Science IDEAS as an Integrated Instructional Model for K-5 Impacts Comprehension: Learn Why!

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What is Involved with Meaningful Learning in Science?

Meaningful learning in science requires
– Meaningful content to be learned
– A curricular structure with opportunities for students to be able to:
  • learn more about what is being learned
  • explicitly relate what is to be learned to what has already been learned (access prior curricular knowledge)
  • build relationships among concepts (e.g., powerful sameness)
  • review what has been learned
What Does Research Tells Us? 
Consensus Research About the Role of Knowledge in Meaningful Learning

Recent Research Related to Learning with Understanding…

3 Major Findings…

• **Prior Knowledge** is a major determinant of future learning

• Understanding involves *organizing/re-organizing* knowledge around core concepts

• Learning involves *knowing when* to use prior knowledge and skills for future learning (*metacognition*)
Consensus Research: Conclusions Relating to the Role of Knowledge in Reading Comprehension

Rand Research Findings

• Recommends more content-area reading

• Defines comprehension as...

  The simultaneous process of extracting and constructing meaning from print materials
American Educator
Spring 2003

Entire issue devoted to comprehension

Available from the American Federation of Teachers (AFT.org)
Basal Readers: The Lost Opportunity to Build Background Knowledge to Propel Comprehension

Author: Kate Walsh

American Educator Spring 2003
An Instructional Model
Building Reading Comprehension by Integrating Reading within Science - Grades K-5

Science

IDEAS

SCIENCE CONCEPTS

PROPOSITIONAL CONCEPT MAPPING

READING COMPREHENSION ACTIVITIES

PRIOR KNOWLEDGE

APPLICATION ACTIVITIES

WRITING ACTIVITIES

SCIENCE ACTIVITIES
Knowledge-Based Instruction (KBI) Model

consists of

Knowledge-Based Teaching (KBT)
emphasizes
Roles of Teachers in Instruction

Roles of Teachers in Instruction

include

Curriculum Planning

Instructional Task Development

and

Teaching and Assessment

is basis for

Concept Mapping as a Tool
to focus on

Content Knowledge to be Learned

is basis for

Knowledge-Based Instructional Routines

are used for

that emphasize

Learning with Comprehension

Knowledge-Based Learning (KBL)
emphasizes
Roles of Students as Learners

Roles of Students as Learners

include

Content Analysis of Text

and

Writing with Guidelines

and

Study Aid Strategy

Note: For Content Analysis of Text - a knowledge-focused reading comprehension strategy is a key process that complements concept mapping (i.e., to read with comprehension: apply reading comprehension strategy, then concept map content).
Concept Mapping as a Graphic Organizer

CONCEPT MAPPING (Simplified)

- Concept Map of Concept Mapping
- Concept Mapping
- NS/IERI Science IDEAS
  Project #0228353

KNOWLEDGE

represents

BIG IDEAS (as nouns)

highlights

are connected to

SUB-ORDINATE IDEAS

uses

VERBS

are used as

IDEA CONNECTORS

ORGANIZATION

has

IS

Concept Mapping

Science IDEAS
Constructing Propositional Concept Maps

CONCEPT MAPS

represent

KNOWLEDGE

consistent of

CONCEPTS AND RELATIONSHIPS

has an

ORGANIZED STRUCTURE

distinguish between

SUPERORDINATE & SUBORDINATE CONCEPTS

are made up of

BIG IDEAS

virtually display

CONCEPTS

are located in

BOXES OR CIRCLES

are labeled using

NOUNS

CORE ORGANIZING PRINCIPLES OF THE KNOWLEDGE

amplify

RELATIONSHIPS AS CONCEPT LINKS

are shown using

LINES TO CONNECT CONCEPTS

are labeled using

VERBS

determine

ALL RELATIONSHIPS FORM SENTENCES
Propositional Concept Maps: A Curriculum Planning Tool

- Concept maps -
  - are useful in representing the organization or structure of the content knowledge prior to and resulting from instruction.
  - are powerful because they inform the teacher about:
    - Prior knowledge that is needed by students
    - New knowledge students attend to
    - How new knowledge is perceived by students
    - What learners judge to be important
    - What they actually learn
Propositional Concept Maps: A Curriculum Planning Tool

- Curriculum Concept Maps help to-
  - Organize the school curriculum
  - Highlight ‘big’ ideas in the curriculum as organizing concepts for learners
  - Prioritize concepts to be taught (less is more)
  - Identify ‘gaps’ in the curriculum
  - Identify concepts which can be used to connect other disciplines
  - Establish consistency among the curriculum units being taught at a grade level or for a course
Propositional Concept Maps: A Curriculum Planning Tool

- Curriculum Concept Maps help to-
  - Identify a plan for instruction including daily lessons (See Evaporation Map)
  - Serve as a framework to evaluate texts and other instructional materials
  - Organize curriculum across grade levels or courses as well as provide for vertical articulation
  - Integrate FLSSS in science with literacy
Propositional Concept Maps: A Curriculum Tool for Teachers

Propositional Concept Maps help to –

• Organize the school curriculum.
  – Construct a single lesson
  – Construct a map representing multiple lessons
  – Construct a map for an entire Unit of study
    • Notes and Considerations are important
  – Map out the curriculum across a grade level
  – Map out the curriculum vertically (K-12)
  – Identify gaps and overlaps in terms of what is being taught
Easy Start-Up for Concept Maps

• Initial Use:
  – Grade level planning – all teachers – with some guidance (if possible)
  – Create large poster-size maps as teacher guides in the classroom
  – Reference them often while teaching (students like to know where they are)
  – Illustrate large map with indicators showing activities, reading, writing ideas
  – Teacher plan unit/lesson assessments using maps
  – Use maps with students for review
  – Add samples of student work to illustrate what has been learned
Propositional Concept Maps: The Starting Point for All Curriculum Units

CURRICULUM CONCEPT MAP FOR FACTORS THAT EFFECT WATER EVAPORATION

- Water Evaporation
  - Involves:
    - Phase of Matter Change Process
      - Involves:
        - Liquid Changing to a Gas
          - Water as the Liquid
          - Water Vapor as the Gas
    - Activity 2: Real Examples
      - Morning Dew Disappearing,
      - Damp Cloth Drying,
      - Heated Water Disappearing From a Pot,
      - Wet Sidewalk Drying
  - Examples Include:
    - Activity 7: Reading
    - Activity 13: Add. Reading
  - Can Occur At:
    - Activity 6: Journaling
    - Activity 8: Concept Map
    - Activity 9: Writing
  - Faster or Slower Rate
    - Depends Upon:
      - Activity 10: Application
      - Combined Effects of 3 Different Factors
        - More Heat-Speeds Evaporation
        - More Surface Area-Speeds Evaporation
        - More Air Flow-Speeds Evaporation
  - Activity 12: Reflection
Teachers spent many weeks researching science concepts to construct concept maps representing units of study.

Teachers realized the potential of using multiple sources.
Title: The Earth's 4 Layers

December 9, 2003

Goal: Understand more about each layer

Can be classified as

Can be formed by

Explosions

Examples:

Types of Volcanoes

- Strombolian
- Eruption
- Lava
- Ash
- Gas

- Composite Volcanoes
- Cinder Cones
- Lava
- Ash

- Cinder and Ash
- Lava
- Gas

- Population
- Living things
- Erosion
- Weathering

Shapes of Volcanoes

- Composite
- Cinder Cone
- Shield Volcano
- Stratovolcano

- How they are formed

- How they are classified
Focusing on Content Knowledge
Concept Map Example: Heat Energy

HEAT ENERGY can be transferred through
- RADIATION comes from SUN'S RAYS
  - heat the EARTH
- CONVECTION is made up of CONVECTION CURRENTS
- CONDUCTION occurs between OBJECTS
  - must be DIFFERENT TEMPERATURES
  - and TOUCHING

HOT SUBSTANCES will EXPAND and RISE
COLD SUBSTANCES will CONTRACT and SINK
Science IDEAS Model as a Cognitive-Science Exemplar

Knowledge-Based Instruction

focuses on

Content-Area Knowledge

organized according to

Logic of Discipline

determines

Core Concepts to be Taught

provide context for

What Student Prior Knowledge is Relevant

All Instructional Strategies and Activities

What New Knowledge Students Learn
Combining In-Depth Content-Area Reading with Propositional Concept Mapping to Impact Reading Comprehension

An Activity
Group Activity: Applying the Science IDEAS Reading Comprehension Routine

1. Read over Solar System (Harcourt Science)
2. Generate “Knowledge Notes”
3. Transform into questions
4. Re-Read and discuss line-by-line
5. Summarize first paragraph
6. Re-read and place key ideas on post-it notes
7. Arrange postit notes on paper, draw lines between related concepts, place verbs on the lines (See completed sample for page)
Our Solar System

The Sun

In the investigation you made a model of our solar system. A solar system is a group of objects in space that move around a central star. Our sun is a star, a burning sphere (SFEER) of gases. This enormous fiery ball is more than 1 million kilometers (about 621,000 mi) in diameter. The sun is the largest object in our solar system. It is larger than the rest of the objects in the solar system put together.

The sun puts out a lot of energy in all directions. In fact, it is the source of almost all the energy in our solar system. Some of this energy reaches Earth as light, and some reaches it as heat.

Two features of the sun’s surface are shown on this page. The dark areas, called sunspots, are cooler than the rest of the sun’s surface and don’t give off as much light. The red streams and loops of gases that shoot out from the sun are called prominences (PRAHM•ih•nuhn•suhs). These hot fountains often begin near a sunspot. They can be thousands of kilometers high and just as wide. Sunspots and prominences usually last for only a few days. Some can last for a few months.

What is the largest object in our solar system?

The sun is the largest object in our solar system. The next largest object, Jupiter, is small compared to the sun. Earth is even smaller.
Space consists of Solar System and Stars.

Solar System includes Central Star, Planets, Asteroids, and Comets.

Central Star revolves around Planets and is called the Sun.

Planets may have One or More Moons and are called Satellites.

Asteroids can be described as Small and Rocky Objects located between Mars and Jupiter.

Comets are Small Mass of Dust and Ice.

Source of almost all Energy travels in All Directions as Heat or Light travels as Burning Sphere of Gases.

Sun is the 1 Million Km in Diameter Most Massive Object of Solar System.

Satellites are called Prominences.

Prominences are Cooler than Surroundings and emit Less Light and Red Streams and Loops of Gases.

Example of propositional concept map constructed from Our Solar System passage.
Guiding student creation of concept maps following in-depth reading and/or review:

- Re-read passages/pages
- Identify key concepts as nouns (place on post-it notes)
- Place all postit notes off to the side of a sheet of paper
- Guide organization of key concepts (arrange post-it notes in hierarchical/top-down structure)
- Guide student identification of linking verbs to connect concepts
- Edit/revise as necessary
Teacher Guidelines for Construction of Propositional Concept Maps

- Identify major concepts and sub concepts and place on individual postit notes
- Concepts are represented as nouns and are placed in boxes or on postit notes
- Keep the number of concept words on each postit note to a minimum (e.g., one or two)
- Use a variety of sources to select ideas
Teacher Guidelines for Construction of Propositional Concept Maps

• Don’t try to organize concepts while simultaneously brainstorming all the ideas you consider important

• Ask: What is the general organizing concept or most subsuming concept that can serve to organize the topic? Place it on top of map

• Next: Select the next layer of major concepts that organize (or categorize) the topic into broad subtopics,
Teacher Guidelines for Construction of Propositional Concept Maps

• Arrange organizing major concepts on map, and rehearse the links (e.g., verbs or verb phrases) that would be helpful to create a complete proposition or thought

• Note: Initially all links (e.g. verbs) should be written in pencil to allow for changes

• Maintain focus on relatedness among concepts as the key for organizing the concepts

• A single map cannot represent everything you know about a topic (use submaps for elaborations)
Teacher Guidelines for Construction of Propositional Concept Maps

• Don’t hesitate to add or delete concepts as needed
• Arrows positioned at end of links are helpful in showing flow of concept relationships
• Specific examples and small details are usually placed at the bottom of maps
• Continue: Use the same process for each concept on a map, arranging and linking as appropriate. Read map aloud to yourself. Ask: Does it make sense? Edit and rearrange: As necessary...
Summary Thoughts

- Covering topics/benchmarks and moving rapidly from one to the next does not support conceptual understanding.
- Lists of state standards seem to encourage this; hence, the importance of mapping the curriculum.
- Reading and answering questions has been confused with comprehension (meaningful understanding).
- Skills emphasis in the absence of meaningful content to be learned does not support comprehension.
- Maps show concept links; replace memorizing vocabulary terms.
- Use maps for all curricular events – the benefit is continually supporting teacher science understanding and student meaningful learning in science and reading comprehension.