# TEACHING SCIENTIFIC LITERACY THROUGH A SCIENCE TECHNOLOGY AND SOCIETY COURSE: PROSPECTIVE ELEMENTARY SCIENCE TEACHERS' CASE

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**ABSTRACT**
The study examines Turkish pre-service elementary science teachers' scientific literacy levels. The research took place in Marmara University, in 2001-2002 academic year. The research participants were twenty randomly chosen students among all senior classes of the university mentioned above. The research data were gathered with the documents, i.e. class assignments and activities, collected in science-technology and society course performance portfolios. Interviews with students and field notes from the class were used for data triangulation. Participants' definitions of scientific literacy were determined with document analysis and open coding of data. Then, assertions to explain findings were formed. The assertions displayed that participants define scientific literacy in relation with thinking and inquiry. However; they are having problems to define the term scientific. Documents displayed that although participants had some traditional understandings about science, they hold more contemporary views about scientific literacy.

## INTRODUCTION

Almost all developing and developed countries have the purpose of increasing scientific literacy level of public among their educational goals. This purpose also takes place in Turkish educational agenda. The first step to reach that purpose is to define scientific literacy. There is no consensus on the definition of scientific literacy concept in literature.

Some educational researchers have a tendency to define scientific literacy in relation to language literacy. Koch and Eckstein (1995) emphasized that scientific literacy requires an active and critical engagement of the reader in the interpretation of the meaning of a science text. A scientifically literate person should take a critical stance toward science texts and develop the ability to interpret them from a theoretical perspective (Koch, & Eckstein, 1995).

Sutman (1996) made a similar connection between language literacy and scientific literacy in his definition of functional literacy. Sutman (1996) argues that scientific literacy is not dependent upon any specific science content or process knowledge. Scientific literacy consists of the abilities and willingness to continue to learn science content, to develop science processes on one's own, and to communicate the results of this learning to others (Sutman, 1996).

In contrast to Sutman, Mayer (1997) argues that scientific literacy is dependent upon specific amounts of science content knowledge. Mayer (1997) defines scientific literacy as the knowledge of the substantive content of science that is related specifically to understanding the interrelationships among people and how their activities influence the world around them (Mayer, 1997).

Current reform efforts in education have brought another definition of scientific literacy. Project 2061 (American Association for the Advancement of Science, 1990) defines scientific literacy as the ability to use scientific knowledge and ways of thinking for personal and social purposes. According to Project 2061 scientific literacy has many facets. These include being familiar with the natural world and respecting its unity; being aware of some of the important ways in which mathematics, technology, and the sciences depend upon one another; understanding some of key concepts and principles of science; having a capacity for scientific ways of thinking; knowing that science, mathematics, and technology are human enterprises, and knowing what that implies about their strengths and limitations (American Association for the Advancement of Science, 1990, pp.xvii-xviii).

The National Science Education Standards define scientific literacy as "the knowledge and understanding of scientific concepts and processes required for personal decision making, participation in civic and cultural affairs and economic productivity" (National Research Council, 1996, p.22). In addition, NRC standards describe a vision of the scientifically literate person and present criteria for science education, emphasizing the inquiry nature of science within the science content standards.

Parallel to the science education reform efforts taking place in the United States, there are some international efforts in Europe as well as in other parts of the world. The Royal Society in the United Kingdom, which is an organization similar to AAAS, defines 3 aspects of scientific literacy, those are consistent with AAAS's definition. These dimensions of scientific literacy include:

- Science content: understanding facts, laws, concepts and theories.
- Scientific inquiry: understanding of the scientific approach to inquiry. The ability to define scientific study and to discriminate between science and non-science.
- Social enterprise: understanding science as a social enterprise (Driver, 1996, pp.12-13).

Although various individuals and organizations contribute slightly different definitions of scientific literacy, they tend to weigh science content and science processes equally. Take, for instance, Driver's position. She identifies scientific literacy as public understanding of science and states:

Public understanding of science involves not only an understanding of empirical inquiry procedures, but also of the role of theoretical and conceptual ideas in framing any empirical inquiry and interpreting its outcomes (Driver, 1996, p.12).

Based on Mayer's definition of scientific literacy, science literacy brings problem solving together. People approach to solve problems by understanding interactions among people and how human activities influence our life. In that sense, increasing one's scientific literacy level is very important.

**COURSE DESIGN**

Science- technology and Society (STS) is a course designed to improve people's understandings about science and scientific literacy. There are several reasons to justify the need for STS education. The validity and reliability of scientific knowledge rests on its worldly use. If we provide a clear social role to science in everyday life it will be possible to draw attention to the relevance of science. A course on STS is a way to make science relevant. The basic principle for STS education is to tackle practical problems aroused in society scientifically. That leads us to an interdisciplinary approach as a central pedagogical principle. Within this interdisciplinary approach STS connects society with the nature of science.

There are also historical and philosophical approaches to STS education. What we learned in the past changed to something new and different. STS education needs to stress that science and technology grow and change in societies in which they are embedded. STS education shows the increasing role of science and technology in society. Additionally, philosophical approach provides another objective to STS education. That is the need to address the "nature of science" (Solomon, Aikenhead, 1994).

This research study originated from that final objective. The basic principle of STS course examined for this research study is to interrelate the nature of science and technology with the changing demands of society.

**OBJECTIVE**

Purpose of this research is to determine the scientific literacy level of pre-service elementary science teachers and also to examine their definitions of scientific literacy.

**METHOD**

Research participants were twenty senior students randomly chosen among those who attend to Science Teaching Department of Marmara University Ataturk Faculty of Education. They all were taking the STS course.

**DATA COLLECTION**

Research data were gathered via performance portfolios consist of student-generated artifacts produced in the course. STS is a three-credit theoretical course that is based on the influence of individuals' understandings about scientific inquiry and philosophy of science on their understandings of teaching. The main purpose of the

course was to help individuals increase their level of scientific literacy. For that purpose course participants were asked to prepare performance portfolios, which contain the assignments listed below:

1 Participants' interpretations about Richard Feynman's chapters on "Uncertainty of Science" and "Uncertainty of Values" (Feynman, 1999).
2 Reflections to "Einstein Style Thinking Form" prepared by Scott Thorpe (2000).
o Writing a research problem by using the form
3 Definition of scientific literacy.
o Drawing a concept map
4 Characteristics of a scientifically literate individual.
o Drawing a concept map.

For data triangulation, the researcher, who is the instructor of the STS course at the same time, took field notes and did interviews with participants.

**DATA ANALYSIS AND FINDINGS**

Qualitative analysis of data includes document analysis and open coding. Documents in participants' portfolios are open coded to identify common themes. Themes are coded to form groups and these groups were used to form assertions. Finally, assertions were checked against field notes of the researcher.
Following assertions are formed due to data analysis of participants' sayings.

1 Assertions about what science is

Science is a systematic body of facts based on observations and experiments. Scientific knowledge is formed with a scientific method, which includes controlled experiments.

Science is a way to discover things or it is a knowledge gained things that are discovered.

2 Assertions about what scientific literacy is:

Scientific literacy is to make interpretations of what is read. Everybody can read a scientific article but to write a scientific article requires an accumulation of scientific knowledge.

The central aspect of scientific literacy is uncertainty of scientific knowledge. Scientifically literate person is an individual who believes the uncertainty and asks questions.

Doing research and inquiry are the two important characteristics of a scientifically literate person.

**DISCUSSION**

Research findings about what science is and who scientifically literate is, seem to be consistent in terms of having traditional and contemporary views of science, except assertion 1. Unlike others, assertion 1 seems to address the traditional model of the nature of science. Palmquist and Finley (1997) explain the traditional model of the nature of science with the following characteristics:

1 Science relies on precise control of experiments for proof.
2 Science is doing experiments.
3 The use of traditional scientific method is necessary to discover and validate theories.

Assertion 1 is consistent with what is listed above.
On the other hand, assertion 2 brings a new dimension to participants' definition of science. It defines science as a way to discover the things. This definition implies the processes of science, as well as products. That belongs to contemporary model of the nature of science. Palmquist and Finley (1997) list some of the characteristics of contemporary model of the nature of science as follows.

1 Science is a search for finding.
2 Science consists of many disciplines and processes.

Consistency between assertion 2 and what is listed above displays the influence of what participants' read from course assignment.

Assertions 3 and 4 about scientific literacy support assertion 2. Assertion 3 mentions "interpretation" and assertion 4 mentions "uncertainty" concepts. These two are mentioned in Palmquist and Finley's lists about contemporary model of the nature of science. Related items from their list are

1 A scientist interprets results based on prior knowledge, observation, logic and social factors.

2 Scientific knowledge is tentative.

Although these two items do not talk exactly about scientific literacy, they may be adapted to it. The connection between "scientist" and "interpretation of results" is similar to connection between scientifically literate person and interpretation of what she/he read. Assertions 2,3,and 4 display that participants' understandings about scientific literacy belong to contemporary model of the nature of science. However; their understandings about science seem more traditional. Therefore; a well-designed STS course may change participants' views about science and the nature of science.

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