain and Wu (2019) investigated 107 twelve grade students' understanding about "Nature of Scientific Inquiry" (NOSI) using "Views about Scientific Inquiry" (VASI) questionnaire. The findings revealed that there were no gender differences in participants' responses.

In another study, Toma, Greca and Orozco Gomez (2019) assessed Spanish 149 elementary grade (2nd and 5th grade) students’ views of NOS in terms of gender and grade level using “The Nature of Science Instrument” (NOSI). Boys held more naïve ideas of the empirical nature of science than girls. Moreover third grade students held more sophisticated views of tentative nature of science than the other grade students.

In general, the aforementioned both national and international studies suggest that the research on gender and grade level differences concerning NOS views across various tenets is inconclusive. Thus, current study aimed to examine these differences and discuss the findings considering context of the study and previous studies.

2.4.Students’ NOS Views regarding Classroom Learning Environment Perceptions

Classrooms consist of physical and psychological environment. Physical environment consists of desk, chairs, space, lightening, and ventilation whereas psychological environment consists of social interactions of students, teachers, and peers. Researchers have described classrooms as a learning environment. At first, past learning environment researches are noticed about physical environment of classrooms and then learning environment researchers investigated the psychological effects of classrooms (Fraser, 1986; 1994; 2000). Perkins (1993) stated that studies on learning environment gained importance because contribution of learning environments on students’ cognitive level was recognized. Also, it is important to know that classrooms create productive learning environments and affect student outcomes (Khine et al., 2018). Similarly, researchers have shown that characteristics of the learning environments have an impact on students’ outcomes and achievement (Aldridge et al., 2006; Wolf & Fraser, 2008). In addition, studies have shown that the relations between students’ learning and perceptions are affected by the classroom environment (Margianti, Fraser, & Aldridge, 2001; Myint

& Goh, 2001; Koul & Fisher, 2002). As a result, learning environments have influence on students' outcomes and improves learning (Moos, 1980; Keyser & Barling, 1981; Fraser, 1986). Developing of some instruments initiate to assess psychological feature of learning environments, many instruments have been documented in the literature to evaluate the participants' learning environments (Martin-Dunlop, 2013) such instruments include; "Classroom Climate Questionnaire" (CCQ) (Walberg, 1968a); "Learning Environment Inventory" (LEI), (Walberg & Anderson, 1968); "Classroom Environment Scale" (CES), (Trickett & Moos, 1973); "Individualized Classroom Environment Questionnaire" (ICEQ) (Fraser, 1990); "Questionnaire on Teacher Interaction" (QTI), (Wubbels & Levy, 1991); "Science Laboratory Environment Inventory" (SLEI) (Fraser et al., 1992); "Constructivist Learning Environment Survey" (CLES), (Taylor et al., 1995); "What Is Happening In This Class?" (WIHIC) (Fraser et al., 1996); "My Class Inventory" (MCI, Majeed et al., 2002); "Technology-Rich Outcomes-Focused Learning Environment Inventory" (TROFLEI) (Aldridge et al., 2004). Table 2.1 indicates the subscales of the existing questionnaires which commonly used in learning environment research. These subscales were developed to determine the psychological feature of learning environment.

Among these instruments, WIHIC is one of the most used instruments to assess students' and teachers' perceptions of psychological aspects of classrooms. Waldrip et al., (2009), recommended using WIHIC in different purposes such as describing students' outcomes and teachers' effectiveness. WIHIC as a valid and reliable instrument has been used to investigate science learning environments in many countries such as Australia, United States, Indonesia, and Canada. Also, WIHIC instrument is to be considered most appropriate instrument to determine psychological environment in Turkey because the aspects of WIHIC are consistent with the Turkish Science Education Curriculum: Both, Turkish Science Education Curriculum and WIHIC instruments focus on student- centered learning. The instrument is intended to be used to determine elementary and middle school students' perceptions of their classroom environments. WIHIC, developed by Fraser et al., (1996), has 56 items on a five point likert scale ("almost never, seldom, sometimes, often, almost always") in 7 dimensions, namely "student cohesiveness, teacher support, involvement, investigation, task orientation, cooperation and equity".

According to Waldrip, Fisher, and Dorman (2009), *Student cohesiveness* concerns the interactions among the students regarding to what extent they support each other and treat each other friendly. *Teacher support* involves that teachers show helpful, friendly, and supportive behaviors toward their students. *Involvement* emphasis students' interest, enjoyment, and participation in classroom activities. *Investigation* focuses on to what extent students use inquiry skills in the problem solving and investigation in the classroom (Alzubaidi et al., 2016; Waldrip et al., 2009). *Task orientation* concerns whether students work on and finalize the planned activities and tasks (Khine et al., 2018; Waldrip et al., 2009). *Cooperation* involves the extent to which students work together on the common task as a group or as in pairs (Khine et al., 2018; Waldrip et al., 2009). *Equity* emphasis whether teachers provide equal opportunities for each student and and whether students think that their teachers behave them fairly in any conditions (Alzubaidi et al., 2016).

Waldrip et al., (2009), suggested that the WIHIC is useful for predicting various student outcomes. Accordingly, in the present study, the WIHIC was utilized to predict students' NOS views. In fact, according to Khoo and Fraser (2008), the process of learning and teaching is affected by learning environments in classrooms. Indeed, Wong et al., (1997), reported that a great amount of variance in student learning outcomes is accounted by their classroom learning environment perceptions. Supporting this idea, there are studies in the literature showing that students' learning experiences are important in the development of their NOS views (Hofer, 2001; Martin-Dunlop, 2013; Solomon, Scott, & Duveen, 1996). For example, Lederman and Druger (1985) suggested students tend to develop sophisticated NOS views in the learning environments where they are active participants of the learning process being provided with inquiry oriented questions and problems. Moreover, studying with 525 female pre-service elementary teachers, Martin-Dunlop (2013) examined the relationship between classroom learning environment perceptions and NOS understanding. “NSKS” and the combination of “SLEI” and “WIHIC” instruments were administered to students. “NSKS” which had six scales; “amoral, creative, developmental, parsimonious, testable and unified” was used to determine the understanding of nature of science. The instrument was administered to students twice as pre-test and post-test. Two dimensions of the “SLEI” (“Open-Endedness and Material Environment”) and 4 dimensions of the “WIHIC” (“Student Cohesiveness, Instructor Support, Investigation, Cooperation”) were combined to produce science learning environment instrument. Each of “SLEI” scales had 7 items and each of “WIHIC” scales had 4 items and the combined instrument which had total 46 items was used to assess learning environment perceptions. The instruments administered to students at the end of the study only once. The results indicated that the independent predictor of creative scale was open-endedness and material environment also the independent predictor of testable scale was cooperation, open-endedness and material environment. Similarly, the independent predictor of unified scale was material environment. In general, according to the quantitative results, it appeared that there were significant, positive bivariate correlations between students’ understanding of NOS and their perceptions of classroom learning environments in terms of “student cohesiveness, instructor support, investigation, cooperation, open-endedness, and presence of adequate material”. In line with these quantitative findings, qualitative results in the study also indicated that laboratory activities which involve students to employ an open-ended divergent approach while doing experimentation and which involve cooperation among students were associated with better understanding of NOS. Based on the results, the author suggested the teacher to be supportive, act as a facilitator, and encourage cooperation among students to help them develop sophisticated NOS views. In an earlier study, Solomon et al., (1996), also proposed that encouraging students to design experiments, collect and analyze data can promote students’ NOS views.

Table 2.1 Dimensions of some Classroom Learning Environemnt Instruments

Instruments	Developers	Number of items	Dimensions			Target group
Learning Environment Inventory (LEI)	1968 Walberg & Anderson	105 items	Cohesiveness, Speed, Goal Direction, Apathy, Satisfaction,	Diversity, Material Environment, Favoritism, Democracy, Disorganization,	Formality, Friction, Difficulty, Cliqueness, Competitiveness	High school students
Classroom Environment Scale (CES)	1973 Trickett & Moss	90 Items	Involvement, Task Orientation, Order and Organization,	Affiliation, Competition, Rule Clarity,	Support, Innovation, Teacher Control	High School Students
Individualized Classroom Environment Questionnaire (ICEQ)	1990 Fraser	50 items	Personalization , Independence, Differentiation,	Participation, Investigation,		Students and Teachers
Questionnaire on Teacher Interaction (QTI)	1991 Wubbels & Levy	77 items	Leadership, Uncertain, Strict,	Helping/friendly, Dissatisfied, Student responsibility/freedom	Understanding, Admonishing,	Students and Teachers
Science Laboratory Environment Inventory (SLEI)	1992 Fraser, Gidding, & McRobbie	35 items	Student Cohesiveness, Integration, Material Environment	Open- Endedness, Rule clarity,		Secondary School and University Students
Constructivist Learning Environment Survey (CLES)	1995 Taylor, Dawson, & Fraser	30 items	Personal Relevance, Shared Control, Student Negotiation	Uncertainty, Critical Voice,		Students and Teachers

Table 2.1 (continued)

Instruments	Developers	Number of items	Dimensions	Target group
What is Happening in This Classroom (WIHIC)	1996 Fraser, Fisher, & Mc Robbie	56 items	Student Cohesiveness, Involvement, Task Orientation, Equity, Teacher Support, Investigation, Cooperation,	Elementary and Middle School Students
My Class Inventory (MCI)	2002 Majeed, Fraser, & Aldridge	38 items	Cohesiveness, Satisfaction, Competitiveness, Friction, Difficulty,	Elementary and Middle School Students
Technology Rich Outcomes Focused Learning Environment Inventory (TROFLEI)	2004 Aldridge, Dorman, & Fraser	80 items	Student Cohesiveness , Involvement, Task Orientation, Equity, Computer Usage, Teacher Support, Investigation, Cooperation, Differentiation, Young Adult Ethos	High School Students

Although related literature indicates that students' learning experiences play an important role in the development of their NOS views (Chai, Deng, & Tsai, 2012), the studies examining the relationships between learning environment perceptions in several dimensions and NOS views using a correlational research design are rare. Thus, this study, can contribute especially to nature of science researchers and science teachers by providing an alternative perspective to improve the teaching and learning of nature of science considering learning environment characteristics found to be conducive to NOS understanding.

2.5.Summary

The aforementioned literature, both national and international, suggest that students' NOS views are not at adequate level (Kang et al., 2005; Khishfe & Lederman, 2006; Das et al., 2018; Dogan & Abd-El-Khalick, 2008; Çakmakci, 2012; Hacıeminoglu et al., 2014.). The literature concerning the role of gender and grade level appears to be inconclusive. In addition, the limited literature on the relationship between learning environment perceptions and NOS views, suggest that students in learning environments, where they are provided with open-ended activities and cooperate with each other are likely to develop adequate views of NOS (Lederman & Druger, 1985; Martin-Dunlop, 2013; Solomon, Scott, & Duveen, 1996).

CHAPTER 3

METHODOLOGY

The chapter specifies participants of the study, data collection procedures, analyses, internal validity threats and limitations of the study.

3.1.Population and Sampling

The target population of this study was all the 7th and 8th grade students attending public school in Ankara. On the other hand, the accessible population was all the 7th and 8th grade students in the public schools of Yenimahalle and Sincan districts. During sample selection, cluster random sampling integrated with convenience sampling was utilized. The districts to conduct the study were selected using convenience sampling. Then, public schools considered as clusters were randomly selected from the districts. The study was conducted during 2016-2017 fall semester. A total of 608 middle school students (n = 286 Grade 7 and n = 322 Grade 8) from four public schools included in the study. Table 3.1 demonstrates the distribution of the students across the schools. Of the 608 students, 319 (52.5 %) were Girls and 289 (47.5 %) were Boys. The participants ranged in age from 13 to 15 with a mean age of 13.59 (SD = .55). The mean of the participants science report grade from the previous semester was 4.30 out of 5 (SD = .86).

Table 3.1 Number of schools and students

Number of schools	Number of students	Percent (%)
1	137	22.5
2	56	9.2
3	170	28.0
4	245	40.3

Table 3.2 displays participants' background characteristics containing the "gender, sibling, mother employment status, father employment status, mother education level, father education level, number of reading book, presence of separate study room, buying daily newspaper, having computer and having internet connection access".

Table 3.2 Background Characteristic of Students

	Frequency	Percent (%)
GENDER		
Girl	319	52.5
Boy	289	47.5
SIBLING		
0	29	4.8
1	139	22.9
2	257	42.3
3	146	24.0
4	25	4.1
5	10	1.6
6	2	0.3
MOTHER EMPLOYMENT STATUS		
Employed	158	26.0
Unemployed	421	69.2
Offensively employed	21	3.5
Retired	8	1.3
FATHER EMPLOYMENT STATUS		
Employed	543	89.3
Unemployed	10	1.6
Offensively employed	11	1.8
Retired	41	6.7
MOTHER EDUCATIONAL LEVEL		
Primary school	167	27.5
Secondary school	170	28.0
High school	209	34.4
University	61	10.0
Ms	0	0
PhD	1	0.2
FATHER EDUCATIONAL LEVEL		
Primary school	99	16.3
Secondary school	156	25.7
High school	228	37.5
University	122	20.1

Table 3.2 (continued)	Frequency	Percent (%)
Ms	0	0
PhD	0	0
NUMBER OF READING BOOK		
0-10	34	5.6
11-25	141	23.2
26-100	223	36.7
101-200	132	21.7
More than 200	78	12.8
PRESENCE OF SEPARATE STUDY ROOM		
Have a separate study room	546	89.8
Do not have a separate study r.	59	9.7
BUYING DAILY NEWSPAPER		
Never	156	25.7
Sometimes	416	68.4
Always	34	5.6
HAVING COMPUTER		
Have a computer	512	84.2
Do not have a computer	95	15.6
HAVING INTERNET CONNECTION ACCESS		
Have an internet connection	471	77.5
Do not have an internet connection	134	22.0

As seen in the table, a great majority of participants' mothers (89.9 %) and fathers (79.5 %) had a high school or lower degree. While approximately 20 % of the fathers had a university degree, only 10 % of mothers graduated from a university. There were no students with parents having M.S. degree. About 69 % of participants' mothers were unemployed. On the other hand, almost 90 % of the fathers were employed. Less than half of the participants were from families with 3 children (42.3 %). Only 4.8 % of the participants were single child. More than three-quarter of the participants had their own study room (89. 8 %), a computer (84.2 %), and Internet access (77.5 %) in their homes.

3.2.Variables

In this study, there were four main variables namely, gender, grade level, nature of science views, and learning environment perceptions. First two variables, i.e. gender and grade level were determined by Background Characteristics Survey. The third variable, that is, students' nature of science views were assessed by "The Students' Views of Nature of Science (SVNOS)" instrument, in seven sub-scales namely, cultural impacts, theory laden, creative nature, non-objective nature, changing/tentative nature, social negotiation and justification. These seven dimensions constituted the variables concerning students' NOS views. The fourth variable, students' learning environment perceptions instrument, was assessed by "What Is Happening in This Class (WIHIC) Questionnaire" in terms of "student cohesiveness, teacher support, involvement, investigation, task orientation, cooperation, and equity". These dimensions constituted the learning environment perceptions variables. The instruments used in the current study are detailed in the following sections.

3.3.Data Collection Procedure

The study was conducted during 2016-2017 fall semester with the necessary permission from Ministry of Education of Turkey (see Appendix E) and METU Ethics committee (see Appendix A). After getting necessary permissions, a pilot study was conducted to validate The Students' Views of Nature of Science instrument for Turkish middle school students. Then, the main study was conducted. All the students attending the study were volunteers and permissions were obtained from their parents. The participants were informed about the research and how to complete the data collection instruments. They were also ensured that their responses to the instruments would be kept confidential and would not have any effect on their grades in any way. The instruments were administered during regular class hours (40 minutes).

3.4.Data Collection Instruments

In the present study, the data were collected by means of background characteristic survey (see appendix B), "The Students' Views of Nature of Science" (SVNOS) Instrument (see appendix C) and "What is Happening in This Class (WIHIC) Questionnaire" (see appendix D). The instruments were used with permission.

3.4.1.Background Characteristic Survey

It is a fifteen items instrument used to examine the background characteristics of the participants. The items were related to "gender, age, grade level, science report grade, name of the participant school, number of siblings in home, employment status of parents, educational level of parents, presence of a separate study room in home, having computer, having internet connection, number of reading books in home and frequency of buying newspaper". The data obtained from the instrument were mainly used to portray the socio-economic status of the sample.

3.4.2.The Students' Views of Nature of Science Instrument (SVNOS)

The SVNOS was constructed by Lin et al., (2013), to assess middle school students' views of nature of science using the items and scales from existing instruments (Tsai & Liu, 2005; Chai et al., 2010; Conley et al., 2004). It consists of 33 items in seven sub-scales: cultural impacts (*n* = 4 items), theory-laden (*n* = 6 items), creative nature (*n* = 4 items), non-objective nature (*n* = 5 items), changing/tentative nature (*n* = 3 items), social negotiation (*n* = 5 items), and justification (*n* = 6 items). The items were on a five-point Likert scale ranging from "1= strongly disagree to 5 = strongly agree". Factor structure of the SVNOS was validated through confirmatory factor analysis (CFA) with following fit indices: $\chi 2$ /df = 2.33, RMSEA = .062, CFI = .98, NFI = .97, NNFI= .98, and GFI = .84. In addition, sub-scale reliabilities were found to range from .77 to .93. Table 3.3 provides sample items and reliabilities for each sub-scale.

Table 3.3 Sample items and reliabilities of the original version of the SVNOS instrument subscales

Subscale	Items	Reliability	Sample item
Cultural impact	7,14,21,27	.77	"Scientific knowledge is same in different cultures."
Theory laden	2,9,16,23,29,32	.87	"Scientists' research activities will be affected by their existing theories."

Table 3.3 (continued)

Subscale	Items	Reliability	Sample Item
Creative nature	3,10,17,24	.87	"Creativity is important for the growth of scientific knowledge."
Non-objective	1,8,15,22,28	.88	"Scientists always agree about what is true in science."
Changing/ tentative nature	5,12,19	.82	"Ideas in science sometimes change."
Social negotiation	4,11,18,25,30	.92	"Valid scientific knowledge requires the acknowledgment of scientists in relevant fields."
Justification	6,13,20,26,31, 33	.93	"Good answers are based on evidence from many experiments."

For the present study, in order to validate the SVNOS for Turkish middle school students, it was first translated into Turkish by the researcher. The translated version was examined by professors in science education familiar with NOS research for content validity. Turkish version of the SVNOS items was also examined for clarity, comprehensiveness, and sentence structure by the professors. In addition, an expert in an Academic Writing Center checked for the appropriateness of the translation and a Turkish language teacher examined the translated items in terms of their appropriateness for Turkish grammar and language structure. Moreover, to determine whether the items are easily understood by middle school students, their opinions regarding the clarity of the items were obtained having them read the translated items. After making necessary revisions based on the suggestions by professors, language experts, and students, Turkish version of the SVNOS was pilot tested with 175 (n = 107 Girls and n =68 Boys) middle grade students. The CFA results did not provide a good model fit ($\chi 2$ /df = 1.63, RMSEA = .060, CFI = .89, NFI = .78, NNFI= .88, and GFI = .79). In addition, reliability coefficients were, in general, low ranging from .27 to .77. Deletion of 2 items from cultural impacts, 1 item from creative nature, 2 items from theory-laden nature, and 1 item from non-objective nature led to an improvement in internal consistencies. In addition, deletion of these items resulted in better CFA indices ($\chi2$ /df = 1.52, RMSEA = .055, CFI = .94, NFI = .84, NNFI= .93, and GFI = .84). However, high phi-coefficients found among creative nature, social negotiation, and justification sub-scales exceeding .98 suggested linear dependency. In addition, although there was an increase in reliability coefficients of corresponding sub-scales after item deletion, they were still low. Thus, these items except for the item from creative nature were decided to be revised and reworded. Negative items were stated as positive items. The revised items were presented in Table 3.4.

Table 3.4 Revised Items

Item	Sub-scale	Revised
"The most important part of doing science is coming up with the right answer."	Non-objective nature	"Coming up with the right answer is the most important part of doing science."
"People from different cultures have the same method of interpreting natural phenomena."	Cultural impacts	"Scientists from different cultures can use different" methods of interpreting natural phenomena."
"Scientific knowledge is the same in various cultures."	Cultural impacts	"Development of scientific knowledge can be different in different cultures."
"Recent scientific knowledge contradicts previous knowledge."*	Theory-laden	"Scientists'' existing theories affect new scientific developments."
"Scientists can make totally objective observations which are not influenced by other factors."	Theory-laden	"Scientists' observations are influenced by their existing theories."

*Based on expert opinion a new item was constructed for theory-laden sub-scale.

After making necessary revisions, final version of the instrument was examined by two professors in science education in order to ensure that, the items still assess the intended constructs. Then, the instrument was again administered to a new sample of middle school students. Results indicated a good model fit ($\chi2$ /df = 3.17, RMSEA = .057, CFI = .93, NFI = .90, NNFI= .93, and GFI = .88). However, phi coefficients around 1 suggested linear dependency among some sub-scales. In addition, reliability coefficients were found to range from .48 to .77. Deletion of 2 items from the non-objective nature sub-scale led to an increase in this sub-scale. After deleting these 2 items (item 1: "All questions in science have one right answer"; and item 8: "Coming up with the right answer is the most important part of doing science"), CFA was again conducted. Although there was an improvement in fit indices linear dependency problem still continued. Thus, creativity, social negotiation, and justification sub-scales, found to be highly correlated with each other, were decided to be merged considering them to measure the same construct. This new factor was named as creative nature/justification. Similarly, cultural impacts and theory-laden nature sub-scales were merged and named as changing/tentative nature. The rationale behind assigning these names and merging these sub-scales are further elaborated in the Discussion section. After making these adjustments in the factor structure, a new CFA was performed to check 4-factor structure of the SVNOS (i.e. theory-laden /cultural impacts, changing/tentative nature, non-objective nature, creative nature/justification). Results indicated a good model fit. However, two items from theory-laden /cultural impacts factor were found to have low loadings. After removing these two items (item7: "The value of scientific knowledge is different for people from different cultures" and item 27: "Science is affect by culture"), CFA results revealed following fit indices indicating a good model fit: $\chi2$ /df = 2.40, RMSEA = .046, CFI = .96, NFI = .93, NNFI= .96, and GFI = .91. Thus, results supported 4-factor structure of SVNOS. Reliability coefficients were .70 for theory-laden /cultural impacts, .56 for changing/tentative nature, .64 for non-objective nature, and .84 for creative nature/justification. Reliability coefficients exceeding the criterion (Cronbach's alpha $\geq$ .55) suggested by (Hatcher & Stepanski, 1994) suggested that reliabilities were high enough to conduct further analyses.

3.4.3.What Is Happening In This Class Instrument (WIHIC)

The WIHIC was used to assess middle school students' learning environment perceptions. It was originally developed Fraser, Fisher and McRobbie (1996) as a 90-item instrument. The 56-item version, used in the present study, was validated by

Aldridge and Fraser (2000) conducting principle factor analysis and reliability analyses. The items are on a 5-point Likert scale ranging from “1 (never) to 5 (always)”. The WIHIC consists of 7 sub-scales with eight items in each: “student cohesiveness, teacher support, involvement, investigation, task orientation, cooperation, and equity”. Cronbach’s alpha coefficients ranged from .81 to .93 for individual level. Table 3.5 presents sample items and reliabilities for each sub-scale. The WIHIC was translated and adopted to Turkish by Telli, Çakıroğlu and Brok (2006). The same factorial structure with the original version was observed for the Turkish sample. In addition, reliability analyses indicated reasonable internal consistencies with Cronbach’s alpha coefficients ranging from .75 to .88.

In the present study, The CFA results also supported the 7-factor structure of the WIHIC ($\chi2$ /df = 2.70, RMSEA = .054, CFI = .98, NFI = .96, and NNFI= .97). Reliabilities were .82 for student cohesiveness, .79 for teacher support, .79 for involvement, .88 for investigation, .84 for task orientation, .86 for cooperation, and .89 for equity.

3.5.Data Analysis Procedure

In the presents study LISREL 8.80 (Jöreskog & Sörbom, 2007) was used to validate factor structure of the instruments through confirmatory factor analyses. “SPSS 15 for windows software program” was used for descriptive and inferential statistical analyses. A part of descriptive statistics reported in the results section means and standard deviations were calculated. As part of inferential statistical analyses, multivariate analysis of variance (MANOVA) and canonical correlation analysis were conducted to examine gender and grade levels differences with respect to students’ NOS views and the relationships between students’ learning environment perceptions and their NOS views, respectively.

3.6.Assumptions and Limitations

3.6.1.Assumptions

1)The instruments were administered under standard conditions in each school.

2)The students in the study read and answer each item carefully and honestly in the instruments.

3)Students did no interact with each other during the implementation of instruments.

3.6.2.Limitations

The present study can provide explicit clues about how science classes can be structured so that students acquire a better understanding of scientific practice. However, it is important to note that current study just relied on data from self-report instruments. In addition, the reliability coefficient of tentativeness sub-scale of the SVNOS, although it was greater than the criterion suggested by Hatcher and Stepanski (1994), was relatively low. Finally current findings are limited to 7th and 8th grade students attending public school in Ankara.

3.7.Threats to Internal Validity of the Study

In the current study, although data concerning participants' background characteristics were collected and gender and grade level were included as variables, subject characteristics such as participants, scientific reasoning ability and attitude toward science can still pose a threat to internal validity. On the other hand, because, the current study employed a cross-sectional design mortality is not considered as an internal validity threat.

Table 3.5 Description of the WIHIC and sample items

Sub-scales	Sample item	Cronbach' alphas (Aldridge & Faser, 2000)	Cronbach' s alphas (Telli, Cakıroglu, & Brok, 2006)	Cronbach' s alpha (Current Study)
"Student cohesiveness"	"I work well with other class members."	.81	.75	.82
"Teacher support"	"The teacher takes personal interest in me."	.88	.86	.79
"Involvement"	"I explain my ideas to other students."	.84	.80	.79
"Investigation"	"I carry out investigations to test my ideas."	.88	.86	.88
"Task orientation"	"I know how much work I have to do."	.88	.81	.84
"Cooperation"	"I cooperate with other students when doing assignments work."	.89	.83	.86
"Equity"	"I have the same amount of say in this class as other students."	.93	.88	.89

Source: Brok, Telli , Cakiroglu, Taconis& Tekkaya, 2010, p.191

*Reliability coefficients are reported for only Australian sample.

Concerning data collector characteristics, in the present study, of four participating schools, two of them did not allow the researcher to administer the instruments. Rather, the school administration, implemented the instruments. Although the researcher informed the school administrators of the directions, data collector characteristics can be a potential threat. On the other hand, because Likert-type instruments were used, data collector bias does not appear as an internal validity threat. However, testing can be threat since the instruments were all administered at the same time. Finally, location is not considered as a potential internal validity threat, because, all the schools involved in the present study were public school with comparable physical conditions.

CHAPTER 4

RESULTS

This chapter presents the results of a series of analysis conducted for the related research questions. The results are categorized in two sections: (1) Descriptive statistics of “The Students’ Views of Nature of Science Instrument (SVNOS)” and “What is Happening in This Class Instrument (WIHIC)”, (2) Inferential Statistics analysis.

4.1.Descriptive Statistics

Detailed basic descriptive statistics were provided in this section for “The Students’ Views of Nature of Science Instrument (SVNOS)” and “What is Happening in This Class Instrument (WIHIC)” variables. Descriptive statistic included means, standard deviations, and frequency distributions.

4.1.1.Middle School Students’ NOS Views

Participants’ NOS views were assessed using the SVNOS instrument. The SVNOS, originally, consisted of 7 subscales, namely cultural impacts, theory-laden, creative nature, non-objective nature, changing/tentative nature, social negotiation, and justification. However, in the current study, four factor structures provided a good fit and all analyses were conducted using four-factor structure. The names of the factors (sub-scales) were theory-laden /cultural impacts, changing/tentative nature, non-objective nature, and creative nature/justification. The descriptive statistics (mean and standard deviation) concerning students’ NOS views in terms of abovementioned four sub-scales were reported with respect to gender and grade level because gender and grade level differences were aimed to be inferentially examined in subsequent analyses. As shown in Table 4.1 and 4.2 all mean scores on NOS tenets were greater than mid-point of the 5-point Likert scale and comparable across both genders and grade levels. These findings imply that middle school students' views on NOS were not naive concerning all NOS tenets. However, the mean scores also suggested that students' views were not highly sophisticated either: There was no mean score around 5 as there were none exceeding 4. According to these results, middle school students appeared to agree, although not at high levels, with the views that scientific knowledge is changeable, scientists' work is affected by their theoretical commitments, beliefs, and experiences as well as the cultural influences, creativity plays an important role in the development of scientific ideas, and justification of scientific ideas involve experimentation and social negotiation.

Table 4.1 Descriptive statistics across gender

	Girls		Boys	
Variables	M	SD	M	SD
"Theory-laden /Cultural impacts"	3.64	.58	3.55	.63
"Changing/tentative nature"	3.42	.80	3.36	.79
"Non-objective nature"	3.86	.24	3.89	.24
"Creative nature/Justification"	3.79	.60	3.66	.62

Table 4.2 Descriptive statistics across grade level

	Grade 7		Grade 8	
Variables	M	SD	M	SD
"Theory-laden /Cultural impacts"	3.59	.60	3.60	.61
"Changing/tentative nature"	3.43	.81	3.36	.78
"Non-objective nature"	3.87	.24	3.88	.25
"Creative nature/Justification"	3.75	.61	3.70	.61

In the following sections, students' responses to individual items in each sub-scale of the SVNOS were presented in detail. Because, means and standard deviations were comparable across gender and grade level for the sub-scales, item level analyses were carried out using the whole data.

Concerning cultural impact-theory laden sub-scale (see Table 4.3), about a quarter of the students were undecided about all the items in this sub-scale. On the other hand, when the “strongly agree” and “agree” responses were combined, their agreement with the items was found to be comparable being around 60 %. According to students’ responses, their agreement level was the lowest with the item “Development of scientific knowledge can be different in different cultures” (50 %). In general, participants’ agreement with the items appeared to be at moderate levels.

Table 4.3 Descriptive statistics of cultural impact-theory laden subscale

				Percentage (%)				
		M	SD	SD*	D*	U*	A*	SA*
Cultural impact – theory laden subscale	14. “Scientist from different cultures can use different methods of interpreting natural phenomenon.”	3.6	1.1	7.0	9.4	22.8	42.2	18.7
	21. “Development of scientific knowledge can be different in different cultures.”	3.4	1.1	7.3	11.4	31.3	32.3	17.7
	2. “Scientists’ research activities will be affected by their existing theories.”	3.6	1.0	5.3	6.6	25.5	44.4	18.3
	9. “Scientists select effective methods to study nature based on their existing theories.”	3.7	1.1	4.8	9.4	23.0	40.8	22.0
	16. “Scientists with different theoretical backgrounds may make totally different observations even for the same phenomenon.”	3.6	1.1	4.8	9.0	23.5	42.4	20.2
	23. “Scientists’ existing theories affect new scientific developments.”	3.7	1.0	6.7	6.6	23.5	40.0	23.2
	29. “Scientists’ observations are influenced by their existing theories.”	3.5	1.0	3.9	9.2	31.3	39.8	15.8
	32. “The theories scientists hold have effects on the process of their exploration in science.”	3.6	1.0	4.6	9.0	27.1	41.9	17.3

*Note: SD: Strongly Disagree; D: Disagree, U: Undecided, A: Agree, SA: Strongly Agree

Regarding the students' responses to the items in non-objective nature sub-scale, results showed that, when agree and strongly agree responses are combined, around 50 % of the students agreed with the items reflecting naïve views about science regarding its subjectivity. For example, 47.5 % of the students thought that "Once scientists have a result from an experiment that is the only answer". On the other hand, 30.4 % of the participants disagreed with this statement. Similarly, while 27.3 % of the students did not agree with the item "Scientists always agree about what is true in science", 49.6 % of them agreed with this statement. Thus, it appeared that although relatively more students view science as objective, there are more than a quarter of the students agreeing with the items reflecting non-objective nature of the science.

Table 4.4 Descriptive statistics of non-objective nature of subscale

				Percentage (%)				
		M	SD	SD*	D*	U*	A*	SA*
Non-objective nature subscale	15. "Scientists pretty much know everything about science; there is not much more to know."	3.6	1.3	8.3	15.3	19.0	21.6	35.7
	22. "Once scientists have a result from an experiment that is the only answer."	3.3	1.3	11.9	18.5	22.1	26.2	21.3
	28. "Scientists always agree about what is true in science."	3.3	1.3	9.7	17.6	22.8	28.9	20.7

*Note: SD:Strongly Disagree,D:Disagree,U:Undecided,A:Agree,SA:Strongly Agree

Participants' responses to changing/ tentative nature subscale revealed that more than a quarter of the students were undecided about each of the items (see Table 4.5). Thus, findings from this subscale should be interpreted with caution. When agree and strongly agree responses were consolidated, it was found that less than half of the students agreed that "The ideas in science books sometimes change" (46.4 %) and "Sometimes scientists change their minds about what is true in science" (47.6 %). The highest percentage of the agreement was on the item that

"Ideas in science sometimes change" (55.4 %). The results in general that, students' views on tentative nature of the science were at moderate levels.

Table 4.5 Descriptive statistics of changing/ tentative nature of subscale

Changing/tentative nature subscale		Percentage (%)						
		M	SD	SD*	D*	U*	A*	SA*
	5. "The ideas in science books sometimes change."	3.3	1.1	7.8	16.8	28.9	32.8	13.6
	12. "Ideas in science sometimes change."	3.5	1.1	6.3	11.1	27.2	35.0	20.4
	19. " Sometimes scientists change their minds about what is true in science."	3.4	1.0	5.3	12.2	34.9	35.0	12.6

*Note: SD:Strongly Disagree,D:Disagree,U:Undecided,A:Agree,SA:Strongly Agree

Regarding Creative nature/Justification sub-scale, participants' appeared to realize the role of creativity in the development of scientific ideas. For example, when agree and strongly agree response were combined, more than a three-quarter of the students (76 %) were found to agree with the statement that "Creativity is important for the growth of scientific knowledge" (see Table 4.6). In addition, the participants appeared to appreciate the role of experimentation in the justification of scientific ideas. For instance, about 72 % of them thought that "A good way to know if something is true is to do an experiment". Moreover, percentage of the undecided responses on the items focusing on the role of experimentation was less compared to rest of the items. On the other hand, less than 60 % of the participants were found to agree with the items related to the role of social negotiation in the justification of scientific ideas.

Table 4.6 Descriptive statistics of creative nature- justification nature of subscale

					Percentage (%)			
	Items	M	SD	SD*	D*	U*	A*	SA*
Creative nature- Justification subscale	6. "Ideas about science experiments come from being curious and thinking about how things work."	3.9	1.1	5.4	6.6	13.6	37.1	37.2
	13. "One important part of science is doing experiments to come up with new ideas about how things work."	4.0	1.2	4.8	8.8	15.1	29.4	41.8
	20. "Good ideas in science can come from anybody, not just from scientists."	3.8	1.2	6.0	8.2	17.3	33.5	35.0
	26. "A good way to know if something is true is to do an experiment."	3.9	1.1	3.9	7.5	17.0	38.1	33.5
	31. "Good answers are based on evidence from many different experiments."	3.7	1.0	3.2	8.8	22.3	41.3	24.3

Table 4.6 (continued)

			Percentage (%)				
Item	M	SD	SD*	D*	U*	A*	SA*
Creative nature - justification subscale							
33. "Ideas in science can come from your own questions and experiments."	3.8	1.0	4.3	6.6	21.3	42.7	25.2
3. "Some accepted scientific knowledge originated from human imagination and hunches."	3.6	1.2	7.4	12.2	19.8	39.4	21.3
10. "The development of scientific theories requires scientists' imagination and creativity."	3.8	1.1	5.8	7.9	21.4	33.2	31.7
17. "Scientists sometimes get ideas from several apparently irrelevant theories."	3.4	1.1	6.7	10.9	30.9	34.4	17.1
24. "Creativity is important for the growth of scientific knowledge."	4.0	1.2	8.2	3.6	12.2	32.4	43.6
4. "New scientific knowledge becomes widely accepted through the recognition of many scientists in the field."	3.5	1.1	5.6	10.2	26.6	39.8	17.8

Creative nature- justification subscale

Table 4.6 (continued)

Items	M	SD	SD*	D*	U*	A*	SA*
			Percentage (%)				
11. "The discussions, debates and result sharing in the science community is one major reason causing the growth of scientific knowledge."	3.7	1.1	4.6	9.0	25.3	36.0	25.0
18. "Valid scientific knowledge requires the acknowledgement of scientists in relevant fields."	3.4	1.1	8.1	12.7	27.0	36.7	15.6
25. "Scientists have agreed upon an acceptable set of standards with which to evaluate scientific findings."	3.4	1.0	4.4	12.8	30.4	39.3	13.0
30. "Through the discussion and debates among scientists, the scientific theories become better."	3.8	1.0	4.3	5.9	21.2	40.6	28.0

*Note: SD: Strongly Disagree; D: Disagree, U: Undecided, A: Agree, SA: Strongly Agree

4.1.2.Middle School Students' Learning Environment Perceptions

"What is Happening in This Class Instrument (WIHIC)" developed on a 5-point Likert scale was used to evaluate participating students' learning environment perceptions. As shown in Table 4.7 the highest mean score belongs to task orientation subscale with a mean of $M = 4.20$. This finding suggests that students are likely to pay attention to activities and try to accomplish them in science classes. However, the lowest mean scores were found to belong to teacher support and investigation subscales. Although, the mean scores were above the mid-point of the 5-point Likert scale for these two dimensions, perceived teacher support and the extent of carrying out investigations in sciences classes appeared to be at moderate levels. The same situation was true for cooperation and involvement sub-scales as well. Students' perceptions of student cohesiveness and equity seemed to be at relatively higher levels.

Table 4.7 Descriptive statistics for learning environment perceptions

Variables	M	SD
"Student cohesiveness"	3,89	.75
"Teacher support"	3,57	.91
"Involvement"	3,66	.83
"Investigation"	3,58	.88
"Task orientation"	4,20	.72
"Cooperation"	3,62	.84
"Equity"	3,86	.90

In the following paragraphs, students' responses to individual items in each sub-scale of the WIHIC were presented in detail. Concerning student cohesiveness sub-scale, as shown in Table 4.8, around half of the students reported that *almost always* "the members of the class are their friends" (51.2 %, item 4), and they are "friendly to the member of the class" (48 %, item 3). When *almost always* and *often* responses were combined on the related items, a great majority of the students appeared to be friendly to each other. On the other hand, students did not appear to help to each other to the same extent. For example, only 28.4 % of the students reported that they *almost always* to "get help from the other students" (item 8) and 36.1 % of them appeared *almost always* to "help the other class members having trouble with their work (item 6)".

Table 4.8 Descriptive statistics of students' cohesiveness subscale

				Percentage (%)				
	Items	M	SD	SD*	D*	U*	A*	SA*
Students' cohesiveness subscale	1. "I make friendships among students in this class."	4.1	1.0	2.7	6.5	14.8	29.6	46.4
	2. "I know other students in this class."	3.9	1.2	3.2	12.4	18.2	21.8	44.4
	3. "I am friendly to the member of this class."	4.1	1.2	3.2	12.4	18.2	21.8	44.4
	4. "The members of the class are my friends."	4.1	1.1	3.6	8.0	13.8	23.5	51.2
	5. "I work well with the other class members."	3.4	1.2	7.1	14.8	35.2	20.1	22.8
	6. "I help the other class members who are having troubles with their work."	3.8	1.2	4.1	11.1	24.5	24.3	36.1
	7. "Students in this class like me."	4.1	1.0	1.5	7.5	16.0	27.4	47.6
	8. "In this class, I get help from the other students."	3.7	1.1	3.7	10.7	30.8	26.4	28.4

*Note: SD:Strongly Disagree,D:Disagree,U:Undecided,A:Agree,SA:Strongly Agree

Regarding teacher support subscale, when *almost always* and *often* responses were consolidated, almost a three-quarter of the students (74.1 %) appeared to perceive that their science teacher "helps them when they have trouble with their work" (item 12). Similar percentages were found for the item 13 and the item 16. Accordingly, based on the students' responses, it appears that science teachers *often* or *almost always* "talks with their students", and their "questions help students to understand". However, only 33.7 % of the students reported that their science teacher "goes out of his/her way to help them" (item 10). According to 21.3 % of the students, their science teacher never demonstrates such a behavior. Actually, this item had the lowest mean in this sub-scale.

Table 4.9 Descriptive statistics of teacher support subscale

				Percentage (%)				
	Items	M	SD	SD*	D*	U*	A*	SA*
Teacher support subscale	9. "The teacher takes a personal interest in me."	3.2	1.3	13.3	17.2	29.1	18.0	22.4
	10. "The teacher goes out of his/ her way to help me."	2.9	1.4	21.3	22.1	23.0	16.2	17.5
	11. "The teacher considers my feelings."	3.6	1.3	7.8	14.5	23.6	21.1	33.0
	12. "The teacher helps me when I have trouble with the work."	4.1	1.1	2.9	8.7	14.3	21.9	52.2
	13. "The teacher talks with me."	4.0	1.1	3.2	7.8	18.0	26.0	44.9
	14. "The teacher is interested in my problems."	3.7	1.2	6.0	11.2	23.6	22.4	36.7
	15. "The teacher moves about the class to talk with me."	3.0	1.3	14.1	21.8	28.1	16.2	19.9
	16. "The teacher's questions help me to understand."	4.0	1.1	3.7	7.5	17.3	26.6	44.9

*Note: SD:Strongly Disagree,D:Disagree,U:Undecided,A:Agree,SA:Strongly Agree

The item level analysis of the items in the involvement subscale (see table 4.10) revealed that the largest items mean belonged to the items 18, 19 and 21 respectively. Item 18 is "I give my opinions during class discussion" and item 19 is "The teacher asks me questions" and item 21 is "I ask the teacher questions". Most of the participating students selected *almost always option* on these items (43.0%, 36.9%, and 36.2% respectively). In addition, when *almost always* and *often* options were combined 61.1 % of the students were found to discuss their ideas in science classes almost always or often (item 17). On the other hand, the lowest mean was obtained on the item 23 "Students discuss with me how to go about solving problems". About 10 % of the students selected *never* option, and 17.9 % of them selected seldom option on this item. In addition, the item 20 "My ideas and suggestions are used during classroom discussions" had the next lowest mean. Around 8 % of the students selected *never* option, and 14.5 % of them selected seldom option. Thus, it appeared that although students tend to participate in science classes, they perceive that discussions among students about how to solve the problems are not frequent and their ideas are not likely to be used in the discussions.

Table 4.10 Descriptive statistics of involvement subscale

				Percentage (%)				
	Items	M	SD	SD*	D*	U*	A*	SA*
Involvement subscale	17. "I discuss ideas in class."	3.8	1.2	5.6	11.6	21.8	20.1	41.0
	18. "I give my opinions during class discussion."	3.9	1.2	4.8	11.4	18.4	22.4	43.0
	19. "The teacher asks me questions."	3.9	1.0	1.9	6.6	24.0	30.6	36.9
	20. "My ideas and suggestions are used during classroom discussions.	3.4	1.2	8.3	14.5	27.0	24.3	25.9
	21. "I ask the teacher questions."	3.9	1.1	3.1	8.2	25.9	26.7	36.2
	22. "I explain my ideas to other students."	3.7	1.2	5.1	12.6	21.4	26.2	34.7
	23. "Students discuss with me how to go about solving problems."	3.3	1.3	10.2	17.9	29.4	20.7	21.8
	24. "I am asked to explain how I solve the problems."	3.4	1.3	10.5	15.3	26.4	22.3	25.5

*Note: SD:Strongly Disagree,D:Disagree,U:Undecided,A:Agree,SA: Strongly Agree

In the investigation subscale, the item 31 “I found out investigations to answer the teacher’s questions” and the item 32 “I solve problems by using information obtained from my own investigation” had the largest means. More than 60% of the participating students selected *often* or *almost always* options on these items (63.9% and 62.2% respectively). On the other hand, the lowest mean in the investigation subscale belongs to the item 26 which is “I am asked to think about the evidence of statements”. About 13 % of the students selected *never* option on this item. In general, in this sub-scale, the mean scores of items ranged from 3.2 to 3.8 which were all above the mid-point of the 5-point likert scale. Thus, it appeared that students tend to carry out investigation and solve problems at moderate levels in science classes. Descriptive statistics for the investigation subscale items are presented in the Table 4.11.

Table 4.11 Descriptive statistics of investigation subscale

				Percentage (%)				
	Items	M	SD	SD*	D*	U*	A*	SA*
Investigation subscale	25. “I carry out investigations to test my ideas.”	3.6	1.3	7.5	13.6	23.5	25.5	29.9
	26. “I am asked to think about the evidence of statements.”	3.2	1.3	12.9	17.3	28.4	21.1	20.2
	27. “I carry out investigations to answer the questions that puzzle me.”	3.4	1.3	10.9	15.0	26.7	18.4	29.1
	28. “I explain the meaning of statements, diagrams and graphs.”	3.4	1.3	7.7	15.8	27.9	21.8	26.9
	29. “I carry out investigations to answer questions that puzzle me.”	3.7	1.1	3.1	11.6	24.9	27.9	32.4
	30. “I carry out investigations to answers the teacher’s questions.”	3.7	1.1	3.6	9.5	28.1	28.6	30.3

Table 4.11 (continued)			Percentage (%)				
Items	M	SD	SD*	D*	U*	A*	SA*
31. "I found out answers to questions by doing investigations."	3.8	1.1	3.1	9.2	23.8	29.9	34.0
32. "I solve problems by using information obtained from my own investigations."	3.8	1.1	4.4	10.4	23.0	29.9	32.3

*Note: SD:Strongly Disagree,D:Disagree,U:Undecided,A:Agree,SA:Strongly Agree

Concerning task orientation sub-scale, the item means ranged from 4.0 to 4.4 which were all well-above the mid-point of five-point Likert scale. The largest mean was obtained on the item 37 "I know what I am trying to accomplish in this class". A great majority of the participants (83.2 %) selected *almost always* or *often* options on this item (see table 4.12). Although, the item 33 "Getting a certain amount of work done is important to me" had the lowest mean, approximately three-quarter of the students selected *almost always* or *often* options on this item. Thus, in general, results revealed that students tend to be aware of the goals for the science classes and what they are trying to achieve as well as they tend to stay on the tasks.

Table 4.12 Descriptive statistics of task orientation subscale

				Percentage (%)				
	Items	M	SD	SD*	D*	U*	A*	SA*
Task orientation subscale	33. "Getting a certain amount of work done is important to me.	4.0	1.1	3.7	7.5	16.2	25.9	46.8
	34. "I do as much as I set out to do."	4.1	1.1	3.9	5.4	17.5	25.2	48.0
	35. "I know the goals for this class."	4.2	1.1	3.7	6.0	12.2	22.8	55.3
	36. "I am ready to start this class on time."	4.1	1.1	3.4	4.6	17.2	23.8	51.0
	37. "I know what I am trying to accomplish in this class."	4.4	1.0	2.7	3.9	10.2	22.3	60.9

Table 4.12 (continued)			Percentage (%)				
Items	M	SD	SD*	D*	U*	A*	SA*
38. "I pay attention during this class."	4.1	0.9	1.2	3.7	12.8	27.9	54.4
39. "I try to understand the work in this class."	4.3	0.9	1.7	3.7	11.7	28.2	54.6
40. "I know how much work I have to do."	4.2	1.0	2.0	5.1	13.8	26.0	53.1

*Note: SD:Strongly Disagree,D:Disagree,U: Undecided,A:Agree,SA:Strongly Agree

In cooperation subscale, the item 43, which is "when I work in groups in this class, there is teamwork" had the largest mean. Approximately 66 % of the students chose almost always or often options on this item. In this subscale, item 45 which is "I learn from other students in this class" also had high item means close to the largest one. For this item, 63.5% of the participating students selected almost always or often responses. Overall, item means ranged from 3.3 to 3.9. The lowest mean belong to the item 48 "Students work with me to achieve class goals". While 9.7 % of the students selected never option, 14.3 % of them selected seldom option on this item. A similar pattern was observed on the item 41, as well. In general, results suggested that cooperation among the students during science activities were at moderate levels.

Table 4.13 Descriptive statistics of cooperation subscale

				Percentage (%)				
	Items	M	SD	SD*	D*	U*	A*	SA*
Cooperation subscale	41. "I cooperate with other students when doing assignments work."	3.4	1.2	8.8	13.8	29.4	23.0	25.0
	42. "I share my books and resources with other students when doing assignments."	3.7	1.2	6.0	9.2	26.7	27.9	30.3
	43. "When I work in groups in this class, there is teamwork."	3.9	1.2	4.4	9.5	19.7	24.1	42.2

Table 4.13 (continued)				Percentage (%)				
	Items	M	SD	SD*	D*	U*	A*	SA*
Cooperation subscale	44. "I work with other students on projects in this class."	3.7	1.2	5.8	12.2	24.3	26.5	31.1
	45. "I learn from other students in this class."	3.8	1.1	3.7	9.7	23.1	30.8	32.7
	46. "I work with other students in this class."	3.6	1.2	5.4	12.2	28.9	27.7	25.7
	47. "I cooperate with other students on class activities."	3.6	1.2	6.3	11.7	25.5	26.5	29.9
	48. "Students work with me to achieve class goals."	3.3	1.2	9.7	14.3	31.3	23.5	21.3

*Note: SD:Strongly Disagree,D:Disagree,U: Undecided,A:Agree,SA:Strongly Agree

In equity subscale, the item 49, which is "the teachers give as much attention to my questions as to other students' questions" and the item 56 which is "I get the same opportunity to answer questions as other students" had the largest means. Approximately half (46.9%and 44.0%) of the students selected *almost always* option on these items. The highest percentage on the *never* option (7.1 %) was obtained for item 55 "My work receives as much as praise as other students' work". About 63 % of the students selected *almost always* or *often* option on this item. In general, according to the results based on students' responses, students tend to be treated in a similar way and have equal opportunities to contribute to discussions in science classes. Descriptive statistics for the equity subscale are presented in the Table 4.14.

Table 4.14 Descriptive statistics of equity subscale

				Percentage (%)				
	Items	M	SD	SD*	D*	U*	A*	SA*
Equity subscale	49. "The teachers give as much attention to my questions as to other students' questions."	4.0	1.2	4.8	9.2	16.2	23.0	46.9
	50. "I get the same amount of help from the teacher as do other students."	3.8	1.3	6.5	12.6	17.7	25.0	38.3

Table 4.14 (continued)

	Items	M	SD	Percentage (%) SD*	D*	U*	A*	SA*
Equity subscale	51. "I have the same amount of sat in this class as other students."	3.9	1.2	5.1	9.9	18.9	25.7	40.5
	52. "I am treated the same encouragement from the teacher as other students."	3.9	1.2	5.6	8.5	18.5	23.5	43.9
	53. "I receive the same encouragement from the teacher as other students do."	3.9	1.2	4.3	9.5	17.7	27.9	40.6
	54." I get the same opportunity to contribute to class discussions as other students."	3.7	1.2	7.8	8.7	21.6	26.5	35.4
	55. "My work receives as much as praise as other students' work."	3.7	1.1	7.1	9.9	19.9	28.4	34.7
	56. "I get the same opportunity to answer questions as other students."	4.0	1.1	3.9	8.2	18.9	25.0	44.0

*Note: SD:Strongly Disagree,D:Disagree,U: Undecided,A:Agree,SA:Strongly Agree

4.2.Inferential Statistics

4.2.1.Multivariate Analysis of Variance

A two-way multivariate analysis of variance (MANOVA) was performed to examine gender and grade level effects on students' views on different tenets of NOS (i.e., "theory-laden /cultural impacts, non-objective nature, changing/tentative nature, and creative nature/justification"). Prior to the analysis, underlying assumptions of MANOVA were checked and it was found that the homogeneity of variance-covariance matrices (Box's M = 22.85, p > .05) assumption was satisfied. Examination of skewness and kurtosis values, mahalanobis distances, standardized scores, and bivariate correlations suggested that normality, absence of outliers and multicollinearity assumptions were also met. Scatter plot also provided evidences for linearity. After checking the assumptions, MANOVA was carried out. In order to control for Type I error, adjustment was made in alpha level, and results were evaluated against new alpha level of .0125 obtained by dividing alpha level of .05 by number of dependent variables which was 4. Results showed that there were no significant main effects of gender (Wilk's lambda = .982, F (4, 581) = 2.62, p > .0125) and grade level (Wilk's lambda = .994, F (4, 581) = .948, p > .0125). In addition, interaction effect was not significant (Wilk's lambda = .997, F (4, 581) = .389, p > .0125).

4.2.2.Canonical Correlation Analysis

A canonical correlation analysis was conducted between the set of learning environment variables and the set of NOS views variables. Before carrying out the analysis, underlying assumptions of normality, linearity, homoscedasticity, absence of outliers, multicollinearity assumptions were checked. No serious violations of the assumptions were found as revealed by examination of skewness and kurtosis values, mahalanobis distances, standardized scores, bivariate correlations, and scatterplots. Table 4.15 presents bivariate correlations among the variables.

Table 4.15 Correlations of the Measured Variables

Variables	1	2	3	4	5	6	7	8	9	10	11
1. Student cohesiveness	1										
2. Teacher support	.47**	1									
3. Involvement	.56**	.63**	1								
4. Investigation	.44**	.48**	.65**	1							
5. Task orientation	.44**	.46**	.50**	.55**	1						
6. Cooperation	.59**	.42**	.53**	.56**	.51**	1					
7. Equity	.45**	.53**	.55**	.54**	.62**	.64**	1				
8. Theory-laden /Cultural impacts	.20**	.19**	.23**	.23**	.28**	.20**	.21**	1			
9. Changing/tentative nature	.09*	.09*	.19**	.09*	.07	.12**	.11**	.31	1		
10. Non-objective nature	.-.03	.03	.05	.01	.14**	-.05	.08	.08*	.05	1	
11. Creative nature/Justification	.22**	.19**	.22**	.20**	.34**	.18**	.20**	.75**	.34**	.17**	1

Note. * $p < .05$. ** $p < .01$

The canonical correlation analysis results showed that the first canonical correlation was .37 (14% overlapping variance). The first canonical variate revealed significant relationships between the two sets of variables. With all four canonical correlations included $\chi2(28) = 120.004$. Data on the first canonical variate is shown in Table 4.16 and displayed as a path diagram in Figure 4.1. As demonstrated in the table and the figure, when 0.30 is considered as a cut-off correlation (Tabachnick & Fidell, 1996), all the learning environment variables were found to be correlated with the first canonical variates. The first canonical variate was positively associated with all these variables. Likewise, all NOS views variables, except for tentative were found to be positively correlated with the first canonical variate.

Table 4.16 Correlations and standardized canonical coefficients

	First Canonical Variate	
Variables	Correlation	Coefficient
Learning environment variables		
"Student cohesiveness"	.54	.17
"Teacher support"	.51	.00
"Involvement"	.60	.19
"Investigation"	.54	.04
"Task orientation"	.97	.96
"Cooperation"	.42	.22
"Equity"	.57	.04
NOS views variables		
"Theory-laden /Cultural impacts"	.79	.22
"Changing/tentative nature"	.19	.16
"Non-objective nature"	.41	.26
"Creative nature/Justification"	.95	.80
Canonical correlation	.37	

The first pair of canonical variates showed that as students perceive the learning environment in their science classes as teacher supportive, cooperative, emphasizing investigation and active student involvement, providing equal opportunities to express ideas, and supporting student cohesiveness, they tend to hold more sophisticated views on all tenets of NOS except for tentativeness. More specifically, these students appeared to have a better understanding of the role of social and cultural influences as well as scientists' theoretical commitments, experiences, and expectations in the scientific practice. They also appeared to hold more sophisticated view about non-objective nature of science, the role of experimentation, and scientific community in the justification of scientific ideas, and the role of creativity in the development of scientific knowledge.

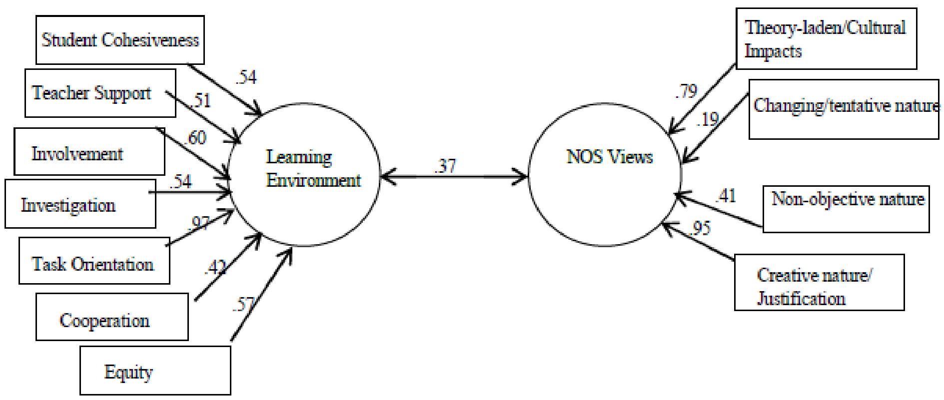

Figure 4.1 The path diagram for the first canonical variate

4.3.Summary of the findings

Descriptive statistics related to students' NOS views showed that, all the mean scores on NOS tenets were greater than mid-point of the 5-point Likert scale and comparable across both genders and grade levels. However, there was no mean score around 5; more specifically none of the mean scores exceeded 4. These findings suggest that middle school students tend to agree, although not at high levels, with the views that scientific knowledge is changeable, scientists' work is affected by their theoretical commitments, beliefs, and experiences as well as the cultural influences, creativity plays an important role in the development of scientific ideas, and justification of scientific ideas involve experimentation and social negotiation.

Two-Way MANOVA results revealed that there was no gender and grade level difference with respect to NOS views.

According to the descriptive findings concerning students' learning environment perceptions, the highest mean score was obtained on the "task orientation" sub-scale (M = 4.20) and the lowest mean scores were found to belong to "teacher support" (M = 3.57) and "investigation" (M = 3.58) subscales.

The canonical correlation analysis results indicated that all learning environment perception variables (i.e., "cohesiveness, teacher support, investigation, involvement, task orientation, cooperation and equity") were positively related to the students' views on all NOS tenets except for "changing/tentative" nature of science.

CHAPTER 5

CONCLUSIONS, DISCUSSIONS AND IMPLICATIONS

This chapter consists of 4 sections. First section presents the summary of the research study and the second section summarizes the conclusions based on the results. The third section provides a discussion the results and implications of the study. The last section offers recommendations for further studies.

5.1.Summary of the Research

In the present study, the effects of gender and grade level on middle school students' nature of science views ("theory-laden/cultural impacts", "non-objective nature", "changing/tentative nature", and "creative nature/justification"), and the relationship between learning environment perceptions and nature of science views were examined. For the specified purposes, 608 middle school students (7^{th} and 8^{th} grade) were administered the Background Characteristics Survey, "The Students' Views of Nature of Science (SVNOS)" and "What is Happening in this Class (WIHIC)" instruments. The SVNOS was adapted for Turkish middle school students in the current study. Data obtained from the administration of the instruments were analyzed through two-way MANOVA and Canonical correlation analysis

5.2.Conclusions

The findings of the present study revealed that although the students' views on nature of science were not naive on all NOS tenets, the students' views on NOS were not highly sophisticated either. According to two-way MANOVA results, there were no significant main effects of gender and grade level on students' NOS views. Canonical correlation analysis results indicated that except for tentativeness subscale, all the SVNOS sub-scale scores were positively correlated with scores on the learning environment perception variables.

5.3.Discussions and Implications of the Results

In the current study, middle school student' views of nature of science were investigated in relation to their gender, grade level, and classroom environment perceptions. Students' NOS views were explored using the SVNOS constructed by Lin et al., (2013). Original version of the SVNOS consists of 33-items in 7 sub-scales (i.e., cultural impacts, theory-laden, creative nature, non-objective nature, changing/tentative nature, social negotiation, and justification. However, in the current study, 4-factor structure provided a good fit with reasonable internal consistencies. At this point it is important to note that the original version of VNOS was developed using the items and scales from existing instruments (Tsai & Liu, 2005; Chai et al., 2010; Conley et al., 2004). In the current study, consistent with the study of Chai et al., (2010), consolidation of theory-laden and cultural impacts sub-scales into a single factor resulted in a better model. In addition, according to results creative nature, social negotiation, and justification were highly correlated suggesting that they all measure the same construct. Thus, these 3 subscales were also merged and considered as a single factor. This factor was named as creative nature/justification. Social negotiation was not included in the factor name, because it was considered as a part of justification: As indicated by Hodson (1991), scientific knowledge is produced as a result of a complex social activity leading to and following individual attempts of discovery or creation. Thus, an individual scientists' confidence in new experimental findings or new theoretical propositions is not adequate to launch it as a part of the body of scientific knowledge. It must be subject to confirmation by other researchers (Allen & Baker, 2017). In sum, in the current study, SVNOS was used in four dimension namely, theory-laden and cultural impacts, non-objective nature, changing/tentative nature, and creative nature-justification.

Descriptive findings concerning students NOS views as measured by the SVNOS suggested that middle school students' NOS views were not highly sophisticated. This finding was consistent with relevant literature (Khishfe & Abd-El-Khalick, 2002; Khishfe, 2008; Akerson & Donnelly, 2010). According to the studies, science textbooks may be one of the reasons why students fail to develop highly sophisticated NOS views (Bell, 2004; Irez, 2009; Abd-El-Khalick, Waters & Le, 2008; Izci, 2017). For example Izci (2017) investigated the appropriateness of 7th grade science textbooks to the curriculum objectives about NOS aspects such as "empirical, tentative, inferential, creative, theory-laden, social and cultural embeddedness of science, nature of theories and laws". Findings showed that scientific "theories and laws" aspect was not mentioned in the textbooks. Also, inferential and theory-laden aspects were not directly addressed but these aspects were implicitly mentioned. Some middle school science education textbooks were not suitable for students to develop sophisticated understanding about NOS. Second reason for students' inadequate NOS views may be parents' education level. For example, Yankayış et al., (2014), examined middle school students' understanding of NOS according to demographic variables such as grade level, academic success and educational level of parents. The findings revealed that NOS views significantly differ among students having parents with different educational level. In addition, students of teachers who have inadequate NOS views are likely to have NOS views which are not highly sophisticated. The related studies showed that teachers tend to hold inadequate NOS views (Akerson et al., 2000; Akerson & Hanuscin, 2007; Köksal & Çakiroğlu, 2010). For example, Köksal and Çakiroğlu (2010) examined science teachers' understanding of NOS concepts and findings revealed that science teachers held naive understanding of some NOS aspects such as relationship between theory and law, but teachers held more sophisticated understanding on creativity and imagination aspect. According to relevant literature, even teachers with sophisticated NOS views may not translate their views into classroom practices effectively (e.g. Akerson & Abd-El-Khalick, 2003; Lederman, 1999). In the current study, although the students' views on nature of science were highly sophisticated on all NOS tenets, their views were not highly naive either. Considering aforementioned national and international literature, and context of this study, these three factors, namely science textbooks, parents' educational level and science teachers' NOS views, all, are likely to be influential in the present findings. Future studies, can also examine these role of these factors in students' NOS views in detail.

Examination of middle school students' views on NOS with respect to gender and grade level using the SVNOS revealed that there were no significant gender and grade level differences consistent with the hypothese stated in the introduction section. As pointed out by Deng et al., (2011), the relevant research concerning gender and grade level differences produced inconclusive results: some studies revealed significant gender and grade level differences with respect to some of the dimensions of NOS (e.g. Huang, Tsai, & Chang, 2005; Lin et al., 2013). On the other hand, some others demonstrated that there is no gender difference (e.g. Hacıeminoglu, et al., 2014) or grade level differences vary across grades (e.g. Ozdem-Yılmaz, et al., 2010). In the present study, the non-significant grade level effect can be explained as follows: the data were collected only from Grade 7 and Grade 8 students. If students from higher or lower grade levels were also included in the sample, significant differences might have been found. Because, as indicated by Hofer (2001), students' educational experiences can be influential in the development of their epistemic beliefs. This effect may be either positive or negative. The findings of the studies exploring age-related trends in NOS views in western countries generally revealed a positive developmental trend with the increase in experience or age (Lin et al., 2013). On the other hand, Asian students seemed to demonstrate a reversed trend (Chai et al., 2012; Lin et al., 2013). Concerning the gender difference, Pintrich (2002) proposed that if (scientific) epistemological beliefs are examined focusing on specific dimensions rather than considering it as general, holistic ways of thinking, gender differences may not emerge. Consistent with this idea, and some of the studies in the literature (e.g. Conley et al., 2004) current study revealed non-significant gender difference with respect to NOS views.

Current study also investigated the relationship between middle school students' classroom environment perceptions and their views on nature of science. Students' learning environment perceptions were measured by WIHIC. According to the results, all dimensions of the WIHIC (i.e. “student cohesiveness, teacher support, involvement, investigation, task orientation, cooperation, and equity") were significantly linked to all dimensions of the SVNOS except for tentativeness. This was, in general, an expected finding because related literature suggested that specific instructional activities and behaviors implemented in a classroom greatly influence students’ views on nature of science (Hofer, 2001; Lederman, 1992). The study conducted by Lederman and Druger (1985) showed that supportive learning environments emphasizing inquiry oriented instruction are likely to contribute to a better understanding of NOS. In a more recent study, Martin-Dunlop (2013) found significant, positive bivariate correlations between students’ understanding of NOS and positive classroom learning environments supporting student cohesiveness, instructor support, investigation, cooperation, open-endedness, and presence of adequate material. Qualitative results also indicated that in classroom environments where students cooperate with each other and deal with laboratory activities requiring open-ended divergent approach during experimentation were linked to better understanding of NOS. Thus, the positive links found in the current study, between sophisticated NOS views and favorable learning environment perceptions; revealing the emphasis on active student involvement, open-ended investigations, task orientation, student cooperation, treating all students equally, and teacher support; are consistent with available literature. Indeed, due to abstractness of NOS, it may be difficult for students to develop sophisticated views on NOS in classroom environments where memorization and laboratory activities focusing on convergent thinking are emphasized (Martin-Dunlop, 2013). Actually, the study conducted by Chai et al., (2012), suggested an important finding that the influence of learning environment may not be always conducive to the development of sophisticated views of NOS depending on students’ classroom experiences. Thus, based on the current findings, supporting available literature, science teachers are advised to create student-centered learning environments where students are actively involved in open ended tasks working in cooperative groups. In order to keep students on task, the activities should be interesting and evoke their curiosity. In addition, during their investigations, students should be able to feel that they have equal opportunities to express their ideas. During all these processes, teachers should be supportive. While designing the instruction in line with these suggestions, science teachers can benefit from history of science. As pointed out by Matthews (2015), history of science can be useful for science teachers suggesting them questions and experiments conducive to development of more sophisticated view of NOS. For example, students can re-do the original experiments and apart from discussing their own findings, they can be encouraged to consider historical elucidations and discussions about the experiments (Matthews, 2015). In this way, they can better understand the tenets of nature of science including “theory-laden nature, social negotiation, cultural impacts, creativity, tentativeness, justification, and non-objective nature”. At this point it is important to note that as argued by Hodson (1991), science education mainly emphasizes attainment and comprehension of scientific concepts and theories and a general gratitude to scientific methods and processes. However, relatively less attention is given to the role of creativity in formulating hypotheses and designing experiments, and even less to role of social negotiation. Indeed, Lederman (1999) found that high school biology students assign limited roles to creativity imagination, and subjectivity in the development of science. The author concluded that as a starting point, students should be involved in scientific inquiry but they should also be provided with opportunities to make discussions and reflections about their investigations making nature of science more explicit. Similarly, Moss (2001) concluded that without making NOS explicit, implementing project-based and hands-on science courses were not sufficient to change students’ NOS views. In addition, recently, McComas and Noushin (2016), reported that there is a lack of or little emphasis of Next Generation Science Standards (NGSS) on some commonly suggested NOS aspects including creativity and subjectivity Thus, while delivering the instruction designed to improve students view on NOS, science teachers should be careful about these issues employing explicit-reflective approach. For example, while discussing the historical cases, students should be encouraged to realize that socio-cultural influences are important in the development and justification of scientific ideas.

At this point, it is also important to note that, in the current study, the relation between students’ learning environment perceptions and their views on tentative nature of science was found to be non-significant. One explanation for this finding may be that some students may think that scientific knowledge is produced as a result of rigorous scientific activity and their investigations in the classroom may not reflect this rigorous activity well. In other words, they may have a thought that as 'naive scientists' it may not be unusual for them to change their ideas based on new evidences. On the contrary, they may also think that, because the scientific knowledge requires rigorous scientific activities of 'real' scientists, it is not likely to change. If this is the case, again integrating historical cases to science instruction making the tentative nature of science explicit may be helpful. However, the explanation provided regarding the non-significant relation between learning environment perceptions and tentative nature of NOS is speculative and warrants further research.

In sum, current findings suggested that middle school student' NOS views are related to their classroom environment perceptions but not their gender or grade level. Accordingly, this study provided some explicit suggestions for science teachers about how they can structure their science classes so that students have more sophisticated views on nature of science.

5.4.Recommendations for Further Researches

In the present study, Likert type, self-report scales were utilized as data collection instruments to be able to access a larger sample size leading to more generalizable results. Based on the results, this study provides some explicit suggestions about how science classes can be structured so that students acquire a better understanding of nature of science. However, although self-report instruments allow researchers to access more participants, and obtain more generalizable findings, the participants' responses may not truly reflect their actual views or perceptions. Thus, in future studies, qualitative data collection techniques such as observations and interviews can be used to ensure validity of the findings and to examine students NOS views and classroom environments they experience in detail. For example, classroom observation and interviews with students and their teachers can provide a clearer picture of the relation between these two variables.

Furthermore, as indicated in the discussion part, teachers' NOS views can be influential in the development of students' NOS views. Accordingly, in future studies, the role of science teachers' NOS views in the students' NOS views can be examined both quantitatively and qualitatively. In quantitative studies, the data can be collected from both teachers and their students and the obtained data can be analyzed using hierarchical linear modeling (HLM). In qualitative part, science teachers' classroom practices in relation to emphasis on NOS tenets can be observed in detail and their lesson plans can be examined. Moreover, interviews can be conducted both with teachers and their students. Also, the role of home environment on the development of students' NOS views can be studies in the following studies.

In addition, in the current study, the reliability coefficient of tentativeness sub-scale, although it was greater than the criterion suggested by Hatcher and Stepanski (1994), was relatively low. Because the content validity of this sub-scale was ensured by the expert opinions in this study, the data from this sub-scale were included in the analyses. However, in the future studies, because reliability is affected by the number of items, additional items can be constructed to improve the reliability of this sub-scale.

Finally, the study can be replicated with students from different grade levels and in different locations to demonstrate the generalizability of the findings across different settings and context.

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APPENDICES

HUMAN SUBJECTS ETHICS COMMETTEE APPROVAL

UYGULAMALI ETİK ARAŞTIRMA MERKEZİ
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01 EYLÜL 2016

Sayı: 28620816 / 370

Konu: Değerlendirme Sonucu

Gönderilen: Prof.Dr. Semra SUNGUR
İlköğretim Bölümü

Gönderen: ODTÜ İnsan Araştırmaları Etik Kurulu (İAEK)

İlgi: İnsan Araştırmaları Etik Kurulu Başvurusu

Sayın : Prof.Dr. Semra SUNGUR

Danışmanlığını yaptığınız yüksek lisans öğrencisi Ebru EBREN'in "İlköğretim öğrencilerinin bilimsel okur-yazarlığının incelenmesi" başlıklı araştırması İnsan Araştırmaları Kurulu tarafından uygun görülerek gerekli onay **2016-EGT-128** protokol numarası **19.09.2016-30.06.2017** tarihleri arasında geçerli olmak üzere verilmiştir.

Bilgilerinize saygılarımızla sunarız.

Prof. Dr. Canan SÜMER
İnsan Araştırmaları Etik Kurulu Başkanı

Prof. Dr. Meliha ALTUNIŞIK
İAEK Üyesi

Prof. Dr. Ayhan SOL
İAEK Üyesi

Prof. Dr. Mehmet UTKU
İAEK Üyesi

Prof. Dr. Ayhan Gürbüz DEMİR
İAEK Üyesi

Yrd .Doç .Dr. Pınar KAYGAN
İAEK Üyesi

Yrd. Doç. Dr. Emre SELÇUK
İAEK Üyesi

BACKGROUND CHARACTERISTIC SURVEY

Değerli öğrenciler,

Bu çalışmada, sizlerin Fen Bilimlerine karşı görüşlerinizi belirlenmesi amaçlanmıştır. **Lütfen her cümleyi okuduktan sonra, size uygun olan seçeneği <u>mutlaka</u> işaretleyiniz.**

Katkılarınızdan dolayı teşekkür ederim.

Ebru EBREN
ODTÜ Eğitim Fakültesi
İlköğretim Bölümü, Yüksek Lisans Öğrencisi

1.Bölüm: Kişisel Bilgiler

1.Cinsiyetiniz nedir? ❑ Erkek ❑Kız 2. Kardeş sayısı: …… 3. Doğum tarihiniz (Yıl olarak belirtiniz): ……………………… 4. Geçen dönemki Fen Bilimleri dersi karne notunuz: ………… 5. Okulunuzun adı: .... 6. Şubeniz : ❑7A ❑ 7B ❑7C ❑7D ❑7E ❑7F ❑7G ❑ 7 ❑8A ❑ 8B ❑8C ❑8D ❑8E ❑8F ❑8G ❑ 8 7. Anneniz çalışıyor mu? ❑ Çalışıyor ❑ Çalışmıyor ❑ Düzenli bir işi yok ❑ Emekli 8. Babanız çalışıyor mu? ❑ Çalışıyor ❑ Çalışmıyor ❑ Düzenli bir işi yok ❑ Emekli 9. Ne kadar sıklıkla eve gazete alıyorsunuz? ❑ Hiçbir zaman ❑Bazen ❑Her zaman	Anne ve babanızın eğitim düzeyi nedir? 10. Anne: ❑ Hiç okula gitmemiş ❑ ilkokul ❑Ortaokul ❑ Lise ❑ Üniversite ❑ Yüksek Lisans ❑ Doktora 11. Baba: ❑ Hiç okula gitmemiş ❑ ilkokul ❑Ortaokul ❑ Lise ❑ Üniversite ❑ Yüksek Lisans ❑ Doktora 12 Evinizde bir çalışma odanız var mı? ❑ Evet ❑ Hayır 13 Evinizde bilgisayarınız var mı? ❑ Evet ❑ Hayır 14 Bilgisayarınızın internet bağlantısı var mı? ❑ Evet ❑ Hayır 15. Evinizde kaç tane kitap bulunuyor? (Magazin dergileri, gazete ve okul kitapları **dışında**) ❑ Hiç yok ya da çok az (0 - 10) ❑ 11 – 25 tane ❑ 26 – 100 tane ❑ 101 – 200 tane ❑ 200 taneden fazla

STUDENTS' VIEWS OF NATURE OF SCIENCE (SVNOS) QUESTIONNAIRE (IN TURKISH)

2.Bölüm

Aşağıda verilen her bir ifadeyi dikkatli bir şekilde okuduktan sonra, sizi en iyi ifade ettiğini düşündüğünüz rakamı işaretleyiniz. Unutmayın, doğru ya da yanlış cevap yoktur. Yapmanız gereken düşüncelerinizi en iyi tanımlayacak rakamı işaretlemenizdir.

	Kesinlikle Katılmıyorum	**Katılmıyorum**	**Kararsızım**	**Katılıyorum**	**Kesinlikle Katılıyorum**
1.Bilimde, bütün soruların tek bir doğru yanıtı vardır.	1❑	2❑	3❑	4❑	5❑
2.Bilim insanlarının araştırma faaliyetleri, benimsedikleri teorilerden etkilenir.	1❑	2❑	3❑	4❑	5❑
3.Kabul gören bazı bilimsel bilgiler, insanların hayal gücünden ve önsezilerinden ortaya çıkmıştır.	1❑	2❑	3❑	4❑	5❑
4.Yeni bir bilimsel bilgi, alandaki pek çok bilim insanı tarafından tanındığı zaman geniş çapta kabul görür.	1❑	2❑	3❑	4❑	5❑
5.Bilimsel kitaplardaki bilgiler bazen değişir.	1❑	2❑	3❑	4❑	5❑
6.Bilimsel deneylerdeki fikirler, olayların nasıl meydana geldiğini merak edip düşünerek ortaya çıkar.	1❑	2❑	3❑	4❑	5❑
7.Bilimsel bilginin değeri, farklı kültürlerden gelen insanlar için farklıdır.	1❑	2❑	3❑	4❑	5❑
8.Doğruluğu kesin olan bir yanıta ulaşmak, bilimsel çalışmaların en önemli parçasıdır.	1❑	2❑	3❑	4❑	5❑
9.Bilim insanları, doğayı incelerken, benimsedikleri teoriler doğrultusunda etkili yöntemleri seçerler.	1❑	2❑	3❑	4❑	5❑

	Kesinlikle Katılmıyorum	Katılmıyorum	Kararsızım	Katılıyorum	Kesinlikle Katılıyorum
10.Bilimsel teorilerin gelişmesi, bilim insanlarının hayal gücü ve yaratıcılığını gerektirir.	1❑	2❑	3❑	4❑	5❑
11.Bilimsel bilginin gelişmesinin başlıca sebebi; bilim topluluğundaki görüşme, tartışma ve sonuç paylaşımıdır.	1❑	2❑	3❑	4❑	5❑
12.Bilimdeki düşünceler bazen değişir.	1❑	2❑	3❑	4❑	5❑
13.Olayların nasıl meydana geldiği hakkında yeni fikirler bulmak için deneyler yapmak, bilimsel çalışmanın önemli bir parçasıdır.	1❑	2❑	3❑	4❑	5❑
14.Farklı kültürlerdeki bilim insanları, doğadaki olayları yorumlarken farklı bilimsel yöntemleri kullanabilir.	1❑	2❑	3❑	4❑	5❑
15.Bilim insanları bilim hakkında hemen hemen her şeyi bilir, yani bilinecek daha fazla bir şey kalmamıştır.	1❑	2❑	3❑	4❑	5❑
16.Farklı teorileri benimseyen bilim insanları, aynı doğa olayı hakkında tamamen farklı gözlemler yapabilir.	1❑	2❑	3❑	4❑	5❑
17.Bilim insanları bazen görünüşte alakasız olan birçok teoriden fikir alırlar.	1❑	2❑	3❑	4❑	5❑
18.Bilimsel bilginin geçerli olabilmesi için, alandaki bilim insanları tarafından kabul görmesi gerekir.	1❑	2❑	3❑	4❑	5❑
19.Bilim insanları, bilimde neyin doğru olduğu ile ilgili düşüncelerini bazen değiştirirler.	1❑	2❑	3❑	4❑	5❑

	Kesinlikle Katılmıyorum	**Katılmıyorum**	**Kararsızım**	**Katılıyorum**	**Kesinlikle Katılıyorum**
20.Bilimdeki, parlak fikirler sadece bilim insanlarından değil, herhangi birinden de gelebilir.	1❑	2❑	3❑	4❑	5❑
21.Bilimsel bilginin gelişimi farklı kültürlerde farklılık gösterebilir.	1❑	2❑	3❑	4❑	5❑
22.Bilim insanının bir deneyden aldığı sonuç, o deneyin tek yanıtıdır.	1❑	2❑	3❑	4❑	5❑
23.Bilim insanlarının benimsedikleri teoriler yeni bilimsel gelişmeleri etkiler.	1❑	2❑	3❑	4❑	5❑
24.Yaratıcılık, bilimsel bilginin gelişmesi için önemlidir	1❑	2❑	3❑	4❑	5❑
25.Bilim insanları, bilimsel bulguları değerlendirmek için kullanılabilecek kriterler konusunda fikir birliğine sahiptir.	1❑	2❑	3❑	4❑	5❑
26.Bir şeyin doğru olup olmadığını anlamak için deney yapmak iyi bir yoldur.	1❑	2❑	3❑	4❑	5❑
27.Bilim, kültürden etkilenir.	1❑	2❑	3❑	4❑	5❑
28.Bilim insanları bilimde neyin doğru olduğu konusunda her zaman aynı fikirdedirler.	1❑	2❑	3❑	4❑	5❑
29.Bilim insanlarının gözlemleri benimsedikleri teorilerden etkilenir.	1❑	2❑	3❑	4❑	5❑
30.Bilimsel teoriler, bilim insanlarının aralarında yaptıkları görüşme ve tartışmalar yoluyla daha da gelişir.	1❑	2❑	3❑	4❑	5❑
31.İyi çıkarımlar, birçok farklı deneyin sonucundan elde edilen kanıtlara dayanır.	1❑	2❑	3❑	4❑	5❑

	Kesinlikle Katılmıyorum	**Katılmıyorum**	**Kararsızım**	**Katılıyorum**	**Kesinlikle Katılıyorum**
32.Bilim insanlarının benimsediği teoriler, onların bilimsel araştırma sürecini etkiler.	1❑	2❑	3❑	4❑	5❑
33.Bilimdeki düşünceler, konu ile ilgili kendi kendinize sorduğunuz sorulardan ve deneysel çalışmalarınızdan ortaya çıkabilir.	1❑	2❑	3❑	4❑	5❑

WHAT IS HAPPENING IN THIS CLASS (WIHIC) QUESTIONNAIRE (IN TURKISH)

3. Bölüm

Aşağıda verilen her bir ifadeyi dikkatli bir şekilde okuduktan sonra, sizi en iyi ifade ettiğini düşündüğünüz rakamı işaretleyiniz. Unutmayın, doğru ya da yanlış cevap yoktur. Yapmanız gereken düşüncelerinizi en iyi tanımlayacak rakamı işaretlemenizdir.

	Hiç bir zaman	**Çok az**	**Bazen**	**Sık sık**	**Her zaman**
1. Sınıfımdaki öğrenciler ile yakın arkadaşlık kurarım.	1❑	2❑	3❑	4❑	5❑
2. Sınıfımdaki diğer öğrencileri yakından tanıyorum.	1❑	2❑	3❑	4❑	5❑
3. Bu sınıftaki öğrenciler ile uyum içindeyim.	1❑	2❑	3❑	4❑	5❑
4. Sınıftaki herkes arkadaşımdır.	1❑	2❑	3❑	4❑	5❑
5. Bu sınıftaki diğer öğrencilerle birlikte çalışırım.	1❑	2❑	3❑	4❑	5❑
6. Derslerinde zorluk çeken arkadaşlarıma yardım ederim.	1❑	2❑	3❑	4❑	5❑
7. Sınıftaki diğer öğrenciler beni severler.	1❑	2❑	3❑	4❑	5❑
8. Sınıftaki arkadaşlarımdan yardım alırım.	1❑	2❑	3❑	4❑	5❑
9. Öğretmen benim ile kişisel olarak ilgilenir.	1❑	2❑	3❑	4❑	5❑
10. Öğretmen bana yardım etmek için ders işleme şeklini değiştirebilir.	1❑	2❑	3❑	4❑	5❑
11. Öğretmen benim duygularımı dikkate alır.	1❑	2❑	3❑	4❑	5❑
12. Öğretmen, derslerle ilgili bir problemim olduğunda bana yardımcı olur.	1❑	2❑	3❑	4❑	5❑
13. Öğretmen benimle diyalog kurar.	1❑	2❑	3❑	4❑	5❑
14. Öğretmen benim problemlerimle ilgilenir.	1❑	2❑	3❑	4❑	5❑
15. Öğretmen sınıf içinde benim ile konuşmak için yanıma gelir.	1❑	2❑	3❑	4❑	5❑
16. Öğretmen sorduğu sorularla konuları kavramama yardımcı olur.	1❑	2❑	3❑	4❑	5❑
17. Sınıfta fikirlerimi rahatlıkla tartışabilirim.	1❑	2❑	3❑	4❑	5❑
18. Sınıf tartışmalarında fikirlerimi rahatça söyleyebilirim.	1❑	2❑	3❑	4❑	5❑
19. Öğretmen bana sorular sorar.	1❑	2❑	3❑	4❑	5❑
20. Fikirlerim ve önerilerim sınıf tartışmalarında kullanılır.	1❑	2❑	3❑	4❑	5❑
21. Öğretmene sorular sorarım.	1❑	2❑	3❑	4❑	5❑
22. Diğer öğrencilere fikirlerimi açıklarım.	1❑	2❑	3❑	4❑	5❑

	Hiç bir zaman	Çok az	Bazen	Sık sık	Her zaman
23. Sınıftaki arkadaşlarım, derste çözemedikleri problemler konusunda benim ile görüşürler.	1❑	2❑	3❑	4❑	5❑
24. Sınıfta problemleri nasıl çözdüğüm açıklamam istenir.	1❑	2❑	3❑	4❑	5❑
25. Fikirlerimin doğruluğundan emin olmak için araştırmalar yaparım.	1❑	2❑	3❑	4❑	5❑
26. Söylediklerimi destekleyen veriler bulmam istenir.	1❑	2❑	3❑	4❑	5❑
27. Tartışmalarda ortaya çıkan problemleri çözmek için araştırmalar yaparım.	1❑	2❑	3❑	4❑	5❑
28. Söylenen ifadelerin, şekillerin ve grafiklerin anlamını açıklarım.	1❑	2❑	3❑	4❑	5❑
29. Kafamı karıştıran konuları cevaplayabilmek için araştırmalar yaparım.	1❑	2❑	3❑	4❑	5❑
30. Öğretmenin sorularını cevaplamak için araştırmalar yaparım.	1❑	2❑	3❑	4❑	5❑
31. Araştırmalar yaparak soruların cevaplarını bulmaya çalışırım.	1❑	2❑	3❑	4❑	5❑
32. Araştırmalardan elde ettiğim bilgiler ile problemleri çözerim.	1❑	2❑	3❑	4❑	5❑
33. Çalışmaları sonuçlandırmak benim için önemlidir.	1❑	2❑	3❑	4❑	5❑
34. Çalışabildiğim kadar çalışırım.	1❑	2❑	3❑	4❑	5❑
35. Bu dersin amaçlarını biliyorum.	1❑	2❑	3❑	4❑	5❑
36. Ders başladığında derse hazır olurum.	1❑	2❑	3❑	4❑	5❑
37. Bu sınıfta neyi başarmak için çabaladığımı biliyorum.	1❑	2❑	3❑	4❑	5❑
38. Ders sırasında dikkatimi toparlamaya çalışırım.	1❑	2❑	3❑	4❑	5❑
39. Sınıftaki yapılan çalışmaları anlamaya çalışırım.	1❑	2❑	3❑	4❑	5❑
40. Ne kadar çalışmam gerektiğini bilirim.	1❑	2❑	3❑	4❑	5❑
41. Ödevlerimi yaparken diğer öğrencilerle işbirliği yaparım.	1❑	2❑	3❑	4❑	5❑
42. Ödevlerimi yaparken arkadaşlarımla kitap ve kaynaklarımı paylaşırım.	1❑	2❑	3❑	4❑	5❑
43. Sınıfta grup çalışmaları yapılırken iş bölümü yapılır.	1❑	2❑	3❑	4❑	5❑
44. Sınıfta verilen projelerde diğer öğrencilerle çalışırım.	1❑	2❑	3❑	4❑	5❑
45. Sınıftaki diğer öğrencilerden öğrendiğim şeyler olur.	1❑	2❑	3❑	4❑	5❑
46. Bu sınıfta diğer öğrenci arkadaşlarımla çalışırım.	1❑	2❑	3❑	4❑	5❑
47. Sınıf içi faaliyetlerde diğer öğrencilerle işbirliği yaparım.	1❑	2❑	3❑	4❑	5❑
48. Arkadaşlarım sınıftaki hedeflerine ulaşmak için benim ile çalışır.	1❑	2❑	3❑	4❑	5❑

	Hiç bir zaman	Çok az	Bazen	Sık sık	Her zaman
49. Öğretmen sınıftaki diğer öğrencilerin verdiği cevaplara gösterdiği dikkati, benim cevaplarıma da gösterir.	1❑	2❑	3❑	4❑	5❑
50. Öğretmenden, diğer öğrencilerle aynı ölçüde yardım alırım.	1❑	2❑	3❑	4❑	5❑
51. Sınıftaki diğer öğrenciler ile aynı derecede söz hakkı alırım.	1❑	2❑	3❑	4❑	5❑
52. Bana sınıftaki diğer öğrencilerle aynı biçimde davranılır.	1❑	2❑	3❑	4❑	5❑
53. Sınıftaki diğer öğrenciler ile aynı derecede öğretmenden destek alırım.	1❑	2❑	3❑	4❑	5❑
54. Sınıf tartışmalarına katılmak için diğer öğrenciler ile aynı fırsatı elde ederim.	1❑	2❑	3❑	4❑	5❑
55. Çalışmalarım sınıftaki diğer öğrenciler ile aynı miktarda takdir edilir.	1❑	2❑	3❑	4❑	5❑
56. Sınıftaki diğer öğrenciler ile aynı derecede soruları cevaplama imkânı elde ederim.	1❑	2❑	3❑	4❑	5❑

MINISTERY OF NATIONAL EDUCATION RESEARCH APPROVAL

T.C.
ANKARA VALİLİĞİ
Milli Eğitim Müdürlüğü

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(Öğrenci İşleri Daire Başkanlığı)

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b) 10/11/2016 tarihli ve 4918 sayılı yazınız.

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TURKISH SUMMARY /TÜRKÇE ÖZET

ÖĞRENCİLERİN CİNSİYET, SINIF SEVİYESİ VE
SINIF ORTAMI ALGISINA GÖRE BİLİMİN DOĞASINA
YÖNELİK GÖRÜŞLERİ

GİRİŞ

Pozitivistler değerlerden, tutumlardan ve bakış açılarından bağımsız tek bir nesnel gerçeklik olduğunu savunurlar. Bilim insanlarından beklenen, bu gerçekliğe tarafsız bir şekilde ulaşmalarıdır.(Sim ve Wright, 2000). Nitekim bu bakış açısına göre, dünya ve onun içindeki ilişkiler zaten vardır ve bilim insanlarının görevleri sadece bunu keşfetmektir. Dolayısıyla bilim kültürel, politik, sosyal veya felsefik etkiler ve önyargılardan etkilenmeyen (Allen ve Baker, 2017) nesnel bir aktivitedir (Okasha, 2002). Bilim birikimlidir ve hakikate doğru ilerler (Allen ve Baker, 2017; Okasha, 2002). Deneyimci bir bilim görüşüne dayanarak pozitivistler ayrıca deneyimin bilgi için tek geçerli esas olduğunu savunurlar. Dolayısıyla, bilimsel araştırma duyu organlarıyla veri toplamayı gerektirir. Gözlemlenemeyen veya deneyimlenemeyen kavramlar, önermeler ve ifadeler manasızdır.

Onların araştırma yöntemleri başlıca tümevarımsal olup gerçek gözlemlerin genel önermelerin ve yasaların gelişmesine öncülük eder. Ayrıca, pozitivistler fiziksel ve sosyal dünyayı incelemek için kullanılabilecek tek bir bilimsel yöntem olduğunu savunurlar (Sim ve Wright, 2000).

Oysa bazı filozof ve tarihçilere göre, pozitivistlerin bilime bakış açısı naif düzeydedir (naiftir) ve bilimin nasıl işlediğini güncel şekilde temsil edemez (Allen ve Baker, 2017). Örneğin Popper (2002) bilim insanlarının önemli ve geniş kapsamlı teoriler geliştirmek için hayal gücü ve yaratıcılıklarını kullandıklarını savunmuştur. Ayrıca Popper, gerçek bilim insanlarının teorilerini destekleyen kanıtlar elde etmek yerine teorileri yanlışlık riskine maruz bırakmaları gerektiğini iddia etmiştir. Böylece, bilim insanları bilgilerin kesin olmadığının farkındadırlar (O'Hear, 1989). Bunlara ek olarak, Kuhn (1996) bilim insanları tarafından elde edilen verinin teori yüklü olduğunu ileri sürmüştür. Kuhn'a göre, bilim insanlarının geçmiş yaşantılarındaki görüşlerinden veya kuramsal taahhütlerinden bağımsız objektif teorik veri elde etmek mümkün değildir. Kuhn, bilim tarihinden örnekler temin etmiştir, ayrıca bilimin her zaman birikimli olmadığını doğrusal bir şekilde ilerlemediğini de belirtmiştir. Bazen eski paradigmalar yeni kavramların oluşması için yenileriyle yer değiştirebilir. Ayrıca, Kuhn bilim çalışmalarında sosyal bağlamın önemine dikkat çekmiştir. O bilimi, doğası gereği sosyal aktivite olarak görmektedir (Kuhn, 1996, Okasha, 2002). Bütün bu bakış açıları dikkate alındığında, post-pozitivist araştırmacılarının önermeleri, bilimsel bilginin nasıl değiştiğini ve bilimin nasıl işlediğini daha gerçekçi betimlemiştir (Allen ve Baker, 2017). Bilimin doğasını bilimsel okuryazarlığın çok önemli bir parçası olarak savunan çağdaş bilim eğitimi araştırmacıları, post-pozitivist yaklaşımdan yararlanarak bilimin doğasının bazı önemli öğretilerini tanımlamıştır. (Lederman, Abd-El-Khalick, Bell, ve Schwartz, 2002; McComas, 2014). Böylece, bilim eğitimcileri bazı alanlarda fikir birliğine varmışlardır (Deng, Chen, Tsai, ve Chai, 2011). Örneğin, Lederman ve arkadaşları (2002)'na göre bilimin doğasının 7 temel öğretisi vardır.

a)Bilimsel bilginin deneysel doğası

b)Bilimsel kuramlar ve kanunlar

c)Bilimsel bilginin hayal gücü ve yaratıcı doğası

d)Bilimsel bilginin kuram yüklü doğası

e)Bilimsel bilginin sosyal ve kültürel doğası

f)Bilimsel yöntem

g)Bilimsel bilginin değişebilir doğası

Bu ilkeler arasında bilimsel bilginin deneysel doğası, bilimsel bilginin en azından bazı alanlarda, doğal dünyadaki gözlemlerden elde edildiği bilgisini içerir. Buna rağmen, bilim insanları doğal olgulara her defasında doğrudan erişemezler, bunun yerine çıkarım yaparlar. Dolayısıyla, bu konuda daha gelişkin bilgiye sahip öğrencilerin, gözlemi çıkarımdan ayırması beklenir. Bu ayrım, teorik veya çıkarımsal oluşumu daha iyi kavramalarını sağlar (Lederman ve diğ., 2002). Bununla beraber, bilimin doğasının ikinci öğretisi, öğrencilerin bilimsel kuramlar ve kanunlar arasındaki farkı ayırt etmelerini ve bunların farklı tür bilgi olduğunu anlamalarını içerir. Kanunlar gözlenebilir olgular arasındaki ilişkiyi betimlerken, Kuramlar farklı araştırma alanlarında yapılmış görünürde birtakım belirgin gözlemler için çıkarım yapılan açıklamaları sunar (Lederman ve diğ., 2002). Bilimin doğasının üçüncü öğretisine göre, yaratıcılık ve hayal gücü bilimsel bilginin gelişiminde önemlidir. Gerçekten de, bilim, bilim insanlarının yaratıcılığını içeren açıklamaların ve teorik oluşumların gelişmesini gerektirir (Lederman ve diğ., 2002). Örneğin, Kepler var olan bilgilerin ve kuramların ötesine geçti ve sadece sınırlı ve yetersiz verileri kullanarak gökyüzünün haritasını cesurca çıkardı. Böylelikle, onun çalışması basitçe veri toplama ve varsayımsız verileri düzenleme şeklinde gelişmedi (O'Hear, 1989). Bu örneklendirilmiş üçüncü öğreti bilimsel bilginin gelişmesinde yaratıcılık ve hayal gücü ile ilgili olsa da, dördüncü öğreti bilimsel bilginin kuram yüklü doğasının önemini vurgular. Bu öğretiye göre, bilim insanlarının önceki deneyimleri, bilgisi, teorik mutabakatları çalışmalarını etkiler. Böylece, bilim insanlarının inançları ve deneyimleri onların gözlemlerini ve gözlemlerine dayalı çıkarımlarını etkiler (Lederman ve diğ., 2002; Okasha, 2002). Örneğin, Aristocu bir bilim insanı için düşen bir taş parçası doğal kuvvete örnek olarak yorumlanırken, bu durum Newton fiziğine bağlılığı olan bir bilim insanı için yer çekimi kuvveti olarak yorumlanabilir. Bunlara ek olarak, beşinci öğreti bilimsel bilginin sosyal ve kültürel öğelere bağlılığını vurgular. Aslında, bilimsel bilgi daha geniş bir kültürel bağlamda gelişir ve bilim insanları bu kültür içerisinde yetişir. Dolayısıyla, bilim, kültür içerisinde bulunan ve bu kültürden etkilenen zaman ve yer öğelerinden bağımsız değildir. Genel olarak bu öğretiye göre; bilim; sosyal, politik ve ekonomik faktörlerde dahil olmak üzere çeşitli faktörleri etkiler ve bu faktörlerden etkilenir (Allen ve Baker, 2017; Lederman ve diğ., 2002). Bunun yanı sıra bilimin doğasının altıncı öğretisi bilimin mitleri hakkındadır. Doğru bilimsel bilgi elde etmek için izlenecek tek bir bilimsel yöntem olduğu çok sık görülen bir kavram yanılgısıdır. Fakat bilim insanları tarafından adım adım takip edilecek tümevarım gibi bir bilimsel yöntem yoktur (Lederman ve diğ., 2002). Örneğin, Galileo birkaç sarkacı düzenli gözlemleyerek ve daha sonra genelleme yaparak sarkaç hareketi yasalarını oluşturmadı (Mathews, 2015). Aksine o, matematiği kullandı. Açıkçası ona göre, matematik madde dünyasındaki nesnelerin davranışını tanımlamak için kullanılabilir. Ayrıca, o hipotezlerin test edilmesinin de önemini vurgulamıştır (Okasha, 2002). Son olarak Lederman ve arkadaşları (2002) tarafından önerilen son bilimin doğası öğretisi ise bilimsel bilginin değişebilir doğasıdır. Lederman ve arkadaşlarının (2002) bahsettiği gibi, kuram ve yasaları içeren bilimsel bilgiler güvenilir ve devamlı olmasına rağmen, yeni kanıtlar elde edildikçe değişebilir. Örneğin, Newton fiziği bilim insanları tarafından uzun süre temelde doğru kabul edildi. Ancak, 20. Yüzyılın başlarında izafiyet kuramı ve Kuantum mekaniği olarak adlandırılan iki devrim niteliğindeki gelişme Nevton fiziğinin bütün nesneler için geçerli olmadığını gösterdi (Okasha, 2002).

Aynı zamanda McComas (2014) değişkenlik, öznellik, yaratıcılık, tarihsel, kültürel ve sosyal etkileri içeren benzer bilimin doğası öğretilerini önerdi. Bu öğretiler, fen eğitimi araştırmacıları tarafından K-12 fen eğitimi ve öğretimi için en faydalı ve alakalı bilimin doğası öğretileri olarak kabul edilir (Deng ve diğ., 2011; Lin, Goh, Chai, ve Tsai, 2013). Buna bağlı olarak araştırmacılar, öğrencilerin bilimin doğasının temel öğretilerine ilişkin görüşlerini belirtmek amacıyla araçlar geliştirmeye başlamışlardır. Bu ölçeklere; Rubba ve Anderson (1978) tarafından geliştirilen “Nature of Scientific Knowledge Scale (NSKS)”, Lederman ve arkadaşları (2002) tarafından geliştirilen “Views of Nature of Science (VNOS)”, Huang, Tsai ve Chang (2005) tarafından geliştirilen “The Pupils’ Nature of Science Scale (PNSS)”, Liang ve arkadaşları (2008) tarafından geliştirilen “Students understanding of Science and Scientific Inquiry (SUSSI)”, Chen (2006) tarafından geliştirilen “ Views on Science and Education Questionnaire (VOSE)”, Conley, Pintrich, Vekiri ve Harrison (2004) tarafından geliştirilen “Scientific

Epistemological Beliefs Survey (SEBS)", Tsai ve Liu (2005) tarafından geliştirilen "Scientific Epistemological Views (SEVs)" ve Lin ve arkadaşları (2013) tarafından geliştirilen "Students' Views of Nature of Science (SVNOS)" örnek olarak verilebilir. Bu araçlardan bazıları açık uçlu sorulardan oluşuyor. Bundan dolayı sayıca az örneklemlerde kullanılabilir. Literatürde bu araçlar genellikle deneysel yöntemde kullanılırlar ve bu araçlar çıkarımsal istatistik analizine uygun değildir (Martin-Dunlop, 2013). Bu nedenle, öğrencilerin bilimin doğası hakkındaki görüşlerinin daha geniş ölçekte elde etmek için ve çıkarımsal istatistik analizinde bazı genellemeler yapabilmek için Likert-tipi araçlar daha uygundur. Buna göre, bu çalışmada ortaokul öğrencilerinin bilimin doğası hakkındaki görüşleri Likert-tipi araçlar kullanılarak belirlenmesi hedeflenmiştir. Var olan ölçekler arasından SVNOS (Lin ve diğ., 2013) ölçeği seçilmiştir çünkü bu ölçek kültürel etki, yaratıcı doğa, nesnel olmayan doğa, sosyal müzakere, değişken doğası, kuram yüklü doğası ve gerekçelendirme dahil olmak üzere bilimin doğasının temel öğretilerini içeren var olan ölçeklerdeki alt boyutlar veya maddeler seçilerek oluşturulmuştur. Güvenilirlik ve doğrulayıcı faktör analizi sonuçları, ortaokul öğrencilerinin bilimin doğasının önemli öğretilerini ölçmede kullanılabilecek geçerli ve güvenilir bir araç olduğunu göstermiştir. Bu çalışmada, SVNOS kullanılarak öğrencilerin bilimin doğası hakkındaki görüşleri aşağıdaki bölümde belirtildiği gibi cinsiyet, sınıf düzeyi ve öğrenme ortamı algılarına göre incelenmiştir.

Öğrencilerin Cinsiyet, Sınıf Düzeyi Ve Öğrenme Ortamı Algılarına İlişkin Bilimin Doğası Görüşleri

İlgili araştırmalar öğrencilerin öğrenme deneyimlerinin bilimin doğası görüşlerinin geliştirilmesinde önemli rol oynadığını göstermiştir (Hofer, 2001; Solomon, Scott, ve Duveen, 1996). Lederman ve Druger (1985)' e göre, öğrenciler sorgulama odaklı problem ve sorulara vurgu yapılan öğrenme ortamlarına aktif katıldıkları sınıf ortamlarında gelişkin bilimin doğası görüşleri geliştireceklerdir. Öğretmen desteği de gelişkin görüşlerin gelişimine katkıda bulunan önemli bir faktör olarak belirtilmiştir. Bu olguyu destekleyen Martin-Dunlop (2013) öğrencilerin bilimin doğası anlayışları ile öğrenci yaklaşımı, öğretmen desteği, işbirliği, araştırma/inceleme, açık uçluluk, ve yeterli materyalin varlığı olan öğrenme ortamı algıları arasında anlamlı pozitif iki değişkenli korelasyon olduğunu belirtmiştir. Bu nicel bulguları destekleyen nitel sonuçlar da deneyler sırasında açık uçlu ayırıcı (ıraksak) yaklaşımı içeren laboratuar faaliyetleri ve öğrenciler arası işbirliğine dayalı ilişkilerde bilimin doğasının daha iyi anlaşılmasını sağlamıştır. Bu bulgular doğrultusunda, yazar öğrencilerin bilim hakkında daha gelişkin görüşlere sahip olmalarına yardım etmek için fen bilimleri öğretmenlerinin, öğrencilerinin rehber olarak desteklemesi ve öğrenciler arasındaki dayanışmayı teşvik etmelerini önermiştir. Öğretmenler öğrencilerine sorgulayıcı öğrenme odaklı açık uçlu etkinlikler sunmalıdır. Benzer şekilde Solomon ve arkadaşları (1996),

öğrencileri deney tasarlamaya, veri toplamaya ve bu verileri analiz etmeye yönlendirmenin öğrencilerin bilimin doğası görüşlerini geliştireceğini öne sürdü. Dolayısıyla, bu çalışmada kendi kendine raporlama ölçeği kullanılarak, öğrencilerin öğrenme ortamı algıları ve bilimin doğası hakkındaki görüşleri incelenmiştir. Öğrencilerin öğrenme ortamı algıları 7 boyutta: öğrenci yaklaşımı, öğretmen desteği, katılım, araştırma/ inceleme, ödevler, işbirliği, eşitlik Bu Sınıfta Neler Oluyor? (WIHIC) ölçeği (Aldridge ve Fraser, 2000) kullanılmıştır. Öğrenci yaklaşımı; öğrenciler arasındaki birbirlerine karşı tepkileriyle ve yardımcı olmalarıyla ilgili etkileşimleri içerir. Öğretmen desteği boyutu; öğretmenlerin öğrencilerine işbirlikli ve destekleyici olma dereceleriyle ilgilidir. Katılım; öğrencilerin derse karşı ilgisine ve sınıf etkinliklerine katılımına odaklanır. Araştırma/inceleme; öğrencilerin araştırma ve problem çözme sırasında sorgulama yeteneklerini kullanmanın bir ölçütüdür. Ödevler boyutu, öğrencilerin hem planlanan etkinlik ve görevlere dikkat edip etmedikleri hem de onlardan beklenenlerin farkında olup görevlerine devam etmelerine odaklanır. İşbirliği; öğrencilerin sınıf içerisinde proje ve ödevlerini yaparken onların ne derece birbirleriyle işbirliği yaptıklarıyla ilgilenir. Eşitlik boyutu; öğretmenlerin öğrencilerine sınıf etkinliklerine katılmada veya teşvik etmede ve övme de eşit fırsatlar sağlama ölçütünü içerir (Waldrip, Fisher, ve Dorman, 2009). Waldrip ve arkadaşları (2009) ‘WIHIC’ ölçeğinin çeşitli öğrenci sonuçlarını tahmin etmek için yararlı olduğunu belirtmiştir. Buna göre; bu çalışmada öğrencilerin bilimin doğası hakkındaki görüşlerini belirlemek için WIHIC ölçeği kullanıldı. Sonuçlar, fen eğitimcileri ve öğretmenlerine ortaokul öğrencileri arasında bilimin doğasına dair sofistike bakış açısının geliştirilmesi için öğrenme ortamlarını düzenlemeleri ile ilgili bazı önemli çıkarımlar sağlamıştır.

Bu çalışmada öğrencilerin bilimin doğası görüşlerindeki sınıf düzeyi farklılıkları da araştırılmıştır. İlgili literatür, öğrencilerin bilimin doğası görüşlerinde yaşa bağlı eğilimin, öğrencilerin öğrenme ortamındaki deneyimleriyle her zaman olumlu yönde olmayacağını belirtmiştir (Chai, Deng ve Tsai, 2012). Nitekim eğer öğrenciler ezberlemeyi ve çeşitli açılardan düşünmeyi gerektirmeyen tek cevaplı etkinlikleri ve soruları vurgulayan öğrenme ortamlarını deneyimlediklerinde öğrencilerin bilimin doğası hakkındaki görüşleri naif kalacaktır. Eğer sınıf düzey farklılıkları varsa, öğrencilerin öğrenme deneyimleri hakkında bazı ipuçları verebilir. Cinsiyet farkı ile ilgili olarak fen eğitimi alanındaki araştırmacılar öğrencilerin bilimin doğası görüşlerinde cinsiyet farkının araştırılmasına daha fazla önem verilmesi gerektiğini önerdiler (Wen, Kuo, Chang, ve Tsai, 2010). ilgili literatür incelendiğinde hem cinsiyet hem de sınıf düzeyi farklılıkları konusundaki araştırmaların yetersiz olduğu tespit edilmiştir (Deng ve diğ., 2011). Örnek olarak, Huang, Tsai, Chang (2005) tarafından yapılan çalışma erkeklerin bilimin doğasının bilimsel bilginin değişebilirliği ve bilimsel bilginin kültürel ve sosyal doğası boyutlarında daha gelişkin görüşlere sahip olduklarını göstermiştir. Buna ek olarak, 5. Sınıf öğrencilerinin 6. Sınıf öğrencilerinden bilimin doğasının değişken boyutuyla ilgili daha gelişkin görüşlere sahip olduğu saptanmıştır. Hacıeminoğlu, Yılmaz-Tüzün, Ertepınar (2014)'ın yaptığı diğer bir çalışmada ise; bilimin doğası görüşlerinde cinsiyet farklılığı olmadığı tespit edilmiştir. Bunun yanı sıra, altı, yedi ve sekizinci sınıf öğrencileri arasında gözlem ve çıkarım öğretisi ile ilgili anlamlı farklılıklar bulunmuştur. Bilimin doğasının, bilimsel bilginin değişebilirliği boyutu ile ilgili yedinci sınıf öğrencilerinin cevapları, altıncı ve sekizinci sınıf öğrencilerinden önemli ölçüde farklı olduğu bulunmuştur. Hayal gücü ve yaratıcılık boyutunda sınıf seviyelerine göre bir farklılık bulunmamıştır. Bu nedenle, ulaşılabilir literatüre göre sınıf seviyesi farklılıkları ile bilimin doğasının farklı ilkeleri arasında tutarlılığın olmadığı görülmektedir. Ek olarak, cinsiyet farkını araştıran çalışmalarda da farklı sonuçlar ortaya çıkmıştır. Bu nedenle, öğrencilerin cinsiyet ve sınıf seviyesi ile ilgili bilimin doğası görüşlerini açıklığa kavuşturmak için daha fazla araştırmaya ihtiyaç vardır. Öğrencilerin bilimin doğası görüşleriyle ilgili çalışmalar yapmak önemlidir çünkü ilgili literatürdeki çalışmalar, öğrencilerin bilimin doğası hakkındaki görüşlerinin bilgi edinmeleri, öğrenme yaklaşımları ve akıl yürütme ve tartışmaları üzerinde önemli role sahip olduğunu göstermiştir (Deng ve diğ., 2011; Lederman, 1992; Sadler, Chambers, ve Zeidler, 2004). Özellikle, bu sonuçlara göre, bilimin doğası hakkında gelişkin görüşleri olan öğrencilerin anlamlı öğrenmeye yol açan öğrenme stratejilerini kullanma ve bilime karşı olumlu tutum içerisinde olmaları muhtemeldir (Tsai ve Liu, 2005). Bu nedenle öğrencilerin fen öğrenimini ve performanslarını aynı zamanda fen eğitimini iyileştirmek için genel olarak bilimin doğası görüşlerini ve bu görüşlerinin demografik ve öğrenme ortamı algıları ile nasıl ilişkili olduğunun belirlenmesi gerekmektedir. Dolayısıyla, bu çalışma ortaokul öğrencilerinin bilimin doğası görüşlerini cinsiyet ve sınıf düzeyi ve öğrenme ortamı algıları ile ilgili olarak incelemeyi amaçlamaktadır. Tam olarak bu çalışma aşağıdaki soruları irdeleyecektir.

1)Ortaokul öğrencilerinin bilimin doğası görüşlerine göre cinsiyet ve sınıf düzeylerinde farklıklar var mıdır?

2) Ortaokul öğrencilerinin öğrenme ortamı algıları ile bilimin doğası görüşleri arasında ilişki var mıdır?

Çalışmanın Önemi

Literatürde bilimin doğası öğretimini etkili öğretmenin yolunu inceleyen birçok çalışma bulunmaktadır (Akerson ve Hanuscin, 2007; Koksal ve Çakıroğlu, 2010). Benzer şekilde hedeflenen bilimin doğası öğretilerinin anlaşılmasını kolaylaştıran bazı tasarlanmış ders örnekleri bulunmaktadır (Abd-El-Khalick ve Lederman, 2000; Khishfe ve Abd-El-Khalick, 2002; McComas, 2003; Clough, 2006; Akerson ve Hauscin, 2007; Izci, 2017). Çalışmaların çoğu öğretmen ve öğrencilerdeki kavram yanılgılarına (Lederman, 2007; Bell ve diğ., 2011; Concannon ve diğ., 2013) ve bilimin doğası anlayışını geliştirmek için çeşitli girişimlere (Abd-El-Khalick ve Akerson, 2004; Bilican, 2014) odaklanmıştır ve ayrıca çalışmaların çoğu öğretmenlerin ve öğrencilerin bilimin doğası anlayışını değerlendirmektedir (Lederman ve diğ., 2002; Akerson ve Abd-El-Khalick, 2005; Kılıç ve diğ., 2005; Çelikdemir, 2006; Bora ve diğ., 2006; Doğan ve Abd-El-Khalick, 2008; Ozgelen ve Yılmaz-Tüzün, 2010; Schwartz ve diğ., 2010; Donelly ve Argyle, 2011). Ancak, sayıca çok az çalışma, öğrencilerin bilimin doğası anlayışları ile fen bilimleri dersi öğrenme ortamları arasındaki ilişkiyi araştırmıştır (Walberg ve Anderson, 1968; Martin-Dunlop, 2013; Sontay ve Karamustafaoglu, 2018) mevcut durumda Türkiye'de özellikle ortaokul öğrencilerinin bilimin doğası anlayışları ve öğrenme ortamı algıları arasındaki ilişkiyi kesitsel ve korelasyonel araştırma yöntemleri kullanılarak analiz eden çalışmaların eksikliği vardır. Bununla birlikte Ormerod ve Duckworth (1975), çocukluk yıllarının (8 ile 14 yaş arası) bilim hakkındaki tutumlarını geliştirmek için kritik öneme sahip yıllar olduğunu ifade etmiştir. Bu nedenle, bu yaş grubundaki öğrencilerin bilimin doğası görüşlerini sınıf algıları da dahil olmak üzere çeşitli değişkenlerle ilişkisini, bilimin doğası anlayışını geliştirmek amacıyla incelemek önemlidir. Buna göre, bu çalışma, öğrencilerin yeterli bilimin doğası görüşlerini geliştirmelerine yardımcı olmak için Fen bilimleri öğretmenlerine ve bilimin doğası araştırmacılarına yeni perspektifleri sağlama potansiyeline sahiptir. İlaveten, bir önceki bölümde bahsedildiği gibi cinsiyet ve sınıf seviyeleri farklılığı mevcut literatüre göre sonuçsuzdur. Çalışmanın içeriğindeki bulguların tartışılması, mevcut literatürdeki karışık sonuçların daha iyi anlaşılmasını sağlar. Üstelik sonuçlar fen bilimleri sınıflarında cinsiyet önyargıları olup olmadığını veya sınıf uygulamalarında sınıf seviyelerine göre değişiklikler olup olmadığını incelemek için daha fazla çalışmalar yapılması sonucunu doğurabilir.

YÖNTEM

Bu çalışmada Ankara ilinin iki ilçesi olan Sincan ve Yenimahalle' den rastgele seçilmiş 4 ortaokulda okuyan 7. Ve 8. Sınıf öğrencilerinden toplanan veriler kullanılmıştır. Verilerin toplanması için 3 ayrı ölçek kullanılmıştır. Bu ölçeklerden elde edilen veriler SPSS programı kullanılarak analiz edilmiştir.

Evren ve Örneklem

Çalışmanın evrenini Ankara ilinde yer alan devlet okullarında öğrenim gören 7. Ve 8. Sınıf öğrencileri oluşturmaktadır. Erişebilir evreninin ise Ankara'nın Yenimahalle ve Sincan ilçelerindeki devlet okullarında eğitim gören 7. Ve 8. Sınıf öğrencileri oluşturmaktadır. Bu çalışmanın örneklemini 289' u erkek, 319' sı kız ve 286'sı 7. Sınıf, 322'si 8. Sınıf olmak üzere 602 öğrenci oluşturmuştur.

Veri Toplama Araçları

Bu çalışmada veriler; demografik bilgi ölçeği, Türkçeye çevrilen ve adapte edilen Students' Views of Nature of Science (SVNOS) ölçeği ve Bu Sınıfta Neler Oluyor? (WIHIC) ölçeği kullanılarak toplanmıştır.

Demografik Bilgi Ölçeği

15 maddeden oluşan bu ölçek; katılımcıların kardeş sayısı, cinsiyet, yaş, sınıf düzeyi, anne-baba eğitim durumu, anne-baba çalışma durumu, evde öğrenciye ait çalışma odasının olup olmadığı, evde bilgisayar ve internetin olup olmadığı gibi soruları içeren ve öğrencilerin sosyo-ekonomik düzeyleri hakkında bilgi sahibi olmamıza yardımcı olur.

Students' Views of Nature of Science (SVNOS) ölçeği

Lin ve arkadaşları (2013) tarafından geliştirilen bu ölçek 33 madde ve 7 öğretiden oluşmaktadır. Öğrencilerin kesinlikle katılmıyorum, katılmıyorum, kararsızım, katılıyorum ve kesinlikle katılıyorum şeklinde cevaplandırdığı ölçek öncelikle Türkçeye çevrilmiştir. Türkçeye çevrilen maddelerin kapsayıcılık ve anlaşılırlık kontrolü Profesör tarafından yapılmıştır. Ayrıca maddelerin Türkçeye ve ortaokul öğrencileri seviyesine uygunluğu da kontrol edilmiştir. Gerekli düzenlemeler yapıldıktan sonra testin Türkçe versiyonun pilot çalışması yapılmıştır. Pilot çalışmaya 107' si kız, 68' si erkek olmak üzere toplamda 175 ortaokul öğrencisi katılmıştır. Doğrulayıcı faktör analizi sonuçları uyumun iyi olmadığını göstermektedir. Ayrıca, güvenilirlik analizlerininse düşük düzeyde (0.27-0.77) olduğu tespit edilmiştir. İki madde bilimsel bilginin kültürel doğasından, 1 madde bilimsel bilginin yaratıcı doğasından, 2 madde bilimsel bilginin delillere dayalı doğasından ve 1 madde de bilimsel bilginin öznelliği doğasından çıkarıldığında doğrulayıcı faktör analizi sonuçlarının daha iyi olduğu gözlenmiştir. Ayrıca, bilimsel bilginin yaratıcı doğası, bilimsel bilginin gelişiminde iletişimin rolü ve bilimsel bilginin çıkarımsal yapısı boyutları arasında yüksek Phi katsayısı doğrusal bağımlılık olduğunu göstermektedir. Ek olarak, madde silme işleminden sonra ilgili boyutların güvenilirlik katsayılarında artış olmasına rağmen, katsayı değerleri hala düşüktü. Bu yüzden, bilimsel bilginin yaratıcı doğası boyutundaki maddelerin haricindeki maddeler de düzenlendi ve tekrar başka kelimelerle ifade edildi ve olumsuz cümleler olumluya çevrildi. Gerekli düzenlemeler yapıldıktan sonra, ölçeğin son hali fen eğitiminden iki profesör tarafından incelenip değerlendirilerek ölçek tekrardan yeni bir örnekleme uygulanmıştır. Doğrulayıcı faktör analizi sonuçları uyumun iyi olduğunu göstermektedir. Ancak, Phi katsayısı bazı boyutlar arasında doğrusal bağımlılık olduğunu göstermektedir. Üstelik güvenilirlik analizi de 0.48- 0.77 değerleri arasında bulunmuştur. Bilimsel bilginin öznelliği doğası boyutundan 2 madde silinmesi, bu boyutun güvenilirlik katsayısının yükselmesini sağlamıştır. Fakat doğrusal bağımlılık sorunu devam etmektedir. Bu yüzden birbirleriyle uyumlu olan bilimsel bilginin yaratıcı doğası, bilimsel bilginin gelişiminde iletişimin rolü ve bilimsel bilginin çıkarımsal yapısı boyutları birleştirilerek aynı yapıyı ölçmüşlerdir. Bu yeni yapı bilimsel bilginin yaratıcı/ çıkarımsal doğası olarak adlandırılmıştır. Aynı şekilde bilimsel bilginin kültürel doğası ve bilimsel bilginin delillere dayalı doğası boyutları birleştirilerek bilimsel bilginin değişken/ kesin olmayan doğası olarak adlandırılmıştır. Bu boyutların birleştirilmesinin nedeni tartışma bölümünde detaylandırılacaktır. 4 faktörlü yapı (bilimsel bilginin yaratıcı/çıkarımsal doğası, bilimsel bilginin kültürel/ delillere dayalı doğası, bilimsel bilginin değişken/ kesin olmayan doğası ve bilimsel bilginin öznelliği doğası) bilimin doğası ölçeğinin doğrulayıcı faktör analizi uyumun iyi olduğunu göstermektedir. Fakat bilimsel bilginin kültürel/ delillere dayalı doğasının 2 maddesi düşük değerde olduğu için çıkarılmıştır. Sonuçlar bu ölçeğin 4 faktörlü yapısını desteklemiştir. Güvenilirlik katsayıları, analiz için yeterince yüksek değerdedir (bilimsel bilginin kültürel/delillere dayalı doğası. 70, bilimsel bilginin değişken/kesin olmayan doğası .56, bilimsel bilginin öznelliği doğası .64, bilimsel bilginin yaratıcı/çıkarımsal doğası .84).

Bu Sınıfta Neler Oluyor? Ölçeği

Bu ölçek ortaokul öğrencilerinin öğrenme ortamı algılarını değerlendirmek için kullanılmıştır. Fraser ve arkadaşları (1996) tarafından geliştirilen ölçeğin orijinal versiyonu 70 maddeden oluşmaktadır. Bu çalışmada kullanılan 56 maddelik versiyonu Aldridge ve Fraser (2000) tarafından temel faktör analizi ve güvenirlik analiziyle doğrulanmıştır. Öğrencilerin kesinlikle katılmıyorum, katılmıyorum, karasızım, katılıyorum ve kesinlikle katılıyorum şeklinde cevaplandırdığı ölçek 7 boyuttan ve her boyutla ilgili 8 maddeden toplamda 56 maddeden oluşmaktadır. Çakıroğlu ve arkadaşları (2006) tarafından Türkçeye çevrilip adapte edilen ölçeğin, orijinal sürümle benzer faktör yapılarına sahip olduğu belirtilmiştir.

Çalışmanın Sayıltıları

1)Çalışmada kullanılan ölçekler tüm öğrenciler için aynı şartlarda uygulanmıştır.

2)Tüm katılımcılar ölçekteki maddeleri özenle cevaplandırmışlardır.

3)Ölçekler uygulanırken öğrenciler, öğretmenleri veya diğer öğrenciler ile etkileşim halinde olmamışlardır.

Bulgular ve Tartışma

Ortaokul öğrencilerinin bilimin doğasının 4 faktörlü yapısındaki görüşleri hem naif değil hem de yeterince sofistike değildir. Bu bulgulara göre, öğrencilerin bilimsel bilginin değişebileceği, bilim insanlarının çalışmalarının onların kuramsal bağlılıklarından, düşüncelerinden, deneyimlerinden ve yetiştikleri kültürün etkilerinden de etkilendiği ve yaratıcılıkla birlikte iletişimin fikirlerinin gelişmesinde rol oynadığını ve bilimsel bilginin çıkarımsal boyutlarında hem fikir oldukları söylenebilir. Kız ve erkek öğrenciler ile 7. Sınıf ve 8. Sınıf öğrencilerinin verilerinin genel dağılımı birbirlerine benzerdir.

Ayrıca, bulgulara göre, öğrencilerin genel olarak olumlu öğrenme ortamı algılarının bulunduğu söylenebilir. Öğrenme ortamı algılarının da boyutları incelendiğinde de, bu boyutların genel dağılımının birbirine benzer olduğu söylenebilir.

1)Ortaokul öğrencilerinin bilimin doğası görüşlerine göre cinsiyet ve sınıf düzeylerinde farklıklar var mıdır?

2) Ortaokul öğrencilerinin öğrenme ortamı algıları ile bilimin doğası görüşleri arasında ilişki var mıdır?

Çalışmanın 1. Araştırma sorusuna göre ortaokul öğrencilerinin bilimin doğası görüşlerinde cinsiyet ve sınıf düzeyine göre anlamlı bir farklılık bulunmamıştır.

Çalışmanın 2. Araştırma sorusuna göre, ortaokul öğrencilerin öğrenme ortamı algıları ile bilimin doğası görüşleri arasında ilişki bulunmaktadır. Bilimsel bilginin değişebilir doğası dışındaki diğer bilimin doğası boyutları ile öğrenme ortamları boyutları arasında olumlu ilişki vardır.

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