



SCIENTIFIC LITERACY INVESTIGATION IN SCIENCE CURRICULA: THE CASE OF TURKEY

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Abstract. The purpose of this study was to investigate the current science and technology curriculum for the balance of scientific literacy (SL) aspects and its potential to educate scientifically literate citizens. Human body system unit of current science curriculum was investigated to see whether scientific literacy aspects were reflected sufficiently to meet the needs of students. Specifically, the objectives and activities for 6th and 7th grades were analyzed. The framework used by BouJauode (2002) was utilized to find out the potential of the curriculum to make students scientifically literate in terms of its four aspects. The four characteristics used by BouJauode (2002) to evaluate the curriculum were knowledge of science (Aspect 1), investigative nature of science (Aspect 2), science as a way of knowing (Aspect 3), and interaction of science, technology and society (Aspect 4). It was found that general objectives of science curriculum were mostly focus on the knowledge of science aspect of scientific literacy. Moreover, it was found that the investigative nature of science was stressed overwhelmingly over other aspects in the activity part. Throughout the two parts science as a way of knowing aspect was almost missing. Overall, the findings raised the concerns about unbalanced curriculum to educate scientifically literate students.

Keywords: scientific literacy, science curriculum investigation, scientific literacy aspects.

INTRODUCTION

School people and public have come to realize that it is through the programs of the schools that science will be advanced and the ideals of a free world will be perpetuated (Hurd, 1958). It was in 1957, Soviet Union launched the Sputnik (the first satellite) into earth's orbit. Some developed nations especially Americans were shocked with Sputnik and disappointed with their science and technology (Jong, 2007). Sputnik caused experts to think on science curricula. Hurd (1958) was probably the first to use the term "scientific literacy" in stating the goals of science education. Hurd emphasized the rapid developments in science and technology and the American people wondered whether their children were getting adequate education which will provide them necessary knowledge and skills to take place in a society full of scientific and technological developments. The need was pointed for a kind of education which is compatible with the forces of science. Hurd focused on the gap between scientific achievement and scientific literacy. The problem was that scientific achievement was high but scientific literacy was poor among the students. Another problem

mentioned was the lack of an education meeting the requirements of the future. This education should prepare young people to expect changes in science and technology and to meet these changes without fear and anxieties. Hurd claimed that "Progress in science and technology has reached the place where their future is dependent upon an education that is appropriate for meeting the challenges of an emerging scientific revolution" (p. 14). Although Hurd highlighted the necessity of scientific literacy, he did not provide a definition for scientific literacy.

After Sputnik, *Rethinking Science Education*, the Fifty-ninth Yearbook of the National Society for the Study of Education published in 1960, declared that science educators should aim to produce people who are aware of science and the work of scientists (DeBoer, 2000). Then the goals of science education undergone changes and the main focus were to educate people to be aware of scientific and technological developments. If people understand science and technology, they can easily adopt to this quickly changing world. DeBoer stated that "Scientific literacy was to provide a broad understanding of science and of the rapidly developing scientific enterprise whether one was to become a scientist or not." (p. 586).

Scientific literacy has been considered as a goal of science education for decades, standing for "broad and functional understanding of science for general education purposes and not preparation for specific scientific and technical careers," (Deboer, 2000, p. 594). Many efforts were done for scientific literacy. However, a project called as Project 2061 which was carried out in USA was one of the most important ones in the history of scientific literacy to be viewed as a goal for science education and to initiate reform in science education. "Science for All Americans" (American Association for the Advancement of Science [AAAS], 1989) and "Benchmarks for Science Literacy" (AAAS, 1993) were the products of this project. Of course, these were not only efforts in science education reform. The National Science Education Standards (National Research Council [NRC], 1996) contributed to the reform in science education by setting the standards for achieving scientific literacy.

Definition, and Aspects of Scientific Literacy

Deboer (2000) discusses that although scientific literacy has been defined as a goal of science education, there is no agreement about its meaning. Roberts (2007) also stated that: "[I]t is well known in the science education community that no consensus exists about the definition of SL" (p.729). Scientific literacy has a vast majority of different definitions in the literature. It is stated by Durant (1994) as "[SL] stands for what the general public ought to know about science" (p. 129). In *Science for All Americans* (AAAS, 1998), a scientifically literate individual has been broadly defined as follows:

is familiar with the natural world; understands some of the key concepts and principles of science; has a capacity for scientific ways of thinking; is aware of some of the important ways in which mathematics, technology and science depend upon one another; knows that science, mathematics and technology are human enterprises, and what that implies about their strengths and limitations; is able to use scientific knowledge and ways of thinking for personal and social purposes (p. 6).

The Organization for Economic Cooperation and Development's (OECD) Programme for International Student Achievement (PISA) defines scientific literacy as; "the capacity to use scientific knowledge, to identify questions and to draw evidence-based conclusions in order to understand and help make decisions about the natural world and the changes made to it through human activity" (OECD, 2003, p. 133).

It is obvious that scientific literacy can be considered as multidimensional including science concepts and ideas, the nature of science and the interaction of science and society (Laugksch, 2000).

BouJaoude (2002) developed a framework of aspects of scientific literacy based on its definitions and frameworks in the literature. This framework included four aspects of scientific literacy. It is also used to analyze the science curricula. The framework is given in Appendix part of the paper. It will be mentioned in method section more.

New Science and Technology Curriculum in Turkey and Scientific Literacy

The current Science and Technology curriculum was introduced in 2004 by Turkish Ministry of National Education (MNE). The new national curriculum in Turkey has embraced a different approach in education. It not only aims to improve students' knowledge and skills but also underlines the need for education for citizenship. Millar (1996) proposed that science education should offer the same standards for all students to make them scientifically literate in order to advance the public understanding of science. The vision of new Science and Technology curriculum is to educate every single student as scientifically and technologically literate without considering their individual differences (MNE, 2006). In this vein, scientific literacy should be considered as one of the goals of science education for all students. Demiraslan (2008) stated that Turkey has encountered some economic and social problems deriving from the educational system and the only way to deal with these problems is to have citizens who are scientifically and technologically literate.

The philosophical perspective of new curriculum is constructivism which has different premises for learning and teaching. Malcolm and Keane (2001) stated that constructivism is one of the learning theories and has been embraced by the researchers in the science education. It is well known for its premise which emphasizes the construction of knowledge by the learners. Students' previous experiences and their everyday knowledge are vital for students' learning of science (Stears, 2009). Students are actively involved in their own science knowledge construction guided by the teachers (Corley, 1997). Constructivists suppose that "we actively construct knowledge based on what we already know and the new information we encounter" (Woolfolk, 1995, p. 275). That is, constructivism emphasizes that students have previous experiences, knowledge, and beliefs. Therefore, their background should be taken into consideration in learning process. Constructivist teachers are not the pure source of knowledge; they are just facilitators in learning process.

METHOD

The purpose of this study was to investigate the current science and technology curriculum for the balance of scientific literacy aspects and its potential to educate scientifically literate citizens. Human body system unit of current science curriculum was investigated to see whether scientific literacy aspects were reflected sufficiently to meet the needs of students. Specifically, the objectives and activities for 6th and 7th grades were analyzed. The framework used by BouJauode (2002) was utilized to find out the potential of the curriculum to make students scientifically literate in terms of its four aspects. BouJauode developed this framework based on the study of Chiapetta, Sethna, and Fillman (1993). The four characteristics used by BouJauode (2002) to evaluate the curriculum were knowledge of science (Aspect 1), investigative nature of science (Aspect 2), science as a way of knowing

(Aspect 3), and interaction of science, technology and society (Aspect 4). The objectives and activities in the curriculum were classified as belonging to Aspect 1, Aspect 2, Aspect 3, or Aspect 4. Then the frequencies and percentages of each aspect of scientific literacy were computed.

FINDINGS

In this study the objectives and activities in the curriculum were classified as belonging to Aspect 1, Aspect 2, Aspect 3, or Aspect 4 by two independent researchers. The Kappa Measure of Agreement value was found to be .78 which represents good agreement between two researchers. Then the frequencies and percentages of each aspect of scientific literacy were tabulated. The distribution of percentages of new science curriculum of 6th grade in the unit of human body system is shown in Table 1. It is found that the knowledge of science (Aspect1) is overemphasized when compared to other three aspects. The Investigative nature of science (Aspect 2) and interaction of science, technology and society (Aspect 4) fairly and equally emphasized. On the other hand, science as a way of knowing (Aspect 3) was underestimated.

Table 1. Percentage distribution of the aspect of scientific literacy in the general objectives of 6th grade

Aspect of Scientific Literacy			
The Knowledge of Science (%)	The Investigative nature of science (%)	Science as a way of knowing (%)	Interaction of science, technology and society (%)
52	22	4	22

The analysis of the objectives of 7th grade, given in Table 2, showed that Aspect 1, Aspect 2 and Aspect 4 are reasonably highlighted in the human body system unit. Conversely there was not any reference to Aspect 3 in this part of the curriculum.

Table 2. Percentage distribution of the aspect of scientific literacy in the general objectives of 7th grade

Aspect of Scientific Literacy			
The Knowledge of Science (%)	The Investigative nature of science (%)	Science as a way of knowing (%)	Interaction of science, technology and society (%)
43	23	0	34

The percentage distribution of the aspects of scientific literacy in the activity part of 6th grade in the human body system unit of Turkish science curriculum was given in Table 3. The results showed that there is a heterogenous distribution among the aspects of scientific literacy in activity part of the curriculum. Center of attention directed toward Aspect 2 while Aspect 1 and Aspect 3 were underrated by the curriculum developers. Aspect 4 was acceptable in this range.

Table 3. Percentage distribution of the aspect of scientific literacy in the activity part of 6th grade

Aspect of Scientific Literacy			
The Knowledge of Science (%)	The Investigative nature of science (%)	Science as a way of knowing (%)	Interaction of science, technology and society (%)
9	56	9	26

As shown in Table 4, similar fashion maintains in the activity part of 7th grade as well. An exception is that there is not any reference to Aspect 3. The focus of Aspect 1 decreased 5 percent, while Aspect 2 and Aspect 4 increased 10 and 4 percent respectively.

Table 4. Percentage distribution of the aspect of scientific literacy in the activity part of 7th grade

Aspect of Scientific Literacy			
The Knowledge of Science (%)	The Investigative nature of science (%)	Science as a way of knowing (%)	Interaction of science, technology and society (%)
4	66	0	30

DISCUSSION

Scientific literacy is seen one of the major goals of science education by many science educators, researchers, and governments (BouJaoude, 2002; Zembylas, 2002; Turkish Ministry of National Education, 2006). Countries should be ready to adopt themselves to the changes in science and technology and this depends on the individuals of the societies. If they are educated well to meet the today's technology and science requirements, their societies will be more powerful and developed. Thus the important point is the education of the individuals as much scientifically literate as possible. Herein, science classrooms are the key components to educate scientifically literate individuals for the future.

General objectives of both 6th and 7th grades of Turkish Science Curriculum in the unit of human body system were mostly focus on the knowledge of science aspect of scientific literacy while science as a way of knowing aspect was almost missing. This aspect, emphasizing thinking, reasoning, and reflection in the construction of scientific knowledge, should be integrated and stressed more to prepare potential of better scientifically literate students. Researchers should focus on to improve students' thinking, reasoning and reflections in science knowledge construction in science classrooms through classroom practices.

In the activity part of the curriculum, Aspect 2 (the investigative nature of science) was stressed overwhelmingly over other aspects. Similar to the general objective part of the curriculum Aspect 3 (science as a way of knowing) was nearly absent in this part. Curriculum developers and policymakers should also consider this shortcoming while making necessary changes for curriculum to meet the needs of better classroom practices.

As BouJaoude (2002) founded for Lebanese curriculum, there is similar inconsistency between general objective and activity part of the Turkish curriculum. General objective part is focusing more on Aspect 1, while activity part does the same for Aspect 2 part. To overcome this contradiction, two parts should be consistent in terms of aspects of scientific literacy.

To sum up, science research community should conduct studies to integrate all aspects of scientific literacy into the curriculum. Curriculum is vital component of science education, its objectives and activities should stress the scientific literacy more. Making necessary changes in science curriculum in terms of scientific literacy may result in the changes in classroom practices in science classrooms to yield scientifically literate citizens. By emphasizing all aspects of scientific literacy, the new science curriculum will better prepare potential scientifically literate citizens for more developed nation and more suited civilian toward rapid global changes, and will help the Turkish people equipped with the needs of both today's and tomorrow's world.

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Appendix

Scientific Literacy Framework*

Aspect of Scientific Literacy			
The Knowledge of Science (Aspect 1)	The Investigative nature of science (Aspect 2)	Science as a way of knowing (Aspect 3)	Interaction of science, technology and society (Aspect 4)
<ul style="list-style-type: none"> * Facts, concepts, principles, laws, hypotheses, theories, and models of science 	<ul style="list-style-type: none"> * Using methods and process of science such as observation, measuring, classifying, inferring, recording and analyzing data, communicating using a variety of means such as, writing speaking using graphs, tables, and charts, making calculations, and experimenting * Emphasis on hands-on minds-on science 	<ul style="list-style-type: none"> * Emphasizes thinking, reasoning, and reflection in the construction of scientific knowledge and the work of scientist * Empirical nature in science * Ensuring objectivity of science * Use of assumptions in science * Inductive and deductive reasoning * Cause and effect relationship * Relationship between evidence and proof * Role of self- examination in science * Describe how scientist experiment 	<ul style="list-style-type: none"> * Impact of science on society * Inter-relationship between science, society, and technology * Careers * Science related social issues * Personal use of science to make everyday decision, solve everyday problems, and improve one`s life * Science related moral and ethical issue

*Adapted from BouJaoude, S. (2002). Balance of scientific literacy themes in science curricula: The case of Lebanon. *International Journal of Science Education*, 24(2), 139-156.