Promoting Science Passage Comprehension via Concept Mapping Instruction

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Concept Map: Definitions

- Concept maps are diagrams showing network of concept nodes connected by relational links (Haugwitz, Nesbit, & Sandmann, 2010).

- Concept maps are schematic devices for representing interrelationships among a set of concept meanings embedded in a framework of propositions and two-dimensional, hierarchical, node-like diagrams that represent verbal, conceptual, or declarative knowledge in visual or graphic forms (Kwon & Cifuentes, 2009).
Concept Mapping: Benefits
Haugwitz, Nesbit, & Sandmann (2010)

- Concept maps use less text than prose format to present information.
- Concept maps display many relationships involving a single concept without rewriting the concept.
- Concept maps are easier to read because of simpler syntax.
- Concept maps allow more semantic processing in visuospatial working memory and avoid overloading verbal working memory.
- Concept maps are suitable for summarizing text passages because verbatim reproduction of text is not required.
Eleventh grade students (16 - 17 years)

Concept mapping (34 students) versus traditional instruction (36 students)

Cellular respiration concepts (Biology)

Pre-test, posttest, and delayed posttest

Concept mapping instruction group had better acquisition of science concepts than the traditional instruction group
Eleventh grade students (Biology class) vs. Concept mapping (26 students) versus expository instruction (27 students) on Diffusion and osmosis concepts. Immediate and delayed diagnostic test showed that Concept mapping instruction enhanced learning of diffusion and osmosis more effectively than expository instruction.
Secondary school students (13–14 years)

Concept mapping condition (39 groups: 123 students) versus essay writing condition (38 groups: 125 students)

Biology topics: heart function, arteries, capillaries, veins, and blood circulation

Five achievement posttests

Concept mapping groups got higher scores on posttest than the essay writing group

Concept mapping groups produced summaries containing more valid propositions
Research Study: Collaborative Concept Mapping  
Kwon & Cifuentes (2009)

- Seventh grade students (Science class)
- Concept mapping (31 pairs: 62 students) versus self-selected strategy (40 students)
- Topics: weathering, soil, and erosion
- Multiple choice test (10 items)
- Collaborative concept mapping positively influence science concept learning
- Concept mapping leads to deeper understanding of interrelationships among concepts than other study strategies
Concept Mapping Instruction

- Instruction Phase
  - Modeling
  - Practicing
  - Summarizing

- Assessment Phase
  - Maps
  - Questions
  - Summaries
Instruction Phase

- Mapping
  - Compare-Contrast: Carbohydrates
  - Classification: Sponges
  - Cause-Effect: Leaf

- Summaries
Simple Carbohydrates
- Sugars are simple carbohydrates
- Fruits, honey, and milk contain sugar
- Glucose broken down in the cells releases energy for the body

Main source of energy for the body

Carbohydrates
- Made of carbon, hydrogen, and oxygen atoms

Complex Carbohydrates
- Starch and fibres are complex carbohydrates
- Starch is found in potatoes and grains
- Breads, cereals, beans, peas, and vegetables are sources of fibre

Fiber is needed to keep the digestive system running smoothly
Carbohydrates

Carbohydrates usually are the main source of energy for the body. There are three different types of carbohydrates: Sugar, Starch, and Fiber. Sugar is in fruits, honey, and milk, and are also called simple carbohydrates. Starch is found in potatoes and grains, and is called complex carbohydrates. Fiber is found in breads, cereals, and vegetables and is also called complex carbohydrates. Fiber is needed to keep the digestive system running smoothly.
Sponges

Saltwater Sponges
1. Live in warm, shallow salt water.
2. They are brilliant red, orange, yellow, or blue.
3. They are asymmetrical.
4. Most of the 5,000 species of sponges are found in salt water near coastlines or at ocean depths of up to 8,500 m.

Freshwater Sponges
1. Live in freshwater rivers, lakes, and streams.
2. They are dull brown or green.
3. They could have radial symmetry.
4. They can be smaller than a marble or larger than a compact car.

Adult Sponges
1. Live attached to one place during their lifetime.
2. They are called sessiles because they remain attached.
3. They are found with other sponges in permanent groups (i.e., colonies).
4. They are animals because they cannot make their own food.
Sponges

Sponges live in deep or shallow salt water and in fresh water. They have brilliant colors and live in colonies or groups. They also have different sizes and shapes. Sponges are animals because they do not produce their own food. They attach themselves to rocks or a place, but occasionally they would break off because of rough currents.
**Outer Cell Layer: Causes**

1. Epidermis is covered with waxy cuticles.
2. Epidermis is transparent.
3. Epidermis contains small openings.

**Stomata: Causes**

1. Guard cells surround each stoma.
2. Water moves into guard cells.
3. Guard cells lose water.
4. Stomata opens during the day.
5. Stomata closes at night.

**Inside the Leaf: Cause**

1. Carbon dioxide and water vapor fills the spongy layer.

**Outer Cell Layer: Effects**

1. Keeps leaf from drying.
2. Sunlight reaches the cells inside the leaf.
3. Doorways for raw materials to enter and exit the leaf.

**Stomata: Effects**

1. Guard cells control stoma size.
2. Guard cells swell and bend apart, opens stoma.
3. Guard cells deflate, closes stoma.
4. Plants take in raw materials to make food.
5. Less water vapor escapes from the leaf.

**Inside the Leaf: Effect**

1. Food is made in the palisade layer.
Leaves
Leaves are made of many different layers. The outer cell layer is called the epidermis, which is almost transparent. A waxy layer called the cuticle covers the epidermis. The epidermis has small openings. These openings are called Stomata. Two guard cells surround each Stoma. The Stoma lets carbon dioxide, water vapor, and gases enter and exit. Stomata are open during the day and close at night. The inner two layers of the leaf are: Spongy layer and Palisade layer. The Spongy layer holds in the carbon dioxide and water vapor, while the Palisade layer is where the food is made.
Assessment Phase

- Mapping
  - Compare-Contrast: Fish
  - Classification: Brain
  - Cause-Effect: Disease

- Questions
  - Fact
  - Inference

- Summaries
Assessment Phase: Concept Map Scores

- Fish: Compare/Contrast  18 points
- Brain: Classification  16 points
- Disease: Cause/Effect  24 points

Total  58 points
Concept Maps: Analytic Scoring

1. General concepts have been accurately identified
   
   All       Most       Several       Few       None

2. Specific concepts have been accurately identified
   
   All       Most       Several       Few       None

3. Links between general and specific concepts are appropriate
   
   All       Most       Several       Few       None

4. Links illustrate accurate comparative, hierarchical, or casual relationships
   
   All       Most       Several       Few       None

5. Appropriate words and phrases have been used to identify concepts
   
   All       Most       Several       Few       None
## Assessment Phase: Question Scores

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<tr>
<th>Category</th>
<th>Question Type</th>
<th>Points</th>
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<td>Fact Question</td>
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<td>Inference Question</td>
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**Total**: 18 points
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<tr>
<th>Category</th>
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<tr>
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<tr>
<td>Disease</td>
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Compare/Contrast Map: Numerical Scoring Template

Compare-Contrast Map
(16 points - Fish)

Difference 1
(1 point)

Similarity 1
(2 points)

Difference 1
(1 point)

Similarity 2
(2 points)

Difference 2
(1 point)

Difference 3
(1 point)

Jawless Fish
(5 points)

2
Similarity
(2 points)

Cartilaginous Fish
(5 points)

Difference 3
(1 point)

Difference 4
(1 point)

Similarity 3
(2 points)

Difference 5
(1 point)

Difference 4
(1 point)
1. Draw a double bubble map to compare and contrast fish.

**Jawless Fish**
- Have round, toothed mouths
- Tube-like body covered with scale-less, slimy skin
- Attach to fish with tubelike mouth

**Cartilaginous Fish**
- Have skeletons made of cartilage
- Efficient at finding & killing their food
- Have movable jaws
- Body covered with tiny scales

**Have**
- Skeletons made of cartilage
2. Why are lamprey and hagfish called jawless fish?

Because they have round, toothed mouths and long, tube-like bodies covered with scale-less, slimy skin.

3. What is the difference between fish that are parasites and predators?

Parasites attach to fish and feed off of their blood. Predators hunt and kill their prey.
Fish: Summary

There are many different types of fish. For instance, jawless fish and cartilaginous fish. Jawless fish have round, toothed mouths and long tubelike bodies covered with slimy skin. They attach to other fish with their suckerlike mantle. Cartilaginous fish have movable jaws and bodies covered with tiny scales that feel like sandpaper.
Classification: Numerical Scoring Template

**General Concept**

- **Cerebrum**
  1. Fact 1 = 1 point
  2. Fact 2 = 1 point
  3. Fact 3 = 1 point
  4. Fact 4 = 1 point
  5. Fact 5 = 1 point
  6. Fact 6 = 1 point
  7. Fact 7 = 1 point
  8. Fact 8 = 1 point
  9. Fact 9 = 1 point
  **(9 points)**

- **Cerebellum**
  1. Fact 1 = 1 point
  2. Fact 2 = 1 point
  3. Fact 3 = 1 point
  4. Fact 4 = 1 point
  **(4 points)**

- **Brain Stem**
  1. Fact 1 = 1 point
  2. Fact 2 = 1 point
  3. Fact 3 = 1 point
  4. Fact 4 = 1 point
  5. Fact 5 = 1 point
  **(5 points)**

**Classification Map**

**(18 points = Brain)**
1. Draw a classifying map to show parts of brain.

- Brain
  - Cerebrum
    1) Thinking takes place
    2) Largest part of brain
    3) Memory is stored
  - Cerebellum
    1) Coordinates movements
    2) Stimuli from eyes, ears, muscles & tendons
  - Brain Stem
    1) Extends from cerebrum & connects to spinal cord
    2) Made of midbrain, pons & medulla
Brain: Questions

2. What major activities take place within the cerebrum?

   Thinking, movements are controlled & memory is stored.

3. Why are actions controlled by the medulla involuntary actions?

   Because they happen by themselves.
Brain: Summary

The brain is made up of three parts. These parts are called the cerebrum, the cerebellum, and the brain stem. Thinking takes place in the cerebrum. The cerebellum is able to coordinate voluntary muscle movements. The brain stem extends from the cerebrum down to the spinal cord.
Cause/Effect: Numerical Scoring Template

Atherosclerosis
1) Cause 1 = 1 point
2) Cause 2 = 1 point
3) Cause 3 = 1 point
(3 points)

Hypertension
1) Cause 1 = 1 point
2) Cause 2 = 1 point
3) Cause 3 = 1 point
4) Cause 4 = 1 point
(4 points)

Heart Failure
1) Cause 1 = 1 point
2) Cause 2 = 1 point
3) Cause 3 = 1 point
4) Cause 4 = 1 point
5) Cause 5 = 1 point
(5 points)

General Concept

Atherosclerosis
1) Effect 1 = 1 point
2) Effect 2 = 1 point
3) Effect 3 = 1 point
(3 points)

Hypertension
1) Effect 1 = 1 point
2) Effect 2 = 1 point
3) Effect 3 = 1 point
4) Effect 4 = 1 point
(4 points)

Heart Failure
1) Effect 1 = 1 point
2) Effect 2 = 1 point
3) Effect 3 = 1 point
4) Effect 4 = 1 point
5) Effect 5 = 1 point
(5 points)

Caution: Effect Map
(24 points - Disease)
1. Draw a multi-flow map to show causes and effects of cardiovascular disease.

- Atherosclerosis
- Hypertension
- Heart Failure

Cardiovascular Disease

Fatty deposits build up on arterial walls.

When blood pressure is higher than normal, most of the time, extra strain is placed on the heart.

Results when heart can't pump blood efficiently.

2. How can atherosclerosis cause hypertension or high blood pressure?
2. How can atherosclerosis cause hypertension or high blood pressure?
   If fatty deposits build up on arterial walls.

3. What are the symptoms of a heart failure?
   Shortness of breath and if they are tired.
Disease: Summary

Cardiovascular Disease

Atherosclerosis, Hypertension, and Heart Failure are all part of cardiovascular disease. They each do something bad to the heart. The Atherosclerosis is when fat deposits build up on arterial walls. Hypertension is when your blood pressure is higher than normal and Heart Failure is when the heart cannot pump blood efficiently. These are all bad causes to the heart.
## Assessment Phase: Student Performance

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Concept Mapping Intervention: Conclusions

□ Strengths

- Concept mapping helped students understand science content information
- Concept mapping helped students summarize science content information
- Concept mapping helped students identify and connect science concepts

□ Limitations

- Concept map structure limited students’ ability to identify and connect all science concepts
- Concept map had limited impact on students’ ability to infer about concepts
- Concept maps had limited impact on students’ summaries
END OF PRESENTATION

THANK YOU