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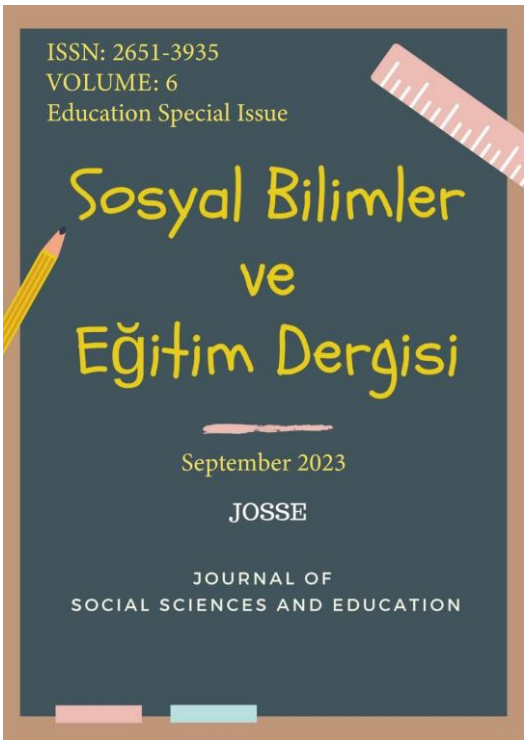


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# Examination of Visual Items in Secondary School Science Textbooks

**Gülşah ZERMAN KEPCEOĞLU** [1]
*Kastamonu University, Institut of Science Teachear*
gulsahzerman@hotmail.com
Orcid ID: 0000-0002-4334-3957

**Murat PEKTAŞ**[1]
*Kastamonu University, Faculty of Education, Department of Science and Mathematics Education*
*Assoc. Prof.*
pektasenator@gmail.com
Orcid ID: 0000-0002-7205-6279

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# Examination of Visual Items in Secondary School Science Textbooks

**Gülşah ZERMAN KEPCEOĞLU**[1]

*Kastamonu University, Institut of Science*

**Murat PEKTAŞ**[2]

*Kastamonu University, Faculty of Education, Department of Science and Mathematics Education*

**ABSTRACT**

Textbooks are seen as the initial resources used in the science learning and teaching process to ensure that the curriculum goals are achieved, and almost half of the pages in the textbooks are covered with visual elements, this study aims to analyze the visual content of the secondary school science textbooks taught in Turkey in the 2022-2023 academic year. It is aimed to examine the elements according to their types, functions, and in-text association status. In this direction, in this research, which is planned as a document analysis, the coding scheme was used in the research of Akçay, Özgür-Kapıcı, and Akçay (2020). After examining 1713 images, it was concluded that more than half of the visuals in the science textbooks at each grade level (5, 6, 7, and 8) were schematized. Also, most of the visuals in the secondary school science textbooks are included in the main text. This is an essential result of the research because learners' interaction with multiple different and complementary stimuli simultaneously makes their learning more meaningful and permanent.

**Keywords:** Textbooks, visual images, representations

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[1] Corresponding author:
*Teacher*
*gulsahzerman@hotmail.com*
*Orcid ID: 0000-0002-4334-3957*
[2] Corresponding author:
*Assoc. Prof.*
*pektasenator@gmail.com*
*Orcid ID: 0000-0002-7205-6279*

## Introduction

Textbooks are the initial resources used in science education to achieve curriculum achievements (Albach & Kelly, 1998; Abd-El-Khalick et al., 2008). In the teaching of all courses, textbooks are the most used teaching material, and the planning of the learning process is shaped according to the textbooks, together with the determination of what will be taught in many classes (Niza & Maza, 2011; Chiappetta & Fillman, 2007). Furthermore, it is known that textbooks provide comfort and convenience to teachers in planning lessons (Elliott & Woodward, 1990). The most accessible sources of knowledge for learners to read and use for homework are textbooks. Because of this, textbooks are crucial in the educational system as a source of instructional strategies and materials. (Aldahmash et al., 2016). It is vital that the textbooks, considered the primary source used by the teachers in teaching the lessons in the classroom, are created in line with the approach determined in the curriculum. Therefore, classroom learning environments can be compatible with the relevant approach in the curriculum only with textbooks in this direction (Erdoğan, 2007). The books, in which the order of the subjects and teaching methods, including the achievements in the curriculum, are seen as guides for both teachers and students.

Göçer (2008), textbooks are also seen as the only resources every student can access and, in most cases, take as a reference while creating their own learning. This situation reveals that the textbook has an active role in terms of creating curiosity about the subjects on which they will learn lessons. The texts contained in the textbook should be suitable for the level of the student, and there should be sections that allow students to measure their own knowledge, as well as sufficient and attractive visual richness (Elliott & Woodward, 1990).

The effectiveness of a textbook can be examined by its degree of compliance with physically determined standards, the way the content is presented and its design, its visual features, and its adequacy in terms of language expression (Ünsal & Güneş, 2004). In their study, Eroğlu-Doğan, Ekinci, and Doğan (2020) analyzed the science textbooks examined in the analysis of studies related to the examination of science books in Turkey, according to the distribution of examination criteria, mainly in terms of "Content," and least in terms of "Style, Language and It was seen that it was handled in terms of the criterion of "Expression." The design of the science textbook according to the principles of visual design is also of interest to the teachers in terms of giving the right message to the student along with the text because teachers can guide students in making connections between images and text. (Uçar and

Somuncuoğlu-Özerbaş, 2017). Via the direct links between text and images created by combining visual and verbal channels, students may build scientific systems' mental models (Anderson, 2014). At the same time, annotated pictures point out significant images and words to readers, help them organize information into cause-effect systems, and allow for elaboration and reinforcement of meaningful content (Coleman et al., 2011).

Researchers in the literature examine the visuals in the textbooks. Among these studies, the visuals in the textbooks used in different years and in different countries were examined according to their types, compatibility with the text, and their functions (Akçay et al., 2020; Guo et al., 2018; Demirdöğen, 2017; Papageorgiou et al., 2017; Liu & Khine, 2016; Dimopoulos et al., 2003). Considering the general results of the studies, it was determined that almost half of the pages in the textbooks were covered with visual elements, and these visual elements were related to the information in the text. While textbooks frequently include images, they do not always include tools for understanding visual material. (Cannon, 2017). Indeed, visual elements not only help students save the relevant concept from abstraction and make sense of the processes but also help students reveal and use their existing thinking styles and determine how they interpret new information according to their functions (Postigo & López-Manjón, 2019). Nowadays, newly published textbooks tend to have a different semiotic catalog or features used to represent objects than older textbooks; This reveals the importance of visual literacy as one of the critical features of teacher education. (Peterson et al., 2021). Therefore this research examined the visual elements in the secondary school textbooks taught in Turkey in the 2022-2023 academic year. In this context, the research questions are as follows:

- How do the visual types in secondary school science textbooks change according to grade levels?
- How do the functions of visuals in secondary school science textbooks change according to grade levels?
- How does the degree of relationship between text and images in secondary school science textbooks vary according to grade levels?

## Method

### Research Design

This research is qualitative research, and the document analysis method was used to analyze the visuals in secondary school science textbooks from various aspects. Document analysis enables inferences to be made from visual and written documents containing information about the subjects or concepts to be researched (Yıldırım & Şimşek, 2011). In this research, textbooks were examined as documents.

### Textbooks Reviewed

In this research, the visuals in the science textbooks taught in secondary schools in Turkey in the 2022-2023 academic year were examined. These textbooks were approved by the Ministry of National Education and were widely used. One textbook was selected from each grade level. Information about the examined textbooks is given in Table 1

**Table 1**

*Textbooks Examined in The Research*

| The name of the book | Class | Authors | Publishing House and Year of Publication |
|---|---|---|---|
| Secondary School and Imam Hatip Secondary School Science Textbook 5 | 5 | Seval AKTER, Hatice Betül ARSLAN, Meltem ŞİMŞEK | MoNE- 2021 |
| Secondary School and Imam Hatip Secondary School Science Textbook 6 | 6 | Semra DEMIRÇALI, Birsen ALKAN | MoNE- 2021 |
| Secondary School and Imam Hatip Secondary School Science Textbook 7 | 7 | İsmail GEZER | Aydın Publications- 2021 |
| Secondary School and Imam Hatip Secondary School Science Textbook 8 | 8 | Murat Volkan YANCI | Vertical Publishing- 2021 |

### Data Analysis

The coding scheme in Table 2, which was obtained by combining the models developed by Khine and Liu (2017) and Dimopoulos, Koulaidis, and Sklaveniti (2003), which Akçay, Özgür-Kapıcı, and Akçay (2020) used in their research for the examination of visual elements in secondary school science textbooks.

**Table 1**

*The coding scheme used in the research*

| Image types | | | Functions of images | | | | Associate with text | |
|---|---|---|---|---|---|---|---|---|
| Realistic | schematized | Mixed | Classifier | Analytical | Narrative | Metaphorical | Associated | Not associated |

Visual elements were analyzed into three types: realistic images, schematized images, and composite images. Realistic images are the visuals that can be depicted by naked eyes, like drawings or photographs (Figure 1). Schematic images represent reality in a coded form, for instance graphs, maps or diagrams (Figure 2). Mixed images are visuals that is a combination of schematic and realistic images in the same image (Figure 3) (Akçay et al., 2020).

**Figure 1**

*Real Image Example (7th Grade Textbook pp. 32)*


**Figure 1**

*Example of Schematized Image (6th Grade Textbook pp. 38)*

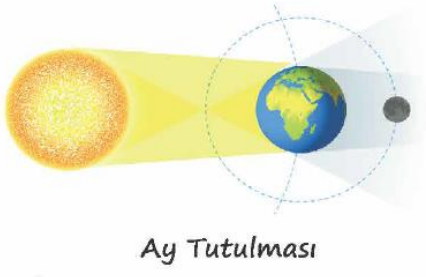


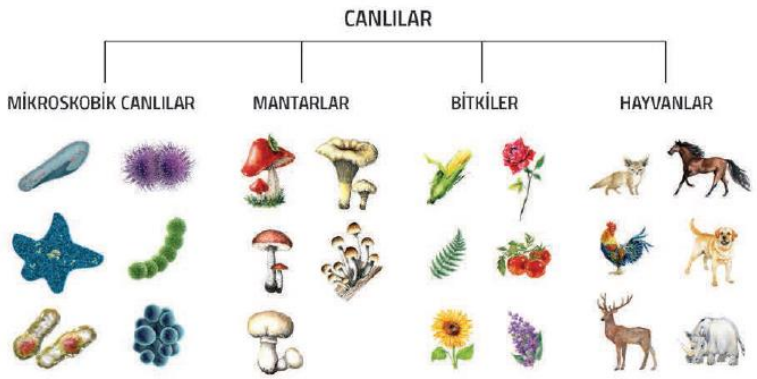
**Figure 3**

*Mixed Image Example (Grade 8 Textbook pp. 84)*


Visuals were examined in terms of their functions in four categories: classificatory, analytical, narrative, and metaphorical. In terms of the educational environment, *classification*, and analytic pictures prioritize visual solid images, whereas narrative and figurative images favor weak visual images. Classification images (Figure 4) depict relationships within a specific classification. The relationships between the part-whole structure are shown by analytical images (Figure 5). Narrative visuals, such as the carbon cycle (Figure 6), clearly or imaginatively depict the process of an action or event. The last one is metaphorical visuals that only provide visual support to the narrative of a subject or consist of the image of a living thing (Figure 7) (Akçay et al., 2020). For the association category with text, if there is a link in the text related to the image, it is coded as associated. Otherwise, it is coded as not indexed (Figure 8).

**Figure 2**

*Classification Image Example (Grade 5 Textbook pp. 56)*



**Fiure 5**

*Analytical Image Example (6th Grade Textbook pp. 57)*

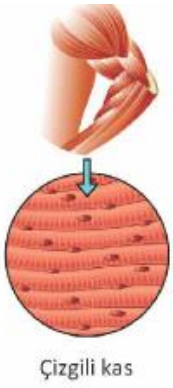



**Figure 6**

*Narrative Image Example (7th Grade Textbook pp. 35)*

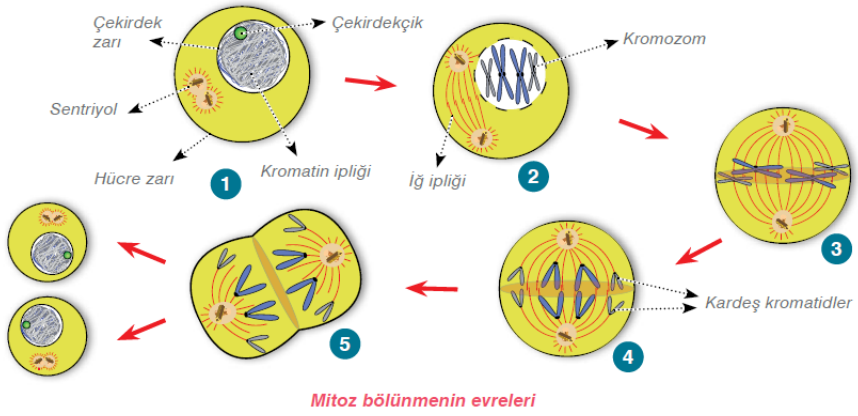



**Figure 7**

*Example of Metaphorical Image (Grade 8 textbook pp. 85)*

**Figure 8**

*Example of An Associated Image (Grade 8 Textbook pp. 85)*


While analyzing the data, the two researchers performed the analyses separately from each other. The two researchers' answers with the same evaluation were accepted as consensus, and the answers with different evaluations were accepted as disagreement. The reliability of the research, Reliability=Consensus/(Consensus + disagreement)*100, is calculated using the mathematical expression. Accordingly, the reliability of the study was found to be 83.33%. A result above 0.70 ensures the reliability of the research (Miles & Huberman, 1994). Therefore, the classification can be expressed reliably. Then, the two researchers came together, and the results were compared. After reviewing the disagreements, a common conclusion was reached.

## Findings

The total number of visuals in secondary school science books within the scope of the research is given in Table 3.

**Table 3**

*Total Number of Visuals in Secondary School Science Textbooks*

| Class | Number of Images |
|---|---|
| 5 | 381 |
| 6 | 397 |
| 7 | 447 |
| 8 | 488 |
| **Total** | 1713 |

When the data in Table 3 are examined, it is seen that there are 1713 visuals in total in the secondary school science textbooks, and these visuals are approximately equally distributed among the classes.

**Findings for the First Research Problem**

The first problem of the research is about the change of visual types in secondary school science textbooks according to grade levels. It can be seen in Table 4 that the textbooks examined in this context mainly contain schematized visuals.

**Table 4**

*Distribution of Visual Types by Classes*

| | Image Type | | | | | | |
|---|---|---|---|---|---|---|---|
| Class | Realistic | | schematized | | Mixed | | Total |
| 5 | 133 | 34.9% | 236 | 61.9% | 12 | 3.1% | 381 |
| 6 | 180 | 45.3% | 189 | 47.6% | 28 | 7.1% | 397 |
| 7 | 206 | 46.1% | 214 | 47.9% | 27 | 6.0% | 447 |
| 8 | 245 | 50.2% | 225 | 46.1% | 18 | 3.7% | 488 |
| Total | 764 | 44.6% | 864 | 50.4% | 85 | 5.0% | 1713 |

When the data in Table 4 are examined, it is seen that schematized visuals are primarily used in secondary school science textbooks. 50.4% (864) of the 1713 visuals in the textbooks are schematized visuals. Among the total visuals, there are mixed visuals where at least 5% realistic and schematized visuals are used together. Considering the grade levels, it is seen that the schematized visuals are at the highest level in the 5th grade, with a rate of 61.9%. This ratio decreases from 5th grade to 8th grade, and the ratio of realistic items also increases. In the 8th grade, the percentage of realistic items (50.2 - 245) is higher than schematized visuals (46.1 - 225%). When we look at the mixed visuals, there is the least number of them at each grade level, and there are mixed visual elements in the 6th grade, with a maximum of 7.1%.

**Findings for fhe Second Research Problem**

The second problem of of the research is about the changes in the functions of the visuals in secondary school science textbooks according to the grade levels. In this context, it is seen in Table 5 that mostly metaphorical visuals are included in the textbooks examined.

**Table 5**

*The Distribution of the Functions of the Images According to the Classes*

| **Functions of images** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Class | Classifier | | Analytical | | Narrative | | Metaphorical | | TOTAL |
| 5th grade | one | 0.3% | 5 | 1.3% | 50 | 13.1% | 325 | 85.3% | 381 |
| **6th grade** | 17 | 4.3% | 32 | 8.1% | 56 | 14.1% | 292 | 73.6% | 397 |
| **7th grade** | 9 | 2.0% | 45 | 10.1% | 140 | 31.3% | 253 | 56.6% | 447 |
| **8th grade** | 32 | 6.6% | 18 | 3.7% | 101 | 20.7% | 337 | 69.1% | 488 |
| | 59 | 3.4% | 100 | 5.8% | 347 | 20.3% | 1207 | 70.5% | 1713 |

When the data in Table 5 is examined, it is seen that metaphorical visuals are mostly used in secondary school science textbooks. 70.5% (1207) of the 1713 visuals in the textbooks are metaphorical visuals. Among the total images, there are the least classifying images, with 3.4%. For the rest of other grade levels, it is seen that the metaphorical visuals are at the highest level in the 5th grade, with a rate of 85.3%. After metaphorical visuals, narrative visuals were the most used (20.3% – 347). Each grade level usually has at least one classifier, then analytical, and then narrative visuals. Only at the 8th-grade level the percentage of classifier visuals (6.6% – 32%) is higher than analytical visuals (3.7% – 18%).

**Findings for The Third Research Problem**

The third problem of the research is related to the change of images in secondary school science textbooks according to the degree of relationship between text and pictures. In this context, it is seen in Table 6 that primarily associated visuals are included in the textbooks examined.

**Table 6**

*Distribution of Association Types of Images by Class*

| **Associate with text** | | | | | |
|---|---|---|---|---|---|
| Class | Associated | | Not associated | | TOTAL |
| 5th grade | 342 | 89.8% | 39 | 10.2% | 381 |
| **6th grade** | 341 | 85.9% | 56 | 14.1% | 397 |
| **7th grade** | 402 | 89.9% | 45 | 10.1% | 447 |
| **8th grade** | 462 | 94.7% | 26 | 5.3% | 488 |
| | 1547 | 90.3% | 166 | 9.7% | 1713 |

When the data in Table 6 is examined, it is seen that 90% of the total 1713 images in secondary school science textbooks are associated with the text. Considering the grade levels, it was seen that 94.7% (462) of the 8th-grade visuals were associated with the highest rate. This rate does not change significantly across grade levels.

## Discussion and Results

This study examined visual elements in secondary school science textbooks taught in Turkey in the 2022-2023 academic year according to their types, functions, and in-text associations. Visual elements consist of pictures, graphs, diagrams, tables, maps, network charts, and similar elements within the text that support the written expression in the text, facilitate the understanding of its content, and make the reader think visually (Cannon, 2017). Visual elements perform functions such as helping to comprehend the content, attracting attention, motivating, and explaining abstract and complex concepts. Visual elements are easily interpreted because they contain condensed information, make it easier to remember, and attract interest and attention (Coleman et al., 2011). Additionally, many tools, such as tables, graphs, and visuals, can strengthen communication (Pozzer et al., 2004). Illustrations should help understand the text (information) and effectively like the lesson. The feature of illustrations is their functionality. Explanation of the subject and information is essential. In the textbook illustrations, importance should be given to the text-image relationship. Book illustrations, maps, graphs, tables, and diagrams are visual elements that facilitate learning.

When the visual elements in the secondary school science textbooks were examined according to the types, it was concluded that more than half of the visuals in the science textbooks at each grade level (5, 6, 7, and 8) were schematized. This result differs from the study of Akçay, Özgür-Kapıcı, and Akçay (2020) and Guo, Wright, and McTigue (2018). In the studies of Akçay, Özgür-Kapıcı, and Akçay (2020), more than 60% of the images in the science textbooks between 2002 and 2017 were realistic. The study conducted by Guo, Wright, and McTigue (2018) concluded that realistic photographs were given more space than drawings in the science books of the 3rd and 5th grades. This situation may lead to the conclusion that it is preferable to schematize objects or living things visually rather than looking realistically at the time passed between the books examined. At the same time, hybrid representations containing a combination of realistic and schematized representations had the lowest rate. However, this type of representation actually enables learners to see abstract and

concrete concepts at the same time, and this makes it easier for learners to learn the desired information..

When the functions of visual images in secondary school science textbooks are examined, it is seen that metaphorical images that only provide visual support to the expression of a subject or that consist of the image of a living thing are included in the books. This situation shows the importance of supporting with visuals while giving a lecture to secondary school students. However, this result is not similar to the study of Akçay, Özgür-Kapıcı, and Akçay (2020) and Dimopoulos, Koulaidis, and Sklaveniti (2003). Most of the visual elements examined in these studies were found analytically. The fact that the publication years of the books examined in the studies were older than the current study may have caused the functions of the visual elements to change.

In terms of the criteria of relation with the text, most of the visuals in the secondary school science textbooks are included in the main text. This is an important result of the research; because learners' interaction with multiple different and complementary stimuli at the same time makes their learning more meaningful and more permanent. In this way, the visuals used and the main texts that need to be interpreted will be more easily understood. (Pozzer et al., 2004). With links or relationships in the text, it can be easier for students to understand the images correctly.

Considering the research findings and results, the use of these elements in national or international science exams can be examined by other researchers since the preference of including visual elements in the books will support the students' learning.

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