

CONCEPT MAPPING: An Instructional Activity for Science Teaching and Learning

A. WHAT IS CONCEPT MAPPING?

Concept mapping is “...a schematic device (i.e. graphic technique) for representing meaningful relationships between and among concepts in the form of propositions” (Kenny & Krathwohl, 1993). A proposition is formed when two concepts are connected by linking words. For example, the concepts of light and energy can be linked by drawing a line with an arrow from light to energy and labeling the line ‘is a form of’. This linkage can then be read as follows: *Light is a form of energy*. Additional concepts can be added until a concept map is built.

B. HOW IS CONCEPT MAPPING RELATED TO SCIENCE LEARNING?

Concept mapping can be used to represent how knowledge within a domain is organized. Most knowledge in science can be represented as a hierarchy with the super-ordinate concepts (those that are the most general and inclusive) at the top. Branching from these will be other concepts that can be generalized eventually moving downward toward more specific subordinate concepts and examples.

Concepts can be presented inside ovals or rectangles on the map and include events or phenomena (e.g., energy, evaporation, photosynthesis) or objects (e.g., sun, planets, root, stem, leaves). Linking words are drawn on lines between each of the ovals and form a proposition which expresses the relationship between two concepts. For example, the ovals *sun* and *heat* can be connected by the words *is the main source of* on the connecting line. Arrows can be used on the connecting lines to illustrate the flow of the ideas.

In contrast to the teaching and learning of science as a mass of discrete facts and ideas, concept maps allow both students and teachers to organize their knowledge, build meaningful relationships, and in the process increase conceptual understanding in science.

C. HOW CAN CONCEPT MAPPING BE USED BY TEACHERS?

There are many different ways in which concept maps can be used by teachers to assist in the planning and organization of instruction. Some major ideas include using concept maps to:

- Plan a teaching unit including identification of super-ordinate and subordinate concepts
- Identify the major concepts for which hands-on activities will be provided for students
- Identify gaps in the curriculum which will need to be augmented or amplified with additional resources and activities (e.g., a single paragraph on mass, volume, and density is not adequate for teaching these concepts to a level of mastery and understanding).
- Plan a daily lesson
- Serve as a blueprint to model clear, meaningful paragraph writing for students
- Assist students in the comprehension of science content while reading

D. STEPS FOR BUILDING CONCEPT MAPS

TEACHERS:

Note: building concept maps, as teachers, is very helpful before actually having to teach it to your students. The first few times you engage in building a map, it is helpful to work with one or more colleagues so as to prompt each others' rich thinking.

- Decide on the unit, chapter, or lesson you will be teaching
- In assembling the material you will need, consider using your science curriculum, science activity guide, state science framework, national standards, science textbook series and other available resources
- Carefully review all these materials and compile a list of the concepts, both large and small, that would be important to enhance student conceptual understanding in science
- Place each concept on a Post-It note and obtain a large sheet of chart tablet or newsprint
- Begin by asking the following questions:
- Which 1 to 4 concepts or ideas are the most important and include all the other ideas?

- What are the major categories of concepts represented by the concepts on the Post-It notes? (for example, if the unit is on energy, the major category might be *Energy*, the next category might be *Forms*, this might be followed by *light*, *heat*, *electrical*, *mechanical*, and *nuclear*. Under each of these might be everyday examples. Or, they can be presented on the map to illustrate the idea that one form of energy can be transformed into another form of energy.)
- Select the Post-It notes and begin to organize them on the large sheet of paper. You will find that you will be discussing the concepts in detail to determine their appropriate position on the map. You will also find that you may move the Post-It notes around many times until you reach a satisfactory arrangement.
- Often times, you will also note that additional ideas might need to be added to improve the overall conceptual framework.
- Once you have arranged the concepts on the sheet of paper, you can begin to draw the connecting lines and place key linking ideas on those lines. You might want to use pencil when drawing lines and writing connecting words, as you might still want to relocate them as your thinking expands.

STUDENTS:

For the first five or six times you engage students in concept mapping, you will want to model the process for them by building upon their ideas and suggestions

- For example, after completing a hands-on science activity and discussion, you might refer students to the related concepts in their science texts. Have students work in pairs and identify 5 key ideas on the page. Have them share the words with the class and make a running list of these words, placing each term on a Post-It note.
- Then, guide the students by thinking aloud about how you would select the most inclusive concept. Place that concept at the top of the paper. You might ask students to help you identify another large concept that is closely connected to the one on the sheet of paper and have them explain why they made that particular selection. Continue with this process until you have used all the concepts listed on the Post-It notes.
- Eventually, students should be able to work in cooperative groups and select the key concepts, place them on cards or Post-It notes and discuss how they would represent those ideas on the map. Have students complete the map and present it to the class. Have other classmates ask questions or make suggestions. Encourage students to consider and make changes that they consider would improve their maps.

Questions for Propositional Concept Mapping

These are questions you may consider when building your concept map.

1. What is the same? What goes together?
2. What is it? What does it consist of? What does it contain?
3. Where does it come from?
4. What does it do?
5. How does it do it?
6. What causes it? What affects it? What is it influenced by?
7. Does it produce something?
8. Does it have forms, types or properties?
9. What can it be classified as?
10. What are the details?
11. What are examples?

Connecting Words for Propositional Concept Maps

are	changes	is independent of
are either	combines with	is a combination of
are grouped by	is connected to	is considered
are obtained from	contains	is determined by
are represented by	is created by	is influenced by
are under	creates	is like
are found only in	depends on	leads to
are based on	describes	makes up
can also be called	is divided into	means
can be	exists in	is measured by
can be described as/by	has as an example	occurs in/by
can be either	is found in	refers to
can be expressed as	goes from	requires
can be used in	has	results in
can represent	have a total of	
is categorized by	is identified as	
causes	includes	