EXPLORING REPRESENTATION OF NATURE OF SCIENCE ASPECTS IN 9TH GRADE CHEMISTRY TEXTBOOKS

A THESIS SUBMITTED TO
THE GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES
OF
MIDDLE EAST TECHNICAL UNIVERSITY

BY

FEYZA ESMER

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR
THE DEGREE OF MASTER OF SCIENCE
IN
SECONDARY SCIENCE AND MATHEMATICS EDUCATION

MAY 2011

Approval of the thesis:

EXPLORING REPRESENTATION OF NATURE OF SCIENCE ASPECTS IN 9TH GRADE CHEMISTRY TEXTBOOKS

submitted by **FEYZA ESMER** in partial fulfillment of the requirements for the degree of **Master of Science in Secondary Science and Mathematics Education Department, Middle East Technical University** by,

Prof. Dr. Canan ÖZGEN _____
Dean, Graduate School of **Natural and Applied Sciences**

Prof. Dr. Ömer GEBAN _____
Head of Department, **Secondary Science and Mathematics Education,**

Prof. Dr. Ömer GEBAN _____
Supervisor, **Secondary Science and Mathematics Education Dept., METU**

Examining Committee Members:

Prof. Dr. Ayhan YILMAZ _____
Secondary Science and Mathematics Education Dept., HU

Prof. Dr. Ömer GEBAN _____
Secondary Science and Mathematics Education Dept., METU

Prof. Dr. Hamide ERTEPINAR _____
Elementary Science and Mathematics Education Dept., METU

Assoc. Prof. Dr. Yezdan BOZ _____
Secondary Science and Mathematics Education Dept., METU

Assoc. Prof. Dr. Esen UZUNTİRYAKİ _____
Secondary Science and Mathematics Education Dept., METU

Date: _____

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

Name, Last name: FEYZA ESMER

Signature:

ABSTRACT

EXPLORING REPRESENTATION OF NATURE OF SCIENCE ASPECTS IN 9th GRADE CHEMISTRY TEXTBOOKS

ESMER, Feyza

M. Sc., Department of Secondary Science and Mathematics Education

Supervisor: Prof. Dr. Ömer GEBAN

May 2011, 57 pages

The aim of this study was to examine the representation of Nature of Science (NOS) aspects in 9th grade chemistry textbooks. Two textbooks nation-wide used are analyzed, one of them is written in Turkish the other in English. These textbooks were written according to 2008-2009 education program's curriculum. A qualitative oriented approach was employed and ethnographic content analysis was used as the methodological framework for this research as Irez (2006) has performed. Data were analyzed by means of books' sentences.

The results of the study revealed that both of two chemistry textbooks were inadequate in representing NOS aspects which are; 1. Observation and inference are distinct entities of science, 2. Science is influenced by the social and cultural environment of the scientist, 3. Science is partly the product of human creativity and imagination, 4. Scientific knowledge is tentative, empirical and theory laden, 5. There exists a distinct, non-hierarchical relationship between scientific theories and laws, 6. "There is no universal, recipe-like, method for doing science." The frequency of presence of each aspect in books was very low.

Keywords: Nature of science, chemistry textbooks, textbook analysis

ÖZ

BİLİMİN DOĞASI BOYUTLARI AÇISINDAN 9. SINIF KİMYA KİTAPLARININ İNCELENMESİ

ESMER, Feyza

Yüksek Lisans, Ortaöğretim Fen ve Matematik Eğitimi Bölümü

Tez Yöneticisi : Prof. Dr. Ömer GEBAN

Mayıs 2011, 57 sayfa

Bu çalışmanın amacı 9. Sınıf Kimya Ders Kitaplarını "Bilimin Doğası" boyutları açısından incelemektir. Tüm ülkede kullanılan biri Türkçe diğeri İngilizce yazılmış iki kitap analiz edilmiştir. Bu kitaplar 2008-2009 öğretim yılı çıkan müfredata göre yazılmışlardır. Irez'in (2006) kullanmış olduğu nitel araştırma ve etnoğrafik içerik analiz yöntemi, metodolojik kapsam baz alınarak kullanılmıştır. Sonuçlar kitaptaki cümleler değerlendirilerek oluşturulmuştur.

Bu çalışmanın sonucunda, iki kimya ders kitabının da "Bilimin Doğası" boyutları açısından yetersiz olduğu görülmüştür. Değerlendirmede; 1. Bilimsel bilgi gözlem ve çıkarım olarak 2 farklı olguya dayanır, 2. Bilimsel bilgi bilim adamının bulunduğu sosyal ve kültürel çevreden etkilenir, 3. Bilimsel bilginin üretilmesinde hayal ve yaratıcılık önemlidir, 4. Bilimsel bilgi değişime açıktır, 5. Bilimsel teori ve kanun birbirlerinden tamamen farklı türden bilgilerdir, 6. Bilim yapmak için geçerli bir bilimsel yöntem yoktur. Her bir açı her iki kitapta da çok düşük frekanslarda bulunmaktadırlar.

Anahtar Kelimeler: Bilimin Doğası, kimya ders kitapları, ders kitabı analizi

To my parents and my husband
and my lovely Çınar who never left me
alone,

ACKNOWLEDGEMENTS

I would like to express my sincere appreciation to Prof. Dr. Ömer GEBAN for his guidance, patience, valuable contributions, suggestions and his politeness throughout the study.

I would like to thank to my supporting, always giving parents and my high school friends for their emotional supports and courage and I am also very grateful to my husband Celâl for his continuous encouraging efforts, endless patience, language and textbook analysis support, motivation, and his precious love.

TABLE OF CONTENTS

LIST OF TABLES

TABLES

ABBREVIATIONS

Inference:	The act or process of deriving logical conclusions from premises known or assumed to be true.
Law:	Laws are statements or descriptions of the relationships among observable phenomena
Nature of Science (NOS):	That science is a way of knowing, and there are values and beliefs inherent to the development of scientific knowledge.
Observation:	Observations are descriptive statements about natural phenomena that are "directly" accessible to the senses (or extensions of the senses) and about which several observers can reach consensus with relative ease.
Science:	Knowledge attained through study or practice.
Scientific knowledge:	Cognizance of a fact or phenomenon acquired through scientific method. Four factors are essential to the classification of an item of information as scientific knowledge: (1) independent and rigorous testing, (2) peer review and publication, (3) measurement of actual or potential rate of error, and (4) degree of acceptance within the scientific community.
Scientific literacy:	According to the United States National Center for Education Statistics, scientific literacy is the knowledge and understanding of scientific concepts and processes required for personal decision making, participation in civic and cultural affairs, and economic productivity

Theory:	Theories, by contrast, are inferred explanations for observable phenomena.

CHAPTER 1

INTRODUCTION

One of the most important aims of the science education is to have "scientifically literate" citizens. "Scientific literacy" is defined as "knowledge and understanding of scientific concepts and processes required for personal decision making, participation in civic and cultural affairs, and economic productivity" according to National Science Education Standards. In order to achieve this; it should be taught that "science" does not comprise of only laws, theories, facts etc. A "scientifically literate" person understands the laws, theories, facts etc together with the processes of the science and knows the relationships between science, technology and society. In Turkey "all citizens should be scientifically literate" vision has been added to science curriculum with the reform activities started at 2004 (Köseoğlu et al., 2008). Additionally in Turkey, Kavak et al. (2006) made a research about how the national newspapers affect the citizens in terms of scientific literacy. The chosen newspapers were examined for one month. The analysis show that the news of science and technology generally emphasis the side effect of them on the environment. They are not giving enough information about the nature of science and science process skills. As Türkmen and Yalçın (2001) stated, in 6-7th September of 2000, at the 4th annual Turkish Science Education Congress, when a question of "What is science" to the group of person is asked, the 80 % of the attendees answered as "collection of the knowledge". From these answers, it can be seen that Turkish science teachers do not have scientific literacy instead they have scientific knowledge. If the teachers are not aware of "scientific literacy", it is hard to think that students would have a will to be scientifically literate. Yalçın and Türkmen concluded in their research, that to have citizens "scientifically literate", positive attitudes towards science should be developed on them. To achieve this, the NOS

(Nature of Science) should be integrated into all levels of science education, and students should fully comprehend the NOS.

There is no clear, agreed-upon definition of what the NOS is. The National Science Teachers Association has declared in their web site the premises of the NOS. The summary of these premises are given below:

1. Scientific knowledge is reliable and tentative.
2. Although no single universal step-by-step scientific method captures the complexity of doing science, a number of shared values and perspectives characterize a scientific approach to understanding nature.
3. Creativity is an important factor in production of scientific knowledge.
4. Science, by definition, is limited to naturalistic methods and explanations.
5. The social and cultural context of the researcher and the observer's experiences and expectations is important in producing scientific knowledge.
6. Scientific research is not directly concerned with practical outcomes, but rather with gaining an understanding of the natural world for its own sake.

Within this thesis, Lederman's (2006) definition of the NOS aspects are used in summarized form as:

1. Observation and inference are distinct entities of science.
2. Science is influenced by the social and cultural environment of the scientist.
3. Science is partly the product of human creativity and imagination.
4. Scientific knowledge is tentative, empirical and theory laden.
5. There exists a distinct, non-hierarchical relationship between scientific theories and laws.
6. "There is no universal, recipe-like, method for doing science."

As it can be seen from the above explanation/premises of NOS, it cannot be taught in one section of science books, or in one class hour. NOS should be integrated/dispersed in all the chapters of the book, in the language of the teacher as

well. But as Aslan et al. (2009) reported that the science teachers in one of the biggest cities in Turkey, have wrong or not enough views on NOS. They concluded that the reason can be the growth in misconceptions from elementary to university education. When they statistically analyzed their research, science teachers are mostly in *acceptable* position in the "definition of the science" (64,6 %). All the other premises of NOS are not adequately understood by the teachers. But this is not the only problem science teachers' having in Turkey. As Özden (2007) summarized these problems as; insufficient practical activity during the university chemistry education, the lack of materials, equipment, laboratory opportunities, the access amount of students in one classroom, the students being oriented only for the central exam (Ö.S.S), insufficiency of chemistry textbooks, and apathy of students toward chemistry. Besides, science teachers in most of the cities in Turkey cannot find opportunity to improve themselves, or follow the new developments in chemistry education. When science teachers have such huge and complex problems, "not being aware of NOS" can be counted as negligible.

Science textbooks are as important as science teachers in science education. Textbooks are second guides through the learning process after science teachers. It does not only help on following the curriculum but also a good source for students. When students do their homework they mostly refer to their textbooks. So for all these reasons, textbooks should be prepared carefully and according to national standards. Their language should also reflect "scientific literacy". To achieve this; NOS also should be integrated within textbooks.

Turkey is just recently adapting the concept of NOS as stated by Türkmen and Yalçın (2001). There are still problems in views of science teachers about NOS. There is still lack of representation of NOS in most of the science textbooks. In fact there are few researches about the Chemisty textbook analysis in Turkey with respect to its usage by the teachers and its reflection of curriculum. For example, when the high school level chemistry textbooks are analyzed by the experienced and preservice teachers in Turkey by Nakiboğlu (2009), she stated that most of the experienced teachers only use textbook for the end of section exercises. Additionally when Aydın (2010) made a research on whether chemistry teachers are content with

the Chemistry 1 textbook fits the curriculum correctly, the results showed that chemistry teachers were not satisfied; they concluded that there are some deficiencies and obstacles in the application of the textbook.

The students in Turkey are not well oriented for to be "scientifically literate". Most of them are not even aware of NOS. For the almost last 20-30 years, all students have been well-oriented to pass the national central entrance examination (Ö.S.S). In order to pass this examination, most of the scientific knowledge are not learned but mostly memorized including chemistry, physics, biology, mathematics and Turkish language. This exam influences teachers to construct learning in students, as most students do rote learning. Teachers who try to instruct in different methods other than rote learning are not welcomed by the students. Students orient their teachers to do instruction in one way. Additionally students mostly used the textbooks where there is a very abstract subject explanation, and bulk amount of problems to memorize the results. So, most of the textbooks are not used by either teachers or students at high level school. This fact has a negative effect on both teachers and textbook's context.

1.1. Problem

In Turkey, there is not any textbook analysis made for the Chemistry textbooks with respect to representation of NOS Aspects. In this thesis, the assessment of the representation of NOS aspects in 9^{th} grade Turkish nation-wide used two Chemistry books is investigated.

1.2. Significance of this study

This thesis is aimed to assess the two of 9^{th} grade Chemistry books used nationwide for the representation of NOS. In Turkey, with 2004 Curriculum reforms, one of the main purpose was to have scientifically literate citizens. One of the key components of having scientific literate citizens is teaching Nature of Science (NOS) in science education. With this purpose, the textbooks were also re-written, but there

has not been analysis made on Chemistry book whether the NOS aspects are represented in them or not.

There have been only few textbook analyses made in Biology textbooks in Turkey. The analysis of chemistry textbooks are slightly different than biology textbooks, as biology text books have a unique chapter discussing science and scientific method, but chemistry books (especially the one used nationwide) does not have a unique chapter, so the analysis should be made to the entire book, not only to the specific chapters. Since there has not been performed one for chemistry book, this investigation will have a significant importance in literature and in science education in Turkey.

CHAPTER 2

LITERATURE REVIEW

2.1. Nature of Science (NOS)

There are a lot of definitions made for NOS since the last 5 decades, within this thesis researcher will use the definition of Lederman's:

Lederman (2006) defines the NOS as how it should be understood by the students;

1. First, students should understand the difference between observation and inference. (In this thesis, this is stated as; Observation and inference are distinct entities of science.)

2. Second, there is a distinction between scientific laws and theories. (In this thesis, this is stated as; there exists a distinct, non-hierarchical relationship between scientific theories and laws.)

3. Third, scientific knowledge involves human imagination and creativity. (In this thesis, this is stated as; Science is partly the product of human creativity and imagination.)

4. Fourth, scientific knowledge is tentative, subjective and/or theory-laden. (In this thesis, this is stated as; Scientific knowledge is tentative, empirical and theory laden.)

5. *"Fifth, science as a human enterprise is practiced in the context of a larger culture, and its practitioners (scientists) are the product of that culture."* (In this thesis, this is stated as; Science is influenced by the social and cultural environment of the scientist.)

6. Finally, it is important to note scientific method and NOS are different from each other. “Scientific method explains the activities related to collecting and analyzing data, and drawing conclusions” *(AAS, 1990, 1993; NRS, 1996)*. (In this thesis, this is stated as; “There is no universal, recipe-like, method for doing science.”)

The definition of NOS may differ but the key points are almost same for all the researchers. When the conception of students on NOS is analyzed, Lederman (2006) concludes that; “students did not possess adequate conceptions of the nature of science or scientific reasoning.” So if the students do not have a considerable NOS view, what about the teachers? So with these results, researchers turned their attention to teaching methods for the nature of science, and the teachers’ conceptions of NOS. Teachers’ conceptions of NOS were not adequate like students. Lederman generalizes the NOS conceptions for the last 50 years research as:

- K–12 students and teachers do not have correct conceptions of NOS.
- NOS aspects are learned through explicit, reflective instruction
- Teachers’ conceptions of NOS are not transferred to classroom practice. Since teachers do not think NOS as an instructional outcome as that of subject matter present in curriculum.

This is how NOS has been understood in the world, in Turkey the researches are very rare, and have recently started.

2.2. Scientific Literacy and NOS

Project 2061 (The American Association for the Advancement of Science (AAAS) founded Project 2061 in 1985 to help all Americans become literate in science, mathematics, and technology.) has been a big step to have scientifically literate citizens in USA. With this project, it is aimed to have literate citizens in USA and all the countries. Since then, the instruction methods have been evolved, and much more new methods have been analyzed in the university theses. But it is really hard to have scientifically literate students and citizens as well. It is then concluded

that scientific literacy cannot be taught only in schools but may be after the universities since there is a lot of factors affecting the scientific literacy.

Many definitions have been made for scientific literacy since 1950s; some of these definitions are given below with respect to the authors made them;

Shamos (1995) define scientific literacy in 3 levels;

(a) Cultural science literacy: a grasp of certain background information underlying basic communication,

(b) functional science literacy: not only know the science terms, but also be able to converse, read, and write coherently using these terms in non-technical contexts, and

(c) true science literacy: understand the overall scientific enterprise and the major conceptual schemes of science, in addition to specific elements of scientific investigation.

National Research Council (1996) consider scientific literacy as "to include understanding of unifying science concepts and processes, science as inquiry, physical science, life science, earth and space sciences, science and technology, science in personal and social perspectives, and history and nature of science."

All the definitions given above for scientific literacy are related with Nature of Science (NOS). In fact, according to Preczewski et al (2009) the means by which to enhance scientific literacy is the understanding of the Nature of Science (NOS). They reported that "understanding of the NOS plays an important role in the development of scientific literacy. NOS is not only the key component of scientific literacy but it is an important factor in teaching science.

In Zambia, Mumba and Hunter (2009) have made a research about how the scientific literacy have been integrated into Zambian High School Chemistry sysllabus, textbook and twelve grade examination papers. The purpose of this study was to find out if chemistry course makes a contribution to have scientifically literate citizens. The results show some differences among the high school chemistry course materials. The chemistry syllabus had a better representation of the scientific literacy

themes than the chemistry textbooks and examination papers. The chemistry textbooks mostly emphasized science as a body of knowledge theme, whereas the examination papers mostly covered the investigative nature of science theme. Both the chemistry syllabus and examination paper placed some emphasis on the interaction of science and technology theme. Despite the differences in the representation of scientific literacy themes among the high school chemistry course materials, researcher agrees that the course has adequate potential to contribute to the preparation of scientifically literate citizens.

2.3. NOS in TURKEY

The NOS researches are not old as in USA in Turkey; in fact, it is almost a new subject. When the researches made in this area are analyzed it is seen that likewise Lederman concluded; in Turkey both students and teachers have inadequate views of NOS. Şahin and Köksal (2009) have studied the perceptions of NOS in "interest" and "importance" dimensions of both teachers and their students. The results show that both teachers and their students had inadequate views of NOS. Additionally, study shows that teachers have more adequate views about NOS knowledge among the other types of knowledge in terms of "importance" than the students. The students' view on knowledge of NOS is corresponding to "of little importance". Also teachers are more interested in knowing of NOS. This is very critical in terms of science education, since it is aimed to have scientific literate citizens, but in this situation; only teachers are interested. So students also should be motivated to learn science. But when the PISA 2006 Science results were analyzed by Bybee (2008), it was seen that Turkey is not doing well in teaching science. PISA is a universal exam made on the 15 year old students throughout the world. Turkey is in the 29th place in 30 countries, which shows that we are not in good position in teaching science. In order to improve our place in such kind of exams, we should improve:

- The instruction methods,
- The teachers,
- The curriculum and the textbooks used during the instruction.

2.4. Instructional Methods for NOS

There have been researches made to improve the instruction methods to teach NOS. Recently Nuangchalerm (2010) has proposed a new method for teaching NOS which is "socioscientific issues-based instruction". Within this instruction method, Nuangchalerm states that socioscientific issues' (such as environmental concerns, technological concerns etc.) solutions are necessarily shaped by moral, political, social and economic concerns; therefore inquiry and negotiation of socioscientific issues require the integration of science concepts and processes with social constructs and practices. But effective teaching in socioscientific-based instruction according to Nuangchalerm, requires teacher resources in addition to subject-matter knowledge, complex subject-specific knowledge for teaching and relevant to teaching identities. Nuangchalerm concludes as socioscientific issues-based instruction can build up a connection between goal of science education and student needs and satisfy them to be scientifically literate with higher order thinking abilities, discussion skills, scientific argumentation, inquiry based learning, and understanding the nature of science.

Lederman (2004) proposes the careful use of reflective questioning. With this approach he asks NOS aspect integrated, carefully selected and reflective questions to the students. He also states that most students do not learn NOS implicitly, simply by doing science activities. It is important to integrate the aspects of the NOS that teacher wanted to emphasize reflective discussions elicited through careful questioning in the lessons. So the NOS aspect to be emphasized needs to be planned and explicitly integrated. Close to this point of view, Bell (2009) also states that having students "do science" does not equate to teaching about the nature of science, even if these activities involve students in high levels of inquiry and experimentation. He advocates explicit instruction's being center of effective nature of science instruction. Learning about the nature of science requires discussion and reflection on the characteristics of scientific knowledge and the scientific enterprise. Additionally an experimental research made by Akerson et al. (2000) also shows that there are substantial gains on some of the NOS aspects in the views of 25

undergraduate and 25 graduate preservice elementary teachers at the post-instruction assessment. Instruction included reflective, explicit, activity-based approach.

In Turkey, Köksal (2009) has proposed an instructional design model to teach NOS. Although this model is criticized by being difficult to implement in regards to the requirement of time and effort consumption, it is a good starting point in Turkey. Also Çepni and Çil (2010) advise that scientific subject knowledge and conceptual mistakes of the NOS should be taken together in conceptual change texts. By this way, while the subject knowledge is taught, it is provided that the students have adopted enough views about the NOS.

Irez and Çakır (2006) after reviewing all proposed approaches to teach the NOS, have argued that critical reflective approach to the NOS instruction could be the most effective way in enhancing pre-service science teachers' views. They also indicate that learning is not an isolated event, it continues lifelong and it is an interactive process and a habit in mind. So it is important to introduce prospective teachers to various resources through which they can extend their professional learning.

Can and Pekmez (2010) have investigated the changes in science process skills of 7^{th} grade students after applying NOS related science activities in the classroom. 60 students have participated to this investigation. The results showed that nature of science activities have increased the students' level of science process skills.

Galluci (2009) has proposed about 7 different cases to teach the NOS aspects, "hypothesis testing", "tentativeness", "observation vs. inferences", "a way of knowing", "empirical evidence", "social and cultural embeddedness" in her Biology courses for non-science college students. In her research she explained all the 7different cases with integration of different NOS aspects. She concludes her research as, "*by choosing to teach how scientific knowledge is acquired ("the context of justification") with authentic case studies, as well as how the scientific enterprise goes about its business ("the context of discovery"), we can promote a more balanced view of NOS in the classroom*."

Many developing countries are also making researches about the students' views of Nature of Science. For example, in Rwanda, Yadav and Shrivastava. (2007) have made a research on Rwandan students' conception of Nature of Science and Technology. The research result showed that many students doesnot know the difference between; observations and inferences, and theories and laws. Many students have unfavorable view regarding the tentative nature of scientific knowledge. Many of them thought that every science follows a well-established 'scientific method.' which is not very surprising as there is a section in biology or chemistry about Scientific Method, the steps of it etc. in most of the Biology or Chemistry books. Researchers have proposed some solutions to overcome the misconceptions in Rwanda's education system, for example, "*Inclusion of a philosophy of science course as part of the undergraduate science major curriculum may improve the concepts related to the Nature of Science*.", "*To enhance scientific and technological literacy, scientists and technologists or science journalists should be encouraged to write popular scientific/technological articles for the public*."

Ping-Kee (2003) has investigated junior secondary students' understanding of nature of science through peer collaboration instruction in science stories. The results show that although peer collaboration helped students in sharing their ideas, the students tend to not to change their inadequate view on one aspect or even they tend to chane it, they change it to another inadequate view.

Dunlop and Hodum (2009) have studied scientist and science educator collaborations to see whether it increases the students' understanding of Nature of Science. For this research, a biologist and his research on Antarctic seabirds become part of an integrated science course for prospective elementary teachers. The experimental group was the students who used the scientist' database for seabird chick growth rate for an investigation, the control group on the other hand had a single science educator, and did not used the database but made an investigation of their own chose. For the assessment of experimental and control groups, Nature of Scientific Knowledge Survey. Additionally, attitude scale and interviews with the students in experimental group were also used as data. Results show that, there was a significant difference between experimental and control group by means of

enjoyment to science lessons. Additionally, the scientist's interpersonal skills are very important in these scientist and science educator collaborations.

As it is been discussed up to now, the science education main goal is to have scientifically literate citizens. For this it should be started from very younger ages. For example; Akerson and Donnelly (2010) have worked with K-2 students to influence them to have Nature of Science views. For this reason, explicit reflective instruction through contextualized and decontextualized guided and authentic inquiry is given to the students for 2,5 hours per week through 6 weeks. The results show that, at first students did not hold an adequate view of NOS aspect, for example they thought that creativity is needed by artists not scientists. On the other hand, after the instruction, post tests and interviews show that K-2 students improved their NOS views over the course of the program, suggesting that they are developmentally ready for these concepts. Students developed adequate views of the distinction between observation and inference, the creative NOS, the tentative NOS, the empirical NOS, and to a lesser degree, the subjective NOS.

2.5. Teachers' view of NOS

Teachers are in the center of the education system. They are the most important factor in learning. Therefore they must be well educated and well prepared in the class when teaching. They should be knowledgeable in their areas and they should continuously improve themselves. But many researches show that teachers do not have adequate views of NOS. For example, İrez (2006) studied the beliefs regarding NOS of a group of prospective science teacher educators. He stated that all participants of the study showed naïve or eclectic beliefs regarding NOS. So even the teachers of prospective teacher do not have adequate view, how can we wait, students to have NOS views? İrez (2006) also concerns that teaching and learning about NOS may fail to become a necessary component of science education curriculum in Turkish schools due to a lack of awareness of importance of this by many science teacher educators. Karakas (2008) similarly tried to find an answer to "how college science faculty teach science and NOS, and incorporate aspects of NOS and history of science into their undergraduate courses". He concludes that the teachers' main concern was to cover the content, developing problem solving skills,

teaching the fundamental principles of their subjects without paying attention the aspects of NOS. So this view continuously transferred from the science teacher educator to science teacher. Other than this, Turkey's Science and Technology Education have a lot more problems to deal with other than embedding NOS into the science education. Özden (2007) states these problems as insufficient number of science and technology teachers' taking active role in the preparation of the programs, the insufficient in-service training of the science teacher in the transition state of a new program, the huge numbers of the students in the class, the informational education orienting students towards only exam achievement, the broken link with other lessons and the insufficient physical conditions of schools.

Teachers' not having adequate views of NOS is not the only problem; the teaching methods for NOS are also in research. There have been three approaches; historical, implicit and explicit-reflective. Köseoğlu et al. (2008) argued based on their literature review, and their past experiences; explicit-reflective scientific argumentation and inquiry strategies are most favorable strategies for teaching science. Argumentation is a process of making assertions and providing justification for these claims. So as Köseoğlu et al. (2008) discussed in their research; as students engage in argumentation they can see science as a process in which ideas are justified, examined and frequently refined or changed. Inquiry is the set of behaviors involved in the struggle of human beings for reasonable explanations of phenomena about which they are curious. This is both a way of constructing explanations about how world works and a methodology of teaching and learning. So this method can be used to highlight some of the NOS aspects for students. Another and almost same resulting research made by Tümay and Köseoğlu (2010); to support the argumentation method where the effect of argumentation focused activities in science on Pre-Service Chemistry teachers' on understanding of NOS is measured. 23 pre-service teachers have attended to this research, historical science vignettes and role-playing activities were used to emphasize the role of argumentation in science and NOS. The results show that there was a noteworthy development and changes in participants' conceptions of the argumentation in science, tentativeness of scientific knowledge and creativity in science. Another method for teaching NOS to

the preservice teachers is made by Morgin et al. (2009). In this research, the effect of Project-Based Lab Applications on preservice teachers' knowledge on NOS aspects is measured. According to results, this method significantly and positively increased the understanding of NOS aspects of preservice teachers.

Teachers' view of NOS aspects affects the students' view also. Akcay (2006) try to clarify whether or not teachers' view of the NOS influence their instructional planning and classroom practices, and she concluded that teacher understanding of the NOS affects their classroom practices and curriculum decisions as well as their students' understanding of NOS. Another study made by Dogan and Abd-El-Khalick, (2008) assess 10th grade Turkish students' and teachers' conceptions of NOS and whether these conceptions were related to gender, geographical region, and socioeconomic status (SES) of their city and region; teacher's disciplinary background, years of teaching experience, graduate degree, and type of teacher training program and student household SES and parents' educational level. They concluded that the majority of participants held "naïve" views of a majority of the target NOS aspects. Teacher views were mostly similar to those of their students. Teacher and student views of some NOS aspects were related to teacher's graduate degree and geographical region, and student household SES, parent education, and SES of their city and geographical region. These relations show that enhanced economic and educational capacities of the students' households, as well as the SES of their cities and geographical regions have positive impact on understanding about NOS. We can see from these results that not only teacher but also the socio-economic status of the parents are important in students' understanding NOS.

Taşar (2003) stated in his research made about teaching history and the nature of science in science teacher education programs that; *Firstly, teachers are life long learners, personal development in this respect is part of that learning. They should continue learning about science from different perspectives, become aware of major curriculum reform efforts such as Project 2061, reflect on these and seek ways of adopting them in their classroom. Second, teachers themselves are also practicing science in their classrooms, and laboratories and setting a role model for students. Perhaps, for most students the first scientist they encounter and contact is their*

teacher. Third, being aware of different views about the nature of science may give teachers the opportunity to reflect on their own practices and thinking, which may in turn foster a constructivist view of science education.

Köksal and Çakıroğlu (2010) have aimed to assess 47 elementary science teachers' NOS conceptions by using "Open-ended questions" and "Knowledge test". The results of the study showed that science teachers had many naive understandings about the aspects of NOS. They had the most extreme naive understandings regarding relationship between theory and law. When the individual answers to open-ended questions were examined, it was seen that some of the teachers for each aspect presented at least more than one naive understanding. As the important side of this study, the answers to knowledge test and open-ended questions gave partially complementary pattern in terms of ten aspects of NOS, except for the three aspects including there is no one accepted way to make science", "roles of theories and laws" and "creative and imaginativeness" aspects.

Another interesting research on teachers' view of NOS is made by Tufan (2007). He have measured the NOS views of both prospective music teachers and graduate students enrolled in the music education program, utilizing the Nature of Scientific Knowledge Scale. The results show that graduate students have scored higher than the prospective music teachers. Researcher explains this result as; the graduate students take research courses and get engaged in educational research and prepare and defend thesis during their carrier. Hence, although have not taken any history or the nature of science courses, they get to better understand the nature of science.

Akarsu (2010) has investigated four elementary teachers' view of nature of science. The teachers were selected according to their length of science teaching experience and the braches of science they studied in teacher preparation colleges, e.g. physics, chemistry, or biology. The researcher's first finding study is that science teaching experience is not importantly related to teachers' understanding of science based on the NOST (Nature of Science Test). The second outcome that researcher has reached is academic status and teaching experience of participants' disciplines (physics, chemistry, and biology) were related with each other according to their

scores on the NOST. It is also shown that they shared similar results in terms of the university graduation, educational qualification, teaching experience and previous in-service teaching. Researchers suggests that; at elementary and secondary schools, every science teacher should spend at least a week to go over the NOS aspects and review them to remind himself/herself and students what it is.

2.6. Curriculum versus NOS

Educators should also include NOS and its aspects to the directly to curriculums' of their education system. For example; Jules and Conner (2009), have analyzed their nation-wide curriculum Documents "*Science in the National Curriculum (SNC)* of Seychelles and *Seychelles National Curriculum Framework."* They proposed that in order to broaden students'understandings about science knowledge and scientific processes, aspects of NOS need to be described in *Science in the National Curriculum* of Seychelles.

In England, Taber (2008), proposes that preparing to teach about an aspect of science (a science concept, or an aspect of the nature of science) has to start from some kind of curricular model, which presents target knowledge that has been designed to be an intellectually honest simplification of current scholarship suitable for the learners. And he argues that to develop curricular models of the nature of science will draw upon scholarship exploring science from various disciplinary perspectives (e.g. history, philosophy, psychology, sociology, communication studies), complemented by research into the teaching and learning of science.

Rudolph (2000) suggests an alternative way to integrate Nature of Science into the science curriculum. He thinks that there are 2 major problems to overcome:

1. The first one concerns the match between these universal views of science and the structure of the school science curriculum based as it is, on traditional disciplinary distinctions. These conceptions of science, either drawn from science studies or simplified for curricular purposes, in their desire for breadth of coverage have sacrificed their ability to inform the specifics of any given disciplinary practice.

2. The second, more fundamental problem that must be addressed is the growing concern over the validity of universal conceptions altogether.

Both these issues suggest the need for a reconsideration of how the nature of science might be both conceptualized and integrated into the science curriculum. He then concludes that educators need to accept that there is no single nature of science exists and to develop curricula that help students understand the concept is very hard, instead of doing these the diverse, local practices that are found within and across scientific disciplines should be applied in the science lessons.

McCarty and Sanders (2007) proposed the use of "Broad Classification" concept in Biology to teach the Nature of Science concept. They questioned about 50 top first year university students in South Africa, 35 school biology teachers, 33 lecturers from university, 5 teacher educators, 4 curriculum developers, 2 textbook authors. At the end of the study, neither the students, nor the teachers, lecturers, teacher educators, curriculum developers, textbook authors seem to have inadequate information about biological kingdoms and historical change in biological systems. Additionally researchers conducted a review of two relevant syllabi and five textbooks; which resulted in insufficient, inaccurate, inconsistent and/or contradictory information about biological classification systems and how they change with time. Researchers suggest to have case studies describing historical developments, and the resulting battles amongst scientists, can be used to generate discussion in classroom. Additionally, researchers conclude that relevant, appropriate and up-to-date curriculum materials are also needed to support the teachers. To achieve these aims it is necessary to ensure that the knowledge of tertiary educators, as well as curriculum developers and textbook authors, is current and appropriate.

Rai and Bajpai (2009) advises that developing proper understanding of Nature of science is more important than imparting only superficial knowledge of science content. So they propose that curriculum framers should keep a balance between the emphasis on- knowledge about science and knowledge in science.

2.7. Textbook's representation of NOS in the world and in TURKEY

Science textbooks are important as science teachers in science education. Textbooks are second guides through the learning process after science teachers. It does not only help on following the curriculum but also a good source for students. When students do their homework they mostly refer to their textbooks. So for all these reasons, textbooks should be prepared carefully and according to national standards. Their language should also reflect scientific literacy. To achieve this; NOS also should be integrated within textbooks.

Recently Abd-El-Khalick et al. (2008) have analyzed 14 chemistry books popular in U.S.A. These books were assessed for the representations of NOS and the extent to which these representations have changed for the past 40 years. Analyses focused on the empirical, tentative, inferential, creative, theory-driven, and social NOS, in addition to the myth of "The Scientific Method," the nature of scientific theories and laws, and the social and cultural embeddedness of science. Even though U.S.A has been studying NOS and its aspects for over 50 years, these 14 most popular/used textbooks were found poor in representing NOS.

A study different than the one Abd-El-Khalick was performed by the Guisasola et al. (2005), where the 30 physics textbooks for university first year courses, published over a long period of time (1972–1999) have been analysed with respect to common characteristics of the Nature of Science, and how they have been presented in the introduction of the concept and theories of magnetic field. The results show that these physics textbooks have not been yet adopted to represent NOS aspects in their content and researchers propose that it would be useful for textbooks to illustrate the characteristics of the Nature of Science by focusing on problems and changes in the development of the theory of magnetic field. These researchers have focused only on one specific subject of Physics.

Chiapetta and Fillman (2007) has studied the representation of 4 NOS aspects which were; (a) science as a body of knowledge, (b) science as a way of investigating, (c) science as a way of thinking, and (d) science and its interactions with technology and society in 5 high school textbooks. In these textbooks, 6 biology

chapters are evaluated; which were the methods of science, cells, heredity, DNA, evolution, and ecology. The results show that, these recently published biology textbooks were better in representing the mentioned 4 NOS aspects with regards to the books published 15 years ago. Additionally, these 5 biology textbooks had more texts to engage the students in finding out answers, gathering information and how scientists do on their work.

McComas (2003) have analyzed only the terms “law” and “theory” concepts in U.S. Secondary School Biology textbooks, since these 2 concepts are outputs of the science. He reviewed and analyzed with respect to how the concepts of “law” and “theory” were defined and applied, in an attempt to determine whether students and teachers using such texts would gain an accurate impression of these terms and the distinction between them. As a result, the term “law” is rarely defined in any text but various laws such as those found in genetics are frequently included as examples in the books, the term “theory” is frequently defined but with a wide range of completeness of the definitions. Only some theories in biology included as examples.

Mumba et al. (2006), has analyzed one high school physics syllabus, three physics textbooks (Physics 10, 11 and 12) and fifteen public physics examination papers (Papers 1, 2 and 3) that were written by high school students between 2000 and 2004 to investigate the balance and emphasis of scientific literacy themes in Zambian high school physics course. The investigation results that; in spite of the innumerable scientific and technological advancements that have occurred in physics over the past decades and that have greatly affected society, textbook authors and examiners have not included them in physics curriculum. This is likely to be an obstacle in promoting scientific literacy among students. They concluded that national syllabus and examinations emphasized the investigative nature of science while textbooks placed most emphasis on basic knowledge of science.

Most recently, Yamak (2009) has studied the representation of NOS aspects with respect to 3 categories as “Science as Authoritative Knowledge”,”Science as Understanding Phenomena” and ”Science as the Social Construction of Knowledge” in 3 biology textbooks’ 2 units. She concluded that all of the three biology textbooks

have inadequate representation of NOS, in fact the percentages of all categories were under fifty. The “Science as Authoritative Knowledge” category recorded relatively higher percentage with respect to other 2 categories. This shows that Turkey is still dealing with science as body of knowledge.

Irez (2008) performed an assessment of representation of NOS on five mostly used biological textbooks in Turkey. This study resulted that the textbooks were “collection of facts, not as a dynamic process of generating and testing alternative explanations about nature.” The authors of the textbooks seem to not to understand the processes good enough to explain them therefore written misleading explanations regarding scientific enterprise.

2.8. Summary

As a result of literature review made above; the term Nature of Science has been in the education life more than 50 years, it is still developing. Nature of Science is one of the key components of being scientifically literate citizen. So for science education system, integrating NOS into the science lessons become an important issue. When the views of students and teachers are analyzed, it is seen that both of them have inadequate views. For this reason, there has been accountable number of researches made about the views of students and teachers about NOS, the education techniques to teach NOS, but there are fewer researches made on textbooks and curriculums. As textbooks and curriculums are guides to both students and teachers, NOS aspects should be integrated to these materials. In Turkey, the researches about the NOS is very low since the NOS concept is a very new and recent. The researchs are continuing to be made. More researches on analysis of science textbooks and especially curriculums should be made to get the attention of the authors and curriculum developers on the NOS subject, as they are not very aware of this subject.

CHAPTER 3

METHOD

In this chapter the problem, the design of the study, data source, reliability, assumptions and limitations are presented.

3.1. Problem

How the aspects of the NOS are represented in the 9th grade Chemistry textbooks?

3.2. Design of the Study

Method followed within this thesis is referenced from Irez (2008) "Nature of Science as Depicted in Turkish Biology Textbooks" with the exception that no concept maps are prepared. As Irez (2008) mentioned in his paper, "a qualitative oriented approach is employed and ethnographic content analysis (ECA) described by Aitheide (1996) is chosen as an appropriate methodological framework. ECA aims to provide a systematic and analytical, but not rigid, approach to content analysis. Categories and variables initially provide guidance, but others are allowed and expected to emerge during the analysis, including an orientation to constant discovery and constant comparison of relevant situations, settings, styles, images, meanings, and nuances (Aitheide, 1996, p. 16)."

During the analysis the following steps are applied:

1. The entire book was read and all the sentences/paragraphs/sections where there was a clue of the NOS aspect or opposite of the NOS aspect were located.

2. The sentences were coded with numbers where NOS provided information was present, by this way the themes of the related NOS aspect will be identified.
3. Themes are generated to check the expression type (implicit/explicit) or opposite of NOS in the sentences.
4. Statements were generated from the coded sentences for evidence.

Within this thesis, Lederman's (2006) definition of NOS aspects were used in summarized form as:

1. Observation and inference are distinct entities of science.
2. Science is influenced by the social and cultural environment of the scientist.
3. Science is partly the product of human creativity and imagination.
4. Scientific knowledge is tentative, empirical and theory laden.
5. There exists a distinct, non-hierarchical relationship between scientific theories and laws.
6. "There is no universal, recipe-like, method for doing science."

3.3. Analysis Results

The sentences found in the both books are given below with the order of book 1 and book 2. 1st book is the Turkish book, 2nd book is the English book.

1. Turkish: "Simya teorik temelleri olmayan sınama ve yanılmaya dayanan çalışmaları içerdiği ve sistematik bilgi birikimi sağlayamadığı için bilim değildir".

   English and coding: 1(Alchemy is not Science, since it includes "trial and error" methods), 2 (is not theory basis), 3 (systematic source of knowledge).

   Consistency with the following NOS Aspect: Observation and inference are distinct entities of science.

   Theme generation: It seems that there is a definition of science but it is not related with any of the NOS aspect.

Statement generation: Science is theory driven, Science is a source of systematic knowledge, Science does not use "trial and error" methods (1st book, pg.21, Chapter 1, Section 1.2)

2. Turkish: "Bu kabul tamamen düşünceye dayalı hiçbir denel gerçeklik temeline oturmayan madde algısıdır".

   English and coding: 4(This acceptance only depends on idea, it does not include any experimental reality basis.)

   Consistency with the following NOS Aspect: Scientific knowledge is tentative, empirical and theory laden.

   Theme generation: It seems that there is a definition of science but it is not related with any of the NOS aspect.

   Statement generation: Science takes the experimental reality as basis (1st book, pg. 22, Section 1.3)

3. Turkish: "Bu yorumlar, bilimsel temele daha yakındır".

   English and coding: 5(These comments are closer to scientific basis.)

   Consistency with the following NOS Aspect: Scientific knowledge is tentative, empirical and theory laden.

   Theme generation: It seems that there is a definition of science but it is not related with any of the NOS aspect.

   Statement generation: Scientific comments should take science as basis (1st book, pg. 22, Section 1.3)

4. Turkish: "İbni Sina, kendi dışındaki hiçbir otoritenin görüşünü, kendi araştırma ve mantık süzgecinden geçirmeden kabul etmemiş ve bu yönü ile de bilim dünyasına ışık tutarak modern bilimsel yöntemin öncülüğünü yapmıştır".

English and coding: 6(İbni Sina did not accept any authoritical idea unless he himself investigates and logically thinks about it) 7 (and by this way he not only leads the scientific world but also the development of scientific method.)

Consistency with the following NOS Aspect: Observation and inference are distinct entities of science.

Theme generation: Explicitly description of the NOS aspect.

Statement generation: Scientist should firstly investigate, logically think and make inference to accept any scientific theory (1st book, pg. 24, Reading Section)

5. Turkish: "Bilim olma sürecine geçilmesi, yasaların, kuralların ortaya konulmasıyla ve bilgileri sistematik hale getirmeyle gerçekleşmiştir".

   English and coding: 8 (Acceptance as a science, started with evolution of the theories and laws) and 9 (organizing the knowledge systematically)

   Consistency with the following NOS Aspect: Scientific knowledge is tentative, empirical and theory laden.

   Theme generation: Explicit description of the NOS aspect.

   Statement generation: Science is composed of theories, laws and systematical knowledge (1st book, pg. 25, Chapter 2)

6. Turkish: "Kimyayı simyadan ayıran en önemli özelliklerinden birisi ölçmeye dayalı olmasıdır. Deneysel sonuçların ölçülmesi ve yorumlanması kimyanın temel kanunlarının ortaya çıkmasına neden olmuş ve kimyada bilimsel süreç böylece başlamıştır".

   English and coding: 10 (One of the differences of alchemy and chemistry is that chemistry depends on measurement). 11 (Measurements of experimental results and inferences helped evolution of basic laws of chemistry and afterwards the scientific process of the chemistry has began)

Consistency with the following NOS Aspect: Observation and inference are distinct entities of science.

Theme generation: Explicit description of the NOS aspect.

Statement generation: Science depends on measurement. Both measurement and inferences help the evolution of the theories and laws. These all contribute to the evolution of the scientific process (1st book, pg. 26, Chapter 2)

7. Turkish: "Yaptığı denemelerde hep aynı sonuca ulaşmıştır. … Bu sonuçların ışığında Kütlenin Korunumu kanununu ifade etmiştir".

   English and coding: 12 (He achieved the same result with all the experiments he has performed). 13(He has explored the Conservation of Mass Law.)

   Theme generation: Implicit description of the NOS aspect.

   Consistency with the following NOS Aspect: Observation and inference are distinct entities of science.

   Statement generation: Scientists do as much as experiments to prove their law/theory. (1st book, pg. 27, Section 2.1)

8. Turkish: "Ayrıca, deneylerinde, özellikle ölçme işleminde gösterdiği olağanüstü duyarlılık, kendisini izleyen yeni kuşak araştırmacılar için özenilen bir örnek olmuştur. Kimya, dil, mantıksal düzen ve kuramsal açıklama yönlerinden bilimsel kimliğini Lavoisier'e borçludur".

   English and coding: 14 (Especially the incredible sensitivity he shows on his measurements and experiments, makes him an adorable scientist for the follower scientists). 15(Chemistry owns its being science as a language, as logical discipline, and as theoretical explanations to the Lavoisier)

   Theme generation: Implicit description of NOS aspect.

   Consistency with the following NOS Aspect: Observation and inference are distinct entities of science.

Statement generation: Science is combination of sensitive measurements, experiments, logical discipline and theoretical explanations. (1st book, pg. 27, Section 2.1)

9. Turkish: "Bununla beraber, Sabit Oranlar Kanunu atomik teorinin doğruluğuna kanıt oluşturmaz".

   English and coding: 16 (Constant Ratio Law is not an evidence for the approval of atom theory).

   Consistency with the following NOS Aspect: There exists a distinct, non-hierarchial relationship between scientific theories and laws.

   Theme generation: Implicit description of NOS aspect

   Statement generation: Laws and theories are different. (1st book, pg. 28, Section 2.2)

10. Turkish: "Dalton'un atom teorisi Katlı Oranlar Kanununu destekler…….Dalton Atom teorisi, Katlı Oranlar Kanununu basit bir şekilde açıklar."

    English and coding: 17 (Dalton's Atom Theory supports the The Law of Multiple Proportions). 18 (Dalton Atom Theory simply explains the The Law of Multiple Proportions)

    Consistency with the following NOS Aspect: There exists a distinct, non-hierarchial relationship between scientific theories and laws.

    Theme generation: Explicit description of NOS aspect.

    Statement generation: Laws and theories are different. (1st book, pg. 29, Section 2.3)

11. Turkish: "Dalton'un maddenin doğasına ilişkin zekice önsezisi 19. Yüzyılda kimyanın hızla gelişmesinde en önemli itici güç olmuştur."

English and coding: 19 (Dalton's brilliant foresight has been an important influence on the fast development of chemistry in 19th century.)

Consistency with the following NOS Aspect: Science is influenced by the social and cultural environment of the scientist.

Theme generation: Explicit description of NOS aspect.

Statement generation: Scientist have a valuable foresight. (1st book, pg. 30, Section 2.3)

12. Turkish: "Simyanın bilim sayılmamasının nedenleri nelerdir? Açıklayınız."

English and coding: 20 (Why alchemy is not science? Explain.)

Consistency with the following NOS Aspect: Scientific knowledge is tentative, empirical and theory laden.

Theme generation: Implicit description of NOS aspect.

Statement generation: Science does not use trial and error methods. (1st book, pg. 39)

13. Turkish: "Lavoisier'in teraziyi kimyaya uygulaması ile kimya tarihinde en önemli adımlardan biri atılmıştır."

English and coding: 21 (Lavoisier has utilized balance which has been an important turning point in chemistry history.)

Consistency with the following NOS Aspect: Science is partly the product of human creativity and imagination.

Theme generation: Explicit description of NOS aspect.

Statement generation: Science needs imagination and creativity. (1st book, pg. 82)

14. Turkish: "Wöhler'in bu buluşu planlanmış bir çalışmanın neticesi değildir. Nitekim kendisi de bu buluşunu hayretle karşılamış ve neticesini ilan etmeden

once sentezini defalarca tekrarlayarak zamanın diğer tanınmış kimyacılarına bildirmiştir."

English and coding: 22 (Wöhler's discovery was not a result of planned work) 23 (He himself also was surprised with the results, so he repeated his synthesis over and over again to be sure and then he declared his results to the well-known scientist at that time.)

Consistency with the following NOS Aspect: Observation and inference are distinct entities of science.

Theme generation: Explicit description of science and characteristics of scientists.

Statement generation: Science and scientist need imagination and creativity. (1st book, pg. 82)

15. Turkish: "Modern plastik endüstrisi kazara keşfedilen bu maddeyle doğmuştur."

English and coding: 24 (Modern plastic industry has been evolved with unintended discovery of this material.)

Consistency with the following NOS Aspect: There is no universal, recipe-like method for doing science.

Theme generation: Explicit description of NOS aspect.

Statement generation: Science needs observation and inference, and science affects the culture significantly. (1st book, pg. 124)

16. Turkish: "Yaşamımızın vazgeçilmez bir parçası olan kimya biliminin verileri, temizlik maddelerinin üretiminden, evimizin yapımına.. kadar pek çok yerde kullanılmaktadır."

English and coding: 25 (Chemistry science's data is used in variety of places like from the cleaning of the house to the structure of the house.)

Consistency with the following NOS Aspect: Science is influenced by the social and cultural environment of the scientist.

Theme generation: Implicit description of NOS aspect.

Statement generation: Science affects the culture significantly. (1st book, pg. 188)

17. Turkish: "Suyu tanımak, muhafaza edebilmek için kaplar yapma zorunluluğundan seramik doğmuştur."

English and coding: 26 (To know and keep the water, container is needed, so invention of ceramic was must.)

Consistency with the following NOS Aspect: There is no universal, recipe–like, method for doing science.

Theme generation: Implicit description of NOS aspect.

Statement generation: There is no universal, recipe–like, method for doing science. (1st book, pg. 210)

18. Turkish: "Bir bilim insanı saksıya dikip büyüttüğü ağaç fidesini bir kaç yıl sonra gözlemesi sonucunda ağaçtaki büyüme ile ortaya çıkan kütle artışının topraktaki kütle miktarının azalmasıyla aynı olmadığını görür."

English and coding: 27 (A scientifically literate person can observe that the tree he/she has planted does not gain weight as the same proportion soil has lost.)

Consistency with the following NOS Aspect: Observation and inference are distinct entities of science.

Theme generation: Explicit description of NOS aspect.

Statement generation: A scientifically literate person should do good observation and inferences. (1st book, pg. 216)

19. Turkish: “Bilim adamları bunları kullanmaktan kaçınmak ya da zararlarını ortadan kaldırmak için çevre dostu alternatif enerjiler bularak bunların kulanımını yaygınlaştırmaya çalışmaktadırlar.”

English and coding: 28 (Scientists find alternative energy resources and try to expand the usage since the other energy resources are harmful to humankind)

Consistency with the following NOS Aspect: Science is influenced by the social and cultural environment of scientist.

Theme generation: Explicit description of NOS aspect.

Statement generation: Scientists are influenced by the environment they live in. (1st book, pg. 236)

2nd book: Since the second book is written in English, there will not be any Turkish writing, directly Coding will be at the start.

1. Coding: 1 (To raise new questions, new possibilities, to regard old problems from a new angle, requires creative imagination and marks real advance in science)

   Consistency with the following NOS Aspect: Science is partly the product of human creativity and imagination.

   Theme generation: Explicit description of NOS aspect.

   Statement generation: Science needs imagination and creativity. (2nd book, pg 5)

2. Coding: 2 (Jabir emphasized experimentation and development of methods to achieve reproducibility in his work)

   Inconsistency with the following NOS Aspect: There is no universal,recipe-like method for doing science.

   Theme generation: Opposite explanation of NOS aspect.

   Statement generation: Science needs experimentation and development of methods to achieve reproducibility.(2nd book, pg 16)

3. Coding: 3 (Their enthusiasm for chemical preparations led to advances in practical technique and to a number of new discoveries.)

   Consistency with the following NOS Aspect: Science is partly the product of human creativity and imagination.

   Theme generation: Implicit description of NOS aspect by emphasizing "enthusiasm"

   Statement generation: Scientist should be enthusiastic.(2nd book, pg 18)

4. Coding: 4 (Lavoisier, a well trained scientist, repeated Priestley's experiment under carefully controlled conditions.)

   Consistency with the following NOS Aspect: Science is partly the product of human creativity and imagination.

   Theme generation: Implicit description of NOS aspect by emphasizing "well-trained"

   Statement generation: Science is tentative, so the experiments can be repeated to find the true knowledge.(2nd book, pg 20)

5. Coding: 5 (This statement is an example of a scientific law, a general statement based on the observed behavior of matter to which no exceptions are known.)

   Consistency with the following NOS Aspect: There exists a distinct non-hierarchal relationship between scientific theories and scientific laws.

   Theme generation: Implicit definition of NOS Aspect. (Within the definition of law given above, no relationship is given with theories.)

   Statement generation: Scientific law is a general statement based on the observed behavior of matter to which no exceptions are known. (2nd book, pg 21)

6. Coding: 6 (Experiments have shown that Dalton's hypothesis about the particulate nature of matter is mostly but not entirely correct. New scientific findings have revealed that not all atoms of the same element are alike in mass.)

Consistency with the following NOS Aspect: Scientific knowledge is tentative, empirical and theory laden.

Theme generation: Explicitly description of NOS aspect.

Statement generation: Science is open to change and may change with the new finding. (2nd book, pg 31)

7. Coding: 7 (Dalton's concept of bonding was essentially non-existent, however, and he imagined that atoms simply sit adjacent to each other in their compound form.)

   Consistency with the following NOS Aspect: Science is partly the product of human creativity and imagination.

   Theme generation: Explicit description of NOS aspect.

   Statement generation: Scientist sometimes use their imagination in science. (2nd book, pg 35)

8. Coding: 8 (Regardless of the area of study, all scientists almost follow a similar procedure to discover the facts of nature.)

   Inconsistency with the following NOS Aspect: There is no universal, recipe-like method for doing science.

   Theme generation: Opposite of the NOS Aspect.

   Statement generation: Scientist follows a procedure to discover the facts of nature. (2nd book, pg 37)

9. Coding: 9 (The steps involved in scientific method are simple and make sense to everyone.

   Inconsistency with the following NOS Aspect: There is no universal, recipe-like method for doing science.

Theme generation: Opposite of the NOS Aspect.

Statement generation: Scientific method is simple and makes sense to everyone. (2nd book, pg 37-41)

10. Coding: 10 (To raise new questions, new possibilities, to regard old problems from a new angle, require creative imagination and marks real advance in science.)

Consistency with the following NOS Aspect: Science is partly the product of human creativity and imagination.

Theme generation: Explicit description of NOS aspect.

Statement generation: Science needs creative imagination for both new problems and old problems to look them in a new angle. (2nd book, pg 38)

11. Coding: 11 (A good experimenter is a good observer.)

Consistency with the following NOS Aspect: Observation and inference are distinct entities of science.

Theme generation: Explicit description of NOS aspect.

Statement generation: Science needs a good observer and experimenter. (2nd book, pg 39)

12. Coding: 12 (If a theory becomes so well established by experimental evidence in many different situations over many years, and can be disproved by no means, It becomes a scientific law.)

Inconsistency with the following NOS Aspect: There exists a distinct non-hierarchal relationship between scientific theories and laws.

Theme generation: Opposite description of NOS aspect.

Statement generation: Theory becomes law if it is so well established and cannot be disproved by no means. (2nd book, pg 41)

13. Coding: 13 (What happens to a theory when a new observation is made that the theory should be able to explain, but cannot?)

Consistency with the following NOS Aspect: Scientific knowledge is tentative, empirical and theory laden.

Theme generation: Explicit question of the NOS aspect.

Statement generation: Science is tentative; it is subject to change with new observations. (2nd book, pg 45, Check Yourself section)

14. Coding: 14 (Chemical reactions have a profound effect in our lives.)

Consistency with the following NOS Aspect: Science is influenced by the social and cultural environment of the scientist.

Theme generation: Implicit description of NOS aspect.

Statement generation: Science and technology is very related with each other. (2nd book, pg 213)

3.4. Data Source

For the sampling method "purposive sampling method" is chosen. As the latest chemistry curriculum has been changed at 2008-2009 education program, the chemistry textbooks chosen includes this curriculum content. 2 books are chosen for this purpose, one of them is written in English, the other in Turkish. The Turkish one is being used throughout the whole country, the English one is used in private high schools, as the education in these schools are made in English.

The books evaluated are given in the table below:

Table 1: Textbooks which were analyzed in this study

Book #	**Type**
Book 1	Turkish
Book 2	English

3.5. Reliability

It was a time consuming process to read all the 2 books and analyze all the sentences. So reliability measures are done on the researchers' set of sentences found in the book. Another research assistant has also analyzed the sentences found by the researcher with respect to the NOS aspects' presence or not. (All the indicators of NOS aspects are determined as sufficient (1) or insufficient (0))

The reliability analysis is made on this basis using the Cohen's Kappa with SPSS for Windows version 12.

Interpretation of Kappa values according to Landis and Koch (1977) are:

- Poor agreement = Less than 0.20
- Fair agreement = 0.20 to 0.40
- *Moderate agreement = 0.40 to 0.60*
- Good agreement = 0.60 to 0.80
- Very good agreement = 0.80 to 1.00

In the current study the Cohen's kappa was found to be ***0.504***. This value was found acceptable for this study.

There have been 3 corrections made after the colleague's analysis of the theme statements, which are coded 1,2 and 3 in first book. These were thought to be implicit definition of NOS aspect but after doing one more analysis it is agreed with the colleague's analysis that there is no relation of NOS aspects within those sentences.

3.6. Assumptions and Limitations

The assumptions and limitations of this study are explained below.

3.4.1. Assumptions

The Turkish Chemistry textbook analyzed has been published by the National Ministry of Education, and at the first page of this book, it is written as "it has been accepted as a chemistry textbook with the 30.06.2008 dated and 146th number decision of National Ministry of Education…" So this book is assumed to be written in accordance with the latest curriculum written in 2008-2009 education program. The English Chemistry textbook is also assumed to be written in accordance with the 2008-2009 education program curriculum.

3.4.2. Limitations

In this study, "content analysis" is made by reading each sentence in the book, and determining whether the sentence includes the NOS aspect in it referencing Irez's (2008) study on biology textbooks. This type of analysis is dependent on the researcher's point of view. So there is no stepwise format for doing the analysis itself. There were not any standard category in evaluating sentences, for example one researcher may think that there is a NOS aspect in the analyzed sentence but the other researcher may think there is not. This is one of the most important limitations in this study. In order to overcome this limitation, another research assistant has also analyzed the sentences found by the researcher. She has analyzed these sentences with respect to presence of NOS aspect or not. There were 3 sentences where the other research assistant thought that there were not any NOS aspects as researcher have thought. So, researcher has changed these 3 sentences. The details of this analysis are measured at Reliability section.

CHAPTER 4

RESULTS

The results show that all the NOS aspects are represented in the two of the chemistry books, some with higher proportion and some with lower proportion. The proportions are calculated with respect to other NOS aspects. When the overall frequencies are analyzed; first book has 16 occurrences, where 2nd book has 15 occurrences throughout the entire book. These results are very low, when we think that there is hundreds of sentences in each book. (First book has 245 pages, second book has 260 pages.) The overall results are tabulated in Table 14.

Below tables show the book sentences that ha the NOS aspect included/embedded in it. It can be represented explicitly or implicitly, both were counted as one. Additionally the sentences which have opposite of the NOS aspect were also counted.

1. *Observation and inference are distinct entities of science:* Results showed that first book had 32% of representation (according to Table 14) with respect to other NOS aspects, and only 6 occurrences. Second book had 7% of representation (according to Table 14) with respect to other NOS aspects, and only 1 occurrence.

   Likewise other branches of science, chemistry is the one of the most important branch where its basis is the “observation” and “inference”, but when this result is analyzed, it is seen that both books only give the definition of theories or laws, the emphasis on “observation” and “inference” in science is not given sufficiently. The historical background of the knowledge was not detailed in both of the books.

Table 2: Representation of the NOS Aspect "*Observation and inference are distinct entities of science*" in the First book.

Coding	Theme Generation	Statement Generation	Evidence
6,7	Implicitly and partially description of NOS aspect	Scientist should firstly investigate, logically think and make inference to accept any scientific theory	1st book, pg. 24
10,11	Explicit description of NOS aspect	Science depends on measurement. Both measurement and inferences help the evolution of the theories and laws. These all contribute to the evolution of the scientific process	1st book, pg. 26
12,13	Implicit description NOS aspect	Scientists do as much as experiments to prove their law/theory.	1st book, pg. 27
13, 14	Implicit description of NOS aspect	Science is combination of sensitive measurements, experiments, logical discipline and theoretical explanations.	1st book, pg. 27
22, 23	Implicit description of NOS aspect	Science and scientist need imagination and creativity.	1st book, pg. 82
27	Explicit description of NOS aspect	A scientifically literate person should do good observation and inferences.	1st book, pg. 216

Table 3: Representation of the NOS Aspect "*Observation and inference are distinct entities of science*" in the Second book.

Coding	Theme Generation	Statement Generation	Evidence
11	Explicit description of NOS	Science needs a good observer and experimenter.	2nd book, pg 39

2. *Science is influenced by the social and cultural environment of the scientist:* Results show that first book had 16% of representation (according to Table 14) with respect to other NOS aspects, and only 3 occurrences. Second book

had 7% of representation (according to Table 14) with respect to other NOS aspects, and only 1 occurrence.

First book more emphasized this aspect with respect to second book. Even though second book had famous scientists' quotes at the beginning of each chapter, how these scientists were affected by their social environment were not explained in detail.

Table 4: Representation of the NOS Aspect "*Science is influenced by the social and cultural environment of the scientist"* in the First book.

Coding	Theme Generation	Statement Generation	Evidence
19	Implicit description of NOS aspect	Scientist have a valuable foresight.	1st book, pg. 30
25	Implicit description of NOS aspect	Science affects the culture significantly.	1st book, pg. 188
28	Explicit description of NOS aspect	Scientists are influenced by the environment they live in.	1st book, pg. 236

Table 5: Representation of the NOS Aspect "*Science is influenced by the social and cultural environment of the scientist"* in the Second book.

Coding	Theme Generation	Statement Generation	Evidence
14	Implicit description of NOS aspect	Science and technology is very related with each other.	2nd book, pg 213

3. *Science is partly the product of human creativity and imagination:* Results show that first book has 5% of representation (according to Table 14) with respect to other NOS aspects, and only 1 occurrence. Second book has 27% of representation (according to Table 14) with respect to other NOS aspects, and only 4 occurrences.

The second book has emphasized the life of the scientist, on the other hand first book only focuses on the theories, laws that the scientists have found. Also the quotes of the scientists included some words about creativeness, imagination etc.

Table 6: Representation of the NOS Aspect "*Science is partly the product of human creativity and imagination"* in the First book.

Coding	Theme Generation	Statement Generation	Evidence
21	Implicit description of NOS aspect.	Science needs imagination and creativity.	1st book, pg. 82

Table 7: Representation of the NOS Aspect "*Science is partly the product of human creativity and imagination"* in the Second book.

Coding	Theme Generation	Statement Generation	Evidence
1	Implicit description of NOS aspect	Science needs imagination and creativity.	2nd book, pg 5
3	Explicit description of NOS aspect	Scientist should be enthusiastic.	2nd book, pg 18
7	Implicit description of NOS aspect	Scientists sometimes use their imagination in science.	2nd book, pg 35
10	Explicit description of NOS aspect	Science needs creative imagination for both new problems and old problems to look them in a new angle.	2nd book, pg 38

4. *Scientific knowledge is tentative, empirical and theory laden:* Results show that first book has 21% of representation (according to Table 14) with respect to other NOS aspects, and only 2 occurrences. Second book has 27% of representation (according to Table 14) with respect to other NOS aspects, and only 4 occurrences.

The occurrences of both books are same, but when the statements are analyzed, first book discussed this aspect's "theory laden" part mostly where as the second book emphasized the "tentative" part of book.

Table 8: Representation of the NOS Aspect "*Scientific knowledge is tentative, empirical and theory laden."* in the First book.

Coding	Theme Generation	Statement Generation	Evidence
8,9	Explicit description of NOS aspect.	Science is composed of theories, laws and systematical knowledge	1st book, pg. 25
20	Explicit description of NOS aspect.	Science does not use trial and error methods.	1st book, pg. 39

Table 9: Representation of the NOS Aspect "*Scientific knowledge is tentative, empirical and theory laden."* in the Second book.

Coding	Theme Generation	Statement Generation	Evidence
4	Explicit description of NOS aspect	Science is tentative, so the experiments can be repeated to find the true knowledge.	2nd book, pg 20
6	Explicit description of NOS aspect	Science is open to change and may change with the new finding.	2nd book, pg 31
10	Explicit description of NOS aspect	Science needs creative imagination for both new problems and old problems to look them in a new angle.	2nd book, pg 38
13	Explicit question of the NOS aspect	Science is tentative, it is subject to change with new observations.	2nd book, pg 45

5. *There exists a distinct, non-hierarchial relationship between scientific theories and laws:* Results show that first book has 10% of representation (according to Table 14) with respect to other NOS aspects, and only 2

occurrences. Second book has 13% of representation (according to Table 14) with respect to other NOS aspects, and only 2 occurrences.

First book has explained the theories and laws different with no relationship between them and representing the NOS aspect correctly, but on the other hand 2nd book has one opposite definition of this concept which was the common misconception of theories and laws.

Table 10: Representation of the NOS Aspect "*There exists a distinct, non-hierarchial relationship between scientific theories and laws."* in the First book.

Coding	Theme Generation	Statement Generation	Evidence
16	Explicit description of NOS aspect.	Laws and theories are different.	1st book, pg. 28
17,18	Explicit description of NOS aspect.	Laws and theories are different.	1st book, pg. 29

Table 11: Representation of the NOS Aspect "*There exists a distinct, non-hierarchial relationship between scientific theories and laws."* in the Second book.

Coding	Theme Generation	Statement Generation	Evidence
5	Implicit definition of NOS Aspect. (Within the definition of law given above, no relationship is given with theories.)	Scientific law is a general statement based on the observed behavior of matter to which no exceptions are known.	2nd book, pg 21
12	Opposite description of NOS aspect.	Theory becomes law if it is so well established and can not be disproved by no means.	2nd book, pg 41

6. *There is no universal, recipe-like, method for doing science:* It is resulted that first book has 10% of representation (according to Table 14) with respect to other NOS aspects, and only 2 occurrences. Second book has negative representation of NOS aspects with 20% (according to Table 14) with 3 occurrences.

The second book has a special unit where the "Scientific Method" is explained with the steps in detail. This is not the aspect of the NOS, but as Lederman (2006) explained, these are overlapped and interacted with each other.

Table 12: Representation of the NOS Aspect "*"There is no universal, recipe-like, method for doing science."*" in the First book.

Coding	Theme Generation	Statement Generation	Evidence
24	Implicit description of NOS aspect.	Science needs observation and inference, and science affects the culture significantly.	1st book, pg. 124
26	Explicit description of NOS aspect.	There is no universal, recipe – like, method for doing science.	1st book, pg. 210

Table 13: Representation of the NOS Aspect "*"There is no universal, recipe-like, method for doing science."*" in the Second book.

Coding	Theme Generation	Statement Generation	Evidence
2	Opposite description of NOS aspect.	Science needs experimentation and development of methods to achieve reproducibility.	2nd book, pg 16
8	Opposite description of NOS aspect.	Scientist follow a procedure to discover the facts of nature.	2nd book, pg 37
9	Opposite description of NOS aspect.	Scientific method is simple and make sense to everyone.	2nd book, pg 37-41

The overall results of the frequencies of the NOS aspects in these two books are tabulated below:

Table 14: The overall results of the frequencies and percentages of NOS aspects in two books

NOS Aspect	Freq in 1st book	Percentage	Freq in 2nd book	Percentage
Observation and inference are distinct entities of science.	6	37,5	1	6,67
Science is influenced by the social and cultural environment of the scientist.	3	18,75	1	6,67
Science is partly the product of human creativit and imagination.	1	6,25	4	26,67
Scientific knowledge is tentative, empirical and theory laden.	2	12,5	4	26,67
There exists a distinct, non-hierarchial relationship between scientific theories and laws.	2	12,5	2	13,33
There is no universal, recipe-like, method for doing science .	2	12,5	3	20,00

CHAPTER 5

DISCUSSION, IMPLICATION AND RECOMMENDATIONS

This chapter discusses the overall findings of the present study, the implications and recommendations for the future studies.

5.1. Discussion

This study aimed to investigate the representation of the following NOS aspects; 1. Observation and inference are distinct entities of science, 2. Science is influenced by the social and cultural environment of the scientist, 3. Science is partly the product of human creativity and imagination, 4. Scientific knowledge is tentative, empirical and theory laden, 5. There exists a distinct, non-hierarchical relationship between scientific theories and laws, 6. There is no universal, recipe-like, method for doing science as defined by Lederman (2006), in 9th grade, 2 Chemistry textbooks one of which is Turkish, the other is English, prepared according to latest curriculum, and used nation-wide. Overall results of this study are in accordance with the previous studies made related with the textbook analysis.

As seen on Table 14 the overall rate of the NOS aspects found in both textbooks are very low. This is the indication of the authors either do not have adequate views of NOS, or do not give importance on embedding NOS aspects in their books. It is analyzed that neither of the NOS aspects is represented adequately in books; all of their frequencies are low. There is no chapter which discusses the NOS or its aspects. Only in second book, there is section about “scientific method”, which is the major misconception in defining NOS (Lederman, 2006).

When each of the aspect of the NOS is analyzed, the low percentage of the first aspect may be because of the lack of historical background of the knowledge given

was not detailed in both of the books. More importance should be given how the scientific knowledge has been established. By this way, the students would understand that actual knowledge/truth was always there; all the scientists needed were to make good observation and afterwards logical inferences.

First book more emphasized the second aspect with respect to second book. Even though second book had famous scientists' quotes at the beginning of each chapter, how these scientists were affected by their social environment were not explained in detail. The third aspect had a higher frequency in second book since some of the quotes of the scientists included some words about creativeness, imagination etc.

For the fourth aspect, book 1 had explained the theories and laws as two different concepts with no relationship between them and representing the NOS aspect correctly, but on the other hand 2nd book had one opposite definition of this concept which was the common misconception of theories and laws, as with more evidence theories becoming law. This misconception is also common on teachers. This can be prevented by giving more examples about the theories and laws, and how they become theory or law.

There are laboratory experiment procedures in both of the books which can be a good approach in viewing the NOS aspects if they are applied adequately in the classrooms. But as Özden (2007) mentioned that one of the problems teachers have in Turkey is the less laboratory opportunities, it is doubtfull that if these experiments are performed. The researches (Ramsey and Howe, 1969; Lavach, 1969) show that laboratory-centered, experimental approach supports the gain in understanding of NOS by both the students and/or science teachers.

The second book has a science related quote from the famous scientist at the beginning of the each chapter. For example, at the beginning Chapter 1 "The Development of Chemistry", the following quote of Albert Einstein is given which in fact, includes the NOS aspect "*Science is partly the product of human creativity and imagination*":

The formulation of a problem is often more essential than its solution, which may be merely a mathematical or experimental skill.

To raise new questions, new possibilities, to regard old problems from a new angle, require creative imagination and marks read advance in science.

This approach may be helpful for the students to know more about the lifes' of the scientists, how they thought when they were doing experiments, how they have believed in what they have doing, what problems they have encountered etc. More information on scientists' life may be attractive to the students, which then makes them attracted to the science lessons.

This study focuses on reading all the sentences of the books and then analyzing the sentences with respect to whether sentences included one of the NOS aspect in it explicitly or implicitly. But the meaning of the sentences and/or how they are interpreted in students' minds are not analyzed, as McComas and Almazroa (1998) summarized the Munby's (1976) studies, "Munby (1976) advocates that when students read phrases like "…our description of process….", they may understand this to mean that science ideas have an inventive character and thus, may not exactly describe reality. The position that science ideas are useful tools to help us understand the natural world fits nicely with an instrumentalist view of science knowledge. For further explanation Munby gives the following passage example from *Conceptual Physics: A New Introduction to Your Environment* by Hewitt (1971): "

"*Although the innermost electrons in an atom are bound very tightly to the oppositely charged nucleus, the outermost electrons of many atoms are bound very loosely and can be easily disloged…."*

"The description of electrical phenomena in this passage (e.g electrons are bound, disloged…) conveys an entirely different message concerning the ontological status of electrons. Here the role of humans in producing explanations for phenomena is missing and students are left to infer that scientists simply found electrons while doing experiments. Therefore Munby stated that students may derive different views about the nature of science depending on the way that science knowledge is communicated in textbooks. He further suggested that the societal attitude towards science can be explained by the way that science has been communicated in schools."

"*The fact that science is viewed as a source of true, reliable, and dependable*

knowledge might be a consequence of it being taught that way. (Munby, 1976,p.173)"

Both of these books are written according to the national curriculum developed by the Ministry of the Education. The First book (written in Turkish) is also analyzed by the Aydın (2010) according to some criteria such as students' perceptions, examples given in the book, concept instruction, motivation etc. by the 50 chemical teachers in Kırşehir. As it can be seen, the book is not analyzed in point of any NOS aspect. With the criteria given above, teachers found the book in "middle" level, it should be improved in all of the criteria given above and Nature of Science criteria should be integrated into the textbook.

5.2. Implications

One of the most important aims of the science education is to have "scientifically literate" citizens. In order to achieve this; it should be taught that "science" does not comprise of only laws, theories, facts etc. A "scientifically literate" person understands the laws, theories, facts etc together with the processes of the science and knows the relationships between science, technology and society. This can be achieved by giving students NOS views as one of the key components on scientific literacy. In order to achieve this; both the science teachers and the science textbooks read in the schools should be improved by having NOS aspects. This study only focused on the textbook view, so with the results achieved with this study and results reviewed from literature, some suggestions can be made.

This study showed that the science textbooks reveal the NOS aspects in very low ratio. And some aspects are even revealed in wrong way. Books are comprised of definitions of theories and problems. There should be a separate chapter; it can be the first chapter, to explain the NOS and its aspects, this could be a good introduction to the lesson. After being introduced in the first chapter of the textbooks it can be embedded to other chapters by using the language to be interpreted by the students as Munby (1976) has suggested. All of the NOS aspects should be represented throughout the book with the same ratio. Additionally, this introduction chapter to NOS should include a discussion section where students would have an opportunity

question the NOS aspects, and clear their misconceptions of the NOS aspects if they have any.

Related with the textbook updates about the NOS aspect, curriculums of all science disciplines can be updated to include NOS aspects as an introduction chapter. Actually, first the science curriculums should be updated in order to make them reflect to the science school textbooks.

The authors should be taught about the NOS and its aspects, they should be aware of NOS and its importance in textbooks. NOS and its aspects should be in the curriculum also. So both the textbook writers and curriculum writers should be knowledgeable about the NOS and its benefits to the students and science education. Additionally, students naïve ideas about the NOS should be stressed in the textbooks. For curriculum developers to write or integrate NOS aspects, the educational system should also be developing itself.

5.3. Recommendations

In this part, some recommendations for the future studies will be given:

The present study analyzed only 2 Chemistry books of 9^{th} grade level. This can be expanded to 10^{th}, 11^{th} and 12^{th} Chemistry books with the different authors.

This study only analyzed the sentences in the books, for future studies the "language" as a whole can be analyzed, even it seems as there is no NOS aspect within the sentence, the mean of it may comprise NOS aspect, this can also be studied. The usage of "NOS Language" can also be taught to the science teachers, it can be made through a new instruction method.

This study can be performed in timely manner, for example for every curriculum change; the related changed textbooks can be analyzed to see if there is any improvement on representing NOS aspects. Or whenever a new textbook is published it can be analyzed. For analyzing textbooks a checklist can be prepared to check if every criterion is met in the textbook, and nature of science skills can be added to this checklist.

As another recommendation, a course related with NOS aspects can be opeend in education faculties of the universities. As it is discussed in the Literature Review part of this thesis, teachers donot have adequate views of NOS aspects, may be these course would help them gain adequate views.

REFERENCES

Abd-El-Khalick, F., Waters, M. and Le, A.-P. (2008), Representations of nature of science in high school chemistry textbooks over the past four decades. *Journal of Research in Science Teaching*, *45*, 835–855

Akarsu, B. (2010). The Influence of Disciplines on the Knowledge of Science: A Study of the Nature of Science. Bulgarian Journal of Science and Education Policy, 4 (1), 99-118.

Akerson, V. L., Abd-El-Khalick, F., Lederman N. G. (2000). Influence of a Reflective Explicit Activity-Based Approach on Elementary Teachers' Conceptions of Nature of Science. Journal of Research in Science Teaching, 37 (4), 295-317

Akerson, V. and Donnelly, L. A. (2010). Teaching Nature of Science to K-2 Students: What understandings can they attain? International Journal of Science Education, 32 (1), 97-124.

Aitheide, D. L. (1996). Qualitative media analysis. Thousand Oaks, CA: Sage.

Aslan, O. Yalçın, N., Taşar, M. F. (2009). The Views of the Teachers of the Science and Technology on the Nature of Science. Ahi Evran Üniversitesi Eğitim Fakültesi Dergisi, 10 (3), 1-8

Bell, R.L. (2009). Teaching the Nature of Science; Three Critical Questions. National Geographic, SCL22-0449A

Black, P. & Wiliam, D. (1998). Inside the black box: Raising standards through classroom assessment. Retrieved July 29, 2008, from http://www.pdkintl.org/kappan/kbla9810.htm.

Bybee, R. W. (1997). Achieving Scientific Literacy: From Purposes to Practices. *Portsmouth, NH: Heinemann Educational Books*.

Bybee, R. W. (2008). Scientific Literacy, Environmental Issues, and PISA 2006: The

2008 Paul F-Brandwein Lecture. *Journal of Science Education Technology, 17*, 566-585.

Can, B. and Pekmez, E. Ş. (2010). The Effects Of The Nature Of Science Activities On The Development of Seventh Grade Students' Science Process Skills. *Pamukkale Üniversitesi Eğitim Fakültesi Dergisi, 27*, 113-123.

Çelik, S. and Bayrakçeken S. (2006). The effect of a 'Science, Technology and Society' course on prospective teachers' conceptions of the nature of science. *Research in Science & Technology Education, 24 (2),* 255-273.

Çepni, S. and Çil, E. (2010). Using a conceptual change text as a tool to teach the nature of science in an explicit reflective approach. *Asia-Pacific Forum on Science Learning and Teaching, 11 (1)* 1.

Chiappetta, E. L. and Fillman, D. A. (2007). Analysis of Five High School Biology Textbooks Used in the United States for Inclusion of the Nature of Science. *International Journal of Science Education, 15*, 1847-1868.

Dogan, N. and Abd-El-Khalick, F. (2008), Turkish grade 10 students' and science teachers' conceptions of nature of science: A national study. *Journal of Research in Science Teaching*, *45*,1083–1112.

Dunlop, C. M. and Hodum, P. (2009). Scientist–Science Educator Collaborations: Do They Improve Students' Understanding of the Nature of Science? *Journal of College Science Teaching,* 66-75.

Galluci, K. (2009). Learning About the Nature of Science With Case Studies. *Journal of College Science Teaching,* 5054.

Guisasola, J. Almudi, J. M. Furio, C. (2005). The Nature of Science and Its Implications for Physics Textbooks, The Case of Classical Magnetic Field Theory. *Science & Education, 14*, 321-338.

Holbrook, J. and Rannikmae, M. (2009). The Meaning of Scientific Literacy. *International Journal of Environmental & Science Education, 4*, 275-288.

Irez, S. (2006). Are We Prepared?: An Assessment of Preservice Science Teacher Educators' Beliefs About Nature of Science. *Science Teacher Education.*DOI 10.1002/SCE.20156.

Irez, S. (2006). Nature of Science as Depicted in Turkish Biology Textbooks. *Science Teacher Education.*DOI 10.1002/SCE.20305.

Irez, S. and Çakır, M. (2006). Critical Reflective Approach to Teach the Nature of Science: A rationale and Review of Strategies. *Journal of Turkish Science Education, 3 (2),* 7-23.

Jules, R. and Conner, L. (2009). Nature of science in Science in the National Curriculum of Seychelles: Recommended policy and practice changes. *Pacific-Asian Education, 21*, 19-34.

Kavak, N. Tufan, Y. Demirelli, H. Science and Technology Literacy and Informal Science Education: Potential Role of Newspapers. *GÜ, Gazi Eğitim Fakültesi Dergisi, 26 (3),* 17-28.

Köksal, M. S. (2009). An instruction design model to teach nature of science. *Asia-Pacific Forum on Science Learning and Teaching, 10 (2),* 1.

Köksal, M. S. and Çakıroglu, J. (2010). Examining science teacher's understandings of the NOS aspects through the use of knowledge test and open-ended questions. *Science Education International, 21 (3),* 197-211.

Köseoğlu, F., Tümay, H., Budak, E. (2008). Paradigm Changes about Nature of Science and New Teaching Approaches. *GÜ, Gazi Eğitim Fakültesi Dergisi, 28 (2),* 221-237.

Lavach, J.F. (1969). Organization and evaluation of an inservice program in the history of science. *Journal of Research in Science Teaching*, *6*, 166–170.

Lederman, N. G. and Lederman J. S. (2004). Revising Instruction to teach Nature of Science. *The Science Teacher.* November 2004, 36-39.

Lederman, N. G. (2006). Chapter 28, Nature of Science: Past, Present, and Future.

ch28_8062_Abell_LEA, 831-880.

Landis, J.R. and Koch, G.G. (1977). The measurement of observer agreement for categorical data. *Biometrics, 33 (1),* 159–174.

McComas William F. and Almazroa Hiya. (1998). The Nature of Science Education: An Introduction. *Science & Education 7,* 511-532.

Özden, M. (2007). Problems with Science and Technology Education in Turkey. *Eurasia Journal of Mathematics, Science & Technology Education, 3 (2),* 157-161.

McCarthy, S. and Sanders M. (2007). Broad classification and the provisional nature of science. *Journal of Biology Education (JBE), 41 (3),* 123-130.

Morgil, İ. Temel, S. Seyhan, H. G. Alşan, E. U. (2009). Proje Tabanlı Laboratuar Uygulamasının Öğretmen Adaylarının Bilimin Doğası Konusundaki Bilgilerine Etkisi. *Journal of Turkish Science Education, 6 (2)*, 92-105.

Mumba, F. Chabalengula, V. M. Hunter, W. (2006). A Quantitative Analysis of Zambian High School Physics Textbooks, Syllabus and Examinations for Scientific Literacy Themes. *Journal of Baltic Science Education*, *2 (10),* 70-76.

Munby, H. (1976). Some Implications of Language in Science Education. *Science Education*, *60(1),* 115-124.

Norris S.P. and Phillips L.M (2003). How literacy in its fundamental sense is central to scientific literacy. *Science Education*, *87*, 224-240

Nuangchalerm, P. (2010). Engaging Students to Perceive Nature of Science Through Socioscientific Issues-based Instruction. *European Journal of Social Sciences, 13 (1),* 34-37

McComas, W. F. (2003). A Textbook Case of the Nature of Science: Laws and Theories in the Science of Biology. *International Journal of Science and Mathematics Education, 1 (2),* 141-155.

Mumba, F. and Hunter, W. C. F. (2009). Representative nature of scientific literacy themes in a high school chemistry course: the case of Zambia. *Chemistry Education Research and Practice, 10*, 219-226.

Tao, P. (2003). Eliciting and developing junior secondary students' understanding of the nature of science through a peer collaboration instruction in science stories. *International Journal of Science Eduation, 25 (2),* 147-171.

Preczewski, P.J., Mittler, A. and Tillotson, J. W. (2009). Perspectives of German and US Students as They Make Meaning of Science in Their Everyday Lives. *International Journal of Environmental & Science Education, 4*, 247-258.

Rai, A. K. and Bajpai, A (2009). Nature of Science: A Pespective for Reshaping School Science Education. *Gyanodaya, 2 (1),* 56-64.

Ramsey, G., & Howe, R. (1969). An analysis of research on instructional procedures in secondary school science. *The Science Teacher*, *36*, 62–68.

Rudolph, J. L. (2000). Reconsidering the `nature of science' as a curriculum component. *J. Curriculum Studies, 32 (3),* 403-419.

Shamos, M. H.(1995). The myth of scientific literacy. *Rutgers University Press*.

Şahin, C. T. and Köksal, M. S. (2010). How are the perceptions of high school students and teachers on NOS as a knowledge type presented in schools in terms of "importance" and "interest"?. *International Journal of Environmental & Science Education, 5 (1),* 105-126.

Taber, S. K. (2008). Towards a Curricular Model of the Nature of Science. *Science & Education, 17*, 179- 218.

Taşar, M. F. (2003). Teaching History and The Nature of Science In Science Teacher Education Programs. *Pamukkale Üniversitesi Eğitim Fakültesi Dergisi, 13*, 30-42.

Tufan, E. (2007). Music Teacher Candidates' Views About Nature of Scientific Knowledge. *GÜ, Gazi Eğitim Fakültesi Dergisi, 27 (3),* 99-105.

Türkmen, L. Yalçın, M. Bilimin Doğası ve Eğitimdeki Önemi. *Afyon Kocatepe Üniversitesi Sosyal Bilimler Dergisi,* 189-195.

Yadav, L. L. and Shrivastava, M. (2007). Teaching and Learning of the Nature of Science and Technology: A Look from a Developing Country. *The International Journal of Learning*, 14, 119-126.

Yamak, Yeliz (2009). Exploring representation of nature of science aspects in science textbooks. Unpublished master's thesis, Middle East Technical University, Ankara, Turkey.