Web 2.0 Tools in Concept Teaching

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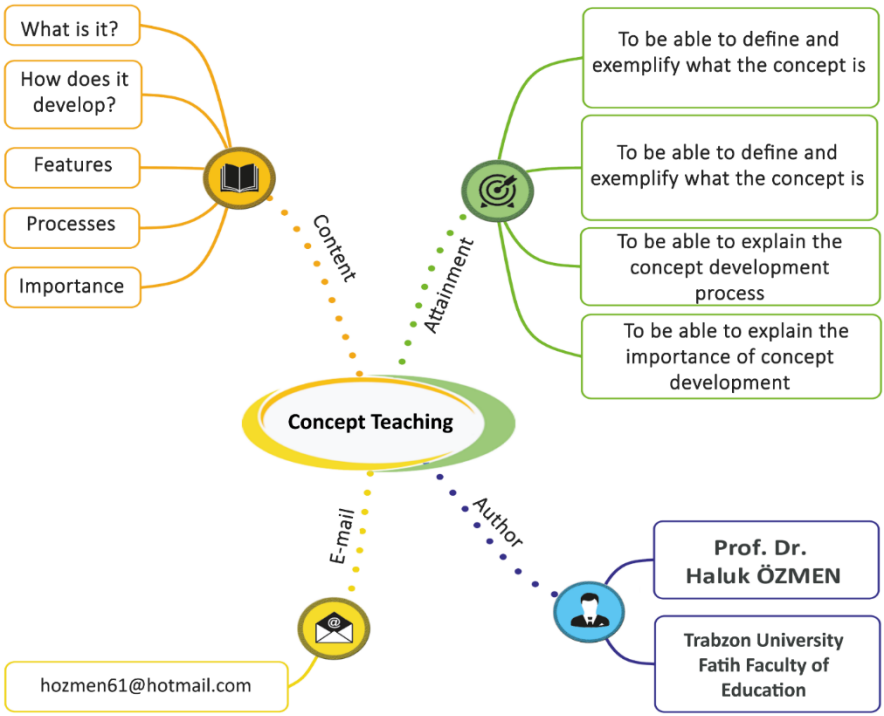
CHAPTER 1

CONCEPT TEACHING

PROF. DR. HALUK ÖZMEN



Soon after they are born, people develop concepts and learn the names of these concepts as a result of their communication and interactions with nature (Ayas, 2016). The related concepts created this way helped new learning take place in time and thus gained meaning. The process that progresses through the creation of new knowledge and the reconstruction of existing knowledge with new meanings makes it possible to either classify newly acquired knowledge and add it to the mental lexicon or create new cognitive structures (Ekici, 2016). In this way, the learning process takes place.

What is a Concept?

According to one of the definitions in the literature, the concept is defined as "the basic elements of the mental processes and the building blocks of a person's cognitive structure" (Klausmeier, 1992). Another definition is that "concepts are the names given to groups when objects, events, people and ideologies are classified according to their similarities" (Ayas, Çepni, Johnson ve Turgut, 1997). Ülgen (2001) defines "concept" as an "information form or structure that gains meaning in the human mind, represents the common features of different objects and facts, and is a variable that is expressed with one word." A similar definition comes from Şimşek (2006), who said that "it is a common name given to objects, views, and events sharing the similar features. In other words, samples within the same cluster, class, or category in terms of common features form a concept". In a similar vein, Senemoğlu (2011) defines "concept" as "a category used in grouping similar objects, people, events, ides, and processes."

When these definitions about the concept are simplified, it is fair to say based on the experiences we have had from the moment we were born that we have formed concepts in our minds by bringing together two or more entities, objects, living or inanimate things according to their common characteristics and grouping as well as naming and distinguishing them from other groups. This general explanation shows that the concepts are the building blocks of the information we have. In other words, our information results from the combination of concepts or the associations of these concepts with each other.

How do Concepts Develop?

Concepts begin to evolve from infancy. The conceptual structuring that took place during this period is quite simple, and infants are more likely to structure concepts that are in their immediate environment and they involve vital activities. After infancy, children begin to use discovery skills such as data collection, observation, counting, recording, and editing to find answers to their questions and construct new concepts (Charlesworth and Lind, 2012). At this stage, children start to develop conceptually and create new concepts through this conceptual development. The concept development process takes place much more rapidly after infancy. For instance, Üstün and Akman (2003) state that we have entered a period in which rapid advances begin to take place in terms of concept formation after the first four years of age.

People begin to construct concepts by examining and exploring the concrete entities that they have seen, encountered, or interacted with and discovering their qualities from the very beginning of their childhood. In this context, it can be said that the first schemas and perceptions related to concepts are formed by observations made on concrete examples. Accuracy and quantity of experiences regarding concrete examples affect the accuracy and adequacy of the concept to be constructed in the mind. In addition, as the number and type of examples observed or interacted increase, the scheme to be formed in the mind will expand and come true. It is because when a single example about a concept is examined or observed, the perception or schema that occurs in the mind about that concept consists of the characteristics of the observed example. However, each sample may not have all the features of the concept it belongs to, in which case the scheme or perception created in in the mind may also be incomplete or incorrect.

What are the Features of Concepts?

The words which are used to name concepts are called “terms.” Concepts are not physical entities that exist in the real world; rather, they are schemas, perceptions, thoughts, or associations that the term creates in the minds. Therefore, concepts are defined as abstract thought units. In daily life, there are examples of concepts used to make abstract units formed in the minds. In this case, everything that takes place in real life is an example of a conception.

The fact that the groupings based on the observations and the features based on the characteristics learned from these observations are important in the

process of conceptualization and necessitates the consideration and discussion of the features of the examples. The most typical example that best represents a concept and has all its features is called "prototype." Undoubtedly, each example does not have all the features of the concept to which it belongs. For this reason, the features of concept examples are divided into two groups, these being "common characteristics" and "variable features" (Şimşek, 2006). While the common features of a concept carry all the examples of that concept, the variable features may not have every example. For example, while being alive and reproducing with eggs is a common feature of all birds, it is a variable feature that all birds cannot fly. Sparrows, pigeons, parrots, penguins, ostrich, and gulls are examples of bird concept, and their common feature is that they are alive. However, while other examples can fly, penguins and ostrich cannot fly, making the flying feature a variable feature. Because people structure concepts in their minds mostly through prototypes, the concept of a bird is shaped by the ability to fly in the mind. For this reason, the term "bird" leads to the actualization of examples that can fly in the mind. The examples with variable properties are accepted or learned as a result of the rearranging of the schemas in the mind through specific mental processes.

Concepts, whether common or variable, must carry some structural features. There are various classifications in the literature regarding the characteristics the concepts must be carrying. For example, Ülgen (2001) classifies some of the structural features that concepts must possess:

- Concepts change over time based on the human experience. As the human mind develops, matures, and as experiences increase, the mental perceptions of some concepts may change.
- The perceived characteristics of objects and events may vary from one individual to another. The most important factor is the past experiences.
- There is an original example (prototype) of each concept carriying all features.
- Some features of concepts can sometimes be found in more than one concept. For example, movement is a feature of plant, animal, and human concepts.
- Concepts consist of both direct and indirect observable features of objects and events.
- Concepts are multidimensional. A concept can sometimes be a central concept and sometimes a sub-concept of another concept. For example, while the animal concept is one of the sub-concepts of the concept of living beings, it can, also, be the main concept that

includes sub-concepts such as vertebrates, invertebrates, and reptiles.
- Concepts can be grouped according to their specific criteria in themselves. For example, animals can be classified as vertebrates, invertebrates, reptiles, etc.
- Concepts are related to the language. All concepts have a word equivalent called the term. Although these terms (words) or symbols are different in different languages, their definitions are universal.
- The feature of concepts is a concept itself.

In the literature, it is stated that the concepts should have five main characteristics: namely learnability, usability, openness, generality, and strength.

What are Concept Development Processes?

The mind uses various processes to develop concepts. These processes are expressed as "generalization, discrimination, induction, deduction", and "identification". The generalization process is the process of disseminating the findings obtained from common features to the whole. In this process, sometimes under-generalizations or over-generalizations can be made incorrectly. For example, a generalization that accepts all living things that can fly like birds, including bats, will be an over-generalization. However, a generalization attempting to explain the concept of liquid only with drinkability will be an under-generalization as it will exclude the liquids such as shampoo, gasoline, and acetone. Unlike generalization, discrimination is a concept development process realized by considering different features. Discrimination, unlike generalization, is a concept development process by taking different features into account. Induction is a concept development process that is performed by obtaining results of the whole as a result of investigations on a limited number of examples. Deduction, on the other hand, is a concept development process which is realized as a result of the reduction of the features of the whole to the examples. As for identification, it is to describe an unknown concept with known words by taking the descriptive and distinctive features into account. In other words, defining an unknown concept means explaining it with other known words (Ayas, 2016). It is not possible to develop every concept through definitions. If such a process were possible, the concept development would be possible by only using a Turkish dictionary.

What is the Importance of Creating a Concept?

The most important contributions that concepts bring to our life are facilitating communication, hindering communication chaos and creating a common language for people. As can be seen from the definitions, the concepts are the names given to a group by considering the common features. For this reason, a concept expressed through a word can be the name of a group that contains only a few examples, or it may be the name of a group that contains hundreds, thousands, millions of examples. Egyptian pyramids, for example, are the only ones in the world having about 100 examples in Egypt. The concept of elements can, also, be considered as another example. There are 118 elements currently known. Pyramids and elements are concepts that are relatively limited in this sense. However, concepts such as cars, pencils, substances, liquids, trees, human beings have thousands or millions of examples in the world. Despite this, we, as humans, collect all these examples under a single group, name them in one word and use them in daily life. In this way, as we facilitate our communication, we use a common language that can be understood in the same way for everyone. Without such a conceptualization process, we would have to give separate names to all examples of a concept. This would make the communication and the work of our brain extremely difficult, and we would have had to use hundreds or thousands of times more words to communicate in everyday life. While the need for explanation is not felt when talking about a concept that everyone knows and uses jointly it is known that the other side perceives what is being said. It is difficult to make sure that the same image is formed in the minds of the narrator and the listener while talking about the concepts not known by everyone.

Another benefit provided by the concepts is ensuring the orderliness of the mind. Suppose that our mind is a computer. The computer has the main folder, subfolders, further subfolders, and individual files. In this type of configuration, every new document or file from outside is placed into the relevant folder and can be found easily by searching in that folder when needed. In our minds, main concepts, sub-concepts, even lower concepts, and finally, examples are available. Such a conceptual structure enables the newly learned concepts to be placed within the relevant structure, and when they need to be remembered, our mind obtains them in the related structure. Such a process facilitates the work and the burden of the mind.

Why Teaching Concept?

In the contemporary sense, constructivism which underlines that the learner should be active and centered in learning and that knowledge should be structured in his mind is the most popular approach today. The approach emphasizes that the newly acquired information is built on current knowledge in the learning process. Therefore, it is extremely important to link the new concepts with the existing concepts when learning new information. As a matter of fact, it is argued in this approach that the learner interprets and accepts the new situations he/she encounters in accordance with his/her existing knowledge and experience. The learner's interpretation and acceptance of the new concepts he receives from his environment depend on the correct construction of the previous ones. This situation shows that learning information correctly at the conceptual level is very important in perceiving and learning the next concepts.

In the context of constructivism, existing concepts that are dealt with and the process of association and interpretation of newly learned concepts should be concluded properly. For this, existing concepts need to be learned correctly and meaningfully, need to be the basis for new concepts to be learned, and previous knowledge needs to be re-evaluated, taking the new one into consideration. (Mintzes, Wandersee and Novak, 1998; Rebello, Siegel, Witzig, Freyermuth and McClure, 2012). In addition, it is stated that failure to learn the basic concepts effectively and correctly adversely affects the learning of later concepts (Griffiths and Preston, 1992). These facts clearly show that it is important for learners to learn the basic concepts correctly and meaningfully. In this sense, concept teaching should be given importance in every phase from pre-school education to higher education. The reasons for the teaching of concepts in the literature are given as the followings. Ayas (2016) explains the reasons for teaching at the level of concepts under several headings.

- Current teaching approaches argue that permanent learning is not operational but conceptual.
- Students' prior knowledge of concepts affects their subsequent learning.
- It is not possible to learn every piece of information due to a large amount of information available, and it is more important to gain basic information conceptually.
- There is a gradual ranking from simple to complex in the teaching at the level of concepts.

Erden and Akman (1996) list the benefits of concept teaching as follows:

- Simplifies communication.
- Makes thinking easier.
- Converts abstract entities to concrete ones.
- Creates permanent and regular information systems.
- Makes it easy to remember as it eliminates details.
- Facilitates the establishment of relationships between events and assets.
- Reduces the complexity of the environment and makes it easier to recognize and learn concepts.
- Ensures that the information is grouped and organized systematically.
- Establishes the principles as a result of establishing relationships between concepts.

Current teaching approaches advocate the student-centered teaching approach in which the teacher is the guide in the teaching process and foresees the students to construct concepts in their minds with their own applications and active participation. Such process ensures that the information gained is meaningful and permanent for students and it can also be transferred (Butler and Lumpe, 2008). In concept teaching, where students are at the center, it should be avoided that the information and definitions about concepts are given by teachers. Students should be encouraged to transform their knowledge, experience, discoveries, and inquiries into knowledge and to reach the concepts themselves (Inel-Ekici, 2016).

Students come to a learning environment with a lot of preliminary information from various sources. In this preliminary information, sometimes scientifically incorrect ones may be found. Such beliefs belonging to students and are different from those accepted as scientific facts are expressed with various terms such as “misunderstanding, misconception, alternative understanding, alternative frame, misconception” (Özmen, 2004). Previous research shows that the most common reasons for causing misconception are the abstract features of concepts, lack of prior knowledge of students about the subject, and beginning the lessons without identifying the misconceptions. In addition to this, failure to consider alternative ideas developed by students during the process and at the end of concept teaching, teaching the concepts with traditional methods, the language used, textbooks and inadequacy of teachers trigger the misconception. (Benson, Wittrock and Baur, 1993; Ülgen, 2001; del Pozo, 2001). According to previous research, it was found that there were

misconceptions in students at all levels, and they negatively affected the subsequent learning. (Griffiths and Preston, 1992). These studies make it necessary to determine and correct the preliminary information and if any, misconceptions, in the concept teaching process, and then move on to teach the new concepts. (Akdeniz, Bektaş and Yigit, 2000; Ebenezer and Fraser, 2001).

Methods Used in Concept Teaching

Although there are different approaches, methods and models that can be used in concept teaching, there are two methods widely used. The first is the concept teaching method proposed by Bruner, which has a relatively traditional characteristic, and the other is the concept teaching method based on active learning and aiming to develop concepts based on examples.

Bruner argues that events, objects and the organization of the relations between them in the mind will take place through concept teaching. According to him, if concepts are taught by following certain steps, they can be classified more easily within the structure in the mind and thus can be learned more easily (Özmen, 2016). The concept teaching method proposed by Bruner consists of five steps. These steps are “the name of the concept, the definition of the concept, the features of the concept, the importance of the concept,” and “the examples of the concept”. It is thought that the students who learn the basic concepts with such a method will be able to learn the whole subject when they manage to establish the relations between them.

The concept teaching method based on the active learning approach is identified with the 5E model, which is frequently used in the constructivist approach in learning environments. According to this process, first of all, preliminary information and the misconceptions of students, if any, need to be determined (introduction step), opportunities need to be provided for them to make discoveries (discovery step), an environment where they make definitions based on the data obtained from the explanations and the conception need to be created (explanation step), the reinforcement of the concept by offering new, different and exception examples need to be provided (deepening step), definitions need to be corrected and their improvement needs to be ensured (evaluation step). In this sense, it is also possible to use different models for teaching concepts. However, although teaching methods, techniques, or models vary, the basic understanding remains the same.

As a result, although Piaget's learning theory states that students pass through the abstract process period at 11 or 12 years of age, it is always more effective for learners to be taught by concretizing the concepts. For this reason, the use of materials that will make the information or concepts in concept teaching concrete for students at all levels positively affects learning. It is a known fact that teaching, which employs more than one sensory organ, and which is realized by doing and experiencing, is more effective and long-lasting. (Yiğit, 2013, p. 69). In addition, research shows that visuals have an important place in the sensory organs, and Çilenti (1988) underlines the importance of sensory organs in learning, stating that hearing is 10% while vision is 83%. These data mean that, besides easy-to-understand explanations, the use of instructional practices and visual materials can be highly effective in learning with conceptual teaching activities in the classroom. To provide a conceptual level of teaching, concept maps, information maps, mind maps, meaning analysis tables, concept networks, V-diagrams, concept cartoons, etc., can be given as examples of materials to be used in learning environments. These materials, which are all student-centered applications, are generally named as graphic materials and are recommended to be developed by students or at least with the cooperation of the students. Considering the fact that all contemporary teaching approaches advocate active learning or constructivism, it is possible to say that these materials focus on student activities and are constructivist-based practices. In addition, these kinds of materials can be used to determine the students' pre-knowledge, which are very important, and misconceptions, if any, in the learning process. The theoretical explanations and practices related to these materials are not covered by this section and are discussed in detail later in this book.

Evaluation Questions

1. What is the concept? Please explain.
2. What are the methods used in concept teaching?
3. What are the concept development processes? Please explain.

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CHAPTER 2

SEMANTIC FEATURE ANALYSIS

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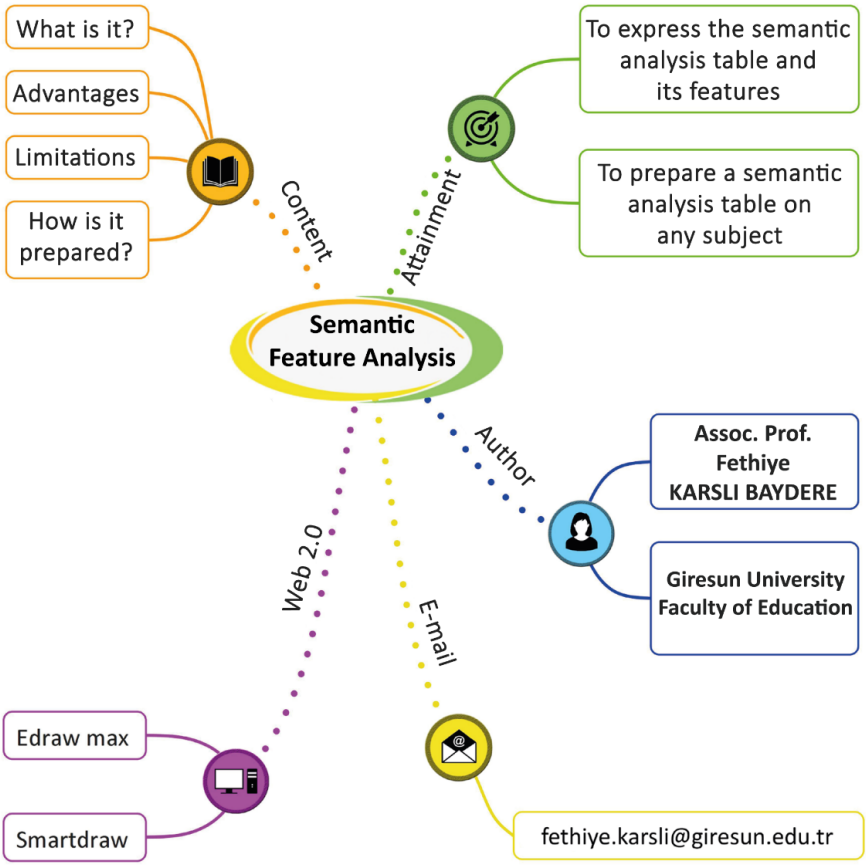

Used as "Semantic Feature Analysis" in the literature (Fredericks and Cheesebrough, 1993), it is an effective tool that students can use to learn similar and distinctive features of concepts, showing relationships between concepts within the subject. In other words, it is an interactive teaching and learning tool that enables students to easily understand a text presented to them and distinguish the concepts and their features, and gives them the possibility to construct their own in their mind (Anders and Boss, 1986).

As mentioned in Ausubel's theory of meaningful learning, after introducing the basic concepts, it is necessary to provide the discrimination process to specify the sub-concepts related to the basic concepts and the descriptive and distinguishing characteristics of these sub-concepts (Ausubel, 1963). In this way, students structure their knowledge when they find the opportunity to relate concepts and features that they have recently encountered with the concepts they already know (Bodner, 1986; Gürlek, 2002). Semantic feature tables offer students the opportunity to make comparisons and construct their knowledge by identifying common or different characteristics of a subject. In addition to this, semantic feature tables can also be used to support concept development by eliminating the complexity of relations between concepts and features of these concepts, learners' pre-knowledge, and misunderstandings and evaluate the learning (Ayas, 2014; Karslı, 2015; Tuncel, 2012).

Semantic analysis, which can also be used as a learning activity in the classroom, allows students to organize and compare key concepts and features of the subject systematically. The development and activation of semantic feature tables by students are very important. The meaning analysis tables that contribute to the learning of similar or different features of concepts or events are two-dimensional tables that effectively reveal what students learn at the level of knowledge, comprehension, classification, comparison, and interpretation. While the table contains entities or concepts that are to be resolved in one dimension, the related concept has properties in the other dimension. Students mark intersecting features by putting "X" or "√" in the related place on the table.

Advantages of semantic feature analysis

- Semantic feature analysis helps students to relate new information to what they know about the basic features of the concept. This allows the concepts to be structured more easily in the mind.

- It provides convenience in comparing common and distinctive features between concepts.
- It provides students with the opportunity to perform the discrimination process.
- The tables can also be used to reinforce learned concepts once they are prepared.
- It is easy to prepare and use and makes students active.
- It supports students' systematic thinking.
- It helps interpretation from different perspectives by ensuring that pre-information is associated with new information.
- It organizes key concepts and terms of the subject.
- Semantic feature analysis, which can also be prepared with web support, makes learning easier (Çetinkaya and Taş, 2011).

Limitations of semantic feature analysis

- Semantic feature analysis can never be a substitute for the role of the teacher, which means that it is not enough by itself.
- Frequent use can cause boredom on the part of the students.
- Tables that are not prepared according to the student levels will not be seen as preparation.

Forming Semantic Feature Analysis

The following steps can be followed in order to develop a semantic analysis table in a classroom environment (Ayas, 2014; Ayas, Çepni, Johnson and Turgut, 1997; Johnson and Pearson, 1984):

1. The subject to be worked on is determined and written on the board (for the selection of topics, students' pre-knowledge and ages should be considered).
2. The students are guided by identifying the characteristics of the designated topic, and the answers are written on the board. For example, students are asked about the characteristics of the mixtures, they write their names and are provided with as many features as they can find.
3. The teacher draws a two-dimensional table on the board. The first column of the table contains the entities, events, or concepts that are to be characterized, and the first line of the table lists the features of those entities, events, or concepts. Concepts and characteristics determined by students are placed in the table.

Students are asked to draw the same table in their notebooks. For example, mixtures are written in one dimension, and features of the mixtures are written in the other dimension of the table.

4. The students form the table of semantic features by placing the "X" or "√" sign at the intersection of the lines and columns where the concepts and features in the lines and columns are compatible.

The sample meaning analysis table that can be used for the acquisition of mixtures in the 7th-grade science course curriculum "7. 3. 3. 1. Gives examples by classifying mixtures as homogeneous and heterogeneous." is given in Figure 1.

Mixed	Features			
	Homogeneous	Heterogeneous	Mixed substances evenly distributed everywhere	The substances mixed are not evenly distributed everywhere
Fog cluster				
Vinegar				
Sweetened tea				
Water-mercury				
Soup				
Sea water				
Coin				
Turkish coffee				
Soda				
Water-naphthalene				

Figure 1: Sample Meaning Analysis Table for mixtures and their properties

The sample meaning analysis table that can be used for "Classifying pure substances according to their atomic, molecular and ionic structures" is given in Figure 2.

Features / Pure Substances	Atomic	Ionic	Molecular
Copper element (Cu)	★		
Chlorine element (Cl_2)			★
Water (H_2O)			★
Potassium iodide (KI)		★	
Sodium chloride (NaCI)		★	
Sugar ($C_6H_{12}O_6$)			★
Hydraulic acid (HCI)		★	
Ammonia (NH_3)			★
Carbon dioxide (CO_2)			★
Iron element (Fe)	★		
Gold element (Au)	★		
Hydrogen element (H_2)			★
Iodine gas (I_2)			★

Figure 2: Sample Meaning Analysis Table for pure substances and their properties

In Figure 3, the meaning analysis table prepared for the acquisition of "7.3. Classifies compounds and mixtures" on the subject structure and properties of the 7th-grade science course curriculum can also be used to evaluate students' learning.

Structure of matter / Features	Compound	Mixture
It contains different types of atoms		
It contains the same molecule		
It has certain formulas		
They can be separated by physical means		
They can be separated by chemical means		
They are pure substances		
They can be homogeneous and heterogeneous		
It is homogeneous except for process temperatures		
Components do not lose their features		
Components lose their features		
There is no specific ratio between its components		

Figure 3: Example of the semantic feature table for the structure and characteristics of the matter

Dear students, in the left part of the table below, some features of the compounds and mixtures are included. What is required from you is that you should indicate whether these properties belong to the compounds or the mixtures by inserting the "X" or "√" sign at the intersection of the line and column.

The semantic feature analysis used for evaluation can determine the knowledge levels, mistakes or learning deficits of the students. The semantic feature analysis can be scored by comparing them with the maximum score that can be taken from a semantic feature table or through a holistic rubric prepared by the teacher (Karslı, 2015).

Evaluation Questions

1. A teacher starts the class with a question, “Which of these will be included in the invertebrate group of animals?” and by showing some animal pictures. She makes a table for this, and writes the names of the animals on one side of the table and different and common features on the other side. She requires the students to mark the appropriate areas. Which of the following has been used in this teacher’s lesson?

   A) Spider web concept maps

   B) Hierarchical concept map

   C) Chain concept map

   D) Semantic feature table

   E) Fishbone map.

2. Which of the following is the most effective tool to use in a science class where the teacher requires the classification of the common and distinctive characteristics of the material from students?

   A) Concept map

   B) Mind map

   C) Fishbone map

   D) Semantic feature table

   E) Similarity contrast map.

3. Eren’s teacher lectures on the changes that are happening in the materials. In this process, he uses the semantic feature table. Which of the following cannot be one of the purposes for the use of the semantic analysis table by Eren’s teacher?

   A) To reveal students’ pre-knowledge about the subject

   B) To make students active

   C) To create a discussion environment

   D) To ensure students classify changes in events occurring in nature

   E) To directly provide information about the subject.

4. Create a semantic feature table to show animals and whether these animals are vertebrates or invertebrates.

Answers: 1-D, 2-D, 3-E

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CHAPTER 3

VEE DIAGRAM

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