

## Underlining the Problems in Biology Textbook for 10th Grades in High School Education Using the Suggestions of Practicing Teachers

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### ABSTRACT

This study aims to analyze the biology textbook for 10th grades prepared by the Ministry of National Education in Turkey. The present research is based on qualitative research techniques and includes two steps. In the first step, the textbook misconceptions, question types, contents topics, visual materials and measurement and evaluation techniques are investigated. In the second step, the learning approach of the textbook is evaluated by five senior class practicing teachers. The results indicate that the biology textbook contains important misconceptions which can affect learning. As no different types of questions are used, the textbook cannot provide the inquiry according to its questioning techniques. Besides these, it is emphasized by the practicing teachers that the textbook encourages students to memorize and that it should be revised accordingly. In the light of these results practicing teachers need to learn the criteria as to how a textbook must be analyzed and the points to be observed in choosing a textbook.

**Keywords:** Problems of Biology Textbook; Misconceptions; Learning Approach; Questioning Techniques; Biology Education.

### INTRODUCTION

The educational-instructional process in formal education is planned and this process is pursued by following instructional programs that could occasionally change depending on the needs. Besides, throughout this process, textbooks designed exclusively for each subject matter course are used. Instructional programs and textbook analysis are popular fields of research both in Turkey and abroad. In Turkey, the instructional programs and textbooks in courses like Social Studies, Science and Technology offer materials for research as their instructional programs were reconstructed at elementary school level in 2005. While examining instructional programs and textbooks, various topics are emphasized like misconceptions, content of the textbooks, its alignment with the constructivist approach and the measurement –assessment techniques claimed to be projected on the instructional programs after the changes in 2005. For instance, having examined the draft curriculum of the 6th grade science and technology, Taşkın, Apaydın and Çobanoğlu (2005) found that the nature of science is disregarded and alternative measurement techniques are not utilized, and that the program does not sufficiently align

with the constructivist approach. A hundred thirty six practicing teachers and 32 teachers assessed Science and Technology Textbook for 6, 7 and 8 grade students and reported that the scientific content of the book and the evaluation strategies in the book was not appropriate (Atıcı, Samancı & Özel, 2007). On the other hand, it was reported that the textbook was effective in encouraging the students to make research, to actively participate in the course. Moreover, the language and sentence structure used in the book was reported to be appropriate for the levels of the students (Atıcı, Samancı & Özel, 2007). There are numerous studies carried out on instructional programs and textbooks at elementary school level (Kabadere, 2003; Ünsal & Güneş, 2003a; 2003b; Çepni, Ayvacı & Keleş, 2001). The issues encountered in the textbooks at elementary school level have served for the opportunity to examine 10th grade biology textbook in order to determine the criteria that the elementary level textbooks meet and the issues faced in these studies carried out at elementary school level.

National and international literature contains many studies on the analysis of biology textbooks. Textbooks play an important role in effective biology education and they are fundamental sources of information in terms of the notions of evolution and ecology in addition to basic biological concepts, scientific research process and experimental activities (NRC (National Research Council), 1996; 1997; Haury, 2000). Textbooks are widely used in biology education (Kuechle, 1995). The studies that were conducted abroad indicate that 90% of the teachers actively use textbooks as their main instructional tool and to assign homework (Stake & Easley, 1978; Blystone, 1989). In Turkey, textbooks are used for various reasons like reference sources and assignments as well (Özay & Hasenekoğlu, 2007). According to Kuechle (1995), if a textbook is the main source of information and order of content at biology lessons, then it should meet the needs of teachers and students. Teachers find it logical to follow the textbooks to make sure that the students learn all the content areas (Kuechle, 1995). However, it was found that students have difficulties to relate the concepts covered in the textbooks with their lives or students' background knowledge is not in line with the new concepts so these textbooks do not encourage students to do research (Leonard & Chandler, 2003). Recent studies carried out on this subject in Turkey indicate that in many schools in Turkey only encyclopedic information is given to the students and that research-based student-oriented teaching methods which develop social skills of the students are not applied (Ekici, 1996; Akaydın & Soran, 1998, Işık & Soran, 2000).

National and international literature contains many studies on the problems encountered in biology textbooks. By examining 17 biology textbooks, Jablon (1992) indicated that these textbooks are explicitly alike. Jablon further stated that although these textbooks cover scientific process skills, and accurate claims about topics like Science-Technology-Society and collaborative learning, they do not completely integrate those strategies; so the experimental activities appear to be like a "cook book" and they do not allow the students to do active research. From another perspective, Gottfried & Kyle (1992) indicated that those textbook-oriented teachers are very dependent on the content of the textbooks; that they do not focus on topics like Science-Technology-Society, personal needs and career sensitivity and that they do not spend time on any of these topics; therefore, the central role that the textbooks claim in the educational process prevents the effective science education from reaching the desired level. Lumpe & Scharmann (1991) emphasize that while the experimental activities common in biology textbooks provide students with such opportunities as manipulating the devices, developing observational skills, the close-ended and rigidly structured activities constrain students' development of higher degree-level of scientific thinking skills such as discussion, setting hypothesis and forming their own inquiry. In biology textbooks, such

phenomena as scientific thinking and the nature of science do not take a major role and these subject matters are not well integrated into the other chapters and topics (Gibbs & Lawson, 1992; Taşkın et al, 2005). Moreover, it is also asserted that the relationship represented in the textbooks between hypothesis, theory and law is inaccurate (Gibbs & Lawson, 1992; Taşkın et al, 2005). Brandwein (1981) claims that specific term in the textbooks serve as a motivating factor in biology education. Besides, Chaing-Soong & Yager (1992) state that the students can not perceive and acquire those specialized specific terms used in biology textbooks. Analyzing the concept of ecology in 12 most preferred biology textbooks, Kuechle (1995) has concluded that the topics related to ecology and environmental principles appear in the last sections of these textbooks. Gibson (1996) claims that there are misconceptions on the concept of “*climax*” by examining various different ecology-oriented textbooks. In analyzed textbooks, the concept of climax is defined as the last and stable phase of the succession; however, it is not mentioned that succession does not always result in climax. Özay & Hasenekoğlu (2007) pointed to the issues observed in the visual materials found in 3 high school textbooks and concluded that the visual materials make it difficult for students to comprehend as they are not clear and comprehensible and the visual presentations do not induce a process of action and logic. Likewise, Kearsy & Sheila (1999) emphasize that there are misconceptions about the visual components. Misconceptions in the section of “Basic Unit of Life-The Cell” covered in 9th grade biology textbook which was recommended by the Ministry of Education were analyzed. As a result of this analysis 14 misconceptions and 10 missing pieces of information were detected (Dikmenli & Çardak, 2004). Some of the misconceptions detected in the analysis of Dikmenli and Çardak included: “*Only plant cells have plastids organelles*” “*One chromosome consists of two chromatists*” “*Meiosis starts in the period of adolescence and continues throughout the adulthood*”. Strangely, it is thought that the misconceptions of high school students are mainly caused by textbooks (Dikmenli & Çardak, 2004).

The goals of biology education include individuals’ perceptions about nature of science, scientific literacy, comprehension and application of the scientific research process (NRC, 1989). Fundamental regulations like Project 2061 (AAAS, 1989) and National Science Education Standards (NRC, 1996) explain the main points in science education as follows: (1) students should comprehend the nature of science and scientific research process while participating higher cognitive level activities, (2) the concept of science should be expanded to broad themes and students should acquire a few key science terms in depth rather than superficially learning the terms that are not so essential, (3) students should understand the fundamentals of science composed of the historical trends and social aspects of the scientific enterprise; (4) students should comprehend the meaning of the relationship between science, technology and society (Lumpe & Beck, 1996).

The main step to be taken to lead the biology education up to the demanded level is to stress the importance of the textbooks in the instructional process (Lumpe & Beck, 1996). In order to reshape high school level biology instruction, it is emphasized that the role of the textbook used during instruction should be analyzed (Bybee, 1989). Since textbooks constitute one of the main components to provide appropriate application of the biology education, questions as to what criteria the textbooks should represent and how they should be designed, selected and used are constantly raised. On the basis of these questions, this study presents the analysis of biology textbook (Ministry of National Education- MEB, 2007) designed for 10th grade elementary level.

The fact that important misconceptions are observed while examining the 10th grade biology textbook proves the significance of this study. This study focuses on various

different points like systematic chapter and topic distribution, questioning techniques, the approach taken by the textbook towards learning, the textbook's alignment with the nature of science, table of contents, visual materials, references used and measurement-assessment. Moreover, it discusses the approach pursued by 10th grade textbook towards learning and its relevance to biology instruction as far as the reconstruction of the educational programs designed at both the elementary and high school levels is concerned.

In light of the points mentioned above, the principle purpose of this study is to:

- a) Determine the common misconceptions in the textbook,
- b) Discuss the appropriateness of the questioning techniques and,
- c) Examine the particular textbook according to its instructional approach.

Given this goal, the biology textbook was reviewed in great detail at page and chapter level and content analysis was conducted. At the same time, the criteria identified by National Research Council (NRC, 1990, pp. 28-29) were considered to a significant extent. The criteria to be taken into account while examining the Biology textbook are clearly mentioned:

- “(1) Adequate but not encyclopedic content  
 (2) Factual accuracy,  
 (3) Incorporation of current conceptual understanding and new subject matter,  
 (4) Logical coherence,  
 (5) Clarity in explanation and effectiveness of illustrations,  
 (6) Appropriateness to students' level and interest,  
 (7) Representation of biology as an experimental subject.”*

This study differs from other studies in that it examines the concerning textbook in great detail and bases its examination on the criteria set by such a prominent institution like National Research Council. The current study bears significance as it is the first one that presents this type of examination.

## **METHODOLOGY**

### **a) Research Design**

This is a qualitative study composed of two stages. The first section of the study analyzes 10th grade Biology textbook published by the Ministry of National Education (Yıldırım & Şimşek, 2005). In doing so, the textbook was intensely read. The misconceptions, question types, content, visual materials and measurement-assessment techniques that appear on the textbook were evaluated. Hereby, the accurate definitions as opposed to misconceptions, alternative question types were systematized and recommended by the researchers. As for the second section, one-to-one interviews were conducted. The participants of this study were 5 practicing teachers who attended biology teacher education programs and who closely followed the subject biology textbook. The participants made recommendations on the textbook's approach towards learning, its readability, reliability, and all the other criteria as mentioned above. Moreover, the textbook's alignment with the nature of science and its usability in instructional processes was questioned with the participation of the practicing teachers. Interviews lasted for 30 to 40 minutes (Merriam, 1998).

### **b) Data Collection and Analysis**

The textbook used in the first section of the study was the data collection tool of the study. During the analysis of the textbook, document analysis technique was used

(Yıldırım & Şimşek, 2005) and data analysis was supported by content analysis technique (Merriam, 1998). Document analysis technique was supported by interview, so the research method and data collection technique serve the purpose of data triangulation and increase the validity of research (Yıldırım & Şimşek, 2005, p.188). The data gathered was explained and interpreted by using content analysis, and the analysis technique provided the detailed reading of data. The subject textbook was agreed to be a textbook by the decision of “*Ministry of Education, Talim ve Terbiye Kurulu (Turkish Education Board) decision no 148 dated 23.05.2003. 220.000 copies were published in the second publication of the textbook in accordance with the certification of Yayınlar Dairesi Başkanlığı, (Authority of Publications Department) decision numbered and dated 11.05.2007*”. Biology textbook 10<sup>th</sup> grade, which contained 150 pages, was written by a committee. The data was evaluated by reading and reviewing the book thoroughly. Each sentence in the texts in sections was analyzed in terms of semantics.

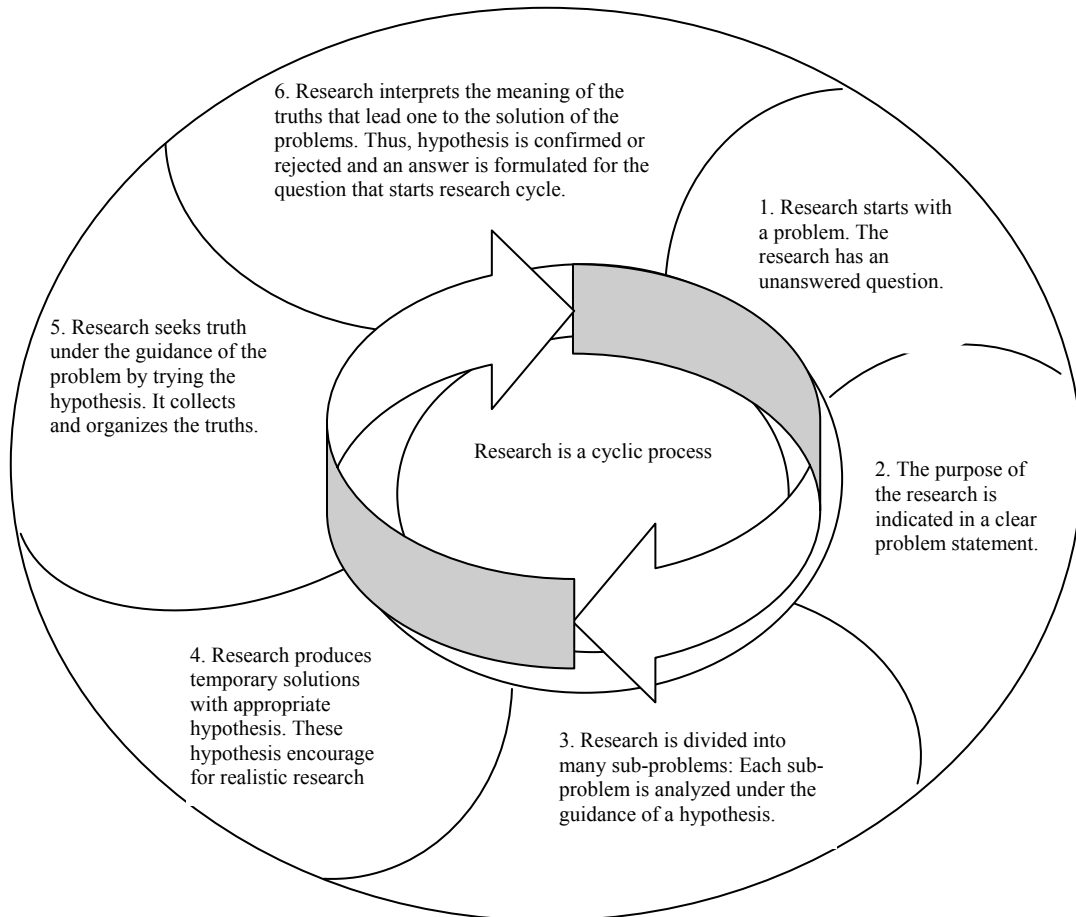
In the second section of the study, the views and recommendations of practicing teachers were taken through interview technique. The data obtained from the second section was interpreted by content analysis technique.

## FINDINGS AND DISCUSSION

The findings of the study are as follows:

### A) *First Stage: The document analysis of the 10th grade biology textbook*

**Subject Matter Content:** Content details and distribution are shown in Table 1. As the content is separated, the relationship among the chapters is disregarded. The order of the subject matters handled in the book lacks holistic approach. For instance, the close relationship between the section on “Opinions on the birth of life” and the “Ecology” is not examined. Subject matter contents are not sufficient. Further to the examples, such contents within the chapter of “Ecology” as “Life unions in Biosphere” and “life unions inland and in water” are just mentioned by the title (p. 45). Moreover, the following statement used within the same chapter “*terrestrial and in water life unions within the biosphere contain population, community and ecosystem*” causes both misconceptions and conceptual confusion (p. 45). Primarily, the unions of land and water life elements are already an ecosystem and community in the biosphere (Kışlalıoğlu & Berkes, 2003; Yıldız, Sipahioğlu & Yılmaz, 2000). Population, community and ecosystem are parts of the ecosphere while constituting the field of study (Kışlalıoğlu & Berkes, 2003; Yıldız et al, 2000). There are other similar examples in the textbook. Again, the chapters on “Reproduction” and “Development and Growth” were presented without building any mutual relationship. Important deficiencies and misconceptions were detected in the first section of the textbook “Biology as a Science” (see Misconceptions). Scientific research steps in the subject section were missing and misstated. The scientific research steps in the textbook were stated as follows (p.15); A. Determination of the problem. B. Seeking Solution Methods “Introducing hypothesis”, C. Setting-Up and Checking of Experiments and drawing conclusions” F. “Theory and Law”. In this list of scientific research steps, titles such as controlled experiment and measurement pointed out only quantitative research, showing a positivist approach. However, this approach contradicts with qualitative research, which is another research method (Yıldırım & Şimşek, 2005, p.60), in addition, the importance of research processes was not pointed out and the fact that research is a cycle was not emphasized. Figure 1 indicates scientific research steps.



**Figure 1.** *Scientific research process steps* (Leedy, 1989, cited from Taşkın, 2008, p.210)

Another section “Behavior of Living Things” contained only encyclopedic information and gave only limited examples from real life. The sections in the textbook, the examples from which were given above, are far from daily life, prevent scientific literacy and limit the application of science in daily life.

Principles ordering the content and chapters from simple to complex, from concrete to abstract and from familiar to distant were not taken into consideration.

**Table 1.** *Subject matter content of the textbook and subject matter distribution*

Chapters	Subject Matter Distribution
<b>1: Biology as a Science</b>	What is the Science?, Characteristics of the Scientists, Scientific Method “Learn to Think and Search”, Nature of Biology, History of Biology, Sub-disciplines of Biology, Application Areas of Biology, Relationship between Biology and other Disciplines, Laboratory Studies
<b>2: Ecology “World and Living Things”</b>	Living Things and Environment, Biotic and Abiotic Elements of Environment, Nutrient Cycles, Life Unions on Biosphere, Environment Pollution, Environment Protection
<b>3: Behavior of Living Things</b>	Definition and Mechanism of Behavior, Natural Behaviors of Animals, Acquired Behaviors, Synchronizer (Biological Clock), Social Behaviors
<b>4: Ideas on the Birth of Life</b>	Ideas on the Birth of Life, Ideas on Evolution
<b>5: Reproduction</b>	Asexual Reproduction, Sexual Reproduction, Sexual Reproduction on Flowering Plants, Fertilization on Animals, Reproduction System of Men, Health of Reproduction System
<b>6: Development and Growth</b>	Development and Growth of Plants, Elements that effect the Growth of Plants, Development and Growth of Animals, Abnormal of Growth, Specific Growth Phases of Multicellular, Cell and Tissue Cultures, Tissue and Organ Transplantation, Length of Life of Living Things

When the content of textbook shown in Table 1 was analyzed in terms of sections, it was found that it is easy to establish relationships between the sections and to write a textbook in a manner that is appropriate to the nature of the science. However, this was ignored in the textbook and an encyclopedia-like approach adopted in the subject book.

**Visual Materials:** The pictures are mostly drawn; for instance, there are not many real pictures of the scientists or animals and plants in the nature (pp. 14, 20, 80). The print quality of the visuals is low. Important incompatibilities between the visual elements and the text are observed (Figure 2).



What was named as “Monocotyledon and dicotyledonous plants” seed structures and the comparison of these structures” was stated as embryonic stem and body within the text (p. 112).

**Figure 2.** Incompatibility between the visual material and the text

Most of the visual elements make it difficult for the students to learn (Figure 3).



The picture intends to show “geothermal energy source”. However, the fact that the print of the picture is bad and there is incompatibility between the text and visual causes difficulties in comprehension the concept (p. 50).

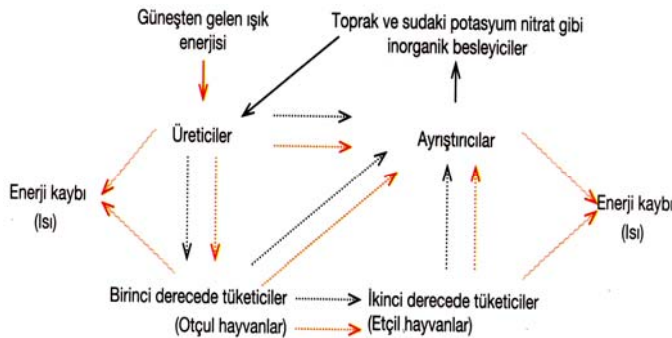
**Figure 3.** Difficulties in perception on the visuals

The photographs and pictures especially in first pages of sections are interesting. Figure 4 shows the photograph at first page of the section “Biology as a Science”.



**Figure 4.** An interesting picture from the book

Figure 5 indicates Energy flow and food cycle (The black arrows indicate material flow, the red arrows indicate energy flow). The indication of two different events on the same chart can make comprehension difficult.



In addition, the fact that energy flow is not a cycle can not be understood from the figure. In addition, it is impossible to understand from the figure that material cycle is a closed cycle.

**Figure 5.** A visual item that is hard to comprehend.



The figure indicates carbon and oxygen cycle. The phenomenon such as “Flora, respiration, organic matter, bottom sediment” can not be clearly seen. In addition, the figure only indicated the addition of carbon to the nature but the consumption of carbon in the nature by various methods is not indicated (Figure 6).

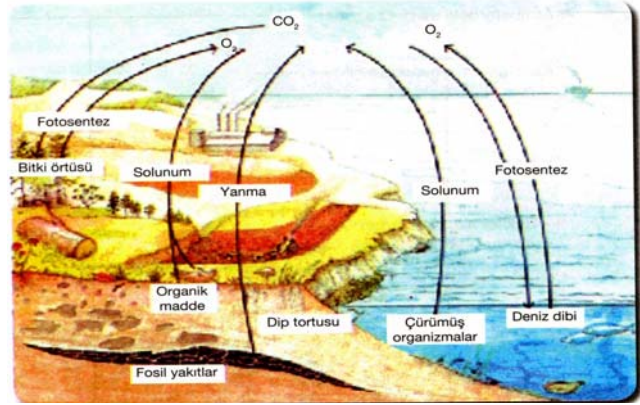


Figure 6. Unclear visual item

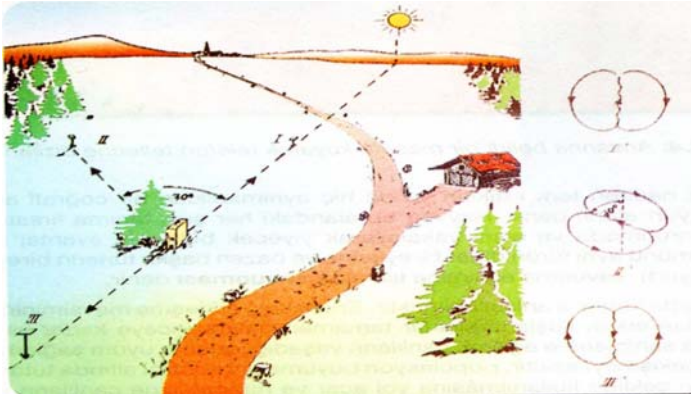


Figure 7. Disorganized visual item

The visual image which tries to indicate the navigation of bees (swinging and waggle dance). Inappropriate organization of the picture may cause problems (Figure 7).

**Misconceptions:** Considering the relationship of the biology discipline with other areas of science, the number of the concepts in the textbook is not sufficient. The textbook provides encyclopedic definitions of the concepts, and conceptual instruction is disregarded. Moreover, the terms were presented one after another without much explication. The textbook lacks models like a concept map showing the relationships amongst the terms but there are simple schemes (pp. 22, 91). In addition to these, there are misconceptions along with insufficient information which could influence learning. For instance, while presenting the scientific research stages, some of the stages in scientific research were not defined while the names of some others were modified (p. 15). Likewise, while defining the nitrogen cycle, nitrogen fixation was not mentioned (p. 48). We face crucial misconceptions apart from insufficient information. Importantly, the relationship between the theory and the law that constitutes the nature of science was misrepresented (p. 17). Moreover, it is implied that the environment and ecosystem have the same definitions by misrepresenting the concepts like environment and ecosystem (p. 36). The common misconceptions in the textbook are shown in Table 2.

Another example showing misconceptions is that in hormonal control subject in reproduction section of the textbook, anterior hypophysis concept was used in the explanation of the control of pituitary gland on female and male reproduction system (p.102). Hypophysis gland consists of anterior lobe and posterior lobe. Using the term “anterior lobe” would be more appropriate than the term “anterior hypophysis”. The fact



that only the term “anterior hypophysis” is used in the subject causes missing information. This can make the students unable to understand the subject.

Another explanation that may cause an important misconception is about feedback mechanism. The explanation in the textbook reads (p.103): “*Estrogen, which is and ovary secretion temporarily slow down the function of pituitary gland. While releasing factor of hypothalamus is effective on the function of hypophysis gland, the hypophysis gland has no effect on hypothalamus. However, pituitary hormones regulate the function of the uterus and ovary hormones regulate the function of the hypophysis. The reciprocal interaction between the glands is called feedback*” (p. 103). The explanation did not include the maintenance of homeostasis which is the reason of the feedback. The explanation above can be corrected as follows: “*After fertilization, hypophysis anterior lob hormones affecting the ovary are inhibited by estrogen hormone that is secreted from the ovary. This is required for the development of uterus wall. This internal balance, namely homeostatic in the body is achieved through feedback mechanism.*” Consequently “*The function of the regulator in the feedback system is to prevent inappropriate changes, thus making it possible to revert to the initial condition. This is a negative feedback system, because the response of the regulator is to reject the stimuli. Many homeostatic mechanisms in the body involve negative feedback systems. If some conditions change in such a way to go far beyond the actual status (extremely high or low) the control system uses negative feedback system for reverting these conditions to their initial status. Body temperature, glucose regulation in the blood and many other metabolic functions are regulated by negative feedback.*”

**Table 2.** Example cases concerning misconceptions prevalent in the textbook

Chapters	Misconceptions	Recommended Definition
1	<p><b>Theory:</b> Theory is a hypothesis that is constantly supported by evidences (s.17).</p> <p><b>Law:</b> When a theory has been merged a universal characteristic and scientific facts, it becomes a law (s.17).</p>	<p><b>Theory:</b> “A collection of general propositions that when taken together in an attempt to explain a class of related phenomena (Lawson, 1995)”.</p> <p><b>Law:</b> “A general proposition that summarizes a pattern of regularity detected in nature-that is, the manner or order in which a set of natural phenomena occur under certain conditions (Lawson, 1995)”.</p>
2	<p><b>Environment:</b> Environment is an outdoor place that people and other living things carry on their lives (s.36).</p> <p><b>Ecosystem:</b> In nature living things lived in a certain area and their relationships with all biotic and abiotic elements compose an ecosystem (s.47).</p>	<p><b>Environment:</b> “All external conditions and factors, living and non-living (chemicals and energy), that affect an organism or other specified system during its lifetime (Miller, 1992)”.</p> <p><b>Ecosystem:</b> “An ecosystem is a complex of producers, consumers, decomposers, and detritivores and the physical environment, interacting through energy flow and materials cycling (Starr and Taggart, 1992)”.</p>
3	<p><b>Reflex:</b> Reflex is sudden and constant reactions in response to effect (action) that has been seen on living things (s.66).</p> <p><b>Stimulus:</b> An exchange that occur indoor or outdoor, cause a change that is seen on living things (s.64).</p>	<p><b>Reflex:</b> “A simple, stereotyped, and repeatable movement elicited by a sensory stimulus (Starr and Taggart, 1992)”.</p> <p><b>Stimulus:</b> “A specific form of energy, such as light, heat, and mechanical pressure that the body can detect through sensory receptors (Starr and Taggart, 1992)”.</p>

Table 2. Continued...

4	Darwin's hypothesis of <b>natural selection</b> which tries to explain how a new species develop from previous species (s.82).	Firstly, <b>natural selection is a phrase, not a hypothesis</b> (Lawson, 1995). " <b>Natural selection</b> happens when some individuals in a population survive and reproduce more successfully than others because of their inherited traits (Cartwright et al, 2000)".
5	<b>Vagina:</b> Vagina is a vestibule that unfertilized ovum discharged (s.99)	<b>Vagina:</b> "Part of a female reproductive system that receives sperm, forms part of the birth canal, channels menstrual flow to the exterior (Starr and Taggart, 1992)".
6	<b>Placenta:</b> Villuses and womb wall tissues constitute placenta. (s.123).	<b>Placenta:</b> "Of a uterus, an organ composed of material tissues and extra embryonic membranes (chorion especially), delivers nutrients to and carries away wastes from embryo (Starr & Taggart, 1992)".

**Question Types:** There are no definite and systematic question types in the textbook. The questions are given under the titles "measurement and test" at the end of each chapter. Majority of the questions within the measurement sections are one-dimensional and the number of why/how questions and multidimensional questions is limited. In the test section, there are multiple choice questions. Generally, there are content knowledge questions that do not inquire the cause-effect relationships and the answers to the questions could easily be found throughout the chapters. This constitutes a problem as it might not allow the students to consult other reference sources. The number of questions at the chapter level is shown in Table 4. As can be seen in the table, there are sufficient questions in the textbook but these questions primarily aim to measure and assess learning at the end of each chapter. There were only a limited number of questions in the text. Moreover, there is no logical order among the questions. Major instructional models like Bloom's Taxonomy (Bloom, 1984) were not utilized. Some of the questions are shown in Table 3.

Table 3. Examples for the common question types in the textbook (taken from evaluation sections)

Chapters	One-dimensional Questions	Multidimensional Questions
1	What are the study areas of molecular biology? What is the biology sub-discipline that researches the environmental factors on living things?	What kind of a relationship is there between hypothesis, theory and law? Try to solve a problem by using scientific method steps.
2	What is the difference between mutualism and commensalisms? What are the functions of nitrification bacteria?	What would happen if all of decomposers in an ecosystem disappear? Why does the energy decrease passing upper steps in an energy pyramid?
3	What are the natural behaviors of living things? What is the study area of ethology?	Why do colour detection of a bee and man show a difference? What is the advantage of own survival land of a living thing?
4	What is the idea of Aristo on active principle? What is the result of Weismann's experiment?	Explain ideas of Darwin on evolution. What is the advantage of adaptation on living things?
5	How many sexual reproductions are there? What are the functions of stamen?	Why do fishes spawn lots of egg one a time? Explain the advantage of sexual reproduction versus asexual reproduction.
6	What are the hormones that effect plant development? What are the functions of placenta?	Why do plants gravitate towards the sun light? What are the development differences between monocotyledon and dicotyledonous plants?

**Table 4.** *Quantitative characteristics for some elements examined in the textbook*

Quantity Characteristics		Chapters					
		1	2	3	4	5	6
Question Types	Number of Activities	4	2	-	-	4	4
	Number of Questions	29	29	23	26	32	40
	Number of Why/How Questions	5	7	2	3	3	15
	Number of One-dimensional Questions	24	22	21	23	29	5
	Number of Concepts	15	60	20	16	75	51
	Number of Misconceptions	5	20	3	3	3	4
	Number of Visual Materials	19	7	7	8	26	24
	Number of Measurement Assessment Techniques	2	2	2	2	2	2

**Measurement-Assessment Techniques:** As mentioned above, single model testing techniques are used. These techniques are given under the title “measurement and test.”

**Design of the Activity:** In the textbook, there are close ended activities that identify the necessary steps to be followed in the experiments as structurally bulleted, and that discourage students to make research and the consequences of which can be predicted. Mostly there are mechanical activities. They are not closely aligned with the nature of science. Although there are stages like identification of the problem, the students are not given the opportunity to identify the problems all by themselves. Stating the goal right upfront in activities takes away all the curiosity and feelings of uncertainty towards scientific inquiry.

**Learning Approach:** The textbook relies on teacher-centered learning. Learning theories were not fully employed and neither behavior-oriented nor process-oriented instruction was presented. Specially, “the nature of science” was stated, however, it is incomplete and inaccurate, and the nature of science is insufficient in application.

**Nature of Science:** As stated above, the statements related with the nature of science are baseless. The scientific research processes are disregarded even in the experimental activities.

### **B) The textbook evaluation according to the NRC (1990) criteria**

**(1) Adequate but not encyclopedic coverage:** The textbook was written in an encyclopedic fashion and so excerpts from the daily life, analogies, daily biologic studies and examples from natural life were not employed. Although there is a great deal of information transfer, it is open to discussion as to what the function of this information is due to such causes as the lack of inquiry and research techniques. It is contended that inquiry techniques, open ended experiment and conceptual pattern will both drift the content apart from the encyclopedic approach and will construct a more meaningful presentation. As emphasized earlier, constructing alignment and relationships among textbook chapters, themes and concepts will facilitate learning as well.

**(2) Factual accuracy:** As encyclopedic information transfer is dominant throughout the textbook, especially the scientific information is based on the realities. However, due to misconceptions and lack of citations or references, the reliability of the textbook is adversely affected.

**(3) Incorporation of current conceptual understanding and new subject matter:** The fact that there is no holistic approach displayed causes the concepts, terms and chapters to look fractured into separate pieces. Since conceptual maps that show the relationships among the concepts are not employed, concepts acquired earlier and the new concepts are not meaningfully connected to one another.

**(4) Logical coherence:** There are some logical mistakes in the textbook. For instance, while defining the concept of “succession”, the definition was incomplete; the primary and secondary succession concepts are not defined at all. Succession was implied to be secondary succession. Likewise, the phases of primary succession are not presented; the logical pattern of the succession phenomenon is ignored (p. 47).

**(5) Clarity in explanation and effectiveness of illustrations:** As mentioned earlier, the print quality of the visual elements is low, is insufficient in projecting the reality (Figure 2) and is not compatible with the text (Figure 1).

**(6) Appropriateness to students' level and interest:** Considering the approach taken by the textbook towards learning, information transfer and readability, it is incompatible with students' levels and interests. Since there are no inquiry techniques and applications of the daily happenings, students' curiosity is not aroused and instruction that is grounded in research does not take place.

**(7) Representation of biology as an experimental subject:** When the chapters are considered, biology is explained only at a theoretical level.

### **C) Second Stage: Practicing Teachers' Opinions**

Practicing Teachers' views can be analyzed under four themes.

**Physical Condition of the Textbook:** Practicing teachers expressed that the number of pages in the textbook is insufficient. They also mentioned that the print quality is low, discolor and could easily be eroded.

**Learning Approach:** Participants emphasized that the textbook is encouraged by memorization and the teachers could use it as a reference book. At the same time, they think that the textbook is not designed according to any of the learning theories and so does not lead to durable learning.

**Content Arrangement:** Participants who declared that the content distribution is not systematized and is fractured into piece also said that the relationships among the concepts are weak and also there is no content integrity. Practicing teachers who think that the activities are few and that the content is not based on research constructively criticized the preparatory work given at the beginning of the teacher education program and the evaluation questions presented at the end of their training program. Besides, they drew attention to the accumulation of the texts and insufficiency of the visual materials. They added that there might be misconceptions.

**Readability (textbook's language) and Reliability:** Participants mentioned that some of the sentences may not be comprehended reporting that the readability of the textbook is weak. For this reason, they do not find the textbook to be reliable but still find it appropriate for the central authority to publish it.

## CONCLUSION AND SUGGESTIONS

In the light of findings given above, it is seen clearly that during preparation of the biology textbook, national standards of science education (NRC, 1996) were disregarded. The textbook is weak and inadequate as it lacks scientific research processes and questioning techniques. Then, the misconceptions in the textbook make this situation even worse. In addition to these results, visual materials are inappropriate and don't serve the goals of topics. The mechanic activities and measurement-assessment techniques are not diverse. So, it is clear that the textbook does not serve to meet the needs of teachers, students, and even instruction. As a consequence, since the nature of science and questioning are altogether disregarded, it is designed in an inadequate manner. Lack of the usage of major learning approaches results in useless description and interpretation which is far away from investigation. The quotation from popular science magazines shows that the references used in the book are far from scientific manner. Moreover, the ideas of practicing teachers' supports the results of the study and this makes clear that the textbook should be revised and prepared according to the national standards of science education. The studies indicated the similarity between the misconceptions in textbooks and the students' misconceptions point out that these misconceptions are acquired by the textbooks (Dikmenli & Çardak, 2004; Yakışan, Selvi & Yörük, 2007; Tekkaya, Çapa & Yılmaz, 2000). In addition, practicing teachers should be encouraged to follow the studies carried out for analyzing the textbooks.

The fact the sections covered in the textbooks are quite interrelated leads to misconceptions. The failure of accurately relating the subjects with each other can make comprehension of important concepts difficult. Thus, the textbooks should be re-assessed from this aspect and cohesion should be achieved between the subjects. During the elimination of misconceptions, different teaching methods should be used. Concept maps and conceptual change methods are effective teaching methods for the elimination of misconceptions (Yılmaz, 1998). Concept maps explain the concepts and the relationships between the concepts in an organized manner and supports meaningful learning (Songer & Mintzes, 1994). Conceptual change texts among conceptual change methods determine the difference between their own information and scientific information. Thus, this method allows the students to realize their misconceptions and makes the elimination of misconceptions easier (Pines & West, 1986).

Considering these basic results a textbook must have certain aims. First of all, a textbook should be helpful to understand the main scientific concepts easily. Main scientific concepts should be presented deeply in the textbook, but the presentation should not bring on misconceptions. Secondly, history of science, nature of science, and science and technology, society issues should be perceived as an intellectual and social aim. Finally, scientific research processes, questioning, inquiry based instruction and problem solving skills should be supported by the book. Biology education provides the students with a discussion setting for important science topics in the classroom. For example students can investigate the environmental problems which they encountered in the area that they live. They can try to search the importance of a wetland in their neighborhoods. And they can save and help to protect the extinct and endangered species. Textbooks that constitute an important part of biology education should encourage the students to

investigate diverse subjects using questioning techniques, instruction approach, visual materials and activities. For improving the efficiency of biology education, it is necessary to associate biology with daily life. Making an effective and appropriate association between daily life and scientific information indicates the importance of teacher training dimension. The contents of the courses should be well-organized so that biology practicing teachers can associate the information they acquired with their daily lives. In addition, biology students are recommended to encourage the students to conduct project studies with which they can associate their information with the daily life.

In light of these results, in the teacher training processes, practicing teachers should be given the opportunity to acquire how to analyze the textbooks and what specific principles to focus on in textbook selection.



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