

**QUANTITATIVE ANALYSIS of a SECONDARY SCHOOL
SCIENCE TEXTBOOK for SCIENTIFIC ITERACY THEMES**

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ÖZET

Kullanılan ders kitabının niteliği, fen öğretimini şekillendiren etkenler arasında yer almaktadır. Çeşitli araştırmalar; öğretmenlerin bir kısmının derste kullanılan ders kitabını bir müfredat programı gibi kabullenip, ders anlatımlarını kitabın genel yapısına ve içerdiği anlatım tekniklerine paralel olarak düzenlemekte olduklarını göstermektedir. Bu anlamda, kullanılan kitabın niteliği daha da önemli bir hale gelmektedir. Günümüz fen eğitiminin amacı öğrencilere bilimsel okur-yazar birey özelliklerinin kazandırılması olarak özetlenebilir. Ders kitaplarının da bu amaca hizmet etmesi gerekmektedir. Bu çalışma, bilimsel okur-yazarlığın alt boyutlarından olan; genel bilgi yapısıyla bilim; keşif yönüyle bilim; düşünme biçimi olarak bilim; toplum-bilim-teknoloji ilişkisi açısından bilim, boyutlarında odaklaşmaktadır. Çalışma; devlet okullarında 8. sınıf düzeyinde okutulmakta olan İlköğretim Fen Bilgisi Ders Kitabı 8 adlı kitabın, bilimsel okur-yazarlığın yukarıda sözü edilen dört alt boyutu açısından içerik analizini hedeflemekte ve bulguları ile fen bilgisi öğretmenlerine, fen programı geliştiren uzmanlara ve ders kitabı yazarlarına çalışmalarında ışık tutmayı amaçlamaktadır.

ANAHTAR KELİMELEER: Fen Bilgisi Ders Kitabı, Fen Bilgisi Eğitimi, Bilimsel Okur-Yazarlık

ABSTRACT

The quality of a textbook is one of the factors that shape up science instruction. Various studies indicate that some of the teachers accept the textbook as

a general curriculum and arrange their instruction according to the context of and teaching technique used in the textbook. Thus, the quality of these teaching aids becomes more important because, the goal of science education can be summarized as to armour students with the features of scientific literacy, and science textbooks should serve for this purpose. This study focuses on the four main themes of scientific literacy: Science as a body of knowledge; investigative nature of science; science as a way of thinking; the interaction of science, technology and society. The aim of the study is to analyze the content of a science textbook; named *Ilkogretim Fen Bilgisi 8*, according to four themes of scientific literacy, and to help science teachers, curriculum designers and textbook writers with its findings.

KEY WORDS: Science Textbooks, Science Education, Scientific Literacy

1. INTRODUCTION

In the educational literature, there are many definitions of scientific literacy. Shiland (1998) defined it as the ability to use commonly accepted theories in science to predict, to explain and understand the natural world. Obviously, this definition is not explanative enough in defining such a broad concept which concerns all the society by means of its qualitative and quantitative aspects. In a more explanatory definition; scientific literacy is seen to have "many facets". Those facets 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 the 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; and being able to use specific knowledge and ways of thinking for personal and social purposes. (Rutherford & Ahlgren, 1990, cited in Eisenhart, Finkel & Marion, 1996)

At this point, one strong aspect of scientific literacy shows itself. That is; it can be applied, with all those aspects mentioned above, both to teaching strategies (or, in general, pedagogical concerns) and textbooks .

Chiappetta, Fillman, and Sethna (1991a) suppose that science textbooks are frequently used to convey a great deal of information that students receive in science courses. They influence how science teachers organize the curriculum and how students perceive the scientific enterprise. In another study; Soong and Yager (1993) summarize the findings of some researchers and put this conclusion: the status of school science could be summarized with one word: textbooks. Ninety percent of all science teachers used their textbooks in excess of 90 % of the time. Yager & Soong (1993), then, continue with the explanation that students expected the textbook to be

used as the source of nearly all information and as the framework from which all science was to be experienced. Even parents accepted the textbook as central and expressed concern if textbooks were not issued and used for assignments.

In another study by Yager (1983, cited in Yore, 1991); he points out that "textbooks appear to imprison science teachers, dictating that most instructional objectives will be knowledge; that the instructional sequence will be assign, recite, test, and discuss test; that lecture, question, and answer will be the instructional mode; that virtually no direct experience will be provided students; and that laboratories, when used, are to be deductive verifications of the textbook. Furthermore, the heavy reliance on textbooks does not appear to produce scientifically and technologically literate graduates". Besides, this "over reliance on those teaching aids often results in an emphasis on terminology and vocabulary, and presents a false impression of the nature of science" (Chiappetta, et.al., 1991a).

These points were not stated to indicate that; teachers, students and parents rely extensively on science textbooks, and so, this situation should be prevented. No; these are just to reveal that; since this is the case in schools, the content of science textbooks should be improved and base more on the nature of scientific literacy. As Chiappetta, Fillman, and Sethna (1991a) point out, "in the process of making science as relevant as possible, these teaching aids must relate science to the everyday lives of students without compromising the integrity of the field of study. Science textbooks can be interesting to students and at the same time illustrate how science, technology and society are interrelated". Chemistry textbooks, on the other hand, can be treated in the same manner as well. Ruis (1988) states that; "chemistry textbooks often do an inadequate job of explaining important concepts and principles because of their superficial treatment of a subject matter... Science textbooks should convey science as more than knowledge about the world in which we live. They should incorporate the historical and human aspects of scientific discoveries, and they should make the reader more cognizant of the impact of science and technology on society". (cited in Chiappetta, et.al., 1991b).

These explanations, while stressing on the importance of scientific literacy, also underlie the four main themes of scientific literacy which all together are able to represent the nature of and philosophy behind scientific literacy. Those four dimensions of scientific literacy in analyzing a textbook were studied in a study by Chiappetta, Fillman, and Sethna (1993), and following four categories were discussed:

1. The knowledge of science

2. The investigative nature of science
3. Science as a way of thinking
4. Interaction of science, technology and society

These four categories will also be represented as the four main themes of scientific literacy in this study, and will be utilized in quantitatively analyzing the content of the science textbook named Fen Bilgisi 8 (Science 8) by Turkish Ministry of Education Board of Publication.

2. METHOD

In this study, one science textbook is selected to quantitatively analyze the content of a science textbook in terms of the four dimensions of scientific literacy. The book is prepared by Turkish Ministry of Education Board of Publication, and is studied in more than 90% of the public schools in Turkey.

Analysis is carried out by choosing three topics: One is from chemistry (Chemical Reactions); another is from physics (Induction); and the other is from biology (Cell and Cell Division). The total number of pages being analyzed covers 15% of the entire book, and it is more than suggested to make generalizations over the book content. According to a study by Garcia (1985); 5% of a book content is well enough to represent the textbook.

The instrument used in the study to analyze the content of the textbook was previously developed by Chiappetta. So, a total of 20 items were utilized after getting permission from Chiappetta through e-mail contact. Items and the format of the instrument are reorganized by the researcher in order to ease the analysis for the raters. Following examples represent typical items included in the instrument:

Item examples for category 1 (The knowledge of science):

How many facts, concepts, principles, and laws are being presented within the units of analysis?

How many times does it require students to recall knowledge or information within the units of analysis?"

Item examples for category 2 (The investigative nature of science):

How many times does it require students to answer a question through the use of charts, tables, etc.?

How many times does it require students to reason out an answer?

Item examples for category 3 (Science as a way of thinking):

How many times does it describe how a scientist experimented?

How many times does it give cause and effect relationship?

How many times does it present the scientific method and problem solving?

Item examples for category 4 (Interaction of science, technology and society):

How many times does it describe the usefulness of science and technology to society?

How many times does it discuss social issues related to science or technology?

The analysis is accomplished by the researcher and two science teachers both are experienced in and capable of identifying, comprehending, and analysing the terms of the study. In order to increase the reliability of the study; each teacher is given a manual (8 pages) before the analysis. The manual includes definitions of the terms, their explanations, and specific examples. It informs teachers about the process of the analysis and teaches in what ways the four categories and their subcategories differentiate from each other.

On the other hand, researcher established some 'units of analysis' to enable raters do the analysis in the most appropriate and uniform way. Those 'units of analysis' (including paragraphs, tables, figures, and questions, but review and goal parts were disregarded) were numbered consecutively. Raters, then, filled out a data sheet accomodating numbers for each units of analysis to be analyzed and the twenty items forming the subcategories of the four themes of scientific literacy. Having analyzed the units, each rater separately matched one unit with just one of the twenty items in data sheet.

At the end of the analysis, codings from each rater were compared, and their choices were evaluated. Then, total number of exact matches were determined, and a percent agreement were calculated among the raters. As a next step; in order to test the reliability of the analysis, Cohen's Kappa value were calculated by substituting the percent agreement into a certain formula. This value ranging from 0 to 1 gives evidence for inter-rater reliability and a value near 1 indicates high reliability between the scorers.

3. DATA ANALYSIS and RESULTS

By comparing the evaluations of the scorers the four themes of scientific literacy were quantitatively expressed in percentages. Average of scores indicate that; first theme of scientific literacy (the knowledge of science) was represented as 65% in selected units; the second (the investigative nature of science) was 17%; the third (Science as a way of thinking) was 5%; and the fourth was 13%. (See table 1).

Table 1. The Inclusion of Four Themes of Scientific Literacy in the Textbook, by percentages

1 st theme	The knowledge of science	% 65
2 nd theme	The investigative nature of science	% 17
3 rd theme	Science as a way of thinking	% 5
4 th theme	Interaction of science, technology and society	% 13

There were twenty items in the instrument. Of those; three were belonging to 'The knowledge of science'; five of them to 'The investigative nature of science'; eight of them to 'Science as a way of thinking'; and the remaining four to 'Interaction of science, technology and society'. Representing the four main category with twenty items was aiming to increase the reliability among the scorers. In the topics selected for the analysis, the researcher have identified 238 'units of analysis' and results from their scorings indicated that they were in 70.6% agreement which meant that 168 units were rated exactly the same. After substituting this percent into a formula; Cohen's Kappa value were calculated and found out to be 0.61. This result is also another evidence for the reliability.

4. EVALUATION

Generally speaking, the study stresses on some evaluations by means of its outcomes:

1. It is seen that the first theme of scientific literacy (the knowledge of science; 65%) is predominant over other three domains (the investigative nature of science, 17%; science as a way of thinking, 5%; and interaction of science, technology and society, 13%). This theme represents the body of scientific knowledge. However, this aspect of science just transmits knowledge to students. It presents concepts, facts, theories, laws, models, and expects them to recall information. As similar studies show this tendency gives a false impression of science and negatively effects students' perceptions towards the nature of science. On the other hand, since the teachers are mainly arranging their curriculum and instruction according to the content of the textbook, an overemphasis on this first theme of scientific literacy tells more about what kind of a learning environment students are involved in. So other three aspects of scientific literacy should be promoted and reflected in textbooks.
2. It is essential that other three dimensions of scientific literacy should be paid more attention to develop remarkable positive attitudes towards the

nature of science. Of these three: “the investigative nature of science” encourages students to investigate and give the impression that science is not an endeavour which only transmits some pieces of knowledge. The third theme (Science as a way of thinking) concentrates mainly on how scientists conduct researches, how scientific knowledge arouses and develops, objectivity in science, cause-effect relationships, problem solving and so forth. The last theme (Interaction of science, technology and society), on the other hand, attracts pupils attention and curiosity to the organic relationship among science, technology and society. Besides, while pointing out the harmful and useful aspects of science, it discusses societal issues.

3. As it is already known, conveying a great deal of knowledge, and setting the objectives of science instruction around this tendency are one of the most problematic issues in our Turkish educational system. Moreover, inclusion of other three aspects of scientific literacy more in textbooks will inevitably increase the quality in instruction.
4. In this sense; science textbook writers should take the four themes of scientific literacy into consideration altogether. This consciousness will produce more valuable results in the short and long run.
5. Finally, this study pinpoints the necessity for further research and alternative ways of analyzing the contents of science textbooks in terms of all themes of scientific literacy. Obviously, more research should be conducted on more textbooks to increase the quality of our teaching aids, and in turn to increase that of our science education.

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