A Research on Visual Learning Representations of Primary and Secondary Science Textbooks in Turkey

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Abstract

The aim of this study is to analyze the types of visual representations in primary and secondary science textbooks in Turkey. The sample of the research constitutes six textbooks prepared by private publishers for primary and secondary science courses (3rd-8th Grade) in Turkey in 2018-2019 academic year. Document analysis design, which is one of the qualitative research methods, is used in this study. The data are analyzed with descriptive analysis method by using the Moline (1995) *"Visual Representation Classification Model"*. The results of the study show that simple diagrams are used more frequently than other types of visual representations in all class levels and units in science textbooks. It is understood that synthetic diagrams are more preferable in the 6th, 7th and 8th grades' science textbooks than in other grade levels, whereas analytical diagrams are more preferable in the sixth grade's science textbooks than the other grade levels. Visuals such as graphics and maps are determined to be little used in all class levels and units, on the other hand table visuals are frequently used in all class levels. In addition, it is determined that the timeline as the visual representation is used in a few units only in the 7th grade's book. The results of this study show that visual learning representations in primary and secondary school textbooks need to be rearranged in terms of diversity and distribution in class level and units.

Keywords: Visual learning representations, Science textbooks, Document analysis

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INTRODUCTION

Textbooks are one of the most basic means in order to store and transmit information (Lee, 2010) and they are the most basic guides to understand specific subjects arranged for students (Khine & Liu, 2017; Morgil & Yılmaz, 1999). According to Kulm, Roseman & Treistman (1999), textbooks not only state the purpose and plan the lesson by presenting, organizing and making learning more appealing to the students, but they also play a major role to help classroom activities. Stern and Roseman (2004) determines that textbooks are the most important resources on which many teachers rely especially when they experience non-area teaching. However, a study by Chiappetta et al. (2006) shows that teachers use textbooks at a rate of 90% while setting students homework.

Depending on the breadth and depth of the field, the importance of books stands out much more in and out of class. Within this framework, science textbooks are taught from 3rd to 8th grades and their effects are felt more on the students. As science grows in a complex way, students face increasing difficulties in understanding and interpreting scientific knowledge (Lee & Jones, 2017). Students are required to be supported with more effective science materials and resources (Duschl vd. 2007). Science textbooks are used as the most basic sources for students to teach science subjects in and out of the classroom and so they have still great importance in courses (Nakiboğlu, 2009).

According to Binns and Bell (2015), science textbooks provide a detailed explanation on the specific content of the course. The content and formal quality of science textbooks have a significant impact on learning and teaching science (Khine, 2013). Schizas, Papatheodorou and Stamou (2018) point out that science textbooks are sources that creatively refine scientific knowledge according to the age of learners and educational criteria. However, science textbook's authors are required to present information effectively and accurately. Nowadays, science textbooks need to be supported with various visual elements that will make easier for students to understand the content of subject together with scientific texts. Visual representations in science textbooks are quite important in terms of giving correct message associated with text to students. Images are powerful learning tools (Carney & Levin, 2002; Guo, Wright & McTigue, 2018). Many researchers point out that the integration of visual learning representations (pictures, diagrams, drawings, tables, graphs, maps, models, etc.) into a science unit greatly facilitates students' understanding the scientific content they study (Cheng & Gilbert, 2014; Cox, 2005; Danish & Enyedy, 2007; Lee, 2010; Lemoni et al.., 2013; Preston, 2016; Wilson & Bradbury, 2016; Gou, Zhang, McTigue, & Wright, 2017). According to the New Generation Science Standards (NGSS, 2013), in addition to writing in science, students' interaction with visual learning representations such as drawings, models, diagrams, graphs and tables is critical to provide students with more effective scientific understanding. (NGSS Lead States, 2013). The quantity and quality of the visuals in the textbooks are sufficient to help students understand the issues more effectively and develop their visual literacy skills (Uçar & Somuncuoğlu Özerbaş, 2017). Correctly supporting textbooks with visual learning representations are essential elements in order to understand scientific texts effectively. Visual representations take place in many different forms in science textbooks as classroom activities, laboratory activities and assessment tools (Shehab & Bou Jaoude, 2017). Visual representations play an important role especially to simplify scientific content in science for students (Tippett, 2016). Coleman, McTigue and Smolkin (2011) state that the use of visual representations for learning has a strong effect on explaining and exemplifying new and abstract concepts in science. Visuals are useful means to help make concepts, processes, and ideas more understandable (Kress & van Leeuwen, 1996). If it is not possible to observe and try the concepts or processes, it is important to make these situations understandable through visual representations in a course (Cook, 2006; Preston, 2017; Rapp, 2005).

In the relevant literature, it is understood that visual representations have a dual classification as figurative and non-figurative representations (Petersson, 2002). Figurative representations include visual learning representations like pictures, diagrams, graphs, photographs, paintings, concept maps, diagrams, tables and various symbols (Doblin, 1980; Moline, 1995; Petterson, 2002; Vekeri, 2002; Coleman, McTigue & Smolkin, 2011). On the other hand, non-figurative visual representations are labels, letters, and verbal descriptions (Petersson, 2002). In addition, Vekiri (2002) summarizes four

common types of visuals. These are diagrams, graphs, maps and tables. Again Roberts et al. (2013) classified eight forms of visual representations. These are graphs with subtitles, diagrams, graphs, flowchart, addendum, maps, tables and time series.

Considering relevant literature, it is understood that the researchers examine the science textbooks in many respects (Calık & Kaya, 2012; Irving, Savasci-Acikalin & Wang, 2006; Sen & Nakiboğlu, 2012; Tekbıyık, 2006). Moreover it is observed that investigations in the context of special contents like the nature of science and socio-scientific issues have been focused in recent years (Abd-El-Khalick et al., 2017; Niaz, Klassen, McMillan, & Metz 2010; Orgill, 2013). However, it is understood that in recent years important studies on visual learning representations in textbooks have been carried out by researchers (Akçay & Akçay, 2018; Gkitzia, Salta & Tzougraki, 2011; Kapıcı & Savaşçı-Açıkalın, 2015; Liu & Khine, 2016; Pozzer & Roth, 2003; Rybarczyk, 2011). In particular, Coleman and Dantzler (2016) examined the types and frequency of visual representations in science books prepared for children in America between 1972 and 2007. The results of this study show that the number and variety of images have been increasing significantly in books.

Science textbooks should support meaningful learning for students to be an effective educational appliance. Given that a great amount of knowledge in the field of science is abstract, complex and difficult, textbooks need to be supported with visuals that facilitate understanding and remembering this knowledge. Based on this, it is quite important to detect whether there are visual learning styles in primary and secondary school science textbooks in Turkey and to what extent they include them. Because it is thought that it will make significant contributions to the authors in the preparation of more effective science textbooks in the coming years. Therefore, the main aim of this study is to analyze the situation of the textbooks prepared within the framework of science education program in Turkey in terms of visual learning representation. While there are a limited number of studies examining science textbooks in Turkey in terms of visual learning representations, the fact that there is no study examining textbooks at all grade levels of primary and secondary schools in terms of visual learning representations makes this study more important. In this context, answers to the following questions were sought.

1. What kind of visual learning representations are included in science textbooks?

2. How are the visual learning representations distributed in accordance with units?

3. What are the differences and similarities in the distribution of visual learning representations in science textbooks on the basis of grades?

METHOD

This study involves document analysis that is the one of the qualitative research designs in which the visual learning representations in primary and secondary school science textbooks in Turkey are examined. Analyzing of written and visual documents in qualitative research is quite important in terms of providing rich and comprehensive conclusions (Bas & Akturan, 2008). The document review includes analysis of written materials containing information about the cases to be investigated. (Simsek &Yildirim, 2013). In this context, official publications, reports and records are at the center of document analysis. (Patton, 2002). According to Bowen (2009), document analysis is a very advantageous method in terms of allowing detailed investigations about the research subject. The documents in the study were examined according to the descriptive analysis systematics. While descriptive analysis is used in the processing of data that do not require in-depth analysis, the data obtained are summarized under predetermined headings and presented in a format that the reader can understand after being interpreted (Büyüköztürk, Çakmak, Akgün, Karadeniz and Demirel, 2009). In this respect, science textbooks were analyzed by descriptive analysis according to the criteria of visual learning representations defined previously, and the status of visual learning representations in textbooks of different grade levels was revealed.

Studying Materials

The sample of this study consists of six textbooks (particularly 3rd, 4th, 5th, 6th, 7th and 8th grades) prepared by private publishing houses for science courses at primary and secondary schools in Turkey in the 2018-2019 academic year. The books selected for the study include course materials to be taught in primary and secondary schools whose eligibility period has been recognized as five academic years according to Article 21 in Textbooks and Educational Materials Regulations by approval of Head Council of Education and Morality, Turkish Ministry of National Education. The records of textbooks are presented in Table 1.

Table 1. The records of primary and secondary school textbooks chosen for the sample

Publisher	Grade	Publish Date	Authors
Tutku Publishing	8th	2018	Ayşe Aytac, Sümeyya Türker, Tuğba Bozkaya, Zühre Üçüncü
Aydın Publishing	7th	2018	İsmail Gezer
Sevgi Publishing	6th	2018	Coşkun Çiğdem, Gizem Minoğlu Balçık, Özgün Karaca
Ada Publishing	5th	2018	İlknur Özkan, Zeynep Mısırlıoğlu
Ata Publishing	4th	2018	Mustafa Çetin, Gündüz Şatıroğlu, Sinem Yanık
Anadol Publishing	3rd	2018	Erhan Yiğit

Data Collection Process and Analysis

The primary and secondary school science textbooks chosen as data collection means of the study have been obtained via two teachers who attend science classes at primary and secondary schools in Kars city center. The obtained textbooks are analyzed by considering Moline's (1995) classification systematic on visual learning representations (Table 2). The analysis of the visuals in the textbooks is made on the basis of 7 units at each class level. The distributions of the units in the primary and secondary school science textbooks are shown in Table 3. Upon being analyzed, visual representations prepared for evaluation purposes at the end of the unit and the subjects are not subjected to examine.

Table2. Moline's (1995) Classification Systematic on Visual Representation

Simple Diagrams They are labels or one scale drawings	Illustrated Dictionary It helps the reader to identify, differentiate or explain parts within a set. Measurement Diagram It depicts the subject with a scale to show dimension, mass or distance.
Synthetic (Artificiality to Simulate Nature)Diagrams It is to establish connections between parts or subgroups of a stage within a broad cluster.	Flow diagram It respectively connects the sections (Water Cycle, Life Cycle) to show a process that moves through time. Tree and Network Diagram It shows the subgroups and classifications within the hierarchy to which the concepts or objects are connected and interconnected series or the form of branched tree
Analytical Diagrams It helps us to see the interior of an object or to understand its inner function.	External Cross-Sectional Diagram It helps us to interpret the relations in the three dimensional plane by sectioning from outside a layer or peeling its shell. Internal Cross-Sectional Diagram It is to reveal the interior of an object in a plane by cutting an object in half or taking an end-to-end slice.

Graphics When the information is measured, it is used to present that information.	Bar Chart It is used to organize information such that it is used for sorting, comparing and measuring within units from left to right. Line Chart It is used to indicate changes in size or values.
Maps It is used to place information within a spatial context.	Bird's Eye View Maps It shows the scene from which the image is taken directly from an upward angle. Environmental Maps Drawings of the observations in the immediate surroundings (school, home, etc.) Flow Maps It summarizes a process where mobility is represented on the map (migration and weather)
Tables It represents a structure consisting of rows and columns, mostly without pictorial elements.	
Timeline They are one-dimensional visuals in which information is organized within chronological sequences and the times are marked by subtracting arrows (the development of flying, the development of personal computers since 1970, etc.).	

Table 3. The distribution of the textbooks analyzed by the grade levels and units

Unit	3rd grade	4th grade	5th grade	6th grade	7th grade	8th grade
1	Let's get to know our planet	Earth Crust and the movements of our Planet	The Sun, The Planet and The Moon	Solar System and Eclipses	Solar System and Beyond	Seasons and climate
2	Our Five Senses	Our Nutrients	World of living things	Systems in our body	Cell and Divisions	DNA and Genetic Code
3	Let's get to know Force	Force Effects	Measurement of Force and Friction	Force and Motion	Force and Energy	Pressure
4	Let's get to know Matter	Properties of Matter	Matter and Transformation	Matter and Heat	Pure Substances and Mixtures	Substance and Industry
5	Light and Sounds Around Us	Lighting and Audio Technologies	Propagation of Light	Sound and Features	Interaction of Light with Matter	Simple Machines
6	Journey to the World of Creatures	Human and Environment	Human and Environment	Systems and Health in Our Body	Reproduction, growth and development in living organisms	Energy Transformations and Environmental Science
7	Electric Vehicles	Simple Electrical Circuits	Electrical Circuit Components	Transmission of Electricity	Electric circuits	Electric Charges and Electrical Energy

Reliability of the Study

Firstly, both researchers independently have described the 8th grade's science textbook according to Moline's (1995) visual learning representations template in order to ensure the reliability of the analysis of the documents in the research. Then, the same book has been analyzed by another specialist in science education by using Moline's (1995) template. As a result of the series of analysis conducted by both researchers, considering the contradictory descriptions made by the other expert's analysis, the series of analysis are reviewed and concluded in such a way that no contradictions remain. Coding reliability is calculated by using formula [Agreement / (Agreement + Disagreement)] (Miles & Huberman, 1994). In the visual representation analysis conducted by both researchers on the basis of seven units on the 8th grade's textbook, the consistency between the researchers is found to be 92%. After this phase, all the textbooks are coded together by both researchers and the analysis findings are finalized.

RESULTS

In this section, analysis results related to the use of visual learning representations in science textbooks used at primary and secondary school are presented. The findings are shown in Table 4 and onwards. In this table, usage of visual representation in science textbooks prepared firstly for 5th, 4th, and 3rd class levels and then for the 8th, 7th, and 6th class levels is described.

Table 4. Findings Related to the Analysis of Visual Learning Representations Used in 3rd, 4th, and 5th Grades' Science Textbooks

		Simple Diagrams		Synthetic Diagrams		Analytic Diagrams		Graphs		Maps			Tables	Timeline
Grade	Unit	Illustrated Dictionary	Measurement Diagram	Flow Diagram	Tree and Network Diagram	External Cross-Sectional Diagram	Internal Cross-Section diagram	Bar Chart	Line Chart	Bird's Eye View Map	Environmental Map	Flow Map		
5th Grade	1	13	1	2		1							1	
	2	84		1	2					1			2	
	3	46											4	
	4	52							5				13	
	5	53						1					3	
	6	30				1							1	
	7	37			1								7	
	Total	315	1	3	3	2		1	5	1			31	
4th Grade	1	44		2	2									
	2	49											1	
	3	66	1		1								1	
	4	77	5	4	4								8	
	5	100			1					4			1	
	6	29												
	7	23												
	Total	388	6	6	8					4			11	
3rd Grade	1	32				2							1	
	2	21											3	
	3	45											1	
	4	45											4	
	5	46			1								4	
	6	42		1	2					4			3	
	7	53			6								1	
	Total	284		1	9	2				4			17	

Table 4. (Continued) Findings Related to the Analysis of Visual Learning Representations Used in 6th, 7th, and 8th Grades' Science Textbooks

		Simple Diagrams		Synthetic Diagrams		Analytic Diagrams		Graphs		Maps			Tables	Timeline
Grade	Unit	Illustrated Dictionary	Measurement Diagram	Flow Diagram	Tree and Network Diagram	External Cross-Sectional Diagram	Internal Cross Sectional diagram	Bar Chart	Line Chart	Bird's Eye View Map	Environmental Map	Flow Map		
8th Grade	1	19		2						6	2	2		
	2	70		2	9			1				3		
	3	23	6											
	4	106	1	2					4			16		
	5	62												
	6	37		6	5				1	1		2		
	7	71			1									
	Total	388	7	12	15			1	5	7	2	23		
7th Grade	1	38			2	1	2				1		1	
	2	37	1	1	11	3						2		
	3	76	5	1						1		2		
	4	110	1	1	3							9	2	
	5	118			4					1		1		
	6	85		8	2									
	7	39							2			1		
	Total	503	7	11	22	4	2		2	2	1	15	2	
6th Grade	1	35	5	2										
	2	118		2	2	7	4					5		
	3	79	1					1	7			7		
	4	102		2				2		1		11		
	5	82			3			1	1			2		
	6	88			5		6					2		
	7	58	1		3							2		
	Total	562	7	6	13	7	10	4	8	1		29		

When Table 4 is examined, it is seen that the number of visual representations about illustrated dictionary under simple diagrams is much higher in all class levels and units than other visual representations. It is determined that the number of illustrated dictionaries in 8th, 7th and 6th grades' science textbooks is higher than other grades'. In addition, it is found that the measurement diagram is used seven times in the upper classes' science textbooks, but it is never used in the third science textbooks.

The use of synthetic diagrams in 6, 7 and 8th grades' science textbooks is preferred more than other grades' and in particular, the number of usages of tree and network diagram as visual representation is found to be higher.

When Table 4 was analyzed in terms of analytic diagrams, it was understood that these diagrams were never used in the eighth and fourth grades but rarely used in the third and fifth grades. In addition, it was found that the internal and external cross-sectional analytical diagrams in the sixth grade textbooks were used more than other grade levels.

When the graphical visual representation is considered, it is seen that it is preferred in the second grade classes (8, 7, 6 and 5), whereas it is not preferred in the first grade (3 and 4) classes.

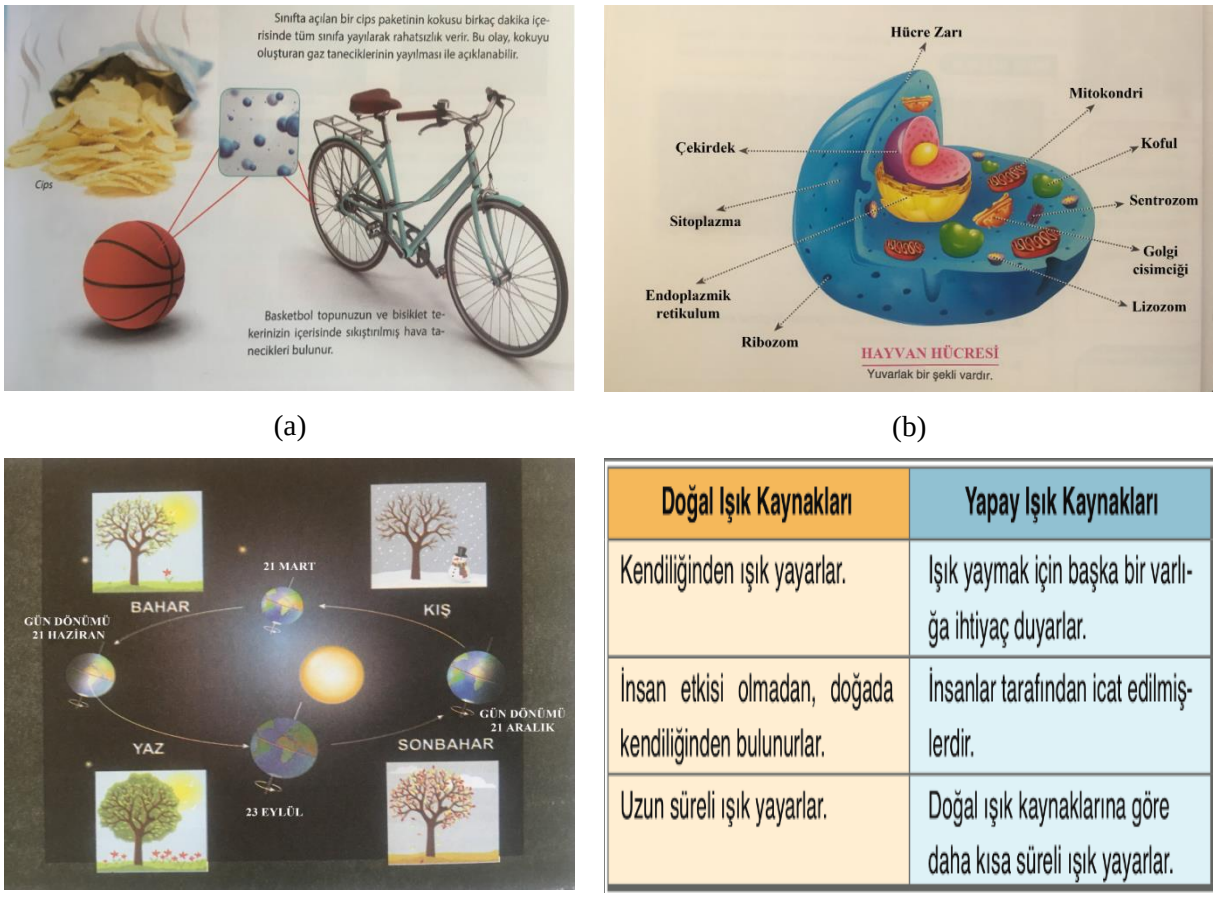
Furthermore, it is seen that line graph is more preferable than bar graphs in graphical visual representation.

When the map as the visual representation is examined, it is seen that environmental maps are never used in science textbooks and the flow map as visual representation is used twice in the 8th grade's unit called Seasons and Climate and only once in the 7th grade's unit called Solar System and Beyond. In this visual representation, it is seen that bird's eye view visual representation is mostly preferred.

When the table as the visual representation is considered, it is seen that this visual representation is frequently used in science textbooks at all grade levels. It is found that the use of the table as visual representation in the fourth units of all grades (Let's Get to Know the Matter, Properties of Matter, Matter and Change, Matter and Heat, Pure Matter and Mixtures and Matter and Industry) is remarkably higher than other units.

It is found that the timeline as the visual representation is used in the unit titled Solar System and Beyond in the part of the space research and in the unit titled Pure Matter and Mixtures in the part of granular structure of the matter in the seventh grade's science textbooks but it is never used in the other classes.

Sample citations related to the visual learning representations used in science textbooks are given in Figure 1.



(a) (b)

(c) (d)

Figure 1. Sample Images in Science Textbooks [(a) Çiğdem, Minoğlu Balçık and Karaca (2018, p.115), 6th grade gas particles illustrated dictionary image; (b) Gezer (2018, p.26) Visual of the internal cross- sectional diagram of a 7th grade animal cell; (c) Aytac, Türker, Bozkaya and Third

(2018, p.20) Visual of flow diagram in the 8th grade seasons in northern hemisphere; (d) Yiğit (2018, p.129) Visual of Table of 3rd grade unit differences between natural and artificial light sources].

DISCUSSION AND CONCLUSION

In this study, the 3rd and 8th grade's textbooks prepared to be taught in science classes are examined in terms of visual learning representations at primary and secondary schools within the body of the Ministry of National Education in Turkey in 2018-2019 academic year. The findings of the study reveal three main results. The first result of the study shows that the visual learning representations in the textbooks are mostly made up of the simple diagrams. However, it is found that synthetic diagrams and table visuals are the most commonly used visuals in comparison to other visuals in pursuit of simple diagrams in all the discussed books. The results of content analysis carried out by Guo et al. (2018) about visual learning representations in science textbooks in grade schools show significant similarities to those of the present research. The researchers ascertained that the most commonly used visual learning representations in the third and fifth grade science textbooks are diagrams. Besides, Liu & Khine (2016) ascertained in a research about the types and characteristics of images in science textbooks that they substantially consist of diagrammatic images. Tippett (2016), in his extensive study of literature studies on diagram-based learning between 2002 and 2014, ascertained that the use of this visual learning tool in science courses contributed significantly to being understood better of concepts by the students. In addition, many studies have shown that diagrams enable students to understand this information more easily by visualizing complex and broad information clusters in science for them (Cromley et al., 2013; Preston, 2016; Tippett, 2016; Waldrip & Prain, 2012). It is emphasized in many studies that tables which is one of the most commonly used visual in science textbooks serve for students' understanding information more easily by simplifying complex and intense science content (Akcay & Akcay, 2018; Coleman, McTigue and Smolkin, 2011; Danish & Enyedy, 2007; Liu & Khine, 2016). Therefore, the fact that both diagrams and tables are frequently included in all of the science textbooks examined in this research can be interpreted as these books' serving an important purpose in terms of the image types expressed in supporting students' learning of science. However, it is clear that the science textbooks used in primary and secondary schools need variety to be offered except for these two visuals in terms of visual learning representations.

The second result of the study shows that the distribution of visual representations according to units is not balanced. It is found that the use of illustrated dictionary especially on the basis of the fourth unit at the secondary school level is considerably higher than those in the other units. In addition, the table image is also used in this unit a lot more than other visuals. According to this result, after an overall assessment, it can be said that the required balance is not taken into consideration in terms of the variety and distribution of the images used. The result of this study showing a disregard of a balanced distribution of units in terms of visual learning representations bear a resemblance to Coleman & Dantzler's (2016) researches. In this study, it is pointed out that the visual representations in physics units in the science books in the USA are more numerous and more diverse than other science fields, especially biology and earth sciences. Also, Qasim & Pandey (2017) found that visuals used in physics subjects were more preferred than those used in chemistry and biology in their content analysis regarding visual representations in science books. The results of this research can be interpreted as a disregard of a balanced distribution of units in terms of visual representations while science textbooks in Turkey are prepared. Therefore, it is understood that science textbooks need to be rearranged in terms of visual learning representations according to units at each grade level.

The third result of the study reveals that the visual representations used in science textbooks do not undergo significant change according to the grade level. When all grade levels of both primary and secondary schools are examined, it is understood that the illustrated dictionary diagram which is simple diagram stands out with a big difference. In addition, it is found that synthetic diagrams and table visuals are the most commonly used visuals in pursuit of the illustrated dictionary diagram at all grade levels. In addition, it is understood that they show a similar distribution at each grade level when the rarity of the other visuals and the non-use of them is observed. In a similar study, Nakiboğlu &

Çamurcu (2014) concluded that the textbooks did not show a significant difference in terms of the use of graphic editors for different grade levels and the number of graphic editors used in the books was not sufficient. By contrast, Postigo & López-Manjón (2019) examined the primary and secondary school science books in Spain in terms of visuals. As a result of the research, the researchers found that the visuals in the primary and secondary school books had significant differences in terms of their types and structures according to class level. In a similar study, Nakiboğlu & Yıldırım (2018) determined to what extent images are included in the secondary school science textbooks and which types of images are available. At the end of the study, the researchers remarked that the distribution of examined secondary school science books is quite different according to grade level. Pinto (2002) points out that the characteristics of visual learning representations should differ significantly according to the age and achievement level of the student. Therefore, science books to be taught in schools should be prepared by taking these factors into consideration.

In science classes, students have difficulty in processing scientific texts in books into their minds effectively. Visual representations play an important role to overcome this situation and to process information into their minds effectively (McTigue, 2009). Therefore, while the science textbooks are being prepared, much more attention should be paid to the arrangement of visual representations. When the results of this study are taken into consideration, it can be said that many images in the related literature are limited in order to support the texts in the books. The related literature emphasizes that the number and variety of visual representations in science textbooks have increased in recent years (Coleman & Dantzler, 2016). In this context, it is understood that the visual representations in science textbooks in Turkey should be enriched. Especially analytical diagrams (internal and external cross-sectional diagrams) are very effective in understanding many complex structures in science, since the visuals show the internal structure or hidden processes of the objects (Moline, 2011). It is important to integrate these texts with the correct visual representations to facilitate student's understanding many complex information presented in science textbooks. Because the addition of visual learning representations prepared in accordance with the scientific texts in the science textbooks will help students relate, understand and remember information more easily. It is often inevitable that students' attentiveness and motivation will be diminished due to the intensity and confusion of knowledge in the field of science. This can be solved by increasing the number and variety of visuals summarizing the content of knowledge in science textbooks for primary and secondary school students.

Suggestions

In line with the results of this research, the following suggestions may be presented to those who will prepare new research and science textbooks:

In this study, the current structures of the textbooks used in science courses in primary and secondary schools were examined in terms of visual learning representations. Considering the results obtained from the study is regarded as important in the sense of uplifting science textbooks to be prepared in the future. In addition, interviews with teachers and students in the field on the intelligibility and use of visual representations are thought to contribute significantly to the improvement and enrichment of textbooks. Also, The Program for International Student Assessment (PISA), also funded by the Organization of Economic Cooperation and Development (OECD), is a study conducted to assess the achievement of countries in science education. One of the basic areas of PISA is science literacy. When the PISA 2015 final report is examined, it is understood that various factors that affect students' achievement in science are emphasized (Tas, Arici, Ozarkan & Ozgurluk, 2016). These factors are socio-economic indicators, equality of opportunity, time allocated to learning, teacher quality, physical infrastructure and educational materials (textbook, tools of information technologies, laboratory and library materials). According to the PISA 2015 final report, the inadequate or low quality of the educational materials is seen as an important factor hindering learning. Especially, it is highlighted in this report that this inadequateness is distinguished at the rate of 46% in Turkey (30% in OECD countries). It is also seen in this final report that ranking of students

in Turkey in science literacy lags quite behind. One of the sufficiency areas defined for success in science in PISA is the ability to define models and demonstrations. In this context, the importance of course materials to support students' visual literacy is much better understood. According to the 2015 PISA final report, the five most successful countries in terms of science literacy are Singapore, Japan, Estonia, Taiwan-China and Finland, respectively. Therefore, it is necessary to examine the textbooks, which are educational materials that have a significant effect on the science achievement of the students in these countries, in terms of visual learning representations. In addition to the scientific texts, while the textbooks are being prepared, it should be possible to establish commissions consisting of experts and science teachers who will work only on visual representations.

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