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Usage of Graphic Organizers in Upper-Secondary School Chemistry Textbooks

Ortaöğretim Kimya Ders Kitaplarında Grafik Düzenleyici Kullanımı

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Abstract

Within the framework of today's programs and teaching approach, it is extremely important to develop students' high-level cognitive skills and teach concepts. This situation also requires students' active participation in the lesson. Using graphic organizers in chemistry textbooks can both increase the active participation of students and contribute to the development of high-level thinking skills. Thus, this study aimed to identify what kinds of graphic organizers were placed in upper-secondary school chemistry textbooks and to determine the purpose of graphic organizer usage and the position of graphic organizers in the textbooks. The study is based on a qualitative research methodology and a document analysis method was used. Four chemistry textbooks, 9th, 10th, 11th, and 12th grades were analyzed by taking into account a concept map concerning the classification of graphic organizers as a rubric. At the end of the study, it was found that 55 graphic organizers, 15 in the 9th-grade chemistry textbook, 21 in the 10th-grade chemistry textbook, eight in the 11th-grade chemistry textbook, and 11 in the 12th-grade chemistry textbook were placed in all chemistry textbooks analyzed.

Keywords: Graphic organizer, chemistry textbooks, upper-secondary school

Öz

Günümüz programları ve öğretim yaklaşımı çerçevesinde öğrencilerin üst düzey bilişsel becerilerinin geliştirilmesi ve kavramların öğretilmesi son derece önemlidir. Bu durum öğrencilerin derse aktif katılımını da gerektirmektedir. Kimya ders kitaplarında grafik düzenleyicilerin kullanılması hem öğrencilerin derse aktif katılımını artırabilir hem de üst düzey düşünme becerilerinin gelişmesine katkı sağlayabilir. Bu çalışmada, ortaöğretim kimya ders kitaplarında ne tür grafik düzenleyicilerin yer aldığını ve bu grafik düzenleyicilerin kullanım amaçları ile ders kitaplardaki yerleşimlerinin belirlenmesi amaçlanmıştır. Çalışma nitel araştırma metodolojisine dayalı olup, doküman inceleme yöntemi kullanılmıştır. Çalışmada 9, 10, 11 ve 12. sınıflar olmak üzere dört kimya ders kitabı, grafik düzenleyicilerin sınıflandırılmasına ilişkin bir kavram haritası dikkate alınarak analiz edilmiştir. Çalışmanın sonunda 9. sınıf kimya ders kitabında 15, 10. sınıf kimya ders kitabında 21, 11. sınıf kimya ders kitabında 8 ve 12. sınıf kimya ders kitabında 11 olmak üzere tüm kimya ders kitaplarında toplam 55 grafik düzenleyicinin bulunduğu belirlenmiştir.

Anahtar Kelimeler: *Grafik düzenleyici, kimya ders kitabı, ortaöğretim*

Introduction

Studies have shown that all level students have problems understanding chemistry topics and concepts (Nakhleh, 1992; Nakiboğlu, 2003; Nakiboğlu, 2006; Nakiboğlu and Nakiboğlu, 2019; Nyachwaya et al., 2011; Rahayu, Treagust and Chandrasegaran, 2021; Sanger and Greenbowe, 1997; Taber, 1994; Taber et all., 2012). The students can also have misconceptions about many chemistry concepts because chemistry concepts seem too abstract for students at this level. One of the reasons related to the problematic nature of chemistry learning is that understanding chemistry needs declarative, procedural, and relational knowledge and problem-solving skills which can each of containing low or high levels of cognitive complexity. This requires that students construct the relationships between facts, concepts, and or ideas within a learning task (Nakiboğlu and Nakiboğlu, 2019; 2021). Because of all these, the chemistry course is one of the most challenging courses in upper-secondary schools and teachers can benefit from many support materials to teach chemistry topics and concepts in their lessons (Nakiboğlu, 2018).

Today, despite the increasing use of various supplementary materials and instructional technology in lessons, textbooks are still considered the most important source of teaching and learning activities (Nakiboğlu, 2009). In countries where education is highly centralized and standardized and teachers are required to adhere strictly to curriculum content (Yang et al., 2020), science textbooks are even seen as the main teaching and learning resources for teachers and students (Upahi and Ramnarain, 2019). The textbooks prepared in line with the curriculum in Turkey are guiding the teachers in many issues such as planning the lesson and conducting in-class activities. Studies have stated that textbooks are used as the most basic resources both inside and outside the classroom in teaching science subjects, and therefore they are still of great importance for students (Nakiboğlu, 2009). Köseoğlu et al. (2003) emphasized that textbooks should support meaningful learning as an effective learning tool, therefore it is important to activate the pre-knowledge about the subject with materials that help to remember such as questions, stories, demonstration experiments, pictures, or video demonstrations.

The role of textbooks in the teaching process reveals the necessity of preparing the textbooks very carefully and taking into account certain standards (Nakiboğlu, 2009). Liu and Khine (2016) have emphasized that science education studies draw attention to the irreplaceable value of textbooks for students to acquire scientific knowledge. Besides, providing the expected benefit from the textbooks is closely related to the method followed during the preparation and the drawings, illustrations, representations, examples, and exercises used in the book. Because textbooks can improve students' conceptual knowledge and be effective on students' cognitive and metacognitive skills (Liu and Khine, 2016) only by using illustrations, notations, representations, examples, and exercises appropriately in the book. Graphic organizers are one of the important tools used in textbooks that will enable students to develop their conceptual meanings and establish the correct relationships between concepts within the subject.

Ausubel (1960) indicated that learning meaningful verbal material could be enhanced by using an advance organizer. An advance organizer (AO) is a tool that is presented before the material to be learned, and that helps students to organize and interpret new incoming information. AOs can be presented graphically and these kinds of advance organizers are also called graphic advance organizers or graphic organizers (GOs) (Nakiboğlu et al., 2010). Sometimes it can be seen that the names of AOs and GOs are used interchangeably. On the other hand, there are several important differences between them. While AOs are being used at the beginning of the teaching period to establish relationships between concepts in the students' minds and incoming information, GOs can be used in any process of the teaching period with different aims. GOs can be used as teaching material according to the purpose of the position of use, or as an evaluation tool according to the position. Besides, while GOs need to be visual, the AOs can be visual, solely prose, or auditory (Nakiboğlu et al., 2010). As a result, while an AO can also be a GO, not every GO has to be an AO.

GOs have a very important place in learning the subject in a meaningful way by organizing the knowledge that students have while learning the subject. Thus, GOs show the relationships on the subject and can be used to summarize or draw conclusions about the subject, as well as being effective in organizing ideas (Nakiboğlu and Çamurcu, 2014). In addition, they help to associate new information with previous information and contribute to the storage and recall of information (Guzel-Özmen, 2009). GOs that visually show the relationships between concepts and ideas provide focus on information and increase the level of understanding of text content by making it clearer (DiCecco and Gleason, 2002; Vaughn and Edmonds, 2006). According to Egan (1999), GOs can be used in classroom teaching individually or in groups. Using them in groups enables students to establish positive social relationships and learn to share information. GOs organize the preliminary information in a diagram, allowing new information to be added to the preliminary information effectively and quickly. According to Yin (2012), GOs are especially helpful in visualizing the information given to students verbally or in prose and making it easier to remember by making it schematic.

It has been revealed as a result of various studies that GOs make it easier for students to learn, remember, understand what they read, and ensure the permanence of knowledge (Braselton and Decker, 1994; Cala, 2019; Griffin, Malone and Kameenui, 1995; Ives, 2007; Kaur and Kamini, 2018; Lusk, 2014; Mitchell and Hutchinson, 2003; Yin, 2012). Most of them found that effective learning can be assisted through the use of GOs and GOs enhanced the critical thinking and higher-order thinking skills of the students. In one of the studies concerning science teaching, Kaur and Kamini (2018) examined the effect of teaching through GOs such as hierarchy diagrams, cycle maps, spider maps, sequence diagrams, timelines, cause and effect charts, and Venn diagrams on academic achievement in Science subjects. The results of the study showed that the achievement in science of the group taught using GOs was significantly more as compared to the group taught by the traditional method. Lusk (2014) determined that teaching methods using GOs were beneficial for students in a special education science classroom who are being taught conceptual scientific knowledge. It was also concluded that the use of GOs accessed information in a manner that allows them greater understanding and comprehension of the complex scientific concepts being taught to them as opposed to lecture-style instruction. Cala (2019) investigated the effect of GOs on 8th-grade students' levels of conceptual understanding concerning several biology topics, and the effect of students' cognitive levels on conceptual understanding.

When the studies conducted on the use of GOs in science teaching and its effects on student achievement and comprehension are examined, it is seen that the studies carried out using a combination of many GOs together are relatively few compared to the studies carried out using a single GO such as the concept maps (Buntting, et al., 2006; Wang et al., 2021), fishbone diagrams (Ahmed, 2020), Spider Map (Bamidele and Oloyede, 2013), and flow diagram (Nakiboğlu et al., 2016)

Buntting et al. (2006) investigated the use of concept mapping in introductory biology tutorial classes. They found that the students thought the use of concept mapping enjoyable and that it could enhance meaningful learning for topics that require students to link concepts. Wang et al. (2021) examined the comparative effectiveness of three concept map activities concerning the topic of reaction enthalpy in an introductory general chemistry course. They found that the three concept map activities had an equal impact on conceptual understanding assessed by the multiple-choice questions.

Ahmed (2020) investigated the effect of the fishbone strategy on the achievement of chemistry and visual thinking among middle school students. It was concluded that the effect of the fishbone strategy in chemistry teaching, led to an effective impact in raising the academic achievement of first-year middle school students and visual thinking. Nakiboğlu et al. (2016) investigated the prospective chemistry teachers' views about performing experiments with flow diagrams in the context of a general chemistry laboratory course. They concluded that the prospective chemistry teachers found that the flow diagrams were useful for time management and the preparation for the experiments.

In the literature review, although analyzes of the chemistry textbooks taught in Turkey were carried out for different purposes, no analysis was found in terms of GO. It was determined that only upper-secondary school physics textbooks (Nakiboğlu and Çamurcu, 2014) and lower-secondary school science textbooks (Nakiboğlu and Yıldırım, 2018) analyzes were made about GOs. Considering the difficulties experienced by students in terms of chemistry concepts, it is important to examine the situation and usage purposes of GOs in upper-secondary school chemistry textbooks, which have an important place in students' conceptual learning. Thus, in this study, it was analyzed the GOs used in chemistry textbooks in terms of several criteria such as the type and style of GOs, Purpose of usage, and position in the textbook. Besides, they were examined whether they were prepared following the GOs preparation rules. For this purpose, answers to the following research questions were sought in the study.

1. What types of GOs are placed in the 9th-grade chemistry textbook, what is the distribution of these GOs according to units, and what are the positions and purposes of use of GOs in the textbook? Are the GOs in the 9th-grade chemistry textbook appropriately prepared in terms of format and context?
2. What types of GOs are placed in the 10th-grade chemistry textbook, what is the distribution of these GOs according to units, and what are the positions and purposes of use of GOs in the textbook? Are the GOs in the 10th-grade chemistry textbook appropriately prepared in terms of format and context?
3. What types of GOs are placed in the 11th-grade chemistry textbook, what is the distribution of these GOs according to units, and what are the positions and purposes of use of GOs in the textbook? Are the GOs in the 11th-grade chemistry textbook appropriately prepared in terms of format and context?
4. What types of GOs are placed in the 12th-grade chemistry textbook, what is the distribution of these GOs according to units, and what are the positions and purposes of use of GOs in the textbook? Are the GOs in the 12th-grade chemistry textbook appropriately prepared in terms of format and context?
5. What are the differences and similarities in the distribution of GOs according to grades in upper-secondary school chemistry textbooks?
6. What are the differences and similarities of GOs' purpose of usage in upper-secondary school chemistry textbooks?

Method

In this study, the document analysis method was used. Document analysis provides a systematic procedure for reviewing or evaluating document material and requires that data be examined and interpreted to elicit meaning, gain understanding, and develop empirical knowledge (Bowen, 2009). Ary, Jacobs, and Sorensen (2010) stated that document analysis is a research method applied to written or visual materials to identify specified characteristics of the material. According to them, these materials analyzed can be textbooks, newspapers, web pages, speeches, television programs, advertisements, musical compositions, or any of a host of other types of documents. In this study, upper-secondary school chemistry textbooks were used as the analyzing materials.

Sample

The GOs in the four upper-secondary school chemistry textbooks, 9th, 10th, 11th, and 12th grades, written according to the 2018 Chemistry Curriculum were analyzed in the present study. The two main criteria were considered while choosing the chemistry textbooks: All textbooks must be certificated by the Board of Education and Training of the Ministry of National Education and published by the Ministry of National Education (MoNE).

Data Collection and Analysis Presentation of Data

The descriptive analysis technique, one of the qualitative data analysis techniques, was used in this study. Descriptive Analysis is superficial compared to content analysis and is used in studies where the conceptual structure of the research is determined (Yıldırım and Şimşek, 2011, p. 223). According to Yıldırım and Şimşek (2011), the descriptive analysis approach includes the steps of processing qualitative data, defining the findings, and interpreting the identified findings depending on a predetermined framework. The process involves a careful, more focused re-reading and review of the data. The reviewer takes a closer look at the selected data and performs coding and category construction, based on the data's characteristics, to uncover themes pertinent to a phenomenon.

The analysis method used by Nakiboğlu and Yıldırım (2018) was followed and the most of predefined codes were used in which science textbooks were analyzed in terms of graphic organizer usage. The concept map classification of GOs adapted from Nakiboğlu and Yıldırım (2018) used in this study was re-examined by the researcher taking into account the literature review, and it was re-prepared with minor corrections and with adding, and then translated into English. The rearranged concept map classification of GOs is shown in Figure 1.

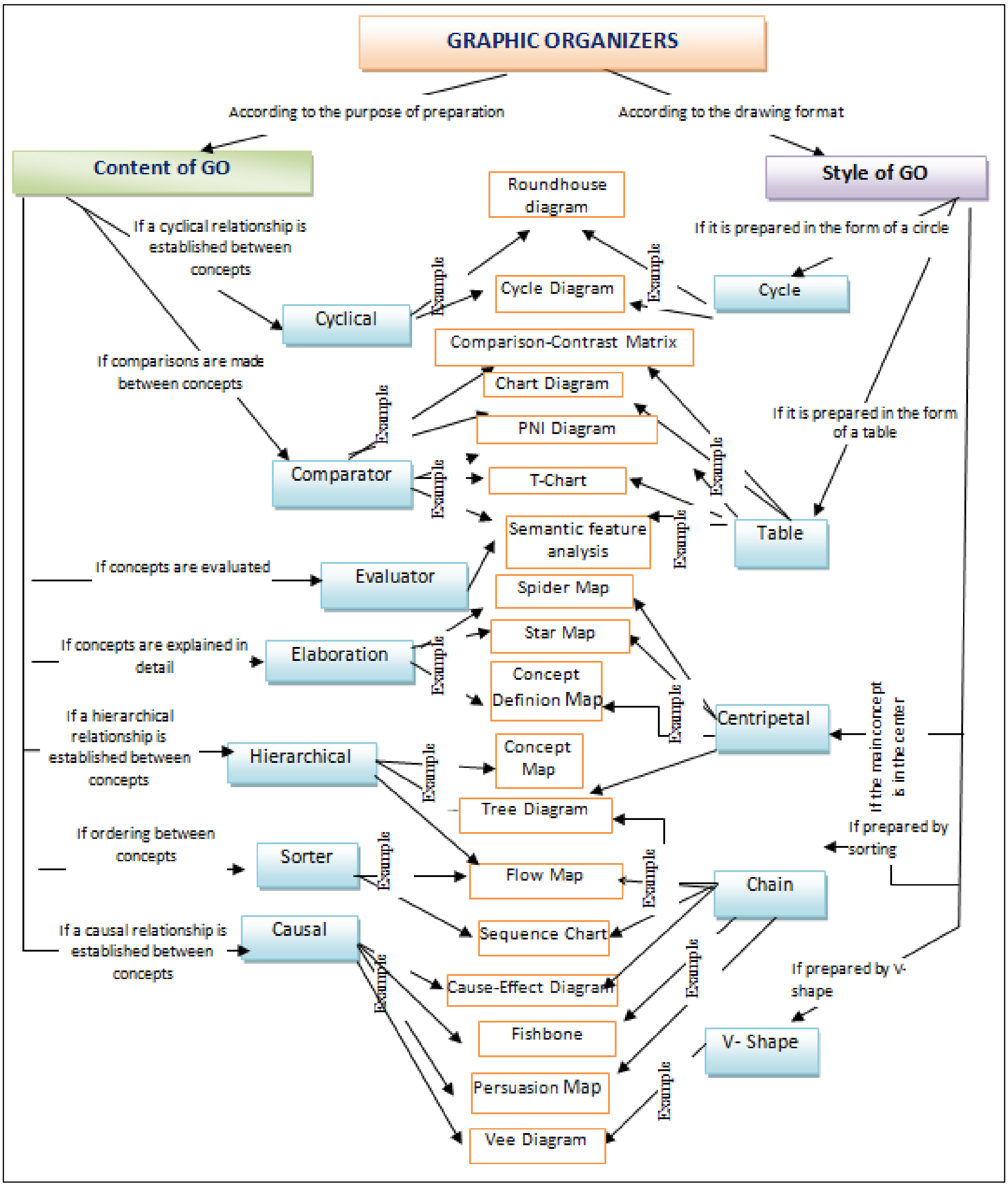


Figure 1. *Concept map for Classification of Graphic Organizers (Adapted from Nakiboğlu and Yıldırım, 2018).*

In the concept map placed in Figure 1, contextual means how the content, ie concepts, is presented. In other words, the contextual title was used to classify how the content was presented, such as whether a cyclical relationship was established between the concepts, whether the concepts were compared or whether the concepts were explained in detail. The meaning of format, on the other hand, is how a graphic editor looks figuratively. In other words, format refers to how the graphic editor is drawn. For example, it has been drawn in the form of a table or chain or has a drawing shape that starts from the center.

By using the graphic organizer classification of the concept map created in this way, the analysis of the chemistry textbooks was carried out as follows: First of all, considering how the content presentation of GO is, it has been determined which category it falls into contextually. Then, the drawing shape was analyzed and it was determined which style category it fell into. Afterward, an analysis was made for the usage purpose of GOs in the books and their positions in the chemistry textbooks. Later, these data were tabulated and analyzed again by the author for about a month. It was determined that there was approximately 100% agreement between the two analyzes. Finally, all GOs were examined one by one in terms of whether they were prepared following the determined GO type, they were compared with the examples in the literature where necessary, and it was determined that they were incompatible and noted. When it was decided that a GO is not prepared properly, that GO was marked with an (*) sign next to that GO in the table. With these transactions, intra-judge reliability was also provided (Gay and Airasion, 2000, p.175).

Presentation of Data

By using the graphic organizer classification of the concept map created in this way, the analysis of the chemistry textbooks was carried out. The findings are presented in tables, including the page numbers of the GOs, showing the location of the unit, the purpose of use, and the unit number. In addition, examples and direct quotations are included where necessary during the explanations of the findings.

Findings

Findings are presented under separate headings below to answer the research questions.

Presentation of Data

The 9th-grade chemistry textbook was analyzed according to which unit the GOs are in, what their types are, where they are located, and their purpose of use. In addition, the GOs in the 9th-grade chemistry textbook were also examined according to whether they were prepared appropriately or not. The findings of this analysis are shows in Table 1.

Table 1. *Findings of 9th-grade chemistry textbook analysis*

Contextual type of GO	Style type of GO	Name of GO	Unit number	Page number	Position	Purpose of usage
Elaboration	Centripetal	Spider Map*	1	31	In the topic	Comprehension
Elaboration	Chain	Concept Map*	2	64	End of chapter	Evaluation
Hierarchical	Chain	Concept Map*	2	72	End of chapter	Evaluation
Hierarchical	Chain	Concept Map*	4	164	End of topic	Evaluation
Hierarchical	Chain	Tree Diagram	3	101	End of chapter	Evaluation

Hierarchical	Chain	Tree Diagram	3	105	In the topic	Comprehension
Hierarchical	Chain	Tree Diagram	3	116	In the topic	Comprehension
Hierarchical	Chain	Tree Diagram	4	154	In the topic	Comprehension
Comparator	Table	SFA*	3	127	End of topic	Evaluation
Comparator	Table	SFA*	3	131	End of topic	Evaluation
Comparator	Table	SFA*	3	137	End of topic	Evaluation
Comparator	Table	T-Chart	4	149	In the topic	Comprehension
Comparator	Table	T-Chart	4	163	In the topic	Comprehension
Comparator	Table	T-Chart	4	182	End of unit	Evaluation
Cyclical	Cycle	Cycle Diagram	4	148	In the topic	Comprehension

* GO that has been determined as not being properly prepared.

When Table 1 is examined, it is seen that GOs placed in the 9th-grade chemistry textbook are included in Elaboration, Hierarchical, Comparator, and Cyclical types as Contextual Type of GO; Format Type of GO, it is seen that there are four types as Centripetal, Chain, Table, and Cyclic. When the GOs of these types are examined, it is seen that five different GOs such as Spider Map, Concept Map, Tree Diagram, Semantic Feature Analysis (SFA), T-Chart, and Cycle Diagram are included in the 9th-grade chemistry textbook. When the usage purposes of GOs in the textbook are examined, it is seen that they are used for evaluation purposes at the end of the subject and unit, and to contribute to comprehension.

Looking at the distribution of the GOs according to the units, it is seen that there is one GO in the first unit, *Chemistry Science*, three in the *Atom and Periodic System* unit, which is the 2nd unit, six in the *Interactions between Chemical Species*, which is the 3rd unit, and six in the *States of Matter* unit, which is the 4th unit. It is also seen that there was no GO in the last unit, *Nature and Chemistry*. It was determined that the spider map on page 31 was prepared about the main professions related to the field of chemistry. The topic title was written in the center and the related professions were explained in detail in the sections around the topic title.

The first concept map about the atom was prepared in the centripetal concept map format. It is used for evaluation purposes at the end of the chapter. Although the atom is written as the central concept, when examined in detail, it has been determined that the concept map is related to atomic models. The concept map is also about the atom, prepared as a hierarchical concept map, and is located at the end of the chapter. The third concept map is a concept map that is stated in the book to be related to the particles of the atom. It is a hierarchical concept map used for evaluation at the end of the topic.

The first of the three tree diagrams deal with "the chemical species" on page 101. It has been determined that it is located at the end of the chapter and used for evaluation purposes. It has been seen that this tree diagram shows how some concepts related to chemical species are related to each other. While the tree's trunk represents the main topic which is chemical species, the branches represent relevant concepts such as the atom, molecule, and ion. The second tree diagram on page 105 is related to "the interactions between chemical species" and it has been determined that it is used to contribute to a better understanding of the subject by classifying it within the subject. The last tree diagrams are about crystalline solids and it has been seen that it is used to contribute to a better understanding what the types of crystalline solids.

It has been determined that the first SFA was prepared for "the features of chemical reactions", it was placed at the end of the topic and was used for evaluation purposes. In this GO, it is seen that the different chemical reactions are compared in terms of three features. The second SFA is related to "the features of molecules" and the molecules are compared in terms of three features. The last SFA was prepared for the chemical and physical changes.

It was determined that the T-chart on page 149 was prepared to compare the physical states of the substance in the form of a list. It is included in the topic and has been prepared for a better understanding of the subject. It has been seen that the T-chart on page 163 was prepared for the comparison of the concepts of "evaporation and boiling", included in the topic, and prepared for a better understanding of the concepts. It has been determined that the last T-chart at the end of the unit on page 182 is included in the book to evaluate the understanding of the concepts of "evaporation and boiling". It has been determined that the cycle diagram, on page 148, has been prepared with no beginning and no end, showing the changes between the states of matter and a recurring cycle of events.

When analyzes regarding the appropriateness of the GOs in the 9th-grade chemistry textbook are examined, it was determined that all three concept maps were not prepared appropriately. Of the three concept maps in the book, the first concept map is about atomic models, and it seems to resemble a star map or spider map rather than a concept map. The only difference for the star map (or the spider map) is that the proposition is written on the arrows coming out of the main concept. It was seen that the textbook referred to this shape as a "concept map" in the text. On the other hand, it has been determined that the propositional statements that connect the concepts and appear on the arrows do not comply with the concept map preparation rules. Another inconvenient situation is the absence of propositions on the arrows from the atomic models given as secondary concepts. In addition, the students were asked to write information in the form of errors and truths of atomic theories in two boxes where the arrows coming out of the secondary concept were directed. An adapted illustration from a part of this concept map showing these explanations is given in figure 2.

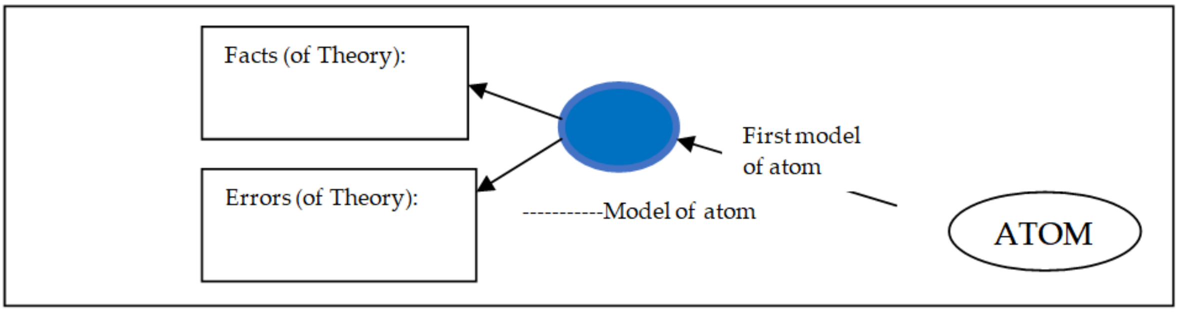


Figure 2. *The adapted illustration from a part of the concept map*

When the concept map on page 72 is examined, it is seen that the propositional statements connecting the concepts and located on the arrows do not comply with the concept map preparation rule (for example, writing a question statement instead of the linking statement) It is seen that the way it is given does not coincide with the concept map rule. Similarly, it was determined that the other concept map on page 164 was not prepared following the rules of concept map preparation. A figure was used for the main concept. In addition, this figure suggests that it is used for two different concepts, liquid, and gas, based on the propositions written to connect it. So, the main concept of the concept map is not clear. In the last part of the concept map, it was determined that four boxes for writing different concepts were put with a proposition.

When examining whether the other GOs placed in the 9th-grade chemistry textbook were prepared appropriately, it was determined that although the spider map and SFA were appropriate in terms of content, they were not prepared appropriately in format. It is seen that there are no arrows that go from the central concept or subject in the spider map to the sub-headings. In the SFA, it was determined that marking to fill in the blanks was not desired, and it was desired to fill in the blanks in writing. In this respect, it was not found appropriate as a format. On the other hand, it was determined that the GOs included in the T-chart and cycle diagram group were prepared following the content to a large extent.

Findings of 10th-Grade Chemistry Textbook Analysis

The 10th-grade chemistry textbook was analyzed according to which unit the GOs are in, what their types are, where they are located, and their purpose of use. In addition, the GOs in the 10th-grade chemistry textbook were also examined according to whether they were prepared appropriately or not. The findings of this analysis are shown in Table 2.

Table 2. *Findings of 10th-grade chemistry textbook analysis*

Contextual type of GO	Style type of GO	Name of GO	Unit number	Page number	Position	Purpose of usage
Elaboration	Centripetal	Star Map	1	56	Beginning of the topic	Advance organizer
Elaboration	Centripetal	Star Map	3	170	End of the unit	Evaluation
Elaboration	Centripetal	Star Map	4	196	End of the unit	Evaluation
Elaboration	Centripetal	Spider Map*	3	150	In the topic	Comprehension
Elaboration	Centripetal	Spider Map*	2	98	In the topic	Comprehension
Hierarchical	Chain	Tree Diagram	2	126	End of the unit	Evaluation
Comparator	Table	T-Chart	1	51	In the topic	Comprehension
Comparator	Table	T-Chart	2	95	In the topic	Comprehension
Comparator	Table	T-Chart	4	181	In the topic	Comprehension
Comparator	Table	T-Chart	4	187	In the topic	Comprehension
Comparator	Table	SFA*	2	92	Beginning of the unit	Evaluation of pre-knowledge
Comparator	Table	SFA*	2	92	Beginning of the unit	Evaluation of pre-knowledge
Comparator	Table	SFA*	2	92	Beginning of the unit	Evaluation of pre-knowledge
Comparator	Table	SFA	2	103	End of the topic	Evaluation
Comparator	Table	SFA*	3	132	Beginning of the unit	Evaluation of pre-knowledge
Comparator	Table	SFA*	3	132	Beginning of the unit	Evaluation of pre-knowledge
Comparator	Table	SFA*	3	132	Beginning of the unit	Evaluation of pre-knowledge
Comparator	Table	SFA*	3	132	Beginning of the unit	Evaluation of pre-knowledge
Comparator	Table	SFA*	4	205	End of unit	Evaluation
Comparator	Table	SFA*	4	206	End of unit	Evaluation
Sorter	Chain	Sequence Chart*	1	68	In the topic	Comprehension

* GO that has been determined as not being properly prepared.

From Table 2, it is seen that GOs placed in the 10th-grade chemistry textbook are included in Elaboration, Hierarchical, Comparator, and Sorter as Contextual Types of GO; As Format Type of GO, it is seen that there are three types Centripetal, Chain, and Table. When the GOs of these types are examined, it is seen that six different GOs such as Spider Map, Star Map, Tree Diagram, SFA, T-Chart, and Sequence Chart are included in the 10th-grade chemistry textbook. When the usage purposes of GOs in the textbook are examined, it is seen that they are used for evaluation purposes at the end of the subject and unit, and to contribute to comprehension. When the distribution of the GOs according to the units is examined, it was seen that there were three GOs in the first unit, *Basic Laws of Chemistry and Chemical Calculations*, seven in the *Mixtures* unit, which is the 2nd unit, six in the *Acids, Bases, and Salts*, which is the 3rd unit, and five in the *Chemistry is Everywhere* unit, which is the 4th unit.

As seen in Table 2, there are three star maps in the 10th-grade chemistry textbook. It was determined that the star map on page 56 was prepared for chemical reaction types. When this Star map was examined, it was seen that it was used as an illustrated advance organizer at the beginning of the subject of chemical reaction types. The star maps on page 170 and page 196 are at the end of the unit for evaluation purposes. In both of them, gaps were left in the explanations around the central concept, and students were asked to fill them in. While the star map on page 170 is related to the usage areas of salt, the star map on page 196 is about dirt.

Table 2 shows that there are two spider maps in the 10th-grade chemistry textbook. It was determined that the spider map on page 150 was prepared for the classification of metals according to their tendency to react, and it was used within the subject to contribute to the understanding of the topic. It has been seen that the spider map on page 98 was prepared for the classification of mixtures according to particle size, included in the topic, and thus prepared to contribute to student comprehension. The single tree diagram in the 10th-grade chemistry textbook on page 126 was prepared at the end of the unit to show how the concepts related to matter are related to each other, and it was prepared for evaluating students' comprehension by leaving blanks on the map for students to fill in.

It has been determined that there are four T-charts in the 10th-grade chemistry textbook. The T-chart on page 51 has been prepared to list and examine two faces of a change in chemical reactions that are changed and conserved in chemical reactions. The T-chart on page 95 was prepared to list the properties of homogeneous and heterogeneous mixtures and to examine the two aspects of the subject of mixtures, on page 181 was prepared for listing and comparing the properties of soap and detergent, and the T-chart on page 187 was prepared for examining the advantages and disadvantages of polymers.

When Table 2 is examined, it is seen that there are ten SFAs in the 10th-grade chemistry textbook. It is seen that the three SFAs on page 92 were prepared at the beginning of the mixtures unit to evaluate the student's prior knowledge. The samples given in the first SFA are required to be determined as pure substance or mixture, and the samples given in the second SFA are required to be determined as homogeneous/heterogeneous. In the third SFFA, the characteristics of homogeneous and heterogeneous mixtures are given and students are expected to choose which is homogeneous and which heterogeneous mixture. Similarly, at the beginning of the four SFA, *Acids, bases, and salts* unit on page 132, it is seen that students are prepared to evaluate their pre-knowledge about acids, bases, and pH. In two of these SFAs, they were given the names of some substances and were asked to identify them as acids or bases in the first and to determine whether the pH values of these substances were greater or less than 7 in the other.

In the third SFA, some expressions are given and asked to choose whether they belong to acids or bases. In the last SFA, it was seen that some matters were given together with their visuals, and it was desired to determine whether the pH values of these matters were greater or less than 7, to determine the color change of litmus paper with these matters, and to determine the ion that these matters gave to the water after they ionized in water. It was seen that the SFA on page 103 is prepared at the end of the topic and for evaluation purposes. In this SFA, it is requested to determine whether the given molecules will dissolve in the given solvents and if so, the type of interaction. In the SFA on page 205, some materials used in daily life were asked to be marked as positive or negative by giving their properties, and on page 206, some statements about the environment were asked to be marked as true or false. Examining the single sequence chart on page 68, it has been seen that this sequence chart contained steps related to the formulas used to convert the amount of substance in chemical calculations into different units such as moles, grains, liters, and grams, and they are arranged sequentially.

When analyzes regarding the appropriateness of the GOs in the 10th-grade chemistry textbook are examined, it was determined that although two spider maps were appropriate in terms of content, they were not prepared appropriately in format. While there are no arrows in the spider map on page 150, it is seen that in the Spider Map on page 98, the arrows are placed similarly to the tree diagram without the subject title being written in the center. It was determined that all of the star maps and T-charts were prepared properly. On the other hand, a GO on page 126 was labeled as Tree Diagram as a result of the analysis and it was determined that it was prepared by the Tree Diagram. However, it was seen that this GO, which was determined as a tree diagram in the 10th-grade chemistry textbook, was referred to as a concept map by the textbook. When this GO was examined, it was determined that the propositions that should be in the concept map were not included and therefore it could not be a concept map. It has been determined that some of the SFA types of GOs are not prepared properly, as shown in Table 2. As a result of the analysis, it was determined that although these are similar in content to Semantic Feature Analysis, they are partially suitable in format. Although the GO on page 68 is similar in shape to the sequence chart, it is seen that it does not fully comply with the content.

Findings of 11th-Grade Chemistry Textbook Analysis

The 11th-grade chemistry textbook was analyzed according to which unit the GOs are in, what their types are, where they are located, and their purpose of use. In addition, the GOs in the 11th-grade chemistry textbook were also examined according to whether they were prepared appropriately or not. The findings of this analysis are shown in Table 3.

Table 3. *Findings of 11th-grade chemistry textbook analysis*

Contextual type of GO	Style type of GO	Name of GO	Unit number	Page number	Position	Purpose of usage
Comparator	Table	T-Chart	1	24	In the topic	Comprehension
Comparator	Table	T-Chart	1	74	End of unit	Evaluation
Comparator	Table	T-Chart*	6	249	In the topic	Comprehension
Comparator	Table	T-Chart*	6	249	In the topic	Comprehension
Comparator	Table	SFA*	1	30	End of topic	Evaluation
Comparator	Table	SFA*	1	64	End of topic	Evaluation
Comparator	Table	SFA*	3	126	End of topic	Evaluation
Comparator	Table	SFA*	4	162	Beginning of the unit	Evaluation of pre-knowledge

* GO that has been determined as not being properly prepared.

From Table 3, it is seen that there is only Comparator as Contextual Type of GO in the 11th-grade chemistry textbook; It is seen that the Format Type of GO is Table as well. When the GOs of these types are examined, it is seen that two different GOs, T-Chart and SFA, are included in the 11th-grade chemistry textbook. When the usage places and purposes of GOs in the textbook are examined, it is seen that they are used for evaluation purposes at the end of the subject and evaluation of pre-knowledge at the beginning of the unit, as well as to contribute to comprehension in the subject.

When the distribution of the GOs according to the units of 11th grade was examined, it was seen that there were four GOs in the first unit, *Modern Atomic Theory*, one in the *Liquid Solutions and Solubility* unit, which is the 3rd unit, one GO in the *Energy in Chemical Reactions* unit, which is the 4th unit, and two GOs in the *Equilibrium in Chemical Reactions* unit, which is the 6th unit. It is also seen that there was no GO in the *Gases* unit, which is the 2nd, and in the *Rate of Chemical Reactions* unit, which is the 5th.

It has been determined that there are four T-charts and four SFAs in the 11th-grade chemistry textbook. The T-chart on page 24 has been prepared in such a way as to list the characteristics of orbit and orbital concepts. It is included in the subject and aims to contribute to the student's understanding. When the T-chat at the end of the unit on page 74 is examined, it has been seen that this T-chart is the form of the T-chart on page 24 converted into a question. Some of the statements written as a list for orbital and orbital concepts were left blank and the students were asked to fill them in. The first of the two T-charts on page 249 shows a comparison of the ionization of strong acids and bases in water. The other T-chart also shows the comparison of the ionization of weak acids and bases in water. The SFA on page 30 was prepared for evaluation and is located at the end of the chapter, and in this SFA, students were asked to write down the quantum numbers of the orbitals given. The SFAs on pages 64 and 126 are also located at the end of the chapter and are prepared for evaluation purposes. The students were asked to determine the interactions between the given pairs of chemical species and to write whether the pairs would dissolve in each other. The last SFA on page 162 is at the beginning of the unit and it was determined that it was prepared to evaluate the student's prior knowledge about the energy change in reactions.

When the analyzes regarding the appropriateness of the GOs in the 11th-grade chemistry textbook are examined, it was determined that the T-charts on pages 24 and 74 were prepared appropriately, but the two T-Charts on page 249 were only suitable in terms of content, that is, they compared two subjects but did not show them in a single table, so it was not appropriate in terms of the format. When the SFAs were examined, it was determined that although all of them were prepared formally, they were not fully prepared in terms of content. It was seen that all of them should be answered in writing instead of marking.

Findings of 12th-Grade Chemistry Textbook Analysis

The 12th-grade chemistry textbook was analyzed according to which unit the GOs are in, what their types are, where they are located, and their purpose of use. In addition, the GOs in the 12th-grade chemistry textbook were also examined according to whether they were prepared appropriately or not. The findings of this analysis are shown in Table 4.

Table 4. *Findings of 12th-grade chemistry textbook analysis*

Contextual type of GO	Style type of GO	Name of GO	Unit number	Page number	Position in the textbook	Purpose of usage
Hierarchical	Chain	Tree Diagram	3	129	In the topic	Comprehension
Hierarchical	Chain	Tree Diagram*	3	161	In the topic	Comprehension
Hierarchical	Chain	Tree Diagram	3	168	In the topic	Comprehension
Hierarchical	Chain	Tree Diagram	3	173	In the topic	Comprehension
Hierarchical	Chain	Tree Diagram	3	180	In the topic	Comprehension
Hierarchical	Chain	Tree Diagram	3	186	In the topic	Comprehension
Comparator	Table	T-Chart	1	29	In the topic	Comprehension
Comparator	Table	T-Chart	1	61	In the topic	Comprehension
Comparator	Table	T-Chart	2	86	In the topic	Comprehension
Comparator	Table	SFA	1	17	End of topic	Evaluation
Comparator	Table	SFA	2	86	End of topic	Evaluation

* GO that has been determined as not being properly prepared.

From Table 4, it is seen that there are two types of the contextual type of GO, hierarchical, and comparator in the 12th-grade chemistry textbook; There are two types of chain and table as format types of GO. When the GOs of these types are examined, it is seen that three different GOs such as tree diagram, T-chart, and SFA are included in the 12th-grade chemistry textbook. When the places and usage purposes of the GOs are viewed, it is seen that most of them are prepared for contributing to comprehension and two of them are for evaluation at the end of the topic.

When the distribution of the GOs according to the units of 12th grade was examined, it was determined that there were three GOs in the first unit, *Chemistry and Electricity*, two in *Introduction to Carbon Chemistry*, which is the 2nd unit, six GOs in *Organic Compounds* unit, which is the 3rd unit. It is also seen that there was no GO in *Energy Resources and Scientific Developments* unit, which is the 4th unit.

When viewing the GOs in Table 4, it has been seen that all tree diagrams are used to contribute to the comprehension of the subject. It has been determined that the tree diagram on page 129 is related to hydrocarbons, the tree diagram on page 161 has been prepared for the classification of alcohols, the tree diagram on page 168 is related to the classification of ethers, the tree diagram on page 173 has been prepared for the classification of carbonyl compounds, and the tree diagrams on pages 180 and 186 were used for the classification of carboxylic acids and fatty acids, respectively. When the three T-charts in the 12th-grade chemistry textbook are analyzed in detail, it was seen that T-chart on page 29 was prepared to compare the characteristics of the anode and cathode, the T-chart on page 61 was prepared to compare the galvanic and electrolytic cells, and the T-chart on page 86 was prepared for comparing organic and inorganic compounds. It is also seen that all of the T-charts are included in the topic and are used to contribute to student understanding. When the two SFAs in the 12th-grade chemistry textbook are examined in detail, it is seen that they are asked to correctly mark the reduction half-reaction and oxidation half-reaction whose equations are given in SFA on page 17. The samples given in SFA on page 86 were asked to be marked as organic or inorganic compounds. It was determined that both SFAs were prepared for evaluation at the end of the topic.

When the analyzes regarding the appropriateness of the GOs in the 12th-grade chemistry textbook are examined, it was determined that all tree diagrams except the tree diagram on page 161 were prepared appropriately but were drawn in a way to show a very simple classification. Although the tree diagram on page 161 was prepared in a suitable form, it was seen that it was not appropriate in terms of content. It has been determined that elaboration is included in this tree diagram. Regarding T-Charts and SFA, it was understood that all of these GOs were prepared properly.

Findings of The Distribution of GOs According to Grades in The Chemistry Textbooks

To answer the fifth research problem, which was written to reveal the differences and similarities in the distribution of the GOs in the upper-secondary chemistry textbooks, a table was prepared for the comparison of the GOs of all the textbooks in terms of "contextual type of GO" and "format type of GO", and then a graph was drawn concerning the comparison of chemistry textbooks in terms of GOs' types. Related findings are presented in Table 5 and Figure 3.

Table 5. *Findings concerning the numerical distribution of contextual and format types of graphic organizers used in chemistry textbooks*

Contextual type of GO	Style type of GO	9th Grade	10th Grade	11th Grade	12th Grade	Total
Comparator	Table	6	14	8	5	33
Hierarchical	Chain	7	1	-	6	14
Elaboration	Centripetal	1	5	-	-	6
Cyclical	Cycle	1	-	-	-	1
Sorter	Chain	-	1	-	-	1
Total	-	15	21	8	11	55

From Table 5, it is seen that GOs are prepared in five GO contextual types in all textbooks. These are comparator (33), hierarchical (14), elaboration (6), cyclical (1), and sorter (1). When the distribution of GOs as formal types in all chemistry textbooks is looked at, it is seen that GOs are prepared in four formal types and these are table (33), chain (15), centripetal (6), and cycle (1). When compared according to grade levels, it was determined that the most GOs were included in 10th-grade chemistry textbooks with 21. It was determined that the 9th-grade textbooks came second with 15, the 12th-grade textbooks were third with 11, and the 11th-grade chemistry textbooks came last with 8 of them.

From Figure 3, it is seen that GO, which is included in all grade levels and is found in all of the chemistry textbooks in total, is SFA. It was determined that the other GO found in all grade levels and all the chemistry textbooks in total was T-chart. At the level of all chemistry textbooks, the third most common GO is the tree diagram and it is also included in the books of the other three classes, except for the 11th-grade chemistry textbook. It can be seen from Figure 3 that there are only three star maps found in the 10th-grade chemistry textbook, three spider maps found in the 9th and 10th-grade books, and three concept maps found only in the 9th-grade chemistry textbooks. It has been determined that there is one each of the sequence chart and the cycle diagram in all chemistry textbooks, and these are 10th and 9th grades, respectively.

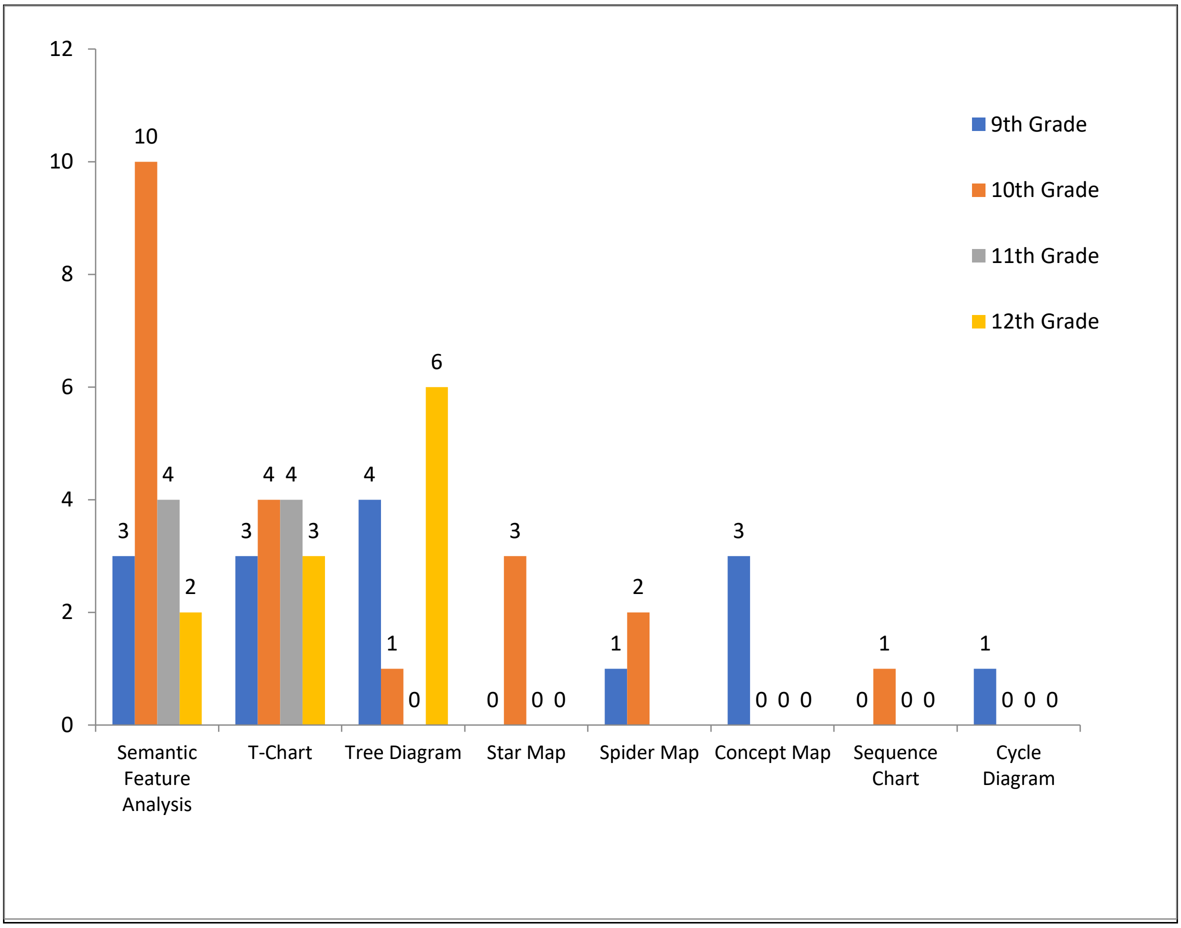


Figure 3. *Comparison of chemistry textbooks in terms of graphic organizers' types*

Findings of The Comparison of The Chemistry Textbooks According to GOs' Purpose of Usage

To answer the sixth research problem, which was written to reveal the differences and similarities of GOs' purpose of usage in the chemistry textbooks, a table was prepared for the comparison of the GOs' purpose of usage. Related findings are presented in Table 6.

Table 6. *Findings on the comparison of GOs' purpose of usage in the chemistry textbooks*

Purpose of usage	9th Grade	10th Grade	11th Grade	12th Grade	f	%
Comprehension	7	7	3	9	26	47.3
Evaluation	8	6	4	2	20	36.4
Evaluation of pre-knowledge	-	7	1	-	8	14.5
Advance organizer	-	1	-	-	1	1.8
Total	15	21	8	11	55	100

When the usage purposes of GOs in chemistry textbooks are viewed from Table 6, it is seen that GOs are used for three purposes. It is understood that 26 of the 56 GOs in all of the books, that is 47.3%, are used in lectures to contribute to comprehension. One of the purposes of the use is evaluation, and it was determined that 36.4% of GOs were used to evaluate their understanding at the end of the subject, chapter and unit. Another purpose of using GOs in textbooks is to evaluate students' prior knowledge, and it is understood that 14.5% of GOs are used in unit entrances for this purpose. Finally, it was found that there was one GO used as an advance GO in the 10^{th}-grade chemistry textbook.

Conclusion and Discussion

In this study, the use of GOs, which contribute significantly to students' meaningful learning, in upper-secondary school chemistry textbooks was evaluated. Thus, the purpose of their usage and place in the chemistry textbooks were determined by analyzing the GOs in the 9th, 10th, 11th, and 12th-grade chemistry textbooks, which were prepared according to the 2018 Chemistry Curriculum and published by the Turkish Ministry of Education, certificated by the Board of Education and Training. Besides, the GOs in the textbooks were analyzed qualitatively and it was examined whether they were prepared following the GO preparation rules.

At the end of the study, it was determined that GOs were used in different contexts and styles in chemistry textbooks. It was concluded that GOs were prepared in five GO contextual types (comparator, hierarchical, elaboration, cyclical, and sorter) and in four styles (table, chain, centripetal, and cycle) in all chemistry textbooks. In the study conducted with the physics textbooks, which is one of the previous studies on the extent to which GOs are included in the textbooks, Nakiboğlu and Çamurcu (2014) determined that the GOs in the upper-secondary school physics textbooks are prepared in four contextual types (comparator, hierarchical, elaboration, and sorter) and four styles (table, chain, centripetal, and cycle). It can be said that these results are in line with the findings of the present study. In another study, Nakiboğlu and Yıldırım (2018) examined GOs in lower-secondary school science textbooks. At the end of the study, they determined that the GOs in the science textbooks are prepared in six contextual types (comparator, hierarchical, elaboration, causal, sorter, and cyclical) and four styles (table, chain, centripetal, and cycle). When the results of the study are compared, it is seen that although the GOs in the science and chemistry textbooks are in the same category in a similar number, more contextual types of GOs are used in the science textbooks. As a result of the studies carried out on the analysis of both physics textbooks and science textbooks in terms of GOs, it has been stated that although it has been determined that GOs are included in the textbooks of every grade level, this number is not very sufficient. Although the expression more or less is a relative concept and may vary according to the point of view, based on the findings of this study, it can be said that a similar conclusion with previous studies was reached.

According to the findings in this study, it was determined that there was only one GO used as an AO in all chemistry textbooks. As mentioned in the introduction section, AO can be prepared graphically and this kind of AO is called a "graphic advance organizer" or "graphic organizer". Since some of the GOs (for example, concept maps) prepared as AO present the information in an organized way, they can help students to organize their cognitive structures more easily and to establish relationships between concepts in their minds more easily and appropriately (Nakiboğlu et al., 2010). The AO can also help students to realize that the topic they are beginning to learn is not new and to provide them with many teaching explanations that include concepts and terms (Nakiboğlu and Çamurcu, 2014). For this reason, science and chemistry education studies support the effective use of the AO in chemistry and science classrooms for learning (Ruangruchira, 1992; West and Kellett, 1981). and to facilitate change in students' conceptualization of the role of creativity in science (Domin, 2008).

When the distribution of GOs in chemistry textbooks by grade level is compared, it has been revealed that there are remarkable differences according to grade. While it was determined that there were the most (21) GOs in the 10th-grade chemistry textbook, it was concluded that the least (8) GOs were found in the 11th-grade textbook. It can be said that it is a very interesting result that although the class level with the highest content and the highest number of units is the 11th grade, there is the least GO in this chemistry textbook. Considering that this situation may be related to the authors. It was also determined that there were 15 GOs in the 9th-grade chemistry textbook. On the other hand, considering the age and learning levels of 9th-grade students, it is thought that the number of GOs (Nakiboğlu and Çamurcu, 2014; Dönmez et al., 2007), which is one of the tools that can be used in the visualization process, should be more and more diverse.

Another conclusion is that the GOs in the textbooks are few in variety. In the concept map for the classification of GOs in Figure 1, 18 types of GO are included. While this number can be increased by diversifying each of these in the literature, GOs that are not very suitable for use in chemistry or science, in general, were not included in this concept map. Together with these, it can be said that the number of GOs in the literature is more than 18. In the study, when the GO varieties in all the textbooks are examined, it is seen that this number is eight. For this reason, the fact that the GO diversity in the chemistry textbooks is not too much can be associated with the fact that the authors of the textbooks do not have enough knowledge about GOs. An important finding that supports the lack of knowledge claims that when referring to the GOs in the analyzed chemistry textbooks, except for the concept map, the others are not addressed by name, and they are mostly called tables, pictures, or figures. Moreover, it was determined that some GOs called concept maps were not concept maps, and the analysis results on whether the GOs were prepared properly to be discussed below showed that half of the GOs in the books were not prepared properly. The GOs, which increase students' interest, participation, and motivation toward the lesson, can be used effectively and efficiently in every step of teaching (Rock, 2004). For this reason, it can be said that the use of only certain and limited numbers of GOs in the analyzed chemistry textbooks also shows that this efficiency of GOs is not sufficiently utilized. Despite this, the fact that some GOs are quite helpful can be an indication that the authors of chemistry textbooks have understood the importance of having such materials in the book, even if they are deficient in GOs.

As shown in the analysis regarding the preparation of GOs, whether they were prepared properly or not, 26 of the 55 GOs in the chemistry textbooks were not prepared properly. When the case of not being prepared correctly in terms of the types of GOs is handled one by one, it has been concluded that all of the concept maps and spider maps, most of the SFA, some of the T-chart, and some tree diagrams are not prepared correctly. Especially the mistakes identified in the books about concept maps are very important. It was determined that most of the rules related to concept maps were not followed in the drawings and one of the GOs called concept maps was not a concept map. Among the GOs, concept maps are the most difficult to prepare and preparation of concept maps requires expertise and experience. Especially the difficulties in adapting the Turkish language structure make it even more difficult to draw a concept map (Bağcı Kılıç, 2003). Bağcı Kılıç (2003) indicated that concept mapping was originally developed in the US for use in the English language and there are some problems in using concept maps in Turkish, arising from linguistic differences between Turkish and English. Another conclusion reached in the study is that SFA is the most used type of GO in all chemistry textbooks. In the study conducted by Nakiboğlu and Yıldırım (2018), it was also determined that one of the GOs used in science textbooks, especially in 5th-grade science textbooks, is the SFA. On the other hand, it is found that not the SFA in chemistry textbooks is prepared properly because it does not show differences and relationships between concepts. This result is similar result to the analysis of physics textbooks. Nakiboğlu and Çamurcu (2014) stated that although some GOs in physics textbooks are similar to the SFA, they were not evaluated as the SFA.

Finally, it was determined that the GOs in the analyzed chemistry textbooks were generally used for three purposes. The first purpose is to contribute to the learning of the students during the teaching period. Considering the use for this purpose, it was understood that the relations between the topic and its sub-concepts were shown mostly by using tree diagrams, or the differences between some topics and concepts were presented by using T-chart, contributing to the student's comprehension. Secondly, it was concluded that it was used for evaluation purposes and lastly to examine students' pre-conceptions. Irwin-DeVitis and Pease (1995) used GOs for the assessment of student learning and they concluded that GOs were excellent assessment strategies that encourage critical and reflective thinking, interdisciplinary connections, and creativity. Gallavan and Kottler (2007) also showed that the GOs they presented can be used in three ways. They explained these usage patterns as follows. The first way is before reading and discussion as a way to pre-assess knowledge, introduce or preview a topic or issue, set the stage, brainstorm ideas, and motivate interest. Secondly, they can use during reading and discussion to provide a tool for taking notes; retaining information; checking, extending, and highlighting the learning as a formative evaluation; and renewing interest. The final way is after reading and discussion to review, reinforce, or assess learning, establish the foundation for future projects and activities, and serve as a summative evaluation. It can be said that the GOs' usage purposes in the analyzed textbooks are close to the usage paths suggested by Gallavan and Kottler (2007). On the other hand, it is seen that it does not coincide with some of the proposed usage patterns such as brainstorming ideas, motivating interest, formative evaluation, renewing interest, and the foundation for future projects and activities.

Using GOs in chemistry textbooks can both increase the active participation of students and contribute to the development of high-level thinking skills (Nakiboğlu and Nakiboğlu, 2021; Nakiboğlu, 2021). Based on these considerations, the following suggestions can be made regarding the use of GOs in chemistry textbooks and the use of GOs in lessons in general.

First, the use of GOs, which are effective in the meaningful learning of students, in textbooks should be increased. However, more important than increasing the number quantitatively, it is very important to be conscious of the intended use of these GOs and their proper preparation. At this point, textbook authors should either get the necessary training or seek an expert opinion when preparing the GOs for the textbooks. Because these materials, which are prepared incorrectly, and the wrong use of their names can mislead teachers and teacher candidates in recognizing the materials.

Although it is important to increase the variety and number of GOs in the textbooks, it can be recommended to include more GOs in the textbooks, especially since some GOs such as concept maps contribute significantly to student comprehension (Nakiboğlu and Erdem, 2010). It has been seen that some of the materials in the textbooks are used almost only for evaluation purposes. Increasing the diversity of the purpose of the use of such materials can make a significant contribution to the student's understanding of chemistry subjects. Especially GOs can be used in teaching dual concepts that are confused by students or correcting misconceptions. For this reason, it can be suggested to use comparison contrast matrices, which have never been used in chemistry textbooks analyzed for dual concepts such as anode/cathode, reducing/oxidant, anion/cation, acid/base.

It was observed that only one GO was used as an AO in the analyzed chemistry textbooks. In a branch of science such as chemistry where there are many misconceptions in students' prior knowledge, it is very important to review the prior knowledge and rearrange it at the beginning of the lesson. For this reason, the number of GOs to be used as AOs in chemistry textbooks should be increased.

Including correctly prepared GOs in the textbooks may not be enough to increase the use of GOs in teaching and to provide the expected benefit. For this purpose, first, there should be teachers who know GOs and will use them appropriately in their lessons. For this reason, it may be recommended to organize in-service training courses on GOs for teachers in the profession. Nakiboğlu (2021) found that the inclusion of a course concerning GOs in the chemistry teacher education program significantly contributed to the professional development of the PCTs. For this reason, it is recommended that the prospective teachers should be given training on how to prepare GOs and how to use the GOs in the textbooks should be taught.

When the chemistry textbooks were examined, it was seen that the students were not informed about GOs and they were not informed about what they are and how to use them. To enable the student to make maximum use of the textbook, it may be suggested that the students be informed about the basic functions of graphic organizers first and then briefly explain the usage areas of each of them in the chemistry textbooks.

Uzun Özet

Ortaöğretim Kimya Ders Kitaplarında Grafik Düzenleyici Kullanımı

Canan NAKİBOĞLU

Giriş

Günümüz programları ve öğretim yaklaşımı çerçevesinde öğrencilerin üst düzey bilişsel becerilerinin geliştirilmesi ve kavramların öğretilmesi son derece önemlidir. Bu durum öğrencilerin derse aktif katılımını da gerektirmektedir. Kimya ders kitaplarında grafik düzenleyicilerin kullanılması hem öğrencilerin derse aktif katılımını artırabilir hem de üst düzey düşünme becerilerinin gelişmesine katkı sağlayabilir. Derslerde çeşitli yardımcı materyallerin ve öğretim teknolojilerinin artan kullanımına rağmen, ders kitapları hala öğretme ve öğrenme etkinliklerinin en önemli kaynağı olarak kabul edilmektedir (Nakiboğlu, 2009). Grafik düzenleyiciler bilgiyi organize ederek konunun anlamlı bir şekilde öğrenilmesinde çok önemli bir yere sahiptir. Konu ile ilgili ilişkileri göstermekte ve konu hakkında özetleme yapmak veya sonuç çıkarmak için kullanılabileceği gibi, fikirleri organize etmede de etkili olmaktadır (Nakiboğlu ve Çamurcu, 2014). Kavramlar ve fikirler arasındaki ilişkileri görsel olarak gösteren grafik düzenleyiciler, bilgiye odaklanmayı sağlar ve metin içeriğini daha net hale getirerek anlama düzeyini artırır (DiCecco ve Gleason, 2002; Vaughn ve Edmonds, 2006).

Alanyazın taramasında Türkiye'de okutulan kimya ders kitaplarının analizleri farklı amaçlarla gerçekleştirilmesine rağmen grafik düzenleyici açısından herhangi bir analize rastlanmamıştır. Grafik düzenleyici analizi ile ilgili sadece lise fizik ders kitaplarında (Nakiboğlu ve Çamurcu, 2014) ve ortaokul fen ders kitaplarında (Nakiboğlu ve Yıldırım, 2018) analizler yapıldığı belirlenmiştir. Öğrencilerin kimya kavramları açısından yaşadıkları güçlükler göz önüne alındığında, öğrencilerin kavramsal öğrenmelerinde önemli bir yere sahip olan grafik düzenleyicilerin ortaöğretim lise kimya ders kitaplarındaki durumlarının ve kullanım amaçlarının incelenmesi önemlidir. Bu çalışmada kimya ders kitaplarında kullanılan grafik düzenleyiciler, türü ve biçimi, kullanım amacı ve ders kitabı içindeki konumu gibi çeşitli ölçütler açısından incelenmiştir. Ayrıca, grafik düzenleyicilerin hazırlama kurallarına uygun olarak hazırlanıp hazırlanmadıkları da araştırılmıştır. Bu amaçla çalışmada aşağıdaki araştırma sorularına cevap aranmıştır.

1. 9. sınıf kimya ders kitabında ne tür grafik düzenleyiciler yer almaktadır, bu grafik düzenleyicilerin ünitelere göre dağılımı nasıldır ve ders kitabındaki konumları ve kullanım amaçları nelerdir? 9. sınıf kimya ders kitabındaki grafik düzenleyiciler biçim ve içerik açısından uygun şekilde hazırlanmış mı?
2. 10. sınıf kimya ders kitabında ne tür grafik düzenleyiciler yer almaktadır, bu grafik düzenleyicilerin ünitelere göre dağılımı nasıldır ve ders kitabındaki konumları ve kullanım amaçları nelerdir? 10. sınıf kimya ders kitabındaki grafik düzenleyiciler biçim ve içerik açısından uygun şekilde hazırlanmış mı?
3. 11. sınıf kimya ders kitabında ne tür grafik düzenleyiciler yer almaktadır, bu grafik düzenleyicilerin ünitelere göre dağılımı nasıldır ve ders kitabındaki konumları ve kullanım amaçları nelerdir? 11. sınıf kimya ders kitabındaki grafik düzenleyiciler biçim ve içerik açısından uygun şekilde hazırlanmış mı?
4. 12. sınıf kimya ders kitabında ne tür grafik düzenleyiciler yer almaktadır, bu grafik düzenleyicilerin ünitelere göre dağılımı nasıldır ve ders kitabındaki konumları ve kullanım amaçları nelerdir? 12. sınıf kimya ders kitabındaki grafik düzenleyiciler biçim ve içerik açısından uygun şekilde hazırlanmış mı?
5. Lise kimya ders kitaplarında grafik düzenleyicilerin sınıflara göre dağılımındaki farklılıklar ve benzerlikler nelerdir?
6. Grafik düzenleyicilerin lise kimya ders kitaplarındaki kullanım amaçlarının farklılıkları ve benzerlikleri nelerdir?

Yöntem

Çalışma nitel araştırma yöntemine dayalı olup, *doküman inceleme yöntemi* kullanılmıştır. Çalışmada 9, 10, 11 ve 12. sınıflar olmak üzere dört kimya ders kitabı, grafik düzenleyicilerin sınıflandırılmasına ilişkin bir kavram haritası dikkate alınarak analiz edilmiştir.

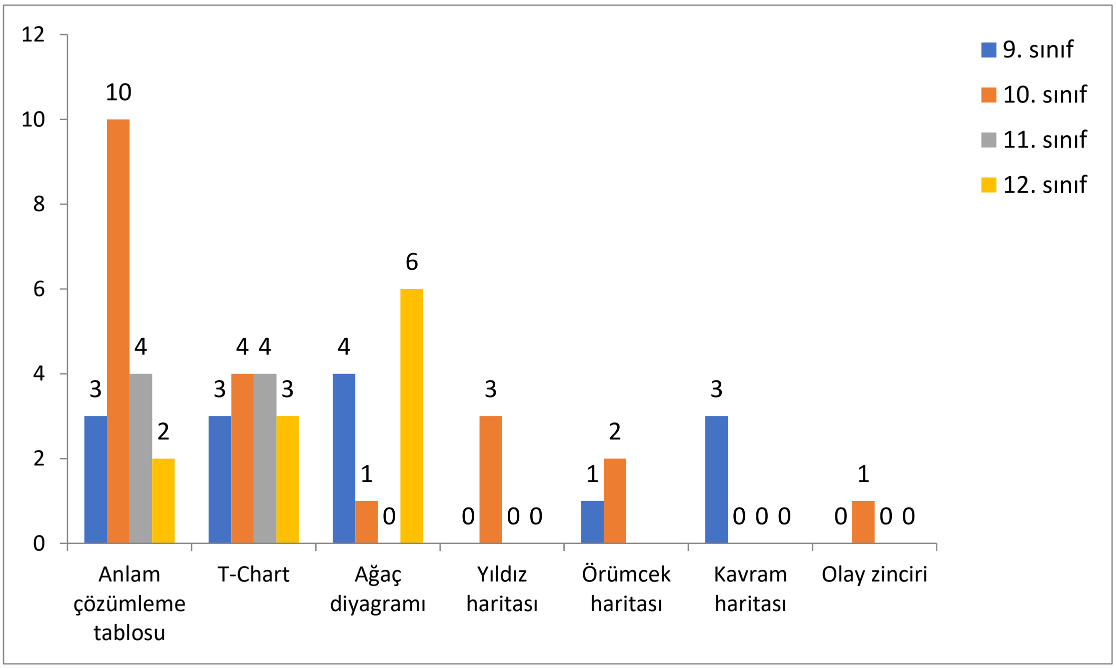
Bulgular

Tüm ders kitaplarındaki grafik düzenleyicilerin sınıflara göre dağılımlarının karşılaştırılmasına yönelik bulgular Tablo 1 ve Şekil 1'de sunulmuştur. Tablo 1, tüm ders kitaplarında yer alan grafik düzenleyicilerin "içeriksel ve biçimsel" açısından karşılaştırılmasını gösterirken, Şekil 1'de grafik düzenleyici türleri açısından karşılaştırmayı gösterir.

Tablo 1. *Kimya ders kitaplarında kullanılan grafik düzenleyicilerin içerik ve biçim türlerinin sayısal dağılımına ilişkin bulgular*

İçeriksel	Biçimsel	9.sınıf	10.sınıf	11.sınıf	12.sınıf	Toplam
Karşılaştırıcı	Tablo	6	14	8	5	33
Hiyerarşik	Zincir	7	1	-	6	14
Detaylandırıcı	Merkezcil	1	5	-	-	6
Döngüsel	Çember	1	-	-	-	1
Sıralayıcı	Zincir	-	1	-	-	1
Toplam	-	15	21	8	11	55

Tablo 1'den görüldüğü gibi, 9. sınıf kimya ders kitabında 15, 10. sınıf kimya ders kitabında 21, 11. sınıf kimya ders kitabında 8 ve 12. sınıf kimya ders kitabında 11 olmak üzere tüm kimya ders kitaplarında toplam 55 grafik düzenleyici bulunmaktadır.



Şekil 1. *Kimya ders kitaplarının grafik düzenleyici türleri açısından karşılaştırılması*

Şekil 1'den bütün grafik düzenleyici türlerinden kitapların tümü için en fazla yer alan grafik düzenleyici türünün "anlam çözümleme tablosu" olduğu görülmektedir. Anlam çözümleme tablosu aynı zamanda 10. Sınıf düzeyinde en fazla kullanılan grafik düzenleyici türüdür.

Grafik düzenleyicilerin kullanım amaçlarına göre karşılaştırılmasına yönelik bulgular Tablo 2'de verilmiştir.

Tablo 2. *Kimya ders kitaplarındaki grafik düzenleyicilerin kullanım amaçlarının karşılaştırılması ile ilgili bulgular*

Kullanım amacı	9.sınıf	10.sınıf	11.sınıf	12.sınıf	f	%
Comprehension	7	7	3	9	26	47.3
Evaluation	8	6	4	2	20	36.4
Evaluation of pre-knowledge	-	7	1	-	8	14.5
Advance organizer	-	1	-	-	1	1.8
Toplam	15	21	8	11	55	100

Tablo 2 incelendiğinde grafik düzenleyicilerin ders kitaplarında üç farklı amaçla kullanıldığı görülür. Bu amaçlar, kavramaya katkı sağlanması, konu, ünite sonu değerlendirme ya da ön bilginin değerlendirilmesi ve ön-düzenleyici olarak kullanılmaları şeklindedir.

Sonuç

Çalışma sonunda ders kitaplarında yer alan grafik düzenleyicilerin çok fazla sayıda olmadığının belirlenmesi nedeniyle, öncelikle ders kitaplarında yer alan toplam grafik düzenleyici sayısının arttırılması önerilebilir. Diğer taraftan kitaplarda uygun şekilde hazırlanmamış grafik düzenleyici olduğu sonucuna ulaşılması nedeniyle, ders kitaplarında yer verilecek grafik düzenleyicilerin uzmanlar tarafından incelendikten sonra ders kitaplarında kullanılması gerektiğini göstermiştir.

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Yazar beyanları/Statements of the authors

Etik	**Ethic**
✓ "*Ortaöğretim kimya ders kitaplarında grafik düzenleyici kullanımı*" başlıklı çalışmanın yazım sürecinde bilimsel, etik ve alıntı kurallarına uyulmuş olup, toplanan veriler üzerinde herhangi bir tahrifat yapılmamış ve bu çalışma herhangi başka bir akademik yayın ortamına değerlendirme için gönderilmemiştir.	✓ Scientific, ethical and citation rules were followed during the writing process of the study titled "*Usage of graphic organizers in upper-secondary school chemistry textbooks*", no falsification was made on the collected data and this study was not sent to any other academic publication medium for evaluation.
✓ Bu çalışmada hayvan deneylerine veya insan ile ilgili uygulamalara yer verilmediğinden etik kurul izni alınmamıştır.	✓ Ethics committee approval was not obtained because animal experiments or human-related practices were not included in this study.
Çatışma Beyanı	**Conflict Statement**
✓ Makale ile ilgili herhangi bir kurum, kuruluş, kişi ile mali çıkar çatışması bulunmamaktadır.	✓ There is no financial conflict of interest with any institution, organization, person related to this study.