

5.2 | Apply: Using Concept Maps to Organize Content

Background

The following instructional unit provides information and practice in the use of the organizing strategy of concept mapping to organize and classify matter. Concept mapping is a cognitive strategy that can be used to foster thinking skills at several different Bloom's thinking levels, including remembering, understanding, applying, and analyzing content. It is also possible to use concept mapping for learning experiences that foster thinking skills at the evaluate and create levels (e.g., using a concept map to evaluate options or to plan a project).

For this example, concept mapping is used to foster the **analyze** thinking skill level because it prompts students to *analyze content by organizing it*. When analyzing by organizing, an individual seeks to determine an appropriate organization that logically relates concepts (or other content parts) to each other and to the whole, as well as to other concepts, problems, and/or material. *The goal in organizing is to determine relationships between the content elements and to the overall structure of a topic.*

This unit also fosters thinking skills at the **evaluate** level because the strategy of concept mapping serves to foster the learner's metacognition (or thinking about and evaluating one's own learning). In this unit, concept mapping is used as a tool (or cognitive strategy) to enable learners to analyze and classify matter (the content). The concept mapping strategy can also be used:

- at the end of a lesson to help learners synthesize new learning,
- at the beginning of a lesson to diagnostically assess student prior knowledge of a topic,
- during a lesson to foster learning of nonlinear concept relationships, by either providing learners with a list of terms to use in labeling a concept map, or by asking learners to generate their own list of terms to label the map,
- during a content review by having learners fill in missing terms or identify relationships between terms in a partially completed concept map, and
- to assess learner understanding and evaluate the effectiveness of teaching methods by analyzing learner concept maps to identify misconceptions and missing concepts.

The Content Analysis Process

To develop this unit, the instructional designer analyzed the related content to identify key concepts and relationships, and the processes involved in the skill of classifying matter. The designer concluded that the central Bloom's thinking skill required for this task would be *analysis*. In addition, the designer determined that the learner's ability to *evaluate* the status of their own ability to analyze and classify matter would be important, and therefore, the demands of the content could be addressed by teaching learners the cognitive strategy of concept mapping. This would enable learners to not only classify matter but to also identify gaps in their knowledge.

Implementation of this Face-to-Face Instructional Unit

Learners should read the instructions and then complete the practice activity. The resulting concept maps are then discussed in class to enable students to learn from each other, and to enable the instructor to identify and clarify misconceptions. Things to note when discussing learner concept maps:

- The phrase "physical methods of separation" can cause confusion among novice learners.
- Science learners often conclude that compounds should be classified as mixtures because they include atoms of more than one element.



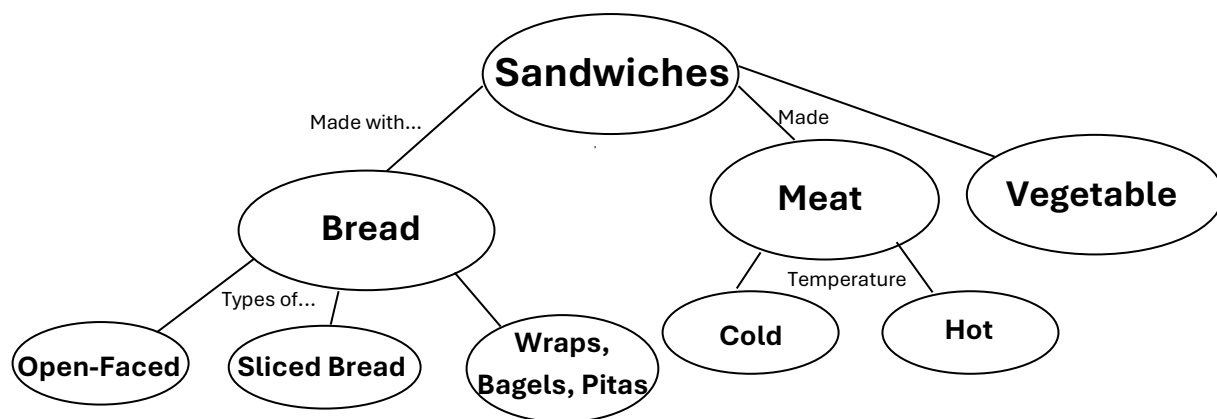
- Do learners understand the difference between physical and chemical separation methods? To determine this, ask them to explain the differences between compounds and mixtures, solutions and mixtures, and solutions and compounds.

Instructional Unit: Classifying Matter by Organizing It Using a Concept Map

Description: A concept map is a two-dimensional, graphic representation of an individual's conceptual framework for the organization of a topic. In a concept map, the elements of a topic are illustrated in circular "nodes" (or "cells") and the relationships between topic elements are represented by labeling the lines or arrows connecting the nodes. These combinations of nodes and lines are referred to as "propositions." Propositions are two or more concepts, questions, or items (labeled circles) linked by lines which are labeled to provide information about the relationships or connections between concepts. Concept maps are often arranged in a hierarchy, with the more general and more inclusive concepts at the top of the map and the more concrete and specific ones at the bottom. They may also be arranged with the more general or inclusive concepts located at the center of the diagram.

Task: You will use a concept map to organize and classify matter.

Example: As can be seen from the following example, there is no one single "right" answer when it comes to classification and organization. This person developed a concept map for sandwiches and organized it into two main sub-topics: the type of sandwich substance (meat – hot or cold, and vegetables) and the type of sandwich wrapping (bread, bagels, pitas, etc.). Another person might have organized sandwiches as: meat and meatless, hot and cold, or sweet and non-sweet. All classification and organizational schemes involve some subjectivity due to the differences in past experiences, values, assumptions, and definitions held by individuals.



Constructing a concept map requires being clear about the meaning and details of a topic, thinking in multiple directions, and switching back and forth between different levels of abstraction. Learning with concept maps requires active involvement. It provides a way to visualize key concepts and summarize relationships, and to consolidate a concrete and precise understanding of a topic.

Steps for developing a hierarchical concept map:

1. *Select* – Identify your theme and the related key words or phrases (concepts).
2. *Rank* – Rank the concepts from the most abstract and inclusive to the most concrete and specific.
3. *Cluster* – Cluster concepts by similarities and interrelationships.
3. *Arrange* – Arrange concepts in a diagram, using them to label the nodes of the diagram.
4. *Link and add propositions* – Link the concepts with lines (or arrows) and label each line with a proposition, or description of the relationship between the two connected concepts.



Practice Activity: Organizing and Classifying Matter with a Concept Map

Objective: You will analyze the provided terms related to matter and will then create a concept map that illustrates a “mental model” of your understanding of matter, examples of matter, and the relationships between the terms.

Key Concepts: The particle theory of matter. Elements, compounds, mixtures, acids, bases, salts, organic, inorganic, solids, liquids, and gases.

1. Review the meaning of the following concepts covered in last week’s readings and lectures. You will create a concept map diagram showing the relationships between the concepts:

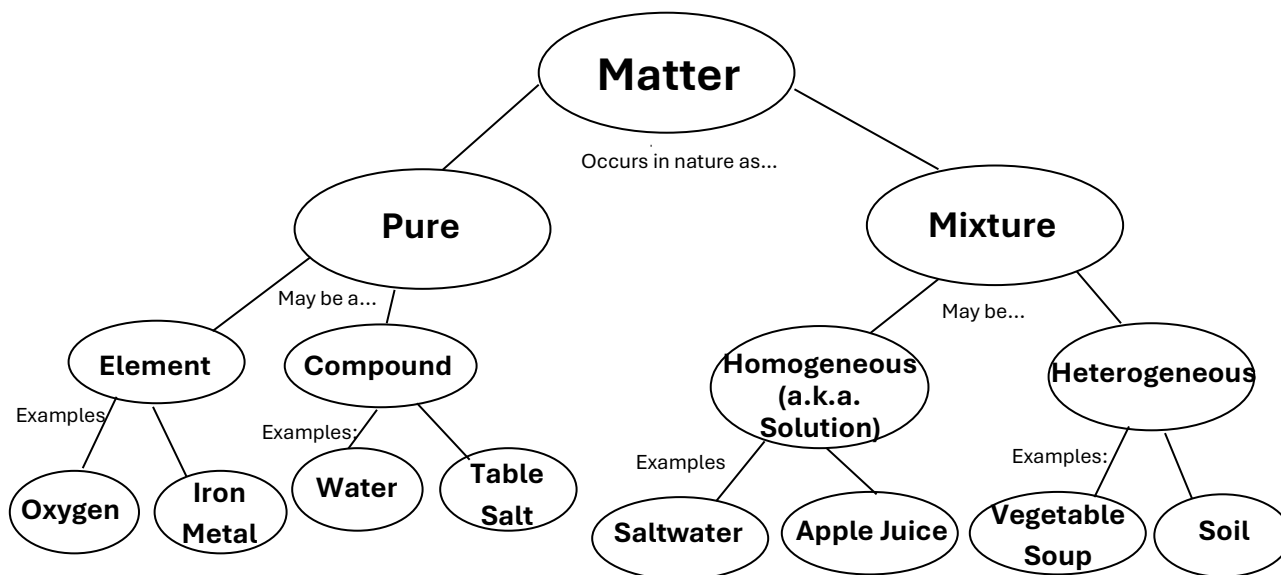
Iron Metal	Element	Mixture	Soil
Table salt (NaCl)	Heterogeneous	Oxygen	Vegetable soup
Apple juice	Homogeneous	Pure substance	Solution
Compound	Matter	Saltwater	Water
2. In order to simplify the task of learning about matter, scientists have developed classification schemes. Here are some questions to help you organize your ideas about these concepts:
 - *How is matter classified to help scientists learn about the properties of matter?*
 - *What are the relationships between the categories and types of matter?*
 - *How are compounds, elements, mixtures, and pure substances related to each other?*
3. To develop a concept map:
 - Select desired terms/concepts.
 - Rank the concepts and arrange them in related clusters.
 - Link concepts according to the “cognitive scheme” or classification of your choice.
 - Remember, there is no one single “right” answer when it comes to classification. All classification schemes involve some subjectivity due to the past experiences, values, assumptions, and definitions held by the classifier.
4. Continue making concept circles and labeling them with the terms listed in step 1, above, linking them to the concept “Matter” in some type of meaningful organization. After completing your organizational scheme, write short phrases on the lines linking the concepts in your map. (**Note:** These links should reflect your understanding of the relationships between the concepts in the map. They can help clarify sources of confusion or misunderstanding.)
5. When finished, compare your concept map to the maps of your assigned classmates (partners) and discuss the similarities and differences, and your rationale for your organization and classification.

TIPS and HINTS:

- To begin, write the word "Matter" in an oval in the center or top of the page.
- Chemical methods of separation include electrolysis.
- Physical methods of separation include filtration, distillation, and crystallization.

**Check Your Work:**

After comparing concept maps with your assigned classmates, we will discuss the similarities and differences as a whole group. Then, the following concept map classification that your instructor thinks makes sense will be handed out and you will discuss it with your classmates. Finally, we will discuss it as a whole group.

**Review – explanations and facts to remember:**

- *Matter* occupies space and possesses mass. It can exist as a solid, liquid, or gas.
- A *pure substance* has an invariant chemical composition (no variation) and distinct properties.
- An *element* is a fundamental pure substance that cannot be separated into simpler substances by chemical methods.
- A *compound* is a pure substance composed of two or more elements in fixed proportions that can be separated into simpler substances and elements only by chemical methods.
- A *mixture* consists of two or more pure substances that retain their individual identities and can be separated by physical methods.
- Mixtures can be either *homogeneous* or *heterogeneous*.
- *Homogeneous mixtures* have a uniform composition and properties throughout.
- A homogeneous mixture is also known as a *solution*.
- *Heterogeneous mixtures* are not uniform in composition and properties.
- *Table salt* is considered a pure substance because it has a uniform and definite composition.
- *Water* is a pure substance.
- Saltwater is NOT a pure substance because its composition (its salinity) can vary. It is a mixture because the salt and the water retain their composition and properties – only the form of the salt is changed when it is dissolved in water.
- Vegetable soup is a heterogeneous mixture because the composition is not uniform throughout the mixture and any given spoonful of soup will contain varying amounts of different vegetables.