AN INVESTIGATION OF PRE-SERVICE ELEMENTARY SCIENCE TEACHERS' SCIENTIFIC LITERACY LEVEL AND THEIR ATTITUDES TOWARDS SCIENCE

A THESIS SUBMITTED TO
THE GRADUATE SCHOOL OF SOCIAL SCIENCES
OF
MIDDLE EAST TECHNICAL UNIVERSITY

BY

ÖZGÜL ULUTAŞ

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

DECEMBER 2009

Approval of the Graduate School of (Name of the Graduate School)

____

Prof. Dr. Sencer AYATA
Director

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

____

Prof. Dr. Hamide ERTEPINAR
Head of Department

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

____________________	____________________
Assoc. Prof. Dr. Jale ÇAKIROĞLU	Prof. Dr. Hamide ERTEPINAR
Co-Supervisor	Supervisor

Examining Committee Members

Prof. Dr. Hamide ERTEPINAR	(METU, ELE)	____________________
Prof. Dr. Ömer GEBAN	(METU, SSME)	____________________
Assoc. Prof. Dr. Jale ÇAKIROĞLU	(METU, ELE)	____________________
Assoc. Prof. Dr. Ceren TEKKAYA	(METU, ELE)	____________________
Assoc. Prof. Dr. Özgül YILMAZ TÜZÜN	(METU, ELE)	____________________

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: Özgül ULUTAŞ

Signature:

ABSTRACT

AN INVESTIGATION OF PRE-SERVICE ELEMENTARY SCIENCE TEACHERS' SCIENTIFIC LITERACY LEVEL AND THEIR ATTITUDES TOWARDS SCIENCE

Ulutaş, Özgül

M.S., Elementary Science and Mathematics Education

Supervisor: Prof. Dr. Hamide ERTEPINAR

Co-Supervisor: Assoc. Prof. Dr. Jale ÇAKIROĞLU

December 2009, 86 pages

This study aims to investigate pre-service elementary science teacher's scientific literacy level and their attitudes towards science. In addition, whether pre-service elementary science teacher's scientific literacy and their attitudes towards science differs in some demographic variables such as gender, high school profile, grade, place of family residence, parents educational level and family income level were examined. Finally, possible relationship between participants' scientific literacy level and their attitudes towards science was explored.

The present study conducted with 285 pre-service elementary science teachers from Elementary Science Education Program at Dokuz Eylül University during the second semester of 2008-2009 academic year. The data were collected by administering

Turkish version of Test of Basic Scientific Literacy (TBSL) and SAI-II (Science Attitude Inventory) scales.

Analysis of the data indicated that pre-service elementary science teachers have satisfactory scientific literacy level and moderately positive attitudes towards science. Moreover, participants' scientific literacy level and attitudes towards science showed differences in only some demographic variables: gender and place of family residence. Finally, the analysis also indicated that there is a positive significant relationship between participants' scientific literacy level and their attitudes towards science.

Keywords: Scientific Literacy, Attitude towards Science, Pre-service Elementary Science Teachers

ÖZ

FEN BİLGİSİ ÖĞRETMEN ADAYLARININ BİLİMSEL OKURYAZARLIK SEVİYELERİNİN VE BİLİME YÖNELİK TUTUMLARININ ARAŞTIRILMASI

Ulutaş, Özgül
Yüksek Lisans, İlköğretim Fen ve Matematik Eğitimi
Tez Yöneticisi: Prof. Dr. Hamide ERTEPINAR
Ortak Tez Yöneticisi: Doç. Dr. Jale ÇAKIROĞLU

Aralık 2009, 86 sayfa

Bu çalışma fen bilgisi öğretmen adaylarının bilimsel okuryazarlık düzeylerini ve bilime yönelik tutumlarını araştırmayı amaçlamıştır. Buna ek olarak, fen bilgisi öğretmen adaylarının bilimsel okur-yazarlık seviyeleri ve bilime yönelik tutumlarının cinsiyet, mezun oldukları lise türü, sınıf, ailenin yaşadığı yer, anne-baba eğitim düzeyi ve aile gelir seviyesi gibi bazı demografik özelliklere göre değişip değişmediği incelenmiştir. Son olarak, katılımcıların bilimsel okuryazarlık sevileri ile bilime karşı tutumları arasındaki olası ilişki araştırılmıştır.

Bu çalışma Dokuz Eylül Üniversitesinin Fen bilgisi Programındaki, 285 fen bilgisi öğretmen adayına, 2008-2009 akademik yılının ikinci döneminde uygulanmıştır. Veriler TBSL (Test of Basic Scientific Literacy) ve SAI-II (Science Attitude Inventory) ölçeklerinin Türkçe versiyonları uygulanarak toplanmıştır.

Verilerin analizi fen bilgisi öğretmen adaylarının bilimsel okuryazarlık seviyelerinin ve bilime yönelik tutumlarının yeterli düzeyde olduğunu göstermiştir. Bununla birlikte, katılımcıların bilimsel okuryazarlık seviyeleri ve bilime yönelik tutumlarının sadece cinsiyet ve ailenin yaşadığı yere göre farklılık gösterdiği bulunmuştur. Son olarak, analizler katılımcıların bilimsel okuryazarlık seviyeleri ve bilime yönelik tutumları arasında anlamlı bir pozitif ilişki olduğunu göstermiştir.

Anahtar Kelimeler: Bilimsel Okuryazarlık, Bilime Yönelik Tutum, İlköğretim Fen Bilgisi Öğretmen Adayları

To My Family

ACKNOWLEDGMENTS

I would like to thank to my supervisor Prof. Dr. Hamide ERTEPINAR and co-supervisor Assoc. Prof. Dr. Jale ÇAKIROĞLU for their valuable guidance and helpful support throughout the study.

I would like to express my thanks to Dr. Pınar ÇAVAŞ and Dr. Bülent ÇAVAŞ for helping the implementation of the instruments in classrooms.

I am also grateful to the pre-service elementary science teachers who enrolled in this study by completing truthfully the questionnaires for their willing participation and valuable contribution to this study.

Beyond all, I am indebted very much to my family for their continuous encouragement, patience, understanding and love.

And last but not least, I am also grateful to Mr. Murat ÖZEN for his endless patience, love and support.

TABLE OF CONTENTS

LIST OF TABLES

TABLES

CHAPTER 1

INTRODUCTION

1.1 Background of the Study

Recently, our world has experienced much progress in science and technology. Therefore, achieving scientific literacy as an educational outcome regarded as important in many countries (Jenkins, 1997). According to the American National Science Teachers Association, achieving scientific literacy for all citizens is seen as one of the major goals of science education. Although there is not clear definition of scientific literacy, professions from many disciplines have widely accepted its necessity of advancing it (BouFaoude, 2002; Laugksch, 2000). Advances in science and technology make individuals require having at least some basic understanding of science and technology in order to take place in the public debate and make choices in scientifically and technologically related policies (Miller, 1983, 1987; O'Hearn, 1976; Pella, 1976; Shen, 1975).

Educators agree that scientific literacy be encouraged urgently as early possible (Barton 1994; Bybee, 1997). Teachers are most important factor and must be effective in promoting scientific literacy. Therefore, they must be well-prepared in science subjects. Teachers who have low scientific literacy level cannot be expected to grow scientifically literate individuals. It is accepted that scientifically literate teachers are essential in meeting society's expectations of science education (European Commission, 2002).

Attitude towards science is also another important construct in science education. Many educators agree that students' attitude directly depends on their science teachers. Stolberg (1969) states that teachers who have a negative or neutral attitude towards science can pass on this attitude to young children. Similarly, Washton's (1971) study indicated that pupils imitate the attitude of their elementary teachers toward science. In a report of his study of 100 New York teachers, Washton concluded that students dislike science because their elementary school teachers dislike science and they were afraid to teach science to them. According to Koballa (1988) attitudes are learned. That is, students are more likely to possess attitudes similar to those of their teachers. According to Schibeci (1983) the measurement of attitudes towards science is important because these attitudes influence students' decisions and actions. Moreover, it was commonly believed that learning about pre-service teachers' present attitudes may help the educators the kinds of science related behaviors in which future teachers are likely engage. As Schibeci (1983) mentioned that by assessing the current attitudes of a group of pre-service teachers toward science and determining the causes of their attitudes, their future behavior in science teaching may be predicted. If the current and next generation of elementary teachers cannot convey positive attitudes toward science as a consequence of their own negative experiences, the cycle will continue and another generation will arise who may also transmit negative attitudes toward science to their students (Grutzner-Sampson, 1992). In order to change this situation, science teacher educators need to know the current attitudes of pre-service elementary teachers toward science.

1.2 The Purpose of the Study

This study aims to investigate pre-service science teachers' scientific literacy level and their attitude toward science. Moreover, the study examines whether pre-service science teachers' scientific literacy level and their attitudes towards science differs in some demographic features such as gender, high school profile, grade, place of family residence, parents' educational level, monthly family income. Finally, the possible relationship between pre-service elementary science teachers' scientific literacy level and their attitudes towards science is explored.

1.3 Research Questions and Hypotheses

The research questions raised as follows:

- What is the level of pre-service elementary science teacher's scientific literacy?
- What are pre-service elementary science teachers' attitudes towards science?
- To what extent do pre-service elementary science teachers demographic variables can influence pre-service elementary science teachers' scientific literacy level and their attitudes towards science?
- What is the relationship between pre-service elementary science teachers' scientific literacy level and their attitudes towards science?

The following hypotheses form the basis of this investigation:

Hypothesis 1: There will be a significant difference in pre-service elementary science teachers' scientific literacy level according to gender.

Hypothesis 2: There will be a significant difference in pre-service elementary science teachers' scientific literacy level according to high school profile.

Hypothesis 3: There will be a significant difference in pre-service elementary science teachers' scientific literacy level according to grade.

Hypothesis 4: There will be a significant difference in pre-service elementary science teachers' scientific literacy level according to place of family residence.

Hypothesis 5: There will be a significant difference in pre-service elementary science teachers' scientific literacy level according to parents' educational level.

Hypothesis 6: There will be a significant difference in pre-service elementary science teachers' scientific literacy level according to monthly family income level.

Hypothesis 7: There will be a significant difference in pre-service elementary science teachers' attitudes towards science according to gender.

Hypothesis 8: There will be a significant difference in pre-service elementary science teachers' attitudes towards science according to high school profile.

Hypothesis 9: There will be a significant difference in pre-service elementary science teachers' attitudes towards science according to grade.

Hypothesis 10: There will be a significant difference in pre-service elementary science teachers' attitudes towards science according to place of family residence.

Hypothesis 11: There will be a significant difference in pre-service elementary science teachers' attitudes towards science according to parents' educational level.

Hypothesis 12: There will be a significant difference in pre-service elementary science teachers' attitudes towards science according to monthly family income level.

Hypothesis 13: There will be a significant correlation between pre-service elementary science teachers' scientific literacy level and their attitudes towards science.

1.4 Significance of the Study

The term "Scientific Literacy" has become a major goal for science education in many countries (Laugksch, 2000). Like many countries, Turkey is aware of the importance of preparing its citizens scientifically literate in order to challenge new century. Therefore, there have been some important attempts to establish scientific literacy as a main goal of science education into curriculum. For example, new elementary and secondary science curricula have been updated since 2004 in Turkey. New elementary science curriculum is based on scientific literacy. There are seven aspects of the new elementary science curriculum. These are: (1) nature of science and technology, (2) key science concepts, (3) skills for scientific processes, (4) relationships among science-technology-society-environment, (5) scientific and technological psychomotor skills, (6) values which form the core of science, (7) science attitudes and values (MEB, 2006). New science curriculum sets out a vision for scientific literacy in Turkey. Therefore, pre-service elementary science teachers need better preparation in the content of scientific literacy so that they could lead to the development of scientific literacy of their students.

In Turkey, there are some studies about scientific literacy but few studies focusing on both pre-service science teachers' scientific literacy and their attitudes towards science at the same time. This study is important in that findings will inform us about the pre-service elementary teachers' scientific literacy level and their attitudes towards science.

1.5 Definition of Terms

Attitude: Attitude can be defined as learned predisposition in responding to a person or an object in a positive or negative manner (Fishbein & Ajzen, 1975).

Attitude towards science: "Learned predispositions, tendencies, or inclinations to respond fairly consistently, in an unfavorable or favorable manner to a given object, namely, science" (Wareing, 1990, p. 373).

Pre-service elementary teachers: Adult learners who are participating in university level education to prepare themselves to be teachers of elementary level children.

Pre-service elementary science teachers: Adult learners who are participating in education faculties of elementary science education program in university level education to prepare themselves to be teachers of elementary level children.

Scientific Literacy: According to National Science Education Standards (NRC, 1996) scientific literacy is defined as, "the knowledge and understanding of scientific concepts and processes required for personal decision making, participation in civic and cultural affairs, and economic productivity" (p. 22).

1.6 Limitations of Present Study

This study is limited to 285 pre-service science teachers at a university in Turkey. Therefore, results of this study cannot be generalized to all pre-service science teachers. The results of the present study can be generalized to subjects having the same characteristics in the similar settings.

CHAPTER 2

REVIEW OF LITERATURE

2.1 Scientific Literacy

In this section, history of the term scientific literacy, conceptions and definitions of the scientific literacy, measurement of scientific literacy and research relevant to scientific literacy will be introduced.

2.1.1 History of the Term Scientific Literacy

The term ‘scientific literacy’ was first existed in late 1950s, and was suggested by US educator Paul Hurd when he (Hurd, 1958) used it in a publication called ‘Science Literacy: Its Meaning for American Schools’ (DeBoer, 1991; Roberts, 1983). However, according to Shamos (1995), interest in the idea that the public should have some knowledge of science, go back at least to the beginning of this century.

When United States (US) experienced the sudden launching earth orbiting satellite by Soviet Union in 1957, this caused a big alarm in the US that they need public support for science in order to respond Soviet launch of Sputnik. As a result, US started to think about that something went wrong about the way of science being taught in the schools (Rutherford & Down, 1995). Waterman (1960) in his article wrote the ten-year resume of the US National Science Education of recognition that progress in science needs a considerable public support of a science education and research. The National Science Foundation established in the U.S in 1954 whose principal aim was to support basic and applied research in science and engineering placed a higher priority on education programs (Shamos, 1995).

After being aware of the importance of science and science education, many authors began to suggest various aspects associated with scientific literacy. Roberts (1983) cited in Laugksch (2000, p. 72) gave the name of the years from about 1957 to 1963 as the 'period of legitimation' of the concept. According to Roberts (1983), during the 1950s, scientific literacy was a "rallying symbol" without definition. By the mid-1960s, the term had numerous interpretations; all suggest that several components were necessary to clarify its meaning. A number of attempts at combining scientific literacy as a concept were made (e.g. Agin, 1974; Pella, 1976), after which a period of further interpretation followed (Roberts, 1983). For instance, Gabel (1976) defined scientific literacy as everything related with science education and gave theoretical model of scientific literacy in his work which based on a large dataset of interpretations of the meaning of the term. Scientific literacy concept became an umbrella concept to signify the purposes of science teaching in the schools.

According to Roberts (1983) cited in Laugksch (2000, p. 73), the periods of the late 1970s and beginning of 1980s was followed by numerous varied definitions and interpretations of scientific literacy. However, there was a still lack of agreement diminished the usefulness of this concept (Graubard, 1983). On the other hand, during this period the United States was facing two important challenges. The first one was related to the emergence of the economic power of Japan and other Pacific Rim countries (i.e. South Korea, Singapore, Taiwan, etc.) and a general belief that America's international economic competitiveness was diminishing (Bloch, 1986; Lewis, 1982 as cited in Laugksch 2000, p.73). The second challenge was related to the declining research in science and engineering in international comparisons of science achievements (Bloch, 1986). Science and technology were seen as the fundamental basis for economic progress.

Because of perceived threats to the economic competitiveness of the United States and the crisis that American science education was seen to be in, a reawakened interest in scientific literacy developed in the early 1980s (Prewitt, 1983). Since this period, the scientific literacy of adults has received regular attention in the United States and elsewhere. The social and cultural relevance of science in a scientific and technological society has also increasingly received attention through the concept of scientific literacy (Chen & Novik, 1984). In recent years, policy statements related to science education have thus been full of references to scientific literacy as a goal (Atkin & Helms, 1993; Jenkins, 1992).

2.1.2 Conceptions and Definitions of Scientific Literacy

The term ‘literacy’ is usually interpreted as the ability to read and write. However, extensions of this term, for example, computer literacy, cultural literacy, political literacy, and, scientific literacy, suggest that semantic aspects of this term are very important in such extensions. Three different interpretations and uses of ‘literate’ are considered: literate as learned; literate as competent; and literate as able to function minimally in society (Kintgen, 1988).

One of the earliest definitions of scientific literacy was made by Pella, O’Hearn and Gale (1966). In this study, scientific literacy was broadly defined as science for effective citizenship. Pella et al. (1966) reviewed 100 papers published between 1946 and 1965 for references to scientific literacy. According to their findings, a scientifically literate person had an understanding of: (1) basic concepts in science; (2) nature of science; (3) ethics that control scientists work; (4) interrelationships of science and society; (5) interrelationships of science and the humanities and (6) differences between science and technology.

Conception of scientific literacy presented in Pella et al. (1966) was improved by Showalter (1974, p. 450), resulting in a definition of scientific literacy consisting of following seven dimensions:

(1) The scientifically literate person understands the nature of scientific knowledge.
(2) The scientifically literate person uses processes of science in solving problems, making decisions and furthering his own understanding of the universe.
(3) The scientifically literate person accurately applies appropriate science concepts, principals, laws and theories in interacting with his universe.
(4) The scientifically literate person interacts with the various aspects of his universe in a way that is consistent with the values that underlie science.
(5) The scientifically literate person understands and appreciates the joint enterprises of science and technology and the interrelationship of these with each and with other aspects of society.
(6) The scientifically literate person has developed a richer, more satisfying, more exciting view of the universe as a result of his science education and continues to extend this education throughout his life.
(7) The scientifically literate person has developed numerous manipulative skills associated with science and technology (p. 9).

Shen (1975) developed three categories of scientific literacy; practical, civic and cultural. Unlike the study of Showalter, Shen's categories were less specific and he took into consideration of the influence of interest group and relevant audiences. Practical scientific literacy relates with the knowledge required to meet basic human needs about food, health and shelter. The interest group in this category would primarily be in developing countries. However, this category could also be relevant in industrialized countries in regard to consumer protection efforts. The second category which is civic scientific literacy includes the knowledge and understandings needed by citizens to participate in science-related public policy and decision making in areas such as health, energy and the environment. Finally, the third category, cultural scientific literacy, would effectively be the 'academic' or higher education community as it improves the motivation and desire to know something about science as a major human achievement.

Science Indicators studies in 1979 and 1981 proposed a multidimensional model of scientific literacy. Jon Miller (1992) suggested three dimensions: (a) a vocabulary of scientific terms and concepts; (b) an understanding of the process of science and (c) awareness and understanding of the impact of science and technology on individuals and society. He viewed a minimal scientific vocabulary as essential to being scientifically literate as the individual who does not understand basic terms will find it nearly impossible to follow public discussion of scientific results (Miller, 1983).

In 1981, Branscomb's conceptualization of scientific literacy, as cited by Laugksch (2000) expanded on Shen's categories by more clearly identifying the relevant interest groups. There were eight categories developed: (a) methodological science literacy (b) professional science literacy (c) universal science literacy (d) technological science literacy (e) amateur science literacy (f) journalistic science literacy (g) science policy literacy and (h) public science policy literacy.

Arons (1983) developed Miller's three dimensions of scientifically literate person. He identified 12 features of scientifically literate person. These features come from the thinking that scientifically literate individuals are able to correctly apply scientific knowledge and reasoning skills for problem solving and decision-making in their personal, civic, and professional lives. These properties were as follow:

- Recognize that scientific concepts are invented or created by acts of human intelligence and imagination.
- Recognize that to be understood and correctly used such terms require careful operational definition and an understanding that a scientific concept involves an idea first and a name afterwards.
- Comprehend the distinction between observation and result in a relevant context.
- Distinguish between the occasional role of accidental discovery in scientific investigation and the deliberate strategy of forming and testing hypotheses.

- Understand the meaning of the word theory in relation to formation, testing and validating.
- The ability to critically question the outcomes of scientific research.
- Have a sense that scientific concepts and theories are mutable and provisional rather than final and unalterable.
- Comprehend the limitations inherent in scientific inquiry.
- Develop enough basic knowledge and understanding in some areas of interest to allow intelligent reading and subsequent learning without formal instruction.
- Be aware of instances in which scientific knowledge has had direct impact on intellectual history and views of the nature of the universe including humanity’s place within it.
- Be aware of the interaction between science and society on moral, ethical and sociological planes.
- Be aware of similarities in modes of thinking between various disciplines; for example forming concepts, testing hypotheses, discriminating between observation and inference, constructing models and doing hypothetical-deductive reasoning (p. 92-93)

American Association for the Advancement of Science (AAAS) developed a project called ‘Project 2061’ during mid-eighties. This project emphasized the interconnections between various disciplines and covered science, mathematics, technology and social science. It indicated that the scientifically literate citizen should know basic science principles rather than detailed science concepts.

Project 2061’s first report was titled as ‘Science for All Americans’ (1989). It was offering the following broad definition of scientific literacy: Science literacy includes; (a) being familiar with the natural world and respecting its unity; (b) being aware of some of the important ways in which mathematics, technology and the sciences depend upon one another; (c) understanding some of the key concepts and principles of science; (d) having a capacity for scientific ways of thinking; (e) knowing that science, mathematics and technology are human enterprises, and knowing what that implies about their strengths and limitations; (f) being able to use scientific knowledge and ways of thinking for personal and social purposes (p. 4).

This perspective on scientific literacy then informed the development of a national curriculum framework in the United States titled National Science Education Standards (U.S. National Research Council, 1996). This framework defined scientific literacy by what an individual could do. It stated scientific literacy:

- Means that a person can ask, find, or determine answers to questions derived from curiosity about everyday experiences. It means that the person has the ability to describe, explain and predict natural phenomena.
- Entails being able to read with understanding articles about science in the popular press and to engage in social conversation about the validity of the conclusions.
- Implies that a person can identify scientific issues underlying national and local decisions and express positions that are scientifically and technologically informed. A literate citizen should be able to evaluate the quality of scientific information on the basis of its source and the methods used to generate it.
- Also implies the capacity to pose and evaluate arguments based on evidence and to apply conclusions from such arguments appropriately (p. 22).

Hazen and Trefil (1991) workout on scientific literacy was similar to the perspective of Project 2061 as they also distinguish between the doing and using of science. They described the doing as the work of the scientist and the using as the level of engagement required of a scientifically literate member of society. Because of this, they defined scientific literacy as the knowledge in the form of facts, vocabulary, concepts, history and philosophy, needed to understand public issues and to take part in national debate. In addition, they presented the view that scientifically literate individuals should be able to place daily science news into a meaningful context. They presented 18 general principles of science, which they viewed as necessary to follow public debate. Hazen and Trefil’s conception of scientific literacy is heavily focused on science content yet they acknowledged in addition to the general facts and concepts the scientifically literate individual needs to know about how science works and draws conclusions, and to know scientists as real people.

Shamos (1995) suggested that there were three levels of development. The most simplistic form was cultural scientific literacy, which related to the terms and phrases needed to follow public debate about science issues reported in the daily news. The next level was functional scientific literacy in which they are not only required to have a command of scientific vocabulary but be able to read, write and converse for responding to and communicating with another member of society in a meaningful context. The third and highest level of scientific literacy was true scientific literacy involved also knowing about the scientific enterprise. This contains for example, an awareness of major theories that form the foundations of science; how science creates order out of a random universe; aims, roles and elements of scientific experiments and investigations; the role of critical questioning; analytical and deductive reasoning; logical thought and science's reliance upon objective evidence.

In England a series of seminars titled as 'Beyond 2000: Science Education for the Future' were arranged. They stated a report: Science curriculum should provide sufficient scientific knowledge and understanding to enable students to read simple articles about science, and to follow TV programs on new advances in science with interest. Such an education should enable them to express an opinion on important social and ethical issues with which they will increasingly come across.

Specifically, scientific literacy was described in this report as:

- Understanding the major scientific ideas;
- Engage critically with issues and arguments which involve scientific knowledge;
- Understand the methods by which science derives the evidence for the claims made by scientists;
- Appreciate the strengths and limits of scientific evidence;

- Make a sensible assessment of risk and to recognize the ethical and moral implications of the choices that science offers for action.

Bybee (1999) offered a broader contemporary definition of scientific literacy that aimed to be inclusive, taking into account an individual's age, developmental stage, life and educational experiences. He proposed a framework of scientific literacy that recognized a continuum of scientific literacy that develops over a lifetime. Suggested in his framework was achievement containing more than just scientific knowledge or vocabulary. Bybee (1999) proposed that scientific literacy should be a general educational goal as it contains the knowledge, skills and values that should be common to all students. Bybee (1999) proposed the following dimensions for scientific literacy.

- Scientific and technological illiteracy: When asked a question relating to science or technology an individual would not have the cognitive capacity to understand or locate the question in the domain of science or technology.
- Nominal scientific and technological literacy: Demonstrates a token explanation for phenomena. Minimal understanding of term or topic as science related.
- Functional and scientific and technological literacy: Individuals can use scientific and technological vocabulary but it is often confined to a particular need and lacks conceptual embellishment.
- Conceptual and procedural scientific and technological literacy: Demonstrates a developing understanding of the way conceptual parts of a discipline relate to the whole discipline.
- Multidimensional scientific and technological literacy: Demonstrates a perspective of science and technology that includes the history of scientific ideas, the nature of science, the role of science and technology in personal life and society. Incorporates philosophical, historical and social dimensions of the discipline.

Goodrum, Hackling and Rennie (2001) made a series of recommendations aimed at closing the gap between the desired achievements of scientific literacy as an educational outcome for all citizens and the reality of science education practices in Australian schools. According to Goodrum et al. (2001), scientific literacy is a high priority for all citizens, helping them: (a) to be interested in, and understand the world around them; (b) to engage in the discourses of and about science, (c) to be skeptical and questioning of claims made by others about scientific matters, (d) to be able to identify questions, investigate and draw evidence- based conclusions, and (e) to make informed decisions about the environment about the environment and their own health and well-being (Goodrum, Hacklin & Rennie, 2001; p. 7).

These recommendations have led to a number of attempts including a project conducted by the Australian Science Teachers Association (ASTA). Rennie (2005) described the aim of this project as to develop and trial a science awareness-raising model that could be used to increase the community's awareness of science and what science is about. An online evaluation report of the ASTA science awareness raising model described scientific literacy and science awareness as desirable outcomes. The evaluation of the project's impact in these areas was focused on the extent to which members of the community:

- Understood what science is about,
- Believed that science is useful to find answers for problems in the community,
- Understood why science is taught in our schools and its value to students,
- Were aware of the community project,
- Understood the science-related issues and science knowledge associated with the project.

Roth and Lee (2004) went further to suggest that there was a need to re-think the concept of scientific literacy. They proposed that scientific literacy was not a construct demonstrated by individuals as it was a collective property of communities. This proposition was based on the observation that society is built on a division of labour and that not everyone needs to know the same set of concepts: First, scientific literacy more broadly and scientific knowledge more narrowly are aspects that characterize social activities rather than individuals. Because the division of labour is a fundamental process that links individual life and social processes, individuals do not need to be knowledgeable in every domain. Rather, they need to be able to participate in collective activity and to locate knowledge when and where they need it.

Lang, Drake and Olsen (2006) noted that many current initiatives like Roth and Lee's claim that students must learn how to participate in public debates over real issues. Lang et al. (2006) suggested that scientific literacy is a literacy that crosses disciplinary boundaries and puts human values at the centre of educational practice.

2.1.3 Measurement of Scientific literacy

There are some different approaches in which the scientific literacy measured. These approaches have varied among the three main interest groups; (a) sociologists of science or science educators with a sociological approach to scientific literacy; (b) social scientists and public opinion researchers; (c) science educators (Laugksch, 2000).

2.1.3.1 Sociological Approach

This measurement context involve, whether the design of instruments is based upon individuals share the scientist's view of the natural world, or whether the instrument used to measure scientific literacy is based on what a citizen needs to know in order to live effectively in a science and technology based society (Jenkins et al., 1986). The purpose of the sociological approach to scientific literacy is, to identify and describe the possible interactions between people's existing understandings of situations involving science and those understandings that originate from science itself. This approach necessarily employs contextual, small-scale, and interpretative studies to describe the scientific literacy of adults. The main methods of obtaining data for this qualitative approach are case studies using participant observation, longitudinal panel interviews, structured in-depth interviews, and local questionnaires on specific issues (Laugksch, 2000).

2.1.3.2 Public Opinion Researchers

Miller's (1983) article proposing a particular multi-dimensional character for scientific literacy marked an important consolidation of this concept. Miller (1992) suggested that civic scientific literacy requires three related dimensions. The first dimension is a vocabulary of basic scientific constructs. The second dimension is an understanding of the process or nature of scientific inquiry. The third dimension is some level of an understanding of the impact of science and technology on individuals and society. According to Miller (1992), by measuring these three dimensions, it is possible to estimate the level of civic scientific literacy in a given group. Moreover, Miller's "three constitutive dimensions" model of scientific literacy provided a sufficiently specific definition of scientific literacy in order for this concept to be measured in a composite manner. Science & Engineering Indicators survey included for the first time items from all three dimensions of scientific literacy, and thus allowed the first construction of a measure of this concept. Measures of all three dimensions of scientific literacy have been constituted a basis for many surveys of this nature in the United States (Laugksch, 2000).

Deficit model was published as a report of 'The Public Understanding of Science' (Royal Society, 1985). The deficit model of scientific understanding supposed that the public's knowledge of scientific discourse and research is non-existent. According to Gregory and Miller (2000), public are "empty vessels" or "blank slates" that need to be informed by a knowledgeable scientific community. That is, it is the public's deficit of knowledge that the scientist aims to fill with simple commands or insights. However, multiple weaknesses of deficit model were found (Durant, Evans, & Thomas, 1992). They included the failure to critically examine science itself and the relationship between professional and popular representations of science, the failure to acknowledge the role of “informal” or local knowledge, and the failure to recognize the irrelevance of scientific knowledge in many social settings (Durant et al., 1992; Ziman, 1991). Durant et al. (1992) stated that the deficit model does not fulfill all aspects of the relationship between science and the public.

2.1.3.3 Science Educators

A number of tests and questionnaires have been developed to investigate particular aspects of students understanding of the nature of science:

- Cooley and Klopfer’s (1961) Test on Understanding Science
- Kimball’s (1967/68) Nature of Science Scale
- Rubba and Anderson’s (1978) Nature of Scientific Knowledge Scale

All three tests employed a large number of test items either based on surveys of the current literature both in science and the history and philosophy of science, or on the early works on scientific literacy (Laugksch, 2000). Aikenhead and Ryan (1992) developed a sophisticated instrument, ‘Views on Science Technology Society’ (VOSTS) that monitors student’s views on science, technology, and society (Laugksch, 2000). Lord and Rauscher (1991) depended on their short scientific literacy questionnaire on information contained in upper primary and middle school life science textbooks. Cannon and Jinks (1992) used a “cultural literacy” approach to assess scientific literacy. Laugksch and Spargo (1996a, 1996b) developed a 110-item ‘Test of Basic Scientific Literacy’ based on selected chapters of Science for All Americans (AAAS, 1989). The test items include understanding of the facts and concepts that AAAS considers to be an integral part of scientific literacy and all high school leavers should have in order to be regarded as a scientifically literate. TBSL tests only basic aspects of scientific literacy. That is, knowledge of interdisciplinary concepts, applications of science, and the ability of applying knowledge for decision-making and problem solving were not included in TBSL (Laugksch & Spargo, 1996b).

2.1.4 Research Related to Scientific Literacy

According to Brekke (2002) scientific literacy far more than knows a list of terms and definitions. He states that it is untrue that knowing definitions of a list of terms or just observing physical or biological phenomena, and making uninformed conclusions about these events, are sufficient conditions for scientific literacy in the high school or in higher education. Scientific literacy is the ability to do process related to a specific field and knowing, at minimum, basic problem solving. He discusses what students need to know in the different science and mathematics fields and describes process. Also, he mentions about importance of the role of teachers to develop scientific literacy of students.

Miller and Prewitt (1979) designed “Survey of Public Attitudes Toward and Understanding of Science and Technology” (SPAUST). It was a biennial survey sponsored by the National Science Foundation (NSF) and begun in 1972. Findings of the survey revealed that while American adults showed high interest in information of new scientific discoveries and new inventions and technologies, the percentage of scientifically literate people was relatively low. In the SPAUST conducted in 1995, only 12% of the survey respondents were qualified as scientifically literate (Miller, 1998). Later, Miller’s framework for the measure of civic scientific literacy has been replicated in other national or multinational surveys (Durants, Evans, & Thomas, 1989; Miller, 1992; Zhang, and Zhang, 1993). Results of the survey studies gathered from adults outside of the U.S were similar; the average level of scientific understanding is low and researcher emphasizes that there is an urgency to improve the public’s level of scientific literacy.

The study carried out by Wei and Thomas (2005) investigated the issue of how to realize the idea of scientific literacy within a secondary school science curriculum by taking the account of new released Junior Secondary School Chemistry Curriculum (JSSCC) in the People’s Republic of China as a case on that time. Subject matter and its companion meanings were used as the framework to explore the embedding of scientific literacy in the study. From the analysis of the curriculum documents relevant to the JSSCC, researchers got to the point of scientific literacy can be explained with reference to sociopolitical background and the national curriculum policies at the macro-level, and to the roles played by chemistry educators, in lieu of academic chemists, at the micro-level. In conclusion, the study of Wei and Thomas (2005) provides an example of curriculum reform in which principles associated with scientific literacy are embedded in the formal curriculum.

A study conducted by Laugksch (2000) investigated the scientific literacy of selected high schools' grade 12 at the secondary / tertiary educational interface in South Africa. In contrast to biology, physical science plays a more significant role in the achievement of scientific literacy in the case of these students. Students taking physical science had a better understanding and awareness of all three dimensions of scientific literacy than students taking biology.

Symington (2004) accepted that scientific literacy is the primary purpose of science in the compulsory years of schooling and from this respect he searched for the answer the question of 'What does scientific literacy mean in a particular community?' Data used in the study were gathered through interviews with a sample of community leaders, in the state of Victoria, Australia, about their views of the purposes of school science. Analysis of the data revealed that although most of the participants had no formal post-school science education, their life experiences provided them with useful insights into the question raised. He concluded that the wisdom of such people could make an important contribution during the initial stages of curriculum development in science.

In another study, Lee (2003) investigated the level of scientific literacy of Taiwanese graduate students using Miller's framework of three dimensions of civic scientific literacy, including: (1) a vocabulary of basic scientific constructs, (2) an understanding of the process of scientific inquiry, and (3) some level of understanding of the impact of science and technology on individuals and on society. A web-based questionnaire was employed to survey Taiwanese graduate students studying in three different types of graduate schools and eleven academic fields. A total of 525 responses were collected for the study. Furthermore, eight participants were purposefully selected for individual interviews in order to get additional information about participants' scientific literacy. As a result of the statistical analyses, major findings listed as: (1) Taiwanese graduate students' civic scientific literacy was not at a satisfactory level; (2) the participants had mixed attitudes towards science and technology; (3) Taiwanese graduate students were not very attentive to new information of science and technology; (4) all three categorical variables (gender, school type, academic areas) had an impact on the participants' understanding of basic scientific constructs, while only school type had an effect on the participants' understanding of the scientific inquiry process; and (5) the interview results did not support the survey results.

Chin (2005) conducted a study to investigate whether first-year pre-service teachers in elementary education and science education programs in Taiwan have a satisfactory level of scientific literacy. In this study, Chinese translations of Test of Basic Scientific Literacy (TBSL) and Test of Science-related Attitudes were used as instruments. Participants of this study included 141 elementary education majors and 138 science education majors from four teachers' colleges. Statistical results of this study indicated, in general, the basic scientific literacy of first-year pre-service teachers was at a satisfactory level. The pre-service teachers showed the highest literacy in health science, STS, and life science. Literacy in the areas of the nature of science and earth science was rated lowest. The results also indicated that science education majors scored significantly higher in physical science, life science, nature of science, science content, and the TBSL than elementary science majors. Next, males performed better than females in earth science, life science, science content, and the TBSL. Moreover, elementary education majors responded with more "don't know" responses than science education majors. In general, the pre-service teachers were moderately positive according to attitudes towards science whereas science education majors had more positive attitudes towards science. Finally, there was no significant difference in attitudes between genders.

Yetişir (2007) examined pre-service teachers' science and technology literacy level. Participants of this study were 450 pre-service teachers from Elementary Education Department in Primary School Education and Science Education in Turkey. Test of Basic Scientific Literacy (TBSL) scale was used to investigate pre-service teachers' science and technology literacy. Findings of the study indicated that pre-service teachers' science and technology literacy level did not differ in terms of some demographic variables. Also, a positive relationship was found between all pre-service teachers' science and technology literacy level and attitudes towards science.

A study conducted by Çavaş (2009) investigated Turkish elementary teachers' scientific literacy level and their competence in science teaching. Both quantitative and qualitative survey methods were used by implementing Science and Technology (STL) and Science and Technology Teaching Competence (STTC) scales and semi-structured interviews. Results of the study showed that elementary teachers' science and technology literacy levels were not at satisfactory levels. However, they felt competent in all sub-dimensions of teaching in science and technology.

More recently, Bacanak and Gökdere (2009) conducted a study to determine the level of primary school teacher candidates' scientific literacy acquired with science education and to investigate whether there is a relationship between gender and their levels of scientific literacy. The sample of this study was fourth-year students from department of elementary education. Of the sample 90 were females and 42 were males. .A multiple choice test with 35 items was used to assess scientific literacy of pre-service teachers. The test items are related to physical science (5 items) life science (5 items), earth science (5 items), the nature of science and science and technology (10 items) and social perspective of science (5 items). Each item had four options. According to findings of the study; primary school teachers got the highest average on the nature of science and scientists properties items, and lowest average on the science and technology items. Also, the results revealed that although the mean scores of females were higher than males, the difference was not significant.

Manhart (1998) investigated gender differences with regard to three factors of scientific literacy. His study involved 772 students in Grades 9 and 10. A 100-item multiple choice test based on National Science Education Standards was used to assess scientific literacy while gender differences were explored using analysis of variance procedures. Males tended to perform better than females on the constructs of science factor. Females tended to do better than males on the abilities necessary to do scientific inquiry factor and the social aspects of science factor.

In another study, BouJaoude (2002) investigated the balance of scientific literacy themes in the new Lebanese science curriculum in an attempt to find out whether or not this curriculum has potential to prepare scientifically literate person. The general objectives, introductions, instructional objectives, and activities for Grades 1, 2, 4, 5, 7, 8, 10 and 11 of the Lebanese science curriculum were analyzed and categorized using a framework developed for the purpose of the study. Findings of the study indicated that the Lebanese curriculum emphasizes the knowledge of science, the investigative nature of science, and the interactions of science, technology and society, but neglects ‘science as a way of knowing’. While ‘science as a way of knowing ’ appears clearly in the general objectives of science education, the more detailed the curriculum becomes, the less evident is the emphasis on this aspect of scientific literacy.

A study conducted by Turmo (2004) examined the relationship between the cultural, social and economic capital of students from the Nordic countries and their level of scientific literacy by using the data from the Programme for International Student Assessment of (PISA) 2000 study. Result of the analysis showed that the relationship between the home’s economic capital and students’ level of scientific literacy is relatively weak in all the Nordic countries, as a result that is consistent with previous research. Surprisingly, there was a relationship between the cultural capital of the home and the level of scientific literacy in several of these countries. Researcher stated that findings of the study can be interpreted as a need in science education for a special focus on students from lower cultural backgrounds. Also, finding of the study indicated that cultural approach is important to make certain that students from lower socio-economic backgrounds also can achieve an adequate level of scientific literacy.

2.2 Attitude

Attitude is one of the affective variables in which educators are interested for several reasons (Young, 1998):

- Attitudes are relatively durable,
- Attitudes are learned and so can be taught,
- Attitudes are related to behavior.

The term “attitude” is very broad one so it has varied meanings depending on where it is used. For instance, attitudes are defined as individual mental process that determines “the actual and potential responses” of an individual in a social context (Fishbein, 1967; p. 6). Petty, Priester and Wegener (as cited in Bohner & Wanke 2002; p. 5) defined attitudes as “enduring concepts which are stored in memory and can be retrieved accordingly”. One definition of “attitude” covers many other definitions and makes us to find out the varied definitions (Koballo, 1988). Many investigators defined attitude as “a learned predisposition to respond in a consistently favorable or unfavorable manner towards an attitude object” (Koballo, 1988; p. 116). Moreover, Koballo stated that most important quality of the attitude concept is considered as one’s favorable or unfavorable feelings towards objects, persons, groups or any other identifiable aspect of one’s environment.

Attitude is defined by many researchers from different aspects. However, there are some certain characteristics of this concept. The characteristics identified are that attitude:

- is a mental set or disposition,
- is a readiness to respond,

- has a physiological basis,
- is permanent,
- has a nature,
- has an evaluative character.

Attitudes are important and useful concepts because of several reasons. Some of these reasons, which stress the importance of attitudes, stated by Oskamp (1977) are:

- "Attitude" is shorthand term. A single attitude (e.g. love for one's family) can summarize many different behaviors (spending time with them, kissing them, comforting them, agreeing with them, doing things for them).
- An attitude can be considered the cause of a person's behavior towards another person or an object.
- The concept of attitude helps to explain the consistency of a person's behavior, for a single attitude may underlie many different actions.
- Attitudes are worth studying although they are not related to a person's behavior since attitudes reflect the way a person perceives the world around him.
- Attitudes may explain the unconscious determinants of a behavior.
- Attitude is an interdisciplinary concept. Not just psychologists but also sociologists, political scientists, communication researchers, and anthropologists all study attitudes.

2.2.1 Attitudes towards Science

According to Osbourne, Simon and Collins (2003), the concept of an attitude towards science is ambiguous, often poorly articulated and not well understood. Therefore, science educators should define the term carefully when they use it in discussions about science education (Koballa, 1988). Attitude towards science refers to whether a person likes or dislikes science, or has "a positive or negative feeling about science" (Koballa & Crawley, 1985). There are many research studies related about this concept. However, they show there is a lack of clarity about the concept under investigation. Osbourne et al. (2003) defined this concept as “feelings, beliefs and values held about an object that may be the enterprise of science, school science, and the impact of science on society…” (p.1054). According to Klopfer (1971), “attitudes towards science” can be categorized a set of affective behaviors in science education as:

- the manifestation of favorable attitudes towards science and scientists;
- the acceptance of scientific enquiry as a way of thought ;
- the adoption of ‘scientific attitudes’;
- the enjoyment of science learning experiences;
- the development of interests in science and science-related activities; and
- the development of an interest in pursuing a career in science or science related work

In this study definition of attitudes towards science has been used as “learned predispositions, tendencies, or inclinations to respond fairly consistently, in an unfavorable or favorable manner, to a given object, namely, science” (Wareing, 1990; p. 373).

2.2.2 Factors Influencing Attitudes towards Science

Research studies have identified a number of factors influencing attitudes towards science in general. These can be defined as gender; personality; structural variables such as geographic location, socio-economic situation, home background, childhood experiences; school variables such as climate and teacher behavior; and curriculum and instructional variables (Gardner, 1975; Osborne et al., 2003). Haladayna and Shaughnessy (1982) stated that students’ attitudes towards science are determined by three independent constructs: teacher, students and learning environment. According to them, the teacher and learning environment variables are important because they have the greatest influence on attitudes and are also easily manipulated to bring about changes in attitudes. Other studies have shown that school variables such as classroom and teacher have strong influences on attitude towards science (Simpson & Oliver, 1990). Parental involvement was also found to play an important role in the development of science attitudes of students (George & Kaplan, 1998). Gardner (1975) claimed that gender is probably the most important variable related to attitudes towards science. Studies indicated that males have more positive attitudes towards science than females (Baker, 1983; Jones & Levin, 1994; National Science Foundation, 1980; Simpson & Oliver, 1985), while others reported less gender difference in attitudes towards science (Schibeci, 1984; Towse, 1983), still others have reported no statistical significance (Bilgin & Geban, 2004; Shrigley, 1974; Türkmen, 2002; Wareing, 1981).

2.2.3 The Importance of Assessing Pre-service Elementary Teachers' Attitudes towards Science

A considerable amount of research has conducted on the science attitudes of teachers, especially, pre-service elementary teachers over the past two decades (Palmer, 2001). Research results have shown that many of teachers hold negative attitudes (Pedersen & McCurdy, 1992) which can be related to their past experiences in secondary school science (Abell & Smith, 1994; Skamp, 1991).

Students' attitudes towards science is considerably affected by their elementary teachers' attitudes they possess (Ellsworth & Buss, 2000). How much time they devote to teaching science and the way they teach science depend on their attitudes (Koballa & Crawley, 1985). As mentioned before, teachers are more likely to affect their students' attitudes' towards science. Elementary years are very critical to affecting attitudes towards science since science- related careers tend to be established at these years. Therefore, attitudes of pre-service elementary teachers are important to science educators for additional reasons and they help to predict the science related behaviors pre-service elementary teachers are likely to adopt in their future classrooms (Koballa & Crawley, 1985).

The most important problem in elementary schools is the weak attitudes of teachers towards teaching science (Koballa, 1988; Pedersen & McCurdy, 1992; Schibeci, 1984; Shrigley, 1974; Westerback, 1982). Neglecting science teaching in elementary schools mostly results from the teachers 'negative attitudes towards science. According to Kennedy (1973), outcomes of negative attitudes may possibly include reluctance or avoidance of teaching science. Lucas and Dooley (1982) assert that teachers possessing negative attitudes towards science either do not teach science, or teach it in such a hesitant and inspirited fashion, which doesn't benefit students. If elementary teachers do not like science, then the students of those teachers are more likely not to like science (Shrigley, 1974). According to Allison and Smith (1974), elementary teachers with negative attitudes towards science do not usually teach science. When these teachers do teach science, they present science as a series of facts to be memorized and vocabulary to be learned. Students who complete this type of science course may develop a negative attitude towards science. And it is unavoidable that the students of these teachers fail to elect further science courses in high school or college.

2.2.4 Research Relevant to Pre-service Elementary Teachers' Attitudes towards Science

Jones and Levin (1994) compared pre-service and in-service elementary teachers' attitudes towards science and science instruction. Moreover, they compared the attitudes of males and females. There were significant differences between pre-service and in-service elementary teachers' attitudes. Findings of the study revealed that pre-service teachers were significantly more positive towards confidence in teaching science and scored higher on all scales except science as a male domain. Also, result of this study indicated that males had a significantly more positive attitude towards confidence in teaching science than females. Both male and female participants agreed the usefulness of science, did not stereotype science as a male domain and somewhat "liked" science, but females felt less confident in teaching science.

Palmer (2001) designed a study to identify pre-service elementary teachers whose attitudes had changed from negative to positive after participating in a one-semester elementary science education course and to identify the course factors that were responsible. The attitudes investigated were interest in science and confidence in teaching science effectively. Personal attributes of the teacher, specific teaching strategies, and external validation were the three main types of factors that had a positive influence. Pedersen and McCurdy (1992) examined the effects of a science method course on the attitudes of pre-service elementary teachers towards science teaching. Data were gathered from 145 pre-service elementary teachers enrolled in a science method course at the University of Nebraska-Lincoln over the course of two years at the first and last meetings. Science Attitude Scale revised by Thomson and Shrigley (1986) was used as an instrument in this study. According to results of the study, “the experiences that pre-service elementary teachers had in the methods course affected their attitudes in a positive manner” (p. 145).

Shrigley (1974) investigated the status of the attitude of pre-service elementary teachers towards science. More specifically, this study was conducted as “an initial investigation of four forces believed by the investigator to be pertinent in analyzing the attitude of elementary teachers” (p. 244). In this study, effect of sex differences, the effect of male elementary teachers, and the effect of organized and incidental elementary science programs and the effect that the number of high school science courses had on the science attitude of pre-service elementary teachers. The sample of this study included 207 third-year elementary education students at Pennsylvania State University. Shrigley used his own 38-item science attitude scale for this study. Findings of the study revealed that pre-service elementary science teachers differed in their attitudes due to the fact that they had organized elementary science programs and the number of high school science courses. A study conducted by Christiansen (1971) to investigate the training, attitudes, and the competence of the pre-service elementary teachers in science education. The results of the study showed that pre-service elementary teachers who had more positive attitudes towards science content courses gained higher achievement scores and indicated more positive attitudes towards teaching elementary science.

Turkmen (2002) explored the attitudes of 191 freshman elementary education major students by revised Science Teaching Attitude Scale-II (STAS-II). The analyze results showed that the attitudes of the participants towards science and science teaching were positive. There were no significant results based on the gender, age, university entrance exam score percentage, and education and income levels of their parents or the number of science courses taken by the students during their secondary education years. However, attitudes of students who take more science courses than other students in high school were more positive.

Bilgin and Geban (2004) investigated the effect of cooperative learning and gender on the attitudes of 84 pre-service teachers in an elementary education department towards science and towards teaching science. Participants of the study were divided in to two groups as control and experimental group. Control group received traditional education model and experimental group took the lesson which based on cooperative learning of students teams-achievement divisions model. Results indicated that the students in the experimental group (n=41) had more positive attitudes towards science than students in the control group (n=43). However, no significant differences were found due to gender.

In another study, Buldu (2005) investigated the attitudes of pre-service elementary teachers towards science in the U.S and Turkey in order to see if there is a difference between the U.S and Turkish pre-service elementary teachers' attitudes towards science and whether variables such as gender and the grade that pre-service teachers wish to teach make a difference in pre-service elementary teachers' attitudes towards science. Findings of the study indicated that both U.S and Turkish pre-service elementary teachers had positive attitudes towards science. On the other hand, U.S pre-service elementary teachers had more confidence in science and they found science more useful than Turkish pre-service teachers. While pre-service elementary teachers in the U.S do not show significant differences in terms of gender, there were significant differences between the Turkish pre-service teachers due to gender.

Tekkaya, Çakıroğlu and Özkan (2002) conducted a study to explore pre-service science teachers' understanding science concepts, their attitudes towards science teaching and their efficacy beliefs in science teaching. Participants of the study were 85 pre-service science teachers. The results showed that pre-service science teachers generally hold positive attitudes towards science teaching and three different domains of science, namely, biology, physics and chemistry.

In summary, in this chapter scientific literacy and attitudes towards science were introduced in two sections. In the first section, scientific literacy was discussed starting from its history, its conceptions and definitions, the ways of measuring scientific literacy and finally research relevant to our study was introduced. In the second section, the term attitude and attitude towards science were presented. In addition, factors affecting attitudes towards science and the importance of assessing pre-service teachers' attitude towards science briefly discussed. Finally, conducted research relevant to our study was introduced.

CHAPTER 3

METHOD

In this study, the researcher investigated pre-service elementary science teachers' scientific literacy level and their attitudes toward science. The methodology of the research as well as the data collection instruments, data collection and data analysis steps are explained in the following sections in accordance with the basic purpose of the study.

3.1 Sample

The sample consisted of 285 pre-service elementary science teachers from Dokuz Eylül University, Turkey. The majority of the sample (67.7 %) were female and 32.3 % were male. The high school profile of the participants is presented in Table 1. Most of the students were graduates of Anatolian and Science high schools (31.2 %) and general high school (30.5 %).

Table 3.1 High School Profile of the Pre-service Elementary Science Teachers

High School Profile	n	%
Anatolian and Science High Schools	87	31,2
General High Schools	85	30.5
Anatolian Teacher Training High Schools	55	19.7
Private High Schools	6	2.2
Others	46	16.5

***Number of missing data is 6.**

As presented in Table 3.2, of the 285 the pre-service elementary science teachers, 34.5 % were freshmen, 19.2 % were sophomores, 24.5 % were juniors, and the remaining (21.7 %) were seniors in college.

Table 3.2 Grade of the Pre-service Elementary Science Teachers

Grade	n	%
Freshmen	97	34.5
Sophomores	54	19.2
Juniors	69	24.5
Seniors	61	21.7

***Number of missing data is 4.**

The education level of pre-service elementary science teachers' parents is depicted in Table 3.3. As seen, high percentage of both mothers' and fathers' education levels were high school (34.2 % for mothers and 29.1% for fathers). The percentages of the university graduated mothers and fathers were 20.6 % and 24.6 %, respectively. The percentages secondary school graduated mothers and fathers were 20.0 % and 24.2 %, respectively. However, 8.5 % of the mothers and 4.2 % of the fathers were illiterate.

Table 3.3 Parents Education Level of the Pre-service Elementary Science Teachers

Education Level	Mother		Father	
	n	%	n	%
University	58	20.6	70	24.6
High School	96	34.2	83	29.1
Secondary School	56	20.0	69	24.2
Primary School	47	16.7	51	17.9
Illiterate	24	8.5	12	4.2

*** Number of missing data is 4 for mother education level.**

The place of family residence of the pre-service elementary science teachers is given in Table 3.4. 40.6 % (n=113) of them live in districts. The percentage of the families live in metropolitan city center and city center were 25.5 % (n=71) and 24.1 % (n=67), respectively. The percentage of the respondents whose family live in town was 9.7 % (n=27).

Table 3.4 Place of Family Residence of the Pre-service Elementary Science Teachers

Place of Family Residence	n	%
Metropolitan City Center	71	25.5
City Center	67	24.1
District	113	40.6
Town	27	9.7

***Number of missing data is 7.**

As depicted in Table 3.5, about half of the participants (50.9 %) indicated that their monthly income level was between 751-1500 TL. About 24 % of the participants with family income level of 1501-2250 TL. The percentages of the participants with income level 0-750 TL and higher than 2250 TL were 15.7 % and 8.9 %, respectively.

Table 3.5 Monthly Family Income Level of the Pre-service Elementary Science Teachers

Monthly Family Income Level	n	%
0-750 TL	44	15.7
751-1500 TL	144	51.4
1501-2250 TL	67	23.9
+ 2250	25	8.9

***Number of missing data is 5.**

3.2 Instruments

The following data collection tools are used related with the problems and sub-problems in the research.

a) Demographic Information Questionnaire
b) Test of Basic Scientific Literacy
c) Science Attitude Scale

3.2.1 Demographic Information Questionnaire

The demographic information section contained six items, which attempted to obtain information on participants' background characteristics that might relate to their level of scientific literacy and their attitudes toward science. This background information included: (1) gender, (2) high school profile, (3) grade, (4) place of family residence, (5) education level of parents and (6) monthly family income level.

3.2.2 Test of Basic Scientific Literacy (TBSL)

After reviewing of the scientific literacy literature, Test of Basic Scientific Literacy (TBSL) developed by Laugksch and Spargo (1996) is selected to investigate pre-service elementary science teachers' scientific literacy level.

The final form of the TBSL consist of 110 'true–false–don't know' scientific literacy test-items, based on a pool of 472 items developed previously from selected literacy goals recommended by the American Association for the Advancement of Science in Science for all Americans (AAAS, 1989). TBSL consists of 3 domains, namely Nature of Science, Science Content Knowledge, and Impact of Science and Technology on Society. Science Content also includes four sub-categories: Earth and Space Science, Physical Science, Health Science and Life Science.

Nature of Science includes items related to processes of science and understanding that science relies on evidence to validate its theories and models. Science Content consists of items related to key scientific concepts. Impact of Science and Technology on Society includes items related to impacts of the advances in science and technology on society, and issues in technology. Earth Science, sub-category of Science Content, includes items related to the universe and earth. Physical Science's items related to conversion of energy and forces of nature. Life Science includes items related to molecule, DNA, biological evolution. Health Science items are related to physical and mental health and human development.

As presented in Table 3.6, the final form of TBSL includes 22 test-items for Nature of Science, 72 test-items for Science Content Knowledge and 16 test-items for the Impact of Science and Technology on Society (STS). The total number of true and false test-items in TBSL is 63 (57 %) and 47 (43 %), respectively.

Table 3.6 Number of Test-Items in TBSL

TBSL Content Area	**No. of Items**
The Nature of Science	22
Science Content	72
Earth and Space Science	*15*
Physical Science	*14*
Life Science	*24*
Health Science	*19*
STS	16
Total	110

According to Angoff procedure applied by instrument developers (Laugksch & Spargo; 1996, p. 345), the performance standard for the Nature of Science, Science Content, and Impact of Science and Technology on Society domains was calculated to be 13, 45, and 10, respectively.

That is, in order to be regarded as minimally scientifically literate, a respondent would have to obtain at least 13 out of 22 Nature of Science items, 45 out of 72 Science Content items, and 10 out of 16 Impact of Science and Technology on Society items of the TBSL, respectively.

Reliability of the test-scores was estimated by the Kuder – Richardson 20 coefficient (α_{20}), which is appropriate for tests where all items are scored either 0 (wrong) or 1 (correct) as calculated by:

$$\alpha_{20} = \frac{n}{n-1}\left[1 - \frac{\sum p(1-p)}{V}\right] \qquad [1]$$

where; n is the number of test-items, p is the proportion of students answering a question correctly, and V is the variance of total test scores (Laugksch & Spargo; 1996, p. 348) (see Table 3.7).

As the TBSL consists of three domains, each measuring different attributes, which means that all TBSL test-items are not designed to measure a single attribute, the internal consistency of each domain was determined individually. The reliability of the test-scores of the three domains of the TBSL, as well as that of the score of the complete TBSL, is given in Table 3.7. As the reliability is affected by the length of a test, the number of test-items per domain is also given.

Table 3.7 The Internal Consistency (α_{20}) of the TBSL (Laugksch and Spargo; 1996, p. 348)

TBSL Content Area	**No. of Items**	α_{20}
Nature of Science	22	0.73
Science Content Knowledge	72	0.94
Impact of Science and Technology on Society	16	0.98
Test of Basic Scientific Literacy	110	0.75

In this research, Turkish version of TBSL was translated from English to Turkish and its language checked by English and Turkish language specialists. Subsequently, Turkish and English versions of the TBSL are reviewed by academicians having PhD. in science education. Turkish version of the TBSL is named as “Fen ve Teknoloji Okuryazarlığı” (FTO) and all experts opinions were obtained from Ege University, Dokuz Eylul University, Hacettepe University and Middle East Technical University to ensure validity of content of the TBSL. In accordance with feedbacks of the experts, the final version of the TBSL was obtained for pilot application. The Turkish version of the TBSL is presented in Appendix A. Pilot application was conducted by Çavaş (2009) with pre-service elementary teachers (n=296) in Ege University and Dokuz Eylül University. Internal Consistency (α_{20}) values of the pilot study and present study are presented for each domain of TBSL in Table 3.8.

Table 3.8 The Internal Consistency (α_{20}) of the Pilot Study

TBSL Content Area	α_{20} Çavaş (2009)	α_{20} Present Study
Nature of Science	0.73	0.75
Science Content	0.81	0.83
Impact of Science and Technology on Society	0.71	0.74
Test of Basic Scientific Literacy	0.89	0.93

T-test was applied to ensure validity of the test by comparing TBSL scores of the senior students who had taken all science course and junior students who had not. The results implied that there were significant differences between groups at the level of 0.05 for TBSL and its domains in favor of senior students (Çavaş, 2009).

3.2.3 Science Attitude Scale

Scientific Attitude Inventory-II (SAI-II) which was developed by Moore and Foy (1997) was used for assessing participants' science attitudes. The 60-item original test was developed by Moore and Sutman (1970). In the revised version, Moore and Foy (1997) shortened the SAI from 60 to 40 questions, and changes were made to improve readability and eliminate gender-biased language. In the original SAI, Moore had opted for a four-point likert response scale with no mid-point. In the revision, they opted for the more common five-point response format, with the midpoint being "neutral/undecided". These 40 items in the scale were structured so as to explain the feelings of the students about science, the nature of science and working styles of scientists. The items were designed in five-point likert response and the responses were grouped as "Strongly Agree", "Agree", "Not Sure", "Disagree" and "Strongly Disagree". There are 12 position statements in SAI-II. Six positions are positive and are labeled 1-A through 6-A. Six are negative and are labeled 1-B through 6-B. The A and B pairs for each position are opposed of each other. The SAI-II is scored by assigning point values to each of the attitude items. Point values are assigned as shown in Table 3.9.

Table 3.9 Point Values for Items of the SAI-II

Response	Positive Items	Negative Items
Strongly Agree	5	1
Agree	4	2
Not Sure	3	3
Disagree	2	4
Strongly Disagree	1	5

The position statements and corresponding attitude statements of the SAI-II are presented below. The position statements are labeled with a number and a letter: for instance, 1-A. The letter designates whether the position statement is positive (A) or negative (B). The attitude statements are in pairs, where the pairs 1-A and 1-B are intended to be opposite positions regarding the same point of view as:

1-A: The laws and/or theories of science are approximations of truth and are subject to change.

1-B: The laws and/or theories of science represent unchangeable truths discovered through science.

2-A: Observation of natural phenomena and experimentation is the basis of scientific explanation.

2-B: The basis of scientific explanation is in authority. Science deals with all problems.

3-A: To operate in a scientific manner, one must display such traits as intellectual honesty, dependence upon objective observation of natural events, and willingness to alter one's position on the basis of sufficient evidence.

3-B: To operate in a scientific manner one needs to know what other scientists think; one needs to know all the scientific truths and to be able to take the side of other scientists.

4-A: Science is an idea-generating activity. It is devoted to providing explanations of natural phenomena. Its value lies in its theoretical aspects.

4-B: Science is a technology-developing activity. It is devoted to serving mankind. Its value lies in its practical uses.

5-A: Progress in science requires public support in this age of science; therefore, the public should be made aware of the nature of science and what it attempts to do. The public can understand science and it ultimately benefits from scientific work.

5-B: Public understanding of science would contribute nothing to the advancement of science or to human welfare; therefore, the public has no need to understand the nature of science. They cannot understand it and it does not affect them.

6-A: Being a scientist or working in a job requiring scientific knowledge and thinking would be a very interesting and rewarding life's work. I would like to do scientific work.

6-B: Being a scientist or working in a job requiring scientific knowledge and thinking would be dull and uninteresting; it is only for highly intelligent people who are willing to spend most of their time at work. I would not like to do scientific work. (Moore & Foy, 1997)

SAI-II scale was adapted to Turkish by Demirbaş and Yağbasan (2006a). The reliability analysis was made by Demirbaş (2009). The Turkish version of the SAI-II scale is presented in Appendix A. SAI-II scale was implemented to 100 science teachers and reliability coefficient was estimated by Cronbach's Alpha as 0.72. In the present study, the Cranbach's Alpha reliability coefficient was calculated as 0.78.

3.3 Data Collection

Respondents are asked to answer these two instruments in class. Participants were given 40 minutes to complete each of the two instruments, TBSL and SAI-II. The two tests were administered to pre-service science teachers from Department of Elementary Education in Science Education Program at Dokuz Eylül University. After the tests were collected, the responses were keyed in and incomplete responses were excluded as invalid data. The complete responses were 285. All the data were analyzed by using an SPSS package. The details of the data analysis and method used for the analyses of the stated research questions of the study are presented in Chapter 4.

CHAPTER 4

RESULTS

The purpose of this study was to investigate pre-service elementary science teachers' scientific literacy level and their attitudes towards science. In this chapter, the collected data from the sample of 285 pre-service elementary science teachers were examined to address the following main questions: (a) What is the level of pre-service elementary science teacher's scientific literacy?, (b) What are pre-service teachers' attitudes towards science?, (c) Whether there is a meaningful relationship between pre-service elementary science teachers' scientific literacy level and their attitudes towards science?, (d) Which demographic factors or features (e.g., gender, income, high school type, grade and education level of their parents) can influence pre-service elementary science teachers' scientific literacy level and their attitudes towards science? In addition, the following sub-questions based on aforementioned main questions were studied: (a) What is the pre-service science teachers' scientific literacy level according to domains of scientific literacy?, (b) What is the pre-service science teachers' scientific literacy level according to sub-categories of science content?

4.1 Pre-service Elementary Science Teachers' Scientific Literacy Level

The mean score of the TBSL for all the participants was found to be 69.6, which is slightly higher than the mean threshold score of 68 set by Laugksch and Spargo (1996, p. 346). Among 285 respondents, 172 (60.1%) respondents have higher score than 68. These results revealed that the scientific literacy level of the participants of pre-service elementary science teachers is moderate.

Table 4.1 presents pre-service elementary science teachers' scientific literacy level according to domains of TBSL. The mean score of the participants was 12.48 (56.7 %) for Nature of Science domain, 9.56 (59.8 %) for Impact of Science and Technology on Society (STS) domain and Science Content was 47.59 (66.1 %). As set by Laugksch and Spargo (1996, p. 345), the performance standard for the Nature of Science, Science Content, and Impact of Science and Technology on Society domains was calculated to be 13, 45, and 10, respectively. These standards mean that in order to be regarded as minimally scientifically literate, a participant would have to obtain at least 13 out of 22, 45 out of 72, and 10 out of 16, on each of the above subtests of the TBSL, respectively. Therefore, participants had satisfactory scores only in Science Content domain. On the other hand, the scores of the participants of pre-service elementary science teachers were slightly below the performance standard for Nature of Science and Impact of Science and Technology on Society domains.

Table 4.1 Pre-service Elementary Science Teachers' Scientific Literacy Levels for Domains of TBSL

Domain	**n**	$\bar{X}$	**S. Dev.**	**%**	**Performance Standard**
Nature of Science	285	12.48	3.43	56.7	13
Science Content	285	47.59	12.08	66.1	45
STS	285	9.56	2.92	59.8	10

Pre-service elementary science teachers' scientific literacy level according to sub-categories of Science Content was depicted in Table 4.2. The mean score of the pre-service elementary science teachers was 8.63 (57.3 %) for Earth Science, 9.27 (66.2 %) for Physical Science, 15.83 (66.0 %) for Health Science 13.87 (66.1 %) for Life Science. That is, participants of pre-service elementary science teachers had lower scientific literacy level in Earth Science than the other sub-categories.

Table 4.2 Pre-service Elementary Science Teachers' Scientific Literacy Levels for Sub-categories of Science Content

Sub-category	n	$\bar{X}$	S. Dev.	%
Earth Science	285	8.63	2.53	57.3
Physical Science	285	9.27	3.11	66.2
Health Science	285	15.83	4.66	66.0
Life Science	285	13.87	4.49	66.1

4.1.1 Pre-service Elementary Science Teachers' Scientific Literacy Level According to Demographic Variables

In this section, the level of scientific literacy of pre-service elementary science teachers was presented according to demographic variables (e.g., gender, high school profile, grade, monthly family income level, place of family residence, and parents' education level).

The comparison of the TBSL scores between genders revealed that females had significantly higher scores than males at significance level of 95 % as presented in Table 4.3 (t_{283}=2.180 and $p < 0.05$). The mean TBSL score of the female participants was higher than the performance standard of 68 set by Laugksch and Spargo (1996; p. 346), whereas it is lower for males. The percentage of the male and female participants whose mean TBSL scores higher than the performance standard was 65.8 % and 58.7 %, respectively.

Table 4.3 T-test Results of Pre-service Elementary Science Teachers' for TBSL according to Gender

Gender	n	$\bar{X}$	S. Dev.	df	t	p
Female	193	71.24	16.41	283	2.180	.030
Male	92	66.60	17.77			

Table 4.4 presents the scores of the female and male participants according to domains of the TBSL in Table 4.4. As seen, although females got higher scores than males for all domains of TBSL, only for Science Content domain the difference between males and females was statistically significant ($p < 0.05$).

Table 4.4 T-test Results of Pre-service Elementary Science Teachers' for Domains of TBSL According to Gender

Domain	Gender	n	$\overline{X}$	S. Dev.	n	p
Science Content	Female	193	48.84	11.65	5.880	.016
	Male	92	45.17	12.55		
Nature of Science	Female	193	12.60	3.20	0.471	.493
	Male	92	12.30	12.60		
STS	Female	193	9.80	2.90	3.440	.065
	Male	92	9.12	2.868		

As abovementioned, the performance standard for the Nature of Science, Science Content, and Impact of Science and Technology on Society domains was 13, 45, and 10, respectively. That is, only for Science Content domain, the mean scores of the females and males were at a satisfactory level. The percentage of satisfactory participants for Science Content was 72 % for females and 60.9 % for males.

The scientific literacy level of females and males was presented for sub-categories of Science Content domain in Table 4.5. The mean score of the female participants was 8.67 for Earth Science, 12.60 for Physical Science, 16.13 for Life Science and 14.51 for Health Science. The mean score of the male participants was 8.54 for Earth Science, 12.30 for Physical Science, 15.26 for Life Science and 12.62 for Health Science. As seen, although females got higher mean scores than males for all sub-categories of Science Content domains, the differences between females and males were significant only for Health Science and Physical Science ($p < 0.05$).

Table 4.5 T-test Results of Pre-service Elementary Science Teachers' for Sub-categories of Science Content According to Gender

Sub-Category	Gender	n	$\bar{X}$	S. Dev.	t	p
Earth Sciences	Female	193	8.67	2.501	0.164	.686
	Male	92	8.54	2.62		
Physical Science	Female	193	12.60	3.00	3.962	.048
	Male	92	12.30	3.27		
Life Science	Female	193	16.13	4.51	2.180	.141
	Male	92	15.26	4.92		
Health Science	Female	193	14.51	4.26	11.589	.001
	Male	92	12.62	4.65		

Table 4.6 presents mean scores of TBSL for participants of pre-service elementary science teachers. Even though the mean scores of TBSL for participants who graduated from Anatolian and Science high schools were higher than the others, any statistically significant difference was not observed between TBSL scores of the participants according to their high school profile ($p > 0.05$). Note that, private high school graduates were excluded from analysis due to their relatively low sample size.

Table 4.6 One-way ANOVA Results of Pre-service Elementary Science Teachers' for TBSL According to High School Profile

High School Profile	n	$\bar{X}$	S. Dev.	F	p
General High School	85	69.80	17.69	1.204	.309
Anatolian & Science	87	72.32	16.08		
Anatolian Teacher Training	55	67.53	17.81		
Others	46	67.13	15.47		

*** Private High School was excluded due to the low sample size (n=6).**

Similarly, scores of the pre-service elementary science teachers did not show any significant difference according to high school profile for domains of TBSL as given in Table 4.7.

Table 4.7 One-way ANOVA Results of Pre-service Elementary Science Teachers' for Domains of TBSL According to High School Profile

Domain	High School Profile	n	$\bar{X}$	S. Dev.	F	p
Science Content	General High School	85	47.59	12.73	1.430	.234
	Anatolian and Science	87	49.72	11.51		
	Anatolian Teacher Training	55	46.02	12.47		
	Others	46	45.80	10.90		
Nature of Science	General High School	85	12.47	3.26	0.676	.576
	Anatolian and Science	87	12.91	3.45		
	Anatolian Teacher Training	55	12.20	3.93		
	Others	46	12.11	3.09		
STS	General High School	85	2.95	0.32	0.560	.782
	Anatolian and Science	87	2.73	0.29		
	Anatolian Teacher Training	55	2.84	0.38		
	Others	46	9.21	3.09		

*** Private High School was excluded due to the low sample size (n=6).**

As shown in Table 4.8, although the mean sub-categories of Science Content scores of the participants graduated from Anatolian and Science were higher than the others, the differences according to high school profile of the participants were not statistically significant ($p > 0.05$).

Table 4.8 One-way ANOVA Results of Pre-service Elementary Science Teachers' for Sub-categories of Science Content According to High School Profile

Domain	High School Profile	n	$\bar{X}$	S. Dev.	F	p
Earth Science	General High School	85	8.61	2.45	0.998	.394
	Anatolian and Science	87	9.01	2.60		
	Anatolian Teacher Training	55	8.35	2.90		
	Others	46	8.35	2.18		
Physical Science	General High School	85	9.41	3.22	0.990	.398
	Anatolian and Science	87	9.60	3.33		
	Anatolian Teacher Training	55	9.07	2.90		
	Others	46	8.61	2.60		
Life Science	General High School	85	15.73	4.56	1.846	.139
	Anatolian and Science	87	16.71	4.49		
	Anatolian Teacher Training	55	14.89	5.35		
	Others	46	15.52	4.17		
Health Science	General High School	85	13.84	4.68	0.573	.633
	Anatolian and Science	87	14.40	4.40		
	Anatolian Teacher Training	55	13.71	4.26		
	Others	46	13.33	4.51		

*** Private High School was excluded due to the low sample size (n=6).**

As presented in Table 4.9, TBSL and its domain scores of the sophomores were higher than the others; the differences however, were not significant ($p > 0.05$). Similarly, sub-categories of Science Content domain did not show any significant difference according to grade of the participants ($p_{earth\ science} = 0.123$, $p_{phsical\ science} = 0.123$, $p_{life\ science} = 0.185$ and $p_{health\ science} = 0.123$).

Table 4.9 One-way ANOVA Results of Pre-service Elementary Science Teachers' for TBSL and Its Domains According to Grade

Domain	Grade	n	$\overline{X}$	S. Dev.	F	p
TBSL	Freshmen	97	70.16	15.36	1.210	.306
	Sophomores	54	73.15	14.08		
	Junior	69	67.46	15.02		
	Senior	61	69.54	21.32		
Science Content	Freshmen	97	12.29	3.15	1.732	.161
	Sophomores	54	12.56	2.85		
	Junior	69	12.16	2.61		
	Senior	61	13.36	4.48		
Nature of Science	Freshmen	97	9.89	2.72	1.966	.119
	Sophomores	54	10.13	2.82		
	Junior	69	9.09	2.91		
	Senior	61	9.28	2.96		
STS	Freshmen	97	47.99	10.96	1.462	.225
	Sophomores	54	50.46	10.14		
	Junior	69	46.22	10.97		
	Senior	61	46.90	14.87		

The mean scores of participants of pre-service elementary science teachers for TBSL and its domains showed significant differences according to place of family residence as given in Table 4.10 ($p < 0.05$). Then, Scheffe Post Hoc test was performed to determine which groups of means were significantly different from the others.

Table 4.10 One-way ANOVA Results of Pre-service Elementary Science Teachers' for TBSL and Its Domains According to Place of Family Residence

Domain	Place of Family Residence	n	$\bar{X}$	S. Dev.	F	p
TBSL	Metropolitan City Center	71	72.80	17.78	5.692	.001
	City Center	67	69.42	17.47		
	District	113	71.39	12.58		
	Town	27	58.22	22.29		
Science Content	Metropolitan City Center	71	49.75	12.40	5.993	.001
	City Center	67	47.21	12.42		
	District	113	49.04	9.15		
	Town	27	39.30	15.89		
Nature of Science	Metropolitan City Center	71	13.04	3.77	2.775	.042
	City Center	67	12.64	3.10		
	District	113	12.54	2.86		
	Town	27	10.85	4.80		
STS	Metropolitan City Center	71	10.01	2.90	3.376	0.019
	City Center	67	9.57	3.15		
	District	113	9.81	2.39		
	Town	27	8.07	3.22		

The Scheffe Post Hoc test results given in Table 4.11 implied that the TBSL and Science Content scores of the participants whose family live in town were significantly lower than the others**.** In addition, in the case of Nature of Science, the scores of the participants whose family live in town was significantly lower than the participants with family living in metropolitan city center. Finally, for STS scores of the participants, whose family residence place was town had significantly lower scores than participants whose family residence place was metropolitan city center and district.

Table 4.11 Scheffe Post Hoc Test Results of Pre-service Elementary Science Teachers' According to Place of Family Residence

Domain	Place of Family Residence		p
TBSL	Metropolitan City Center	City Center	.686
		District	.955
		Town	.002
	City Center	Metropolitan City Center	.686
		District	.893
		Town	.030
	District	Metropolitan City Center	.955
		City Center	.893
		Town	.003
Science Content	Metropolitan City Center	City Center	.649
		District	.984
		Town	.001
	City Center	Metropolitan City Center	.649
		District	.789
		Town	.032
	District	Metropolitan City Center	.984
		City Center	.789
		Town	.002
Nature of Science	Metropolitan City Center	City Center	.923
		District	.811
		Town	.044
	City Center	Metropolitan City Center	.923
		District	.998
		Town	.149
	District	Metropolitan City Center	.811
		City Center	.998
		Town	.147
STS	Metropolitan City Center	City Center	.831
		District	.971
		Town	.026
	City Center	Metropolitan City Center	.831
		District	.959
		Town	.144
	District	Metropolitan City Center	.971
		City Center	.959
		Town	.042

As presented in Table 4.12 and Table 4.13, the mean scores of TBSL and its domains for participants of pre-service elementary science teachers did not show any significant difference according to mothers' and fathers' education levels ($p > 0.05$).

Table 4.12 One-way ANOVA Results of Pre-service Elementary Science Teachers' for TBSL and Its Domains According to Mothers' Education Level

Domain	Mothers' Education Level	n	$\bar{X}$	S. Dev.	F	p
TBSL	Illiterate	24	67.88	16.31	0.683	.604
	Primary School	47	67.32	18.83		
	Secondary School	56	71.46	16.61		
	High School	96	69.82	16.34		
	University	58	71.79	15.31		
Science Content	Illiterate	24	46.50	11.84	0.845	.498
	Primary School	47	45.70	13.60		
	Secondary School	56	49.13	11.93		
	High School	96	47.56	11.71		
	University	58	49.26	10.41		
Nature of Science	Illiterate	24	12.00	3.24	0.371	.829
	Primary School	47	12.26	3.57		
	Secondary School	56	12.55	2.93		
	High School	96	12.78	3.41		
	University	58	12.60	3.48		
STS	Illiterate	24	9.38	2.43	0.411	.800
	Primary School	47	9.36	3.12		
	Secondary School	56	9.79	3.11		
	High School	96	9.48	2.79		
	University	58	9.93	2.71		

Table 4.13 One-way ANOVA Results of Pre-service Elementary Science Teachers' for TBSL and Its Domains According to Fathers' Education Level

Domain	Mothers' Education Level	n	$\overline{X}$	S. Dev.	F	p
TBSL	Illiterate	24	65.58	21.22	0.302	.876
	Primary School	47	69.41	17.93		
	Secondary School	56	70.72	16.27		
	High School	96	70.36	14.83		
	University	58	69.00	18.67		
Science Content	Illiterate	24	44.33	15.13	0.265	.900
	Primary School	47	48.00	12.46		
	Secondary School	56	48.03	11.18		
	High School	96	47.84	10.99		
	University	58	47.40	13.41		
Nature of Science	Illiterate	24	11.92	4.21	0.512	.727
	Primary School	47	12.20	3.70		
	Secondary School	56	12.77	3.66		
	High School	96	12.77	2.76		
	University	58	12.26	3.53		
STS	Illiterate	24	9.33	3.94	0.654	.625
	Primary School	47	9.22	3.00		
	Secondary School	56	9.93	2.57		
	High School	96	9.75	2.87		
	University	58	9.34	3.00		

The pre-service elementary science teachers' scores from TBSL and its domains did not show any significant difference according to monthly family income level as shown in Table 4.14 ($p > 0.05$). Similarly, there were not any significant differences observed between sub-categories of science content (e.g. earth science ($p=0.099$), life science ($p=0.197$), physical science ($p=0.989$) and health science ($p=0.401$)) and monthly family income level.

Table 4.14 One-way ANOVA Results of Pre-service Elementary Science Teachers' for TBSL and Its Domains According to Monthly Family Income Level

Domain	Family Income Level	n	$\bar{X}$	S. Dev.	F	p
TBSL	0 - 750	44	66.95	19.08	1.195	.277
	751 - 1500	144	71.31	14.68		
	1501 - 2250	67	70.69	16.48		
	+ 2250	25	65.92	24.04		
Science Content	0 – 750	44	46.20	13.21	1.082	.357
	751 - 1500	144	48.69	10.89		
	1501 - 2250	67	48.30	10.99		
	+ 2250	25	44.80	17.34		
Nature of Science	0 – 750	44	11.82	3.91	1.042	.374
	751 - 1500	144	12.72	2.78		
	1501 - 2250	67	12.75	3.84		
	+ 2250	25	12.04	4.61		
STS	0 – 750	44	8.93	3.23	1.588	.193
	751 - 1500	144	9.90	2.67		
	1501 - 2250	67	9.64	2.91		
	+ 2250	25	9.08	3.15		

4.2 Pre-service Elementary Science Teachers' Attitudes towards Science

The mean scores for the items of Scientific Attitude Inventory II (SAI-II) Scale were presented in Table 4.15. An average of 3.53 per item on the five-point likert scale which means that respondents of the pre-service elementary science teachers had moderately positive attitudes towards science. In addition, out of 200 maximum score of SAI-II, the mean score of the participants was found as 140.69, and, the minimum and maximum scores were 91 and 172, respectively (see Table 4.16).

Table 4.15 Mean Scores for Items of SAI-II

Item Number	$\bar{X}$	S. Dev.
1	3.89	0.89
2	3.85	0.99
3	3.69	1.02
4	3.34	0.99
5	4.06	0.88
6	3.80	0.82
7	3.53	1.03
8	3.46	1.08
9	4.03	1.02
10	3.71	1.02
11	3.62	1.04
12	4.13	0.80
13	4.07	0.83
14	4.01	0.82
15	3.34	1.08
16	4.10	0.85
17	3.84	0.95
18	3.58	1.10
19	3.78	1.03
20	4.11	0.82
21	2.80	1.05
22	3.80	1.16
23	4.17	1.00
24	3.91	1.01
25	3.50	1.05
26	3.46	1.12
27	1.99	0.84
28	4.04	1.11
29	3.46	1.02
30	3.46	0.99
31	2.19	0.85
32	3.80	1.16
33	2.45	1.05
34	4.39	0.98
35	1.85	0.80
36	3.88	1.22
37	2.38	1.00
38	3.20	1.11
39	4.33	1.01
40	2.21	0.94
SAI-II	3.53	0.11

Table 4.16 Mean Scores for Sub-scales of SAI-II

Sub-scale	No. of. Items	$\overline{X}$	Min.	Max.	S. Dev.
1-AB	6	20.00	13	25	2.43
2-AB	6	21.59	13	29	3.17
3-AB	6	23.25	11	30	3.37
4-AB	6	17.96	10	25	2.16
5-AB	6	21.99	9	30	3.40
6-AB	10	36.00	17	50	5.38
SAI-II	40	140.69	91	172	12.62

4.2.1 Pre-service Elementary Science Teachers' Attitudes towards Science According to Demographic Variables

Scientific Attitude Inventory II (SAI-II) Scale scores of the participants are presented in terms of gender in the Table 4.17. As seen, the mean SAI-II scores of the females was higher than that of males, but the difference between their means was not statistically significant at significance level of 95 % (t_{280} = 1.856 and $p > 0.05$).

Table 4.17 T-test Results of Pre-service Elementary Science Teachers' for SAI-II According to Gender

Gender	n	$\overline{X}$	S. Dev.	df	t	p
Female	193	141.60	11.45	28	1.856	.064
Male	92	138.63	14.63			

Mean SAI-II scores of the participants is presented in Table 4.18 according to high school profile. As shown, while the means score of the participants graduated from

General High School seemed better than the others, the differences between SAI-II means of the participants were not significant ($p > 0.05$).

Table 4.18 One-way ANOVA Results of Pre-service Elementary Science Teachers' for SAI-II According to High School Profile

High School Profile	n	$\bar{X}$	S. Dev.	F	p
General High School	85	141.45	12.84	0.115	.982
Anatolian & Science	87	140.37	14.05		
Anatolian Teacher Training	55	140.19	10.84		
Others	46	140.57	11.73		

*** Private High School was excluded due to the low sample size (n=6).**

As presented in Table 4.19, the mean score of the sophomores was the highest and that of the seniors was the lowest however, the differences between mean scores of grades were not statistically significant ($p > 0.05$).

Table 4.19 One-way ANOVA Results of Pre-service Elementary Science Teachers' for SAI-II According to Grade

Scale	Grade	n	$\bar{X}$	S. Dev.	F	p
SAI-II	Freshmen	97	141.01	9.92	1.920	.127
	Sophomores	54	143.91	10.55		
	Junior	69	139.45	14.79		
	Senior	61	138.73	14.89		

SAI-II scores of the participants according to place of family residence are presented in Table 4.20. The result of ANOVA test implied that there were statistically significant differences between SAI-II scores of the participants according to place of family residence ($p < 0.05$).

Table 4.20 One-way ANOVA Results of Pre-service Elementary Science Teachers' for SAI-II According to Place of Family Residence

Scale	Place of Family Residence	n	$\overline{X}$	S. Dev.	F	p
SAI-II	Metropolitan City Center	70	139.31	12.55	3.702	.012
	City Center	67	141.60	13.21		
	District	112	142.98	10.56		
	Town	26	134.69	16.27		

Then, Scheffe Post Hoc test was performed to determine which groups of means were significantly different from the others. Scheffe Post Hoc test results given in Table 4.21 imply that SAI-II scores of the participants whose family live in town was significantly lower than the participants whose family live in district.

Table 4.21 Scheffe Post Hoc Test Results of Pre-Service Elementary Science Teachers' for SAI-II According to Place of Family Residence

Place of Family Residence		p
Metropolitan City Center	City Center	0.761
	District	0.287
	Town	0.450
City Center	Metropolitan City Center	0.761
	District	0.913
	Town	0.122
District	Metropolitan City Center	0.287
	City Center	0.913
	Town	0.025

Participants of pre-service Elementary Science Teachers' mean SAI-II scores are depicted in Table 4.22 according to education level of their mothers and fathers. As seen, statistically significant differences were not found between scores of the participants for both education level of mothers and fathers.

Table 4.22 One-way ANOVA Results of SAI-II Scores of Pre-Service Elementary Science Teachers' According to Parents' Education Level

Parents	Education Level	n	$\bar{X}$	S. Dev.	F	p
Mother	Illiterate	24	137.63	10.27	0.775	.542
	Primary School	47	139.96	12.59		
	Secondary School	56	142.75	11.21		
	High School	96	140.64	13.99		
	University	58	140.44	12.27		
Father	Illiterate	12	140.75	8.29	1.202	.310
	Primary School	51	138.50	13.96		
	Secondary School	69	139.76	12.76		
	High School	83	143.01	10.87		
	University	70	140.17	13.85		

The mean SAI-II scores of the participants according to monthly family income level are presented in Table 4.23. As shown, statistically significant difference was not found between mean scores of the participants according to monthly family income ($p > 0.05$).

Table 4.23 One-way ANOVA Results of Pre-Service Elementary Science Teachers' for SAI-II According to Monthly Family Income Level

Scale	Income Level	n	$\overline{X}$	S. Dev.	F	p
SAI-II	0 - 750	44	142.79	13.14	1.507	.213
	751 - 1500	144	141.01	11.04		
	1501 - 2250	67	138.11	14.89		
	+ 2250	25	142.44	13.34		

4.3 Relationship between Pre-Service Elementary Science Teachers' Scientific Literacy Level and their Attitudes towards Science

Pearson Correlation Coefficient (r) was calculated to find out to possible relationship between pre-service elementary science teachers' scientific literacy level and their attitudes towards science. The results of the analysis provided in Table 4.24 implied that there was a statistically significant positive relationship between pre-service elementary science teachers' scientific literacy level and their attitudes towards science ($r=0,332$ and $p < 0.05$).

Table 4.24 The Pearson Correlation Coefficient for Relationship between Scientific Literacy Level and Attitude Towards Science

		SAI-II Score
TBSL Score	Pearson Correlation	.332
	Sig. (2-tailed)	.000
	n	285

Similarly, the relationship between domains of TBSL, and attitudes towards science was presented in Table 4.25. As seen, there were statistically significant positive relationships between domains of TBSL and attitude towards science ($p < 0.05$)

Table 4.25 The Pearson Correlation Coefficient for Relationship between Domains of TBSL and Attitude towards Science

		Attitude Score
	Pearson Correlation	.231
Nature of Science	Sig. (2-tailed)	.000
	n	285
	Pearson Correlation	.325
Science Content	Sig. (2-tailed)	.000
	n	285
	Pearson Correlation	.309
STS	Sig. (2-tailed)	.000
	n	285

Finally, the relationship between sub-categories of Science Content, and attitudes towards science was presented in Table 4.26. As seen, there were statistically significant positive relationships between domains of TBSL and attitude towards science ($p < 0.05$).

Table 4.26 The Pearson Correlation Coefficient for Relationship between Sub-categories of Science Content and Attitude towards Science

		Attitude Score
	Pearson Correlation	.202
Earth Sciences	Sig. (2-tailed)	.001
	n	285
	Pearson Correlation	.245
Physical Science	Sig. (2-tailed)	.000
	n	285
	Pearson Correlation	.278
Life Science	Sig. (2-tailed)	.000
	n	285
	Pearson Correlation	.306
Health Science	Sig. (2-tailed)	.000
	n	285

CHAPTER 5

DISCUSSION AND IMPLICATIONS

This study investigated pre-service science teacher's scientific literacy level and their attitudes towards science. The results of the study were presented in the Chapter IV. And in this chapter, results of the study were discussed and implications were presented.

5.1. Overview of the Study

The main purpose of the study was to investigate pre-service elementary science teachers' scientific literacy level and their attitudes towards science. Moreover, the study examined whether pre-service elementary science teachers' scientific literacy level and their attitudes towards science differ in some demographic variables such as gender, grade, high school profile, family income, educational level of parents, place of family residence. Finally, relationship between pre-service elementary science teachers' scientific literacy level and their attitudes towards science was explored. TBSL was used to measure scientific literacy level of participants. Another instrument, SAI-II was used to measure participants' attitudes towards science. These instruments were administered to 285 pre-service elementary science teachers in Dokuz Eylül University.

5.2. Discussion of the Results

According to results given in Chapter 4, the scientific literacy level of pre-service elementary science teachers is found as moderate. That is, the percentage of pre-service elementary science teachers' having satisfactory scientific literacy level is only 60.1 %. However, there were many teacher candidates on the other side who did not have satisfactory scientific literacy level (i.e., almost 40 %). Therefore, there should be more effort in order to improve scientific literacy level of pre-service elementary science teachers.

When the scientific literacy level of pre-service elementary science teacher is examined in terms of three domains of scientific literacy, participants got satisfactory level only in Science Content. The scientific literacy level of participants in Impact of Science and Technology on Society (STS) and Nature of Science were slightly below the satisfactory level. Similarly, when the scientific literacy of level of elementary science teacher candidates were examined in terms of sub-categories of science content, the results revealed that participants had relatively lower scores in Earth Science than the others. These results are consistent with those reported by Science for All Americans (SFAA) that individual may have differences in literacy in different domains. For instance, one may have more understanding of Life Science concepts and words, whereas less understanding of Physical Science concepts and words (AAAS, 1990).

Concerning the scientific literacy level of pre-service elementary science teacher in terms of gender, the results showed that there was statistically significant gender difference in favor of females in TBSL, Science Content, Physical Science and Health Science. However, while interpreting this finding, unequal distribution of female and male participants should not be ignored. Females' better scores in health science can be explained by previous findings that boys and girls have different interests within science. According to results from the Relevance of Science Education Projects (ROSE) in Denmark (Busch, 2005) and England (Jenkins & Nelson, 2005), girls show greater interest in biological topics such as health, mind and well-being. On the other hand, the study conducted by Chin (2005) to investigate scientific literacy level of first year pre-service teachers in elementary and science education and science majors with same scientific literacy instrument (TBSL) revealed that males performed significantly better than females in TBSL, Science Content, Earth Science and Life Science. Females had better mean scores in TBSL and its all domains including sub-categories of Science Content. In addition, the study conducted by Çepni and Bacanak (2002) in order to investigate the level of scientific literacy primary school teacher candidates found that males were not more significantly scientific literate than females except in the life sciences. The other study carried out by Miller (2002) found that there were very few differences between science and technology literacy levels of males and females in the US. The main reasons of these differences could be due to the fact that all these studies were conducted in different countries even in different education departments. Therefore, in order to obtain general idea about effects of gender on scientific literacy level, the more comprehensive studies can be conducted including different universities and departments with a larger sample size.

Scientific literacy level of the pre-service elementary science teachers did not show any significant difference for TBSL and its all domains including sub-categories of Science Content with respect to their high school profile and educational level of parents. Similarly, the study carried out by Yetişir (2008) using same measurement instrument (TBSL) suggested same result for pre-service elementary science teachers and primary school teachers.

Scientific literacy level of the pre-service elementary science teachers did not show any significant difference for TBSL and its all domains including sub-categories of Science Content with respect to grade. Likewise, there was not any significant relationship observed between scientific literacy level of the participants and monthly family income level for TBSL and its all domains. One of the reasons of the result could be due to the fact that the way of reaching information is easier than that of one or two decades before. The person whether coming from lower economical level or higher economic level can easily reach the all information via internet in the same way. In literature, there is a study conducted in Nordic countries by Turmo (2004) in order to study the relationships between scientific literacy level of the students and their cultural, social and economic levels, is consistent with this study. Author found that there was a weak correlation between science and technology literacy and family income level.

The scientific literacy level of participants showed significant differences in terms of the place of family residence as follows: (a) TBSL and Science Content level of the participants whose family live in town were significantly lower than the others, (b) Nature of Science scores of the participants whose family live in town was significantly lower than the participants with family living in metropolitan city center, (c) Science Technology Society scores of the participants, whose family residence place was town had significantly lower scores than participants whose family residence place was metropolitan city center and district. That is, participants who live in towns seem to have lower scientific literacy level than others.

Pre-service elementary science teachers' attitudes towards science were found to be moderate. In addition, results revealed that higher mean SAI-II scores were observed in favors of females, although there were not any significant differences found between females and males. Similar to this study, Chin's study (2005) reported no interaction between gender and attitudes towards science. This result is also consistent with the study conducted by Shrigley (1974) who found no significant differences among genders in the attitudes of in-service elementary teachers toward science.

Moreover, there were not any differences observed between pre-service elementary science teachers' attitudes towards science in terms high school profile, grade, education level of parents and monthly family income. Yetişir (2008) found similar results except for high school profile. Participants whose high school type was Anatolian Teacher Training showed lower attitude level towards science than others. Likewise, the study conducted by Türkmen and Bonnstetter (2000) examining teacher candidates' attitudes towards science in terms of some demographic variables suggested similar findings. According to the study, there were not statistically significant results found between attitudes towards science level and education level of parents.

As similar to findings presented for scientific literacy, the place of family residence showed significant relationship with attitudes towards science. It was found that participants whose family live in town showed significantly lower attitudes towards science.

According to the results, there were significantly positive relationships between TBSL, all domains of TBSL and sub-categories of Science Content and attitudes towards science. These findings suggested that individuals who are more scientifically literate are more favorably disposed towards science and express more positive attitudes towards science than who are less scientifically literate.

5.3 Implications and Suggestions for Future Studies

Achieving scientific literacy is seen as one of the major goals of science education. Pre-service science teachers are key factors who will promote scientific literacy to their future students. Moreover, pre-service elementary science teachers' attitudes towards science is another important factor since according to previous studies students of these teachers will more likely possess similar attitudes (Stolberg, 1969; Washton, 1971; Shrigley, 1983). Therefore, results of this study are important since it provides useful information for elementary science education programs. To achieve high quality education program, it is important to be informed about pre-service elementary science teachers' present scientific literacy level and their attitudes towards science.

Results of the study indicated that among 285 participants, 172 respondents passed the TBSL test which means that 60.1% respondents' scientific literacy level was satisfactory. On the other side, there were almost 40% of pre-service elementary science teachers who don’t have satisfactory level at scientific literacy. When we examined the participants’ scores taken from sub-domains of TBSL and sub-categories of Science Content, lack of scientific literacy was observed in Nature of Science and Impact of Science and Technology on Society Sub-domains and Earth Science. These results suggest that science educators should emphasize to these science topics when they develop programs and courses to enhance students’ scientific literacy level in elementary, secondary schools and also in universities.

The comparison of the TBSL scores between genders revealed that there was a statistically significant difference between females and males. According to the results, females were more scientifically literate than males. Although females were better in mean scores of TBSL, all sub-domains of TBSL and all sub-categories of Science Content, they showed significantly difference in TBSL, Science Content, Health Science and Physical Science.

Another results related to place of family residence was participants whose family residence was town both have lower scientific literacy and showed lower attitude towards science. This can be related with low education quality in elementary schools and secondary schools.

Pre-service elementary science teachers’ attitudes towards science were found as moderately positive. This suggests that there is still a need to make improvements to promote positive attitude towards science among pre-service elementary science teachers. However, there were not any significant differences found between females and males. Final important implications of the study were that there were significantly positive relationships between TBSL, all domains of TBSL and sub-categories of Science Content and attitudes towards science. The importance of these findings is that individuals who are more scientifically literate are more favorably disposed towards science.

Present study investigated the pre-service elementary science teachers' scientific literacy level and their attitudes towards science. Future studies can focus on samples from different departments, universities with a larger sample size.

Present study carried out by Turkish version of TBSL and SAI-II, further study can be conducted by different instruments which are linguistically appropriate and culturally relevant. In terms of Scientific literacy level, this study only focus on three domains of scientific literacy, namely, Nature of Science, Science Content, Impact of Science and Technology on Society. Further studies can be conducted to measure including other aspects of scientific literacy such as applications of science, ability to apply knowledge for decision-making and problem-solving, knowledge of interdisciplinary concepts. This study investigated pre-service elementary science teachers' scientific literacy level and their attitudes towards science. Further studies can focus on finding the way of improving scientific literacy level of pre-service teachers and changing the negative attitudes, if there are any.

BIBLIOGRAPHY

- Abell, S.K., & Smith, D.C. (1994) "What is Science? Preservice Elementary Teachers' Conceptions of the Nature of Science" *International Journal of Science Education*, 16, 475–487.

- Agin, M. L. (1974) "Education for Scientific Literacy: A Conceptual Frame of Reference and Some Applications" *Science Education*, 58(3), 403-415.

- Aikenhead, G. S., & Ryan, A. G. (1992) "The Development of A New Instrument: Views on Science – Technology – Society (VOSTS)" *Science Education*, 76(5), 477-491.

- Allison, R. W., and Smith, D. R. (1974) "Improving Preservice Teachers Attitudes Toward Science" *Paper Presented at the Western Area Convention of the National Science Teachers Association*, Denver: Colorado.

- American Association for the Advancement of Science (AAAS) (1989), *Project 2061– Science for all Americans,* Washington, DC.

- Arons, A. B. (1983) "Achieving Wider Scientific Literacy" *Daedalus*, 112(2), 91-122.

- Atkin, J. M., & Helms, J. (1993) "Getting Serious About Priorities in Science Education" *Studies in Science Education*, 21, 1-20.

- Bacanak, A., & Gökdere, M. (2009) "Investigating Level of The Scientific Literacy of Primary School Teacher Candidates" *Asia–Pacific Forum on Science Learning and Teaching*, 10(1), Article 7.

- Baker, D. R. (1983) "The Relationship of Attitude, Cognitive Abilities, and Personality to Science Achievement in the Junior High School" *Paper Presented at the Annual Meeting of National Association of Research in Science Teaching*, Dallas, TX.

- Barton, D. (1994) *Literacy: An Introduction to the Ecology of Written Language* Cambridge, MA: Blackwell.

- Bilgin, I., & Geban, O. (2004) "Investigating the Effects of Cooperative Learning Strategy and Gender on Pre–Service Elementary Teacher Students' Attitude Toward Science and Achievement Of Science Teaching Class" *Hacettepe Journal of Education*, 26.

- Bloch, E. (1986) "Basic Research and Economic Health – The Coming Challenge" Science, 232(4750), 595-599.

- Bohner, G., & Wanke, M. (2002) *Attitudes and Attitude Change*, Psychology Press.

- BouJaoude, S. (2002) "Balance of Scientific Literacy Themes in Science Curricula: the case of Lebanon" *International Journal of Science Education*, 24(2), 139-156.

- Branscomb, A. W. (1981) "Knowing How to Know" *Science, Technology, & Human Values*, 6(36), 5-9.

- Brekke, S. J. (2002) "True Scientific Literacy for All Students. Teacher Feature. Teachers" *Net Gazette*, 3(6), Jun 2002.

- Buldu, N. (2005) *Attitudes of Pre–Service Elementary Teachers Towards Science: A Cross–National Study Between The USA and Turkey*, PhD. Dissertation, Indiana University.

- Busch, H. (2005) *Is science education relevant?*, Europhysics News, September/October, 162-167.

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

- Bybee, R. (1999) "Toward An Understanding of Scientific Literacy" *In Advancing Standards for Science And Mathematics Education: Views From The Field.* AAAS, Washington DC.

- Cannon, J. R., & Jinks, J. (1992) "A Cultural Literacy Approach to Assessing General Scientific Literacy" *School Science and Mathematics,* 92(4), 196-200.

- Chen, D., & Novik, R. (1984) "Scientific and Technological Education in an Information Society" *Science Education,* 68(4), 421-426.

- Chin, C. C. (2005) "First–Year Pre–Service Teachers in Taiwan – Do They Enter the Teacher Program with Satisfactory Scientific Literacy and Attitudes Toward Science?" *International Journal of Science Education*, 27(13), 1549-1570.

- Christiansen, L. E. (1971) *An Analysis of The Training, Attitudes and Competence of the Preservice Elementary Teacher in Science Education at The University of Oregon,* University Microfilms, ERIC Document Reproduction Service No: ED092310.

- Cooley, W. W., & Klopfer, L. E. (1961) *Test on Understanding Science*, Form W. Princeton, NJ: Educational Testing Service.

- Çavaş Huyugüzel, P. (2009) *Sınıf Öğretmenlerinin Fen ve Teknoloji Okuryazarlıkları ile Öğretim Yeterliklerinin Belirlenmesi*, Doktora Tezi, Dokuz Eylül Üniversitesi, İzmir.

- Çepni, S., & Bacanak, A. (2002) "A Study on Determining Mathematics Student Teachers' Scientific Literacy*" 1st International Education Conference-Changing Times Changing Needs*, May 8-10, Eastern Mediterranean University, Famagusta, North Cyprus.

- DeBoer, G. E. (1991) *A History Of Ideas in Science Education*, New York: Teachers College Press.

- Demirbaş, M. (2009) "The Relationships Between The Scientist Perception and Scientific Attitudes of Science Teacher Candidates in Turkey: A Case Study" *Scientific Research and Essays*, 4(6), 565-576,

- Demirbaş, M., and Yağbasan, R. (2006a) "The Functional Importance of Scientific Attitudes in Science Teaching and Adaptation of Scientific Attitude Scale Into Turkish" *Uludağ University Faculty of Education*, 19(2), 271-299.

- Durant, J. R., Evans, G. A., & Thomas, G. P. (1992) "The Public Understanding of Science in Britain: The Role Of Medicine in The Popular Representations of Science" *Public Understanding of Science*, 1(2), 161-182.

- Ellsworth, J. Z., & Buss, A. (2000) "Autobiographical Stories from Preservice Elementary Mathematics and Science Students: Implications for K–16 Teaching" *School Science and Mathematics*, 100(7), 355-363.

- European Commission. (2002) *Science and Society Action Plan*, Luxembourg: Office for Official Publications of the European Communities.

- Fishbein, M., & Ajzen, I. (1975) *Belief, Attitude, Intention, and Behavior: An Introduction to Theory and Research*, Addison–Wesley.

- Gabel, L. L. (1976) The *Development of A Model to Determine Perceptions of scientific literacy*, PhD. Dissertation, The Ohio State University, Columbus, OH.

- Gardner, P. L. (1975) “Attitudes Toward Science: A Review” *Studies in Science Education*, 2, 1-41.

- George, R. and Kaplan, D. (1998) “A Structural Model of Parents and Teacher Influences on Science Attitudes of Eight Graders: Evidences from NELS:88” *Science Education*, 82, 93-109.

- Goodrum D, Hackling M, Rennie L (2001) *The Status and Quality of Teaching and Learning of Science in Australian Schools*, Canberra: Department of Education, Training and Youth Affairs.

- Graubard, S. R. (1983) “Nothing to Fear, Much to Do” *Daedalus*, 112(2), 231-248.

- Gregory, J. and Miller, S. (2000) *Science in Public: Communication, Culture and Credibility*, London: Perseus.

- Grutzner-Sampson, C. E. (1992) *Relationships Between Previous School and Life Experiences of Preservice Elementary Teachers and Their Attitudes Toward Science And Science Teaching*, PhD. Dissertation, University Of North Dakota.

- Haladyna, T., Olsen, R. and Shaughnessy, J. (1982) “Relations of Student, Teacher and Learning Environment Variables to Attitudes Toward Science”. *Science Education*, 66, 671–87.

- Hazen, R. M., & Trefil, J. (1991) *Science Matters. Achieving Scientific Literacy*, New York: Anchor Books Doubleday.

- Hurd, P. DeH. (1958) “Science Literacy: Its Meaning for American Schools” *Educational Leadership*, 16:13-16.

- Jenkins, E. W. (1992) "School Science Education: Towards a Reconstruction". *Journal of Curriculum Studies*, 24(3), 229-246.

- Jenkins, E. (1997) "Scientific and Technological Literacy: Meanings and Rationales" In Jenkins, E. (ed.), *Innovations in Science and Technology Education,* Vol. VI Paris: UNESCO, 1-39.

- Jenkins, E. W. & Nelson, N. W. (2005) "Important but not for Me: Students' Attitudes Towards Secondary School Science In England" *Research in Science & Technological Education*, 23(1), 41-57.

- Jones, C., & Levin, J. (1994) "Primary/Elementary Teachers' Attitudes Toward Science in Four Areas Related to Gender Differences in Students' Science Performance" *Journal of Elementary Science Education,* 6(1), 46-66.

- Kennedy, T. G. (1973) "The Effect of Process Approach Instruction Upon Changing Preservice Elementary Teachers' Attitudes Toward Science" *School Science and Mathematics,* 73(7), 549-574.

- Kintgen, E. R. (1988) "Literacy literacy" *Visible Language,* 1(2/3), 149-168.

- Kimball, M. E. (1967/68) "Understanding the Nature of Science: A Comparison of Scientists and Science Teachers" *Journal of Research in Science Teaching*, 5, 110–120.

- Klopfer, L. E. (1971) *Evaluation of Learning in Science*, In B. S. Bloom, J. T. Hastings & G. F. Madaus (Eds.), *Handbook of Formative and Summative Evaluation of Student Learning*, London: McGraw-Hill.

- Koballa, T. R., & Crawley, F. E. (1985) "The Influence of Attitude On Science Teaching and Learning" *School Science, and Mathematics, 85,* 222-232.

- Koballa, T. R. (1988) “Attitude and Related Concepts in Science Education” *Science Education,* 72(2), 115-126.

- Lang, M., Drake, S. M., & Olsen, J. (2006). Discourse and the New Didactics of Scientific Literacy, Journal of Curriculum Studies, 38, 2, 177-188.
- Laugksch, R. (2000) “Scientific Literacy: A Conceptual Overview” *Science Education*, 84(1), 71-94.

- Laugksch, R. C., & Spargo, P. E. (1996a) “Development of a Pool of Scientific Literacy Test–Items Based on Selected AAAS Literacy Goals” *Science Education*, 80(2), 121-143.

- Laugksch, R. C., & Spargo, P. E. (1996b) “Construction of A Paper–And–Pencil *Test of Basic Scientific Literacy* Based on Selected Literacy Goals Recommended by The American Association for the Advancement of Science” *Public Understanding Of Science*, 5(4), 331-359.

- Laugksch, R. C., & Spargo, P. E. (2000) “Scientific Literacy of Selected South African Matriculants Entering Tertiary Education: A Baseline Survey” *South African Journal of Science*, 95, 427-432.

- Layton, D., Davey, A., & Jenkins, E. (1986) “Science for Specific Social Purposes (SSSP): Perspectives on Adult Scientific Literacy” *Studies in Science Education*, 13, 27-52.

- Lee, Y. M. (2003) *An Investigation of Taiwanese Graduate Students' Level of Civic Scientific Literacy*, PhD. Dissertation, The University of Texas at Austin.

- Lewis, J. D. (1982) “Technology, Enterprise, and American Economic Growth” *Science*, 215, 1204-1211.

- Lord, T. R., & Rauscher, C. (1991) “A Sampling of Basic Life Science Literacy in A College Population” *The American Biology Teacher*, 53(7), 419-424.

- Lucas, K. B., & Dooley, J. H. (1982) "Student Teacher Attitudes Toward Science and Science Teaching" *Journal of Research in Science Teaching,* 19(9), 805-809.

- Manhart, J. J. (1998) *Gender Differences in Scientific Literacy,* ERIC Documents Reproduction Service, No: Ed 424, 623.
- Miller, J.D., and Prewitt, K. (1979) *The Measurement of the Attitudes of the U.S. Public Toward Organized Science,* Report to the National Science Foundation under Contract SRS78–16839. Chicago: National Opinion Research Center.

- Miller, J. D. (1983) "Scientific literacy: A Conceptual and Empirical Review" *Daedalus,* 112(2), 29-48.

- Miller, J. D. (1987) "Scientific Literacy in the United States". In Evered, D. & O'Connor, M. (Eds.), *Communicating Science to the Public,* 19-40, London: Wiley.

- Miller, J. D. (1992) "Toward a Scientific Understanding of The Public Understanding of Science and Technology" *Public Understanding of Science,* 1(1), 23-26.

- Miller, J. D. (1998) "The measurement of civic scientific literacy" *Public Understanding of Science,* 7, 203-223.

- Milli Eğitim Bakanlığı (MEB) (2006) *İlköğretim 6–7–8 sınıf Fen ve Teknoloji Programı,* Turkey, Ankara.

- Moore, R. W., & Foy, R. L. H. (1997) "The Scientific Attitude Inventory: A Revision (SAI II)" *Journal of Research in Science Teaching,* 34(4), 327-36.

- Moore, R. W., & Sutman, F. X. (1970) "The Development, Field Test and Validation of an Inventory of Scientific Attitudes" *Journal of Research in Science Teaching,* 7, 85-94.

- National Research Council (NRC) (1996) *National Science Education Standards*, Washington, DC: National Academy Press.

- O'Hearn, G. T. (1976) "Science Literacy and Alternative Futures" Science Education, 60 (1), 103-114.

- Osborne, J., Simon, S., & Collins, S. (2003) "Attitudes Towards Science: A Review of the Literature and Its Implication" *International Journal of Science Education*, 25(9), 1049-1079.

- Oskamp, S. (1977) *Attitudes and Opinion*s, Prentice Hall, Inc.

- Palmer, D. H. (2001) "Factors Contributing to Attitude Exchange Among Preservice Elementary Teachers" *Science Teacher Education*, 86(1), 122-138.

- Pedersen, J., & McCurdy, D. (1992) "The Effects of Hands–on, Minds–on Teaching Experiences on Attitudes of Preservice Elementary Teachers" *Science Education*, 76(2), 141-146.

- Pella, M. O. (1976) "The Place or Function of Science for A Literate Citizenry" *Science Education*, 60(1), 97-101.

- Pella, M. O., O'Hearn, G. T., & Gale, C. G. (1966) "Referents To Scientific Literacy" *Journal of Research in Science Teaching*, 4, 199-208.

- Petty, R. E., Priester, J. R., & Wegener, D. T. (1994) *Cognitive Processes in Attitude Change*, In R. S. Wyer and T. K. Srull (Eds.) Handbook of Social Cognition, 2nd ed., Vol. 2, pp .69-142, Hillsdale, NJ: Erlbaum.

- Prewitt, K. (1983) "Scientific Illiteracy and Democratic Theory" *Daedalus*, 112(2), 49-64.

- Rennie, L. (2005) “Science Awareness and Scientific Literacy” *Teaching Science, 51,* 10-14.

- Roberts, D. A. (1983) *Scientific Literacy. Towards a Balance for Setting Goals for School Science Programs*, Ottawa, ON, Canada: Minister of Supply and Services.

- Roth, W, M. and Lee, S. (2004) “Science Education as/for Participation in the Community” *Science Education, 88,263*-291.
- Royal Society (1985) *The Public Understanding of Science*, London: Royal Society.

- Rubba, P. A., & Anderson, H. O. (1978) “Development of an Instrument to Assess Secondary School Students’ Understanding of The Nature of Scientific Knowledge”, *Science Education*, 62(4), 449–458.

- Rutherford, F.J. and Down, A.G. (1995) *The New Quest For Science Literacy,* http://www.cosmos–club.org/web/journals/1995/rutherfd.html
  Last Access: December, 2009.

- Schibeci, R. A. (1983) “Selecting Appropriate Attitudinal Objectives for School Science”, *Science Education,* 67(5), 595-603.

- Schibeci, R. A. (1984) “Attitudes to Science: An update” *Studies in Science Education,* 11, 26-59.

- Shamos, M. H. (1995) *The Myth of Scientific Literacy*, New Brunswick, NJ: Rutgers University Press.

- Shen, B. S. P. (1975) “Science Literacy: The Public Need” *The Sciences,* 27-29.

- Showalter, V. M. (1974) “What is United Science Education? Part 5. Program Objectives and Scientific Literacy” Prism II, 2(3-4).

- Shrigley, R. L. (1974) "The Attitude of Preservice Elementary Teachers Toward Science" *School Science and Mathematics,* 74(3), 243-250.

- Shrigley, R. L. (1983) "The Attitude Concept and Science Teaching" *Science Education*, 67(4), 425-442.

- Simpson, R., & Oliver, S. (1985) "Attitude Toward Science and Achievement Motivation Profiles of Male and Female Science Students in Grades Six Through Ten" *Science Education*, 69, 511-526.
- Simpson, D., & Oliver, S. (1990) "A Summary of Major Influences on Attitude Toward and Achievement in Science Among Adolescent Students" *Science Education*, 74, 1-18.

- Skamp, K. (1991) "Primary Science and Technology: How Confident are Teachers?" *Research in Science Education*, 21, 290-299.

- Stolberg, R. (1969) *The Task Before Us. The Education of Elementary School Teachers in Science.* Reprinted By Kuslan., L. I. and Stone., A. H. in *Readings on Teaching Children Science*, Belmont, CA: Wadsworth Publishing Company.

- Symington, D. (2004) "Community Leaders Views of the Purposes of Science in the Compulsory Years of Schooling" International Journal of Science Education, 26(11), 1403-1418.

- Tekkaya, C., Çakıroglu, J., & Özkan, Ö. (2002) "A Case Study on Science Teacher Trainees" *Eğitim ve Bilim,* 27(126), 15-21.

- Thompson, C. L., & Shrigley, R. L. (1986) "What Research Says: Revising the Science Attitude Scale" *School Science and Mathematics,* 86(4), 331-343.

- Towse, P. J. (1983) "Do New Science Courses Improve Attitudes Toward Science? A Study in Lesotho" *Science Education,* 67, 159-170.

- Turmo, A. (2004) "Scientific Literacy and Socio–Economic Background Among 15–year–olds – A Nordic Perspective" *Scandinavian Journal of Educational Research*, 48 (3), 287-305.

- Turkmen, L. (2002) "Freshman Elementary Education Major Students' Attitudes Toward Science and Science Teaching" *Hacettepe Journal of Education, 23*, 218-228.

- Turkmen, L., & Bonnstetter, R. (2000) "A Study of Turkish Science Teachers' Attitudes Toward Science and Science Teaching and Relations with Several Sosyo-Demographic Factors" *NARST Annual Meeting*, New Orleans, LO (USA)

- Wareing, C. (1981) "Cognitive Style and Developing Scientific Attitudes in The SCIS Classroom" *Journal of Research in Science Teaching,* 18(1), 73-77.

- Wareing, C. (1990) "A Survey of Antecedents of Attitudes Toward Science" *Journal of Research in Science Teaching*, 27(4), 371-386.

- Washton, E.S. (1971) *Improving Elementary Teacher Education in Science*, New York: Macmillan

- Waterman, A. T. (1960) "National Science Foundation: A Ten–Year Resume" *Science*, 131(3410), 1341-1354.

- Wei, B., & Thomas, G. P. (2005) "Rationale and Approaches for Embedding Scientific Literacy into the New Junior Secondary School Chemistry Curriculum in the People's Republic of China" *International Journal of Science Education*, 27 (12), 1477-1493.

- Yetişir, M. I. (2007) *İlköğretim Fen Bilgisi Öğretmenliği ve Sınıf Öğretmenliği Birinci Sınıfında Okuyan Öğretmen Adaylarının Fen ve Teknoloji Okuryazarlık Düzeyleri*, Doktora Tezi, Gazi Üniversitesi, Ankara.

- Young, T. (1998) "Student Teachers' Attitudes Towards Science (STATS)", *Evaluation & Research in Education*, 12: 2, 96 — 111

- Zhang, Z., & Zhang, J. (1993) "A Survey of Public Scientific Literacy in China" *Public Understanding of Science*, 2, 21-38.

- Ziman, J. (1991) "Public Understanding of Science" *Science, Technology & Human Values*, 16(1), 99-105.

APPENDIX A

Sevgili Öğrenciler,

2752

Bu test üç bölümden oluşmaktadır. Birinci bölümde demografik özelliklere ilişkin sorular yer almaktadır. İkinci bölümde, bilime yönelik tutumunuzu belirlemeye çalışan ve üçüncü bölümde sizlerin temel bilimsel okuryazarlık seviyenizi ortaya çıkartmayı hedefleyen sorular bulunmaktadır.
Lütfen soruları olabildiğince hızlı ve dikkatli bir şekilde okuyunuz ve tüm soruları yanıtlayınız.

Araştırma Ekibi

BÖLÜM 1. DEMOGRAFİK SORULAR

1. Cinsiyetiniz
(1) Kadın (2) Erkek

2. Öğrenim gördüğünüz lisans programı
(1) Fizik (2) Kimya
(3) Biyoloji (4) Fen bilgisi öğretmenliği

3. Sınıfınız
(1) 1 (2) 2 (3) 3 (4) 4

4. Anne ve Babanızın eğitim düzeyi nedir?

	Anne	Baba
Okur-yazar değil	(1)	(2)
İlkokul	(3)	(4)
Ortaokul	(5)	(6)
Lise	(7)	(8)
Üniversite	(9)	(10)
Yüksek Lisans	(11)	(12)
Doktora	(13)	(14)

5. Mezun olduğunuz lise türü:
(1) Genel Lise (2) Özel Lise
(3) Anadolu Lisesi (4) Fen Lisesi
(5) Askeri Lise (6) Akşam Lisesi
(7) Polis Koleji (8) Anadolu Güzel Sanatlar L.
(9) Öğretmen Liseleri (10) İmam Hatip Lisesi
(11) Endüstri T. ve M. L. (12) Açıköğretim Lisesi
(13) Çok Programlı Lise (14) Diğer:

6. Ailenizin aylık gelir düzeyi nedir?
(1) 0 – 750 (2) 751 - 1500
(3) 1501 - 2250 (4) 2251 - Üstü

7. Ailenizin yaşadığı yer?
(1) Büyükşehir merkezi. (2) Şehir merkezi
(3) İlçe (4) Kasaba
(5) Köy (6) Diğer

8. Anne ve babanızın mesleğini işaretleyiniz.

Meslek Grupları	Anne	Baba
Doktor, Diş Hekimi, Eczacı	(1)	(2)
Mülki Amir (Vali, Kaymakam)	(3)	(4)
Bankacı, Finans Uzm. , Borsacı	(5)	(6)
Öğretmen	(7)	(8)
Mühendis	(9)	(10)
Asker	(11)	(12)
Mimar	(13)	(14)
Memur	(15)	(16)
İşçi	(17)	(18)
Serbest Meslek	(19)	(20)
Avukat, Hakim ve Savcı	(21)	(22)
Öğretim Üyesi	(23)	(24)
Teknisyen	(25)	(26)
Diğer	(27)	(28)

9. Bilimsel dergi ya da kitapları takip eder misiniz?
(1) Kitap (2) Dergi (3) Hiçbiri

BÖLÜM 2. BİLİMSEL TUTUM ÖLÇEĞİ

Bu bölümde yer alan ifadeler sizin bilime yönelik tutumunuzu belirlemek üzere hazırlanmıştır. İfadeleri ***Kesinlikle katılmıyorum (1), Katılmıyorum (2), Kararsızım (3), Katılıyorum (4), Kesinlikle katılıyorum (5)*** derecelendirmesini dikkate alarak, size en uygun gelen kutucuğu işaretleyiniz.

1. Fen bilimleri çalışmaktan hoşlanırım.	(1)(2)(3)(4)(5)
2. Bilmemiz gereken her şeye fen bilimleri ile ulaşılabilir.	(1)(2)(3)(4)(5)
3. Yeni fikir üzerinde herkes uzlaşmadıkça, o fikri dinlemek faydasızdır.	(1)(2)(3)(4)(5)
4. Bilim insanları daima etrafımızdaki olay ve nesnelerin daha iyi açıklamaları ile ilgilenirler.	(1)(2)(3)(4)(5)
5. Eğer bir bilim insanı, bir fikrin doğru olduğunu söylüyorsa, diğer tüm bilim insanları buna inanacaktır.	(1)(2)(3)(4)(5)
6. Fen bilimlerini sadece eğitim seviyesi yüksek bilim insanları anlayabilir.	(1)(2)(3)(4)(5)
7. Bizler sorularımızın cevaplarını daima bir bilim insanına sorarak alabiliriz.	(1)(2)(3)(4)(5)
8. İnsanların çoğu fen bilimlerini anlama yeteneğinden yoksundur.	(1)(2)(3)(4)(5)
9. Elektronik ürünler, bilimin gerçekten değerli ürünlerinin örnekleridirler.	(1)(2)(3)(4)(5)
10. Bilim insanları, kendi sorularına her zaman cevap bulamayabilirler.	(1)(2)(3)(4)(5)
11. Bilim insanlarının bilimsel bir olay hakkında iyi bir açıklamaları varsa, o açıklamayı geliştirmeye gerek duymazlar.	(1)(2)(3)(4)(5)
12. Çoğu insan fen bilimlerini anlayabilir.	(1)(2)(3)(4)(5)
13. Bilimsel bilgiyi araştırma sıkıcı olabilir.	(1)(2)(3)(4)(5)
14. Bilimsel çalışma benim için çok zor olabilir.	(1)(2)(3)(4)(5)
15. Bilim insanları, bize doğada tam olarak neyin olup bittiğini anlatan kanunları keşfederler.	(1)(2)(3)(4)(5)

dataofis
FORM NO: OD-052

-1-

DEVAMI İÇİN ARKA SAYFAYI ÇEVİRİNİZ.

16. Bilimsel fikirler değiştirilebilirler.	① ② ③ ④ ⑤
17. Bilimsel sorular çevredeki olay ve nesneler gözlemlenerek cevaplandırılırlar.	① ② ③ ④ ⑤
18. İyi bilim insanları, fikirlerini değiştirmeye isteklidirler.	① ② ③ ④ ⑤
19. Bazı sorular, fen bilimleri tarafından cevaplandırılamaz.	① ② ③ ④ ⑤
20. Bir bilim insanı yeni fikirler üretmek için, iyi bir hayal gücüne sahip olmalıdır.	① ② ③ ④ ⑤
21. Fikirler bilimin en önemli sonuçlarıdırlar.	① ② ③ ④ ⑤
22. Bilim insanı olmak istemiyorum.	① ② ③ ④ ⑤
23. İnsanlar fen bilimlerini anlamak zorundadırlar, çünkü fen bilimleri onların hayatlarını etkilemektedir.	① ② ③ ④ ⑤
24. Fen bilimlerinin en önemli amaçlarından birisi, yeni ilaçlar üretmek ve bu yolla hayat kurtarmaktır.	① ② ③ ④ ⑤
25. Bilim insanları gözlemlediklerini rapor etmelidirler.	① ② ③ ④ ⑤
26. Eğer bir bilim insanı bir soruyu cevaplayamıyorsa, bir diğer bilim insanı da cevaplayamaz.	① ② ③ ④ ⑤
27. Bilimsel problemleri çözmek için, diğer bilim insanları ile çalışmak isterim.	① ② ③ ④ ⑤
28. Fen bilimleri, olayların nasıl oluştuğunu açıklamaya çalışır.	① ② ③ ④ ⑤
29. Her vatandaş fen bilimlerini anlamalıdır.	① ② ③ ④ ⑤
30. Çok büyük keşifler yapamayabilirim, ama fen bilimleri ile uğraşmak eğlenceli olabilir.	① ② ③ ④ ⑤
31. Fen bilimlerinin en önemli amaçlarından birisi, insanların daha iyi yaşamalarına yardım etmektir.	① ② ③ ④ ⑤
32. Bilim insanları, birbirinin çalışmalarını eleştirmemelidirler.	① ② ③ ④ ⑤
33. Duyular, bir bilim insanının sahip olduğu en önemli araçlardan birisidir.	① ② ③ ④ ⑤
34. Bilim insanları hiç bir şeyin kesin olarak doğru olduğuna inanmazlar.	① ② ③ ④ ⑤
35. Bilimsel kanunlar tüm muhtemel şüphelere rağmen kanıtlanmışlardır.	① ② ③ ④ ⑤
36. Bilim insanı olmak isterim.	① ② ③ ④ ⑤
37. Bilim insanlarının ailelerine veya eğlenceye ayıracak yeterli zamanları yoktur.	① ② ③ ④ ⑤
38. Bilimsel çalışmalar sadece bilim insanları için faydalıdır.	① ② ③ ④ ⑤
39. Bilim insanları çok fazla çalışmak zorundadır.	① ② ③ ④ ⑤
40. Bir fen bilimleri lâboratuarından çalışmak eğlenceli olabilir.	① ② ③ ④ ⑤

BÖLÜM 3. TEMEL BİLİMSEL OKUR-YAZARLIK TESTİ

Lütfen her bir ifadeyi dikkatlice okuyarak, bu ifadeleri **doğru** (D), **yanlış** (Y) ya da **bilmiyorum** (B) olarak cevaplayınız. Bazı maddelerde italik yazılmış bilgi cümlelerini doğru ifade olarak kabul ediniz

1. Dünya ve evren aynı yaştadır.	Ⓓ Ⓨ Ⓑ
2. Galaksimizde sadece birkaç bin yıldız bulunmaktadır.	Ⓓ Ⓨ Ⓑ
3. Güneşe en yakın yıldızın ışığının bize ulaşması sadece birkaç dakika sürer.	Ⓓ Ⓨ Ⓑ
4. Evrende güneşe benzeyen birçok gökcismi bulunmaktadır	Ⓓ Ⓨ Ⓑ
5. Evren hakkında bilgilerimizin çoğu; uzayın çok küçük parçalarını ve çok kısa zaman aralıklarını incelememiz sonucunda oluşmuştur.	Ⓓ Ⓨ Ⓑ
6. Çapıyla kıyaslandığında, çok kalın bir hava tabakası dünyanın etrafını sarmaktadır.	Ⓓ Ⓨ Ⓑ
7. Bildiğimiz kadarıyla, Güneş sistemindeki birçok gezegen ve uydu yaşantımızı desteklemek için ortaya çıkmıştır	Ⓓ Ⓨ Ⓑ
8. Dünya dışındaki gezegenlerin yüzeyinde sıvı halde su yoktur.	Ⓓ Ⓨ Ⓑ
9. *Dünyanın ekseni eğiktir*, yani yana yatıktır. Bu eğim dünya iklimindeki mevsimsel değişiklikleri oluşturur.	Ⓓ Ⓨ Ⓑ
10. Dünyanın sıcak iç kısmındaki ısı değişimi, dünyadaki iklim değişikliklerinin temel nedenidir.	Ⓓ Ⓨ Ⓑ
11. Dünyanın iklimi binlerce yıldan bu yana çok az değişmiştir.	Ⓓ Ⓨ Ⓑ
12. İnsanların zararlı aktivitelerinin etkisinden önce, okyanuslar ve atmosferde çok önemsenmeyecek miktarda değişimler meydana geliyordu.	Ⓓ Ⓨ Ⓑ
13. *Karbon, oksijen, azot ve kükürt gibi elementler karada, okyanuslarda ve atmosferde bir döngü içerisindedir.* Bu döngü esnasında, elementler kimyasal bileşimlerini değiştirirler.	Ⓓ Ⓨ Ⓑ
14. Dünyanın atmosferi yaşamın ortaya çıkışıyla değişikliğe uğramamıştır.	Ⓓ Ⓨ Ⓑ
15. İnsan aktiviteleri yeryüzünü, okyanusları ve atmosferi çok az değiştirmiştir.	Ⓓ Ⓨ Ⓑ
16. Bilim insanları, yaptıkları çalışmalar ile ilgili bazı ortak tutum ve inanışları paylaşırlar.	Ⓓ Ⓨ Ⓑ
17. Bilim, evrendeki nesne ve olayların tutarlı bir düzende gerçekleşmediğini kabul eder.	Ⓓ Ⓨ Ⓑ
18. Bilim, evrenin işleyişiyle ilgili temel kuralların evrenin her yerinde aynı olduğunu varsayar.	Ⓓ Ⓨ Ⓑ
19. Yaşantımızın bilimsel açıdan incelenemeyecek birçok yönü vardır.	Ⓓ Ⓨ Ⓑ
20. Bilim insanlarının bilimsel bilgiye hata yapmadan ulaşmaları için izlemeleri gereken belirli yöntemleri vardır.	Ⓓ Ⓨ Ⓑ
21. Bilimsel iddiaların doğruluğu, doğal olayların gözlemlenmesi ile er ya da geç ortaya konulur.	Ⓓ Ⓨ Ⓑ
22. Bilim insanları, kanıtları sonuçlarla ilişkilendiren mantıksal akıl yürütme ilkeleri konusunda farklı görüşlere sahiptirler.	Ⓓ Ⓨ Ⓑ
23. Hipotezleri ortaya koyma ve bunları test etme, bilim insanlarının en önemli işlerinden biri değildir.	Ⓓ Ⓨ Ⓑ
24. Bilim insanları doğal olayları açıklamaya çalışırlar. Bu açıklamalarda, bilimsel olarak kabul görmüş prensipler nadiren kullanılır.	Ⓓ Ⓨ Ⓑ
25. Bilimsel teoriler, ilk aşamada o teorileri geliştirirken ele alınmamış diğer gözlemleri de açıklayabilmelidirler.	Ⓓ Ⓨ Ⓑ

26. Bilimsel kanıtlar; verilerin yorumlanması, kaydedilmesi, raporlaştırılması ya da seçilmesi esnasında çarpıtılabilir. Ⓓ Ⓨ Ⓑ
27. Bilim insanları kanıtları kişisel inançları, değerleri ve geçmiş deneyimlerine göre farklı yorumlayabilirler. Ⓓ Ⓨ Ⓑ
28. Bilim insanları, diğer bilim insanlarının çalışmalarındaki olası yanlılıkları belirlemeye çalışırlar. Ⓓ Ⓨ Ⓑ
29. Hiçbir bilim insanı, bir araştırmayı belirli bir sonuca ulaşması gerektiği düşüncesiyle yürütmemelidir. Ⓓ Ⓨ Ⓑ
30. Bilim birçok farklı insan tarafından yürütülmesine rağmen, toplumun değerlerini ve bakış açılarını (kadınlar hakkındaki görüşler, politik inançlar gibi) pek yansıtmaz Ⓓ Ⓨ Ⓑ
31. Bilimsel bilginin yayılması, bilimin ilerlemesi için önemli değildir. Ⓓ Ⓨ Ⓑ
32. Kimya ve biyoloji gibi bilim alanları birbirlerinden belirli sınırlarla kesin olarak ayrılmıştır. Ⓓ Ⓨ Ⓑ
33. Araştırmalar için maddi destek sağlayan kurumlar (farklı devlet kurumları gibi), bilim üzerinde yönlendirici bir etkiye sahiptirler (örneğin ne tür bir araştırmanın yapılması gerektiği gibi). Ⓓ Ⓨ Ⓑ
34. Bilimde güçlü gelenekler yerleşmiş olduğundan, pekçok bilim insanı iş ahlakına uygun ve dürüst bir şekilde davranır. Ⓓ Ⓨ Ⓑ
35. Bilimsel etik (ahlâkî sistem), diğer konuların yanı sıra, bilimsel deneylerin sonucunda oluşabilecek zararlarla da ilgilenir. Ⓓ Ⓨ Ⓑ
36. Bilimsel etik, diğer konuların yanı sıra, araştırma sonuçlarının uygulanması sırasında oluşabilecek zararlı etkilerle ilgilenir. Ⓓ Ⓨ Ⓑ
37. Bilim insanları, nükleer güç ya da çevrenin korunması gibi toplumda tartışılan konulara kesin çözüm bulamayabilirler. Ⓓ Ⓨ Ⓑ
38. *Biyologlar organizmaları gruplara ve alt gruplara ayırırlar.* Bu sınıflandırma yapılırken, organizmaların yapı ve davranışı dikkate alınmaz. Ⓓ Ⓨ Ⓑ
39. Dünyadaki tür çeşitliliğini korumak, insanoğlu için önemsizdir. Ⓓ Ⓨ Ⓑ
40. Yaşam için gerekli olan enerji ve maddeleri temin etmede, insanoğlu besin ağlarından (yani birbirine bağlı besin zincirlerinden) bağımsızdır. Ⓓ Ⓨ Ⓑ
41. Her bir gen, DNA molekülünün bir veya birden fazla özel parçasıdır. Ⓓ Ⓨ Ⓑ
42. Eşeysel üremede genlerin karışımı, iki ailenin çocuklarında büyük bir gen çeşitliliğine neden olur.
43. Organizmaların besinlerden enerji elde etmek gibi temel fonksiyonlarının çoğu, hücre düzeyinde gerçekleştirilir. Ⓓ Ⓨ Ⓑ
44. DNA moleküllerinde kodlanan genetik bilginin, protein moleküllerinin düzenlenmesinde bir rolü yoktur. Ⓓ Ⓨ Ⓑ
45. Hücredeki kimyasal süreçler, hem hücre içinden hem de hücre dışından kontrol edilir. Ⓓ Ⓨ Ⓑ
46. *Çoğu organizma birçok farklı hücreye sahiptir.* Bu tür organizmalardaki hücreler sadece bütün hücreler için ortak olan temel fonksiyonları yerine getirir. Ⓓ Ⓨ Ⓑ
47. Bir ekosistemde bulunan bütün türler, doğrudan ya da dolaylı olarak bu sistemdeki diğer türlere bağlıdır. Ⓓ Ⓨ Ⓑ
48. Bir ekosistemin organizmaları arasındaki bağımlılık, genellikle çok uzun süre sonunda dengeli bir sistem ortaya çıkarır. Ⓓ Ⓨ Ⓑ
49. İklimler değişirse ekosistemler de değişir. Ⓓ Ⓨ Ⓑ
50. Çok farklı yeni türler ortaya çıktıkça, ekosistemler değişir. Ⓓ Ⓨ Ⓑ
51. Canlı organizmalar, diğer doğal sistemler ile aynı madde ve enerji korunum ilkelerini paylaşmazlar. Ⓓ Ⓨ Ⓑ
52. Dünyadaki yaşamın sadece küçük bir kısmı, güneşten gelen enerjinin dönüşümü ile varlığını sürdürür. Ⓓ Ⓨ Ⓑ
53. Canlı varlıkların moleküllerini oluşturan elementler sürekli bir döngü halinde işlenip yeniden kullanılırlar. Ⓓ Ⓨ Ⓑ
54. Kömür ve petrol milyonlarca yıl önce oluşmuştur. Ⓓ Ⓨ Ⓑ
55. *Milyonlarca yıl boyunca karbondioksit atmosferden uzaklaştırılmıştır.* Kömür ve petrol gibi yakıtların yanmasıyla karbondioksit, bu uzaklaştırılmadan daha kısa bir zamanda atmosfere geri dönmektedir. Ⓓ Ⓨ Ⓑ
56. Dünyanın günümüzdeki yaşam şekilleri milyonlarca yıl önce ortak atalardan evrimleşerek oluşmuştur. Ⓓ Ⓨ Ⓑ
57. Dünyadaki yaşam sadece bir kaç bin yıldır var olmaktadır. Ⓓ Ⓨ Ⓑ
58. Ebeveyn genlerinde meydana gelebilecek yeni kombinasyonlar veya mutasyonlar, kalıtımla taşınan yeni özelliklere neden olmaz Ⓓ Ⓨ Ⓑ
59. Doğal seleksiyon, dış çevreye uyum konusunda elverişli özelliklere sahip canlıların hayatlarını sürdürmelerini sağlar. Ⓓ Ⓨ Ⓑ
60. Evrim, basit yaşam formlarının gelişmiş formlarla yer değiştirdiği bir basamak değildir. Ⓓ Ⓨ Ⓑ
61. Modern evrim kavramı, dünyadaki yaşam tarihini anlamaya yönelik birleştirici bir temel ortaya koyar. Ⓓ Ⓨ Ⓑ
62. Teknoloji sayesinde geliştirilen yeni araç ve teknikler, bilimsel araştırmalara çok az katkı sağlar.değerleri de yansıtır. Ⓓ Ⓨ Ⓑ
63. Teknoloji, bilim için sadece araçlar sağlar. Ancak teknoloji, nadiren de olsa, bilimde teori oluşturmak ve araştırma yapmak için gerekli olan motivasyon ve yönlendirmeyi de sağlar Ⓓ Ⓨ Ⓑ
64. Mühendisler bütün sorunlarımıza çözümler üretebilirler. Ⓓ Ⓨ Ⓑ
65.Kısa vadede mühendislik, bilimsel araştırmalara kıyasla toplumları ve kültürleri doğrudan etkiler. Ⓓ Ⓨ Ⓑ
66. *Başarılı mühendislik kararları bilimsel düşünceler içerir.* Bu kararlar aynı zamanda, sosyal ve kişisel Ⓓ Ⓨ Ⓑ
67. *Bir mühendislik tasarımında bütün sınırlılıklar (fiziksel yasalar, ekonomi ve politika gibi) dikkate alınır.* En iyi tasarım, bu sınırlılıklar içerisinden en uyumlu olana ulaşılmasıyla ortaya çıkar. Ⓓ Ⓨ Ⓑ
68. Mühendislik tasarımlarının hemen hemen her zaman test edilmesi gerekir. Ⓓ Ⓨ Ⓑ

 DEVAMI İÇİN ARKA SAYFAYI ÇEVİRİNİZ.

2	7	5	2

69. *Buzdolabı veya fırın gibi oldukça basit birçok aletin çevreye olan etkisi tek başına küçük olabilir.* Bunun birlikte, bu etkiler bir bütün olarak önemli olabilir. Ⓓ Ⓨ Ⓑ
70. Modern teknolojik sistemler çok karmaşık olmasına rağmen, bu teknolojik tasarımların yan etkileri önceden tahmin edilebilir. Ⓓ Ⓨ Ⓑ
71. İnsanların risklere karşı gösterdiği psikolojik tepkiler (uçma ya da araba kullanma korkusu gibi), olayların gerçekte içerdikleri riskle doğru orantılıdır. Ⓓ Ⓨ Ⓑ
72. Herhangi bir teknolojik sistem tüm önlemler alınmış veya çok para harcanmış olsa bile başarısız olabilir. Ⓓ Ⓨ Ⓑ
73. Bir ülkedeki sosyal ve ekonomik güçlerin, o ülkede hangi teknolojinin geliştirileceği konusunda çok etkisi yoktur. Ⓓ Ⓨ Ⓑ
74. Teknolojinin insan toplumunun doğası üzerinde çok az etkisi vardır. Ⓓ Ⓨ Ⓑ
75. Herhangi bir teknoloji ile ilgili alınacak kararda (örneğin bir şehrin yakınına nükleer santralin inşa edilmesi gibi), sadece o teknoloji ile ilgili gerçekler belirleyici olmaz. Ⓓ Ⓨ Ⓑ
76. Hükümet kararları kadar bireysel kararların toplu etkisi de teknolojinin geniş ölçekli kullanımını etkiler. Ⓓ Ⓨ Ⓑ
77. Teknoloji ile ilgili konularda pek çok karar yeterli bilgiye sahip olunmadan alınmaktadır. Ⓓ Ⓨ Ⓑ
78. Dünyadaki her şey, yaklaşık olarak 100 kimyasal elementin farklı bileşimlerden meydana gelmektedir. Ⓓ Ⓨ Ⓑ
79. Her madde sıcaklığa ve basınca bağlı olarak katı, sıvı, gaz gibi farklı hallerde bulunabilir. Ⓓ Ⓨ Ⓑ
80. Atomların birbirlerine bağlanma şeklini, her atomun dış yörüngesindeki elektronların dizilişi belirler. Ⓓ Ⓨ Ⓑ
81. Düşük seviyede radyasyon, yaşadığımız çevrede doğal olarak bulunmaktadır. Ⓓ Ⓨ Ⓑ
82. Evrende enerji, sadece belirli bir biçimde görülür. Ⓓ Ⓨ Ⓑ
83. Bir haldeki veya bir yerdeki enerji (ısı enerjisi gibi) azalırsa, başka bir halde veya yerde bulunan enerjide eşit miktarda artış olur. Ⓓ Ⓨ Ⓑ
84. Moleküllerdeki atomların dizilişi, moleküllerin farklı enerji seviyeleriyle ilgili değildir. Ⓓ Ⓨ Ⓑ
85. Atomik ve moleküler seviyede, enerji de madde gibi belirli birimlerde (yani ayrı paketlerde) halinde bulunur Ⓓ Ⓨ Ⓑ
86. Atomlardan canlılara, yıldızlara kadar evrende bulunan hiçbirşey durgun değildir; tam tersine her zaman bir şeylere göre hareket ediyordur. Ⓓ Ⓨ Ⓑ
87. Hareketlerdeki değişimler her zaman dengelenmemiş kuvvetlerin etkisinden kaynaklanmaktadır Ⓓ Ⓨ Ⓑ
88. Cisimler farklı renklerde görünmesinin nedeni, bu cisimlerin ışığın bazı dalga boylarını diğerlerinden daha fazla yansıtması ya da yaymasıdır. Ⓓ Ⓨ Ⓑ
89. Evrendeki her nesne diğer nesneler üzerine çekim kuvveti uygular. Ⓓ Ⓨ Ⓑ
90. Atomlar arasındaki elektromanyetik kuvvetler, bunlar arasındaki yerçekimi kuvvetine göre çok daha güçlüdürler. Ⓓ Ⓨ Ⓑ
91. Manyetik ve elektrik kuvvetler birbirlerinden bağımsızdırlar. Ⓓ Ⓨ Ⓑ
92. İnsanlar, biyolojik açıdan diğer canlı organizmalara pek benzemez Ⓓ Ⓨ Ⓑ
93. Beden yapısı ve ten rengi gibi özelliklerdeki çeşitliliğe rağmen, insanlar tek türdür. Ⓓ Ⓨ Ⓑ
94. Günlük yaşantımızdaki biyolojik yetersizliklerin üstesinden gelmede teknolojinin bize katkısı çok azdır. Ⓓ Ⓨ Ⓑ
95. Bebeklerin ölüm oranına, çevresel temizlik (kanalizasyon ve lağım arıtma vb.), hijyen ve tıbbî bakım gibi faktörlerin etkisi yoktur. Ⓓ Ⓨ Ⓑ
96. Teknoloji, insanlara ne zaman ve kaç tane çocuk sahibi olabilecekleri konusunda pek çok seçenek sunmaktadır. Ⓓ Ⓨ Ⓑ
97. İnsan vücudundaki organ sistemlerinin kendilerine özgü fonksiyonları yoktur. Ⓓ Ⓨ Ⓑ
98. Bağışıklık sistemi, insanların hastalıklardan kendilerini korumalarında önemli rol oynar Ⓓ Ⓨ Ⓑ
99. İç kontrol, yani koordinasyon, insan vücudundaki karmaşık organ sistemlerinin yönetilmesi ve düzenlenmesi için gereklidir. Hormonlar bu iç kontrolde önemli rol oynarlar. Ⓓ Ⓨ Ⓑ
100. Yeni doğan her hayvan, bazı davranış şekillerini o davranış öğretilmeden gösterir. Ⓓ Ⓨ Ⓑ
101. İnsan davranışlarındaki farklılıklar, sahip oldukları biyolojik kalıtım ve farklı deneyimlerinden kaynaklanır. Ⓓ Ⓨ Ⓑ
102. Öğrenmelerin birçoğu, var olan bilgilerle yeni bilgilerin ilişkilendirilmesi sonucunda oluşmaktadır. Ⓓ Ⓨ Ⓑ
103. İnsanların var olan fikirleri, onların yeni olgu ve fikirleri nasıl yorumladıklarını etkilese de, genelde öğrenmeyi pek etkilemez Ⓓ Ⓨ Ⓑ
104. İnsan vücudunun normal olarak çalışabilmesi için kendisini oluşturan maddelerin (protein, karbonhidrat, vs) tekrar yerine konmasına gerek yoktur. Ⓓ Ⓨ Ⓑ
105. Bireylerin sağlığının iyi olması, insanların havayı, toprağı ve suyu korumada birlikte gösterdikleri çabadan bağımsızdır. Ⓓ Ⓨ Ⓑ
106. Normal olmayan genler, insan vücudunun kısımlarının ve sistemlerinin çalışmasını etkilemez. Ⓓ Ⓨ Ⓑ
107. Akıl sağlığı, bireylerin yaşantısının psikolojik, biyolojik, fizyolojik, sosyal ve kültürel yönlerinin etkileşimiyle ilişkili değildir. Ⓓ Ⓨ Ⓑ
108. Akıl sağlığı ile ilgili görüşler, geçmişten günümüze kadarki farklı zaman aralıklarında aynı kalmıştır. Ⓓ Ⓨ Ⓑ
109. Beyindeki kimyasal dengesizlik gibi biyolojik anormallikler, bazı ciddi psikolojik rahatsızlıklara neden olur. Ⓓ Ⓨ Ⓑ
110. Yakın bir aile üyesinin ölümü gibi psikolojik sıkıntılar, herhangi bir bireyin fiziksel olarak hasta olma ihtimalini etkilemez. Ⓓ Ⓨ Ⓑ

KATILIMLARINIZDAN DOLAYI TEŞEKKÜR EDERİZ.