Web-Based Concept Mapping for Scientific Thinking: A School-University Partnership

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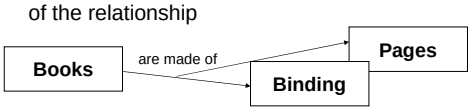
Outline

- Strategies for Employing Concept Maps with Implications for Thinking
- Study Overview
- Basic Features of Cmap Tool
- Preliminary Findings

Strategies for Employing Concept Maps with Implications for Thinking

Concept Mapping Defined

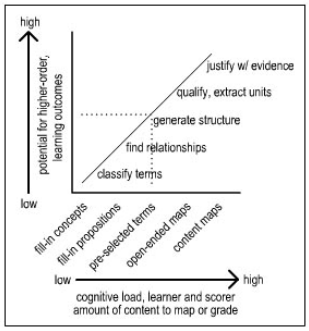
- concept mapping is a technique for organizing and representing information
- a true concept map must include:
  - core concepts - usually enclosed in circles or boxes
  - relationships illustrated by lines and arrows connecting concepts AND by propositions or statements on those lines that explain the nature of the relationship



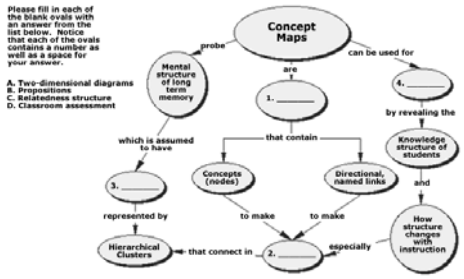
Thinking Skills Model

- Barbara Presseisen, "Thinking Skills: Meanings and Models Revisited"
- Arthur Costa's (Ed.) "Developing Minds: A Resource Book for Teaching Thinking"
- basic thinking skills: qualifying, classifying, finding relationships, transforming, and drawing conclusions
- complex thinking processes: problem solving, decision making, critical thinking, creative thinking

Map Strategies and Influence on Learning/Scoring

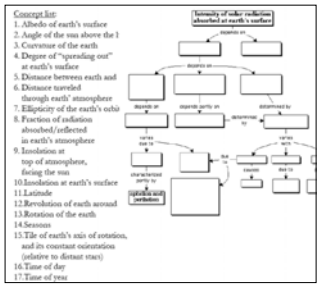


Structured Strategy: Partial Fill-in

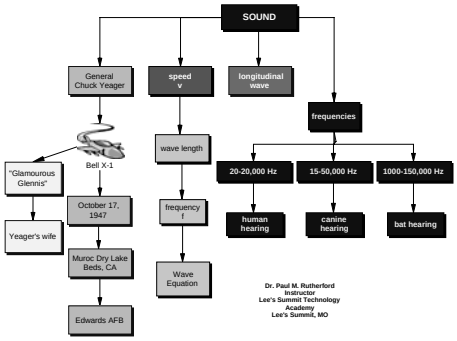


Structured Strategy: Complete Fill-in

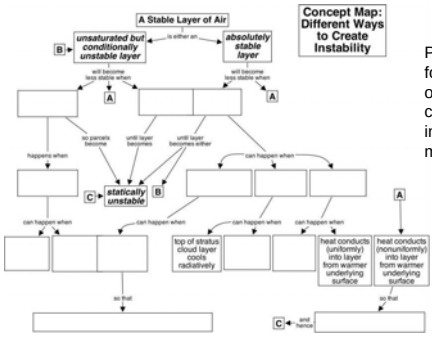
- fill-in blanks in pre-structured map from a list of concepts
- helps students to consolidate understanding of concepts and relations among them



Structured Strategy: Fill-in-the-Proposition Maps



Scoring Structured, Fill-in Maps



Points assigned for each concept or proposition correctly placed in the provided map structure.

Unstructured Strategy: Pre-Selected Term Maps

Design a concept map to show your understanding of CO2, a greenhouse gas, and its past and future effect on climate. Use the following concepts:

- fossil fuels
- deforestation
- clouds
- atmospheric water vapor
- ocean
- CO2
- Industrial Revolution
- longwave solar radiation
- global warming
- human activity
- evaporation
- transpiration
- greenhouse gas concentrations
- ice
- albedo
- photosynthesis
- feedback loops
- shortwave solar infrared radiation

Unstructured Strategy: Seeded Term Maps

- also called "micro-mapping"
- provide students with an unstructured list of "starter" or "seed" terms (5-6)
- students must use these terms in their map AND use another 9-10 terms from their own knowledge of the topic
- a variation is called "expert skeleton" map where a partial map is structured with seeded terms, and students must build on starter map and integrate additional terms

Unstructured Strategy: Open-Ended Maps

- Once students are familiar with concept mapping processes, they can also be asked to do open-ended maps
  - after reading a section of text
  - at the end of a section of course work
  - at the end of the course
- This helps with identifying and tying together core concepts, and also acts as a learning tool for test revision.

Unstructured Strategy: Content Maps

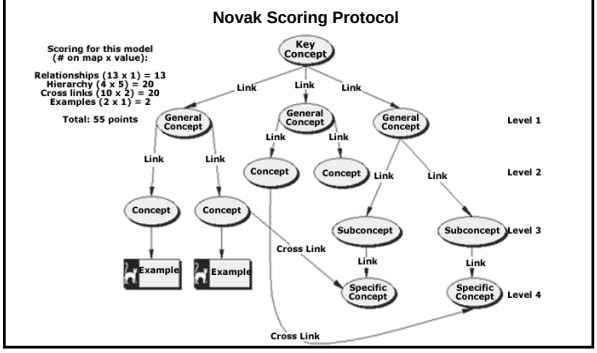
- increasingly, mapping programs allow people to attach resources to concepts (e.g., notes, links, images, files), reminiscent of e-portfolio systems
- selecting and adding content resources to concepts or relationships adds yet another layer of detail to maps
- can be used by students to justify their maps on the basis of real evidence (i.e., critical thinking--the weight of evidence across all these resources suggests these relationships)

Unstructured Maps: 3 Scoring Methods

(Ruiz-Primo & Shavelson, 1996)

1. score map components
   a. relational (propositions only)
   b. structural (all map components)
2. compare the student map to a criterion or expert map
3. combination of both

Method 1: Scoring Map Components



Method 2: Comparing to Expert Map

- count the number of items in a student map that are roughly comparable to an expert map (e.g., one point for each concept match, two points for each proposition match)
- criterion/expert maps can be defined by instructor, experts other than instructor, average of experts, or average of top students
- individual expert maps highly variable in predicting student performance--may lead to different conclusions about student knowledge
- an average of expert maps is the most effective to use as a referent (Acton et al., 1994)

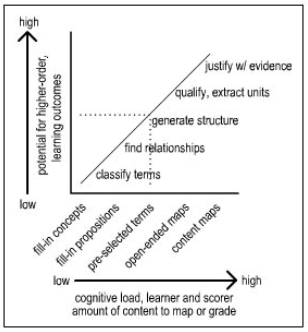
Method 2: Comparing to Expert Map

- comparing back and forth between student and expert map can be challenging, looking for similar items
- made easier by restricting mapping task to a limited number of pre-selected or seeded terms that remain common across student maps, essentially allowing you to look for specific concept groupings and propositions

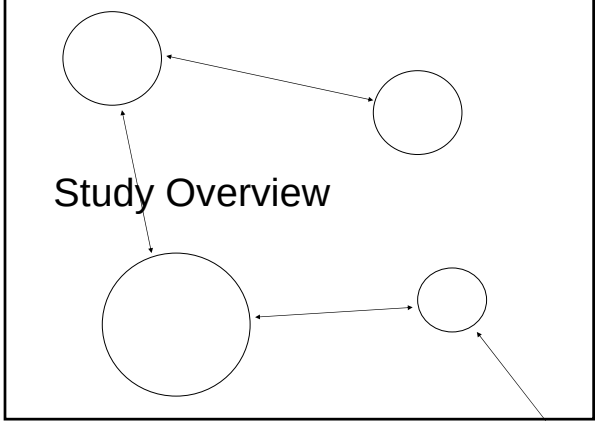
Method 3: Combination

- score student map components by some method (i.e., relational, Novak approach)
- score expert map by same method
- divide student score (83) by expert map score (133) to derive a percentage for comparison (62%); possible for some top students to score more than 100%
- no direct comparison between student and expert map required

Map Strategies and Influence on Learning/Scoring



possibility of scaffolding more complex tasks with collaborative "talk" about map content

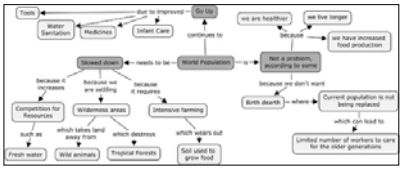


Study Overview

- six teachers selected from spring '06 applications, two grade-level teams (6th and 7th)
- established a Cmap server at the university, allows for remote storage of teacher/student work, and researcher review
- two-day seminar held, summer 2006, with training on Cmap tool, and collaborative lesson planning
- each team developed two sample map lessons

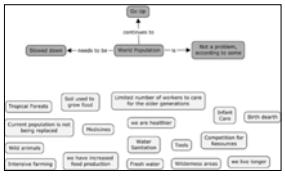
Study Procedures

- teacher selects resources/activities tied to content (e.g., readings, Web sites, lab work); develops related expert map
- test questions drawn from map, emphasis on relationships between terms



Study Procedures

- students take pre-test, then complete various curricular activities (e.g., readings)
- students given pre-selected terms to map drawn from expert map
- students complete map, take post-test
- control classes employed



Research Question, Data Sources

- How well do students exhibit basic thinking skills when mapping with Cmap (i.e., qualifying, classifying, finding relationships)?
- mixed methods
- quantitative pre-post test scores
- qualitative observation/field notes, teacher journal, teacher interview, student survey

Analysis of Maps

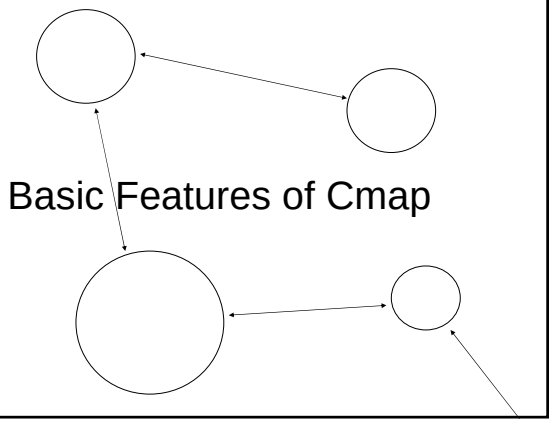
method 2, comparing student and expert maps

- 7 points for correctly classifying terms
- 2 points for identifying concept "sets"
- 4 points for correct propositions

sample student map

related portion of expert map

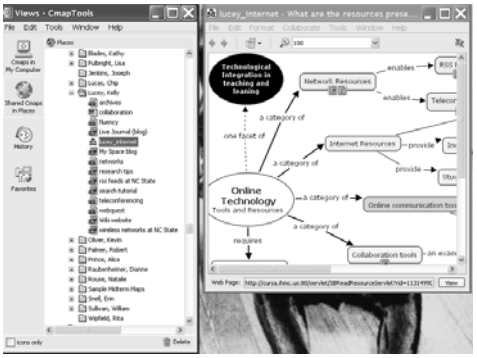
Basic Features of Cmap



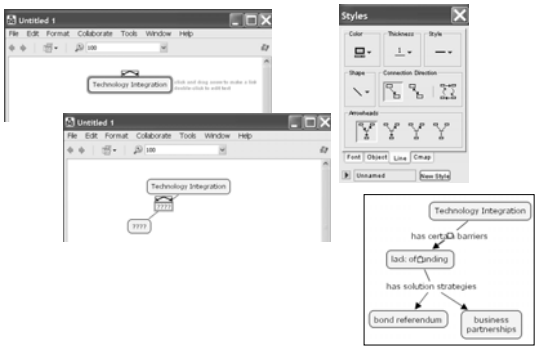
Cmap

- freeware tool developed by the Institute for Human and Machine Cognition (IHMC), affiliated with UWF, UCF, FAU
- James Novak, collaborator
- download desktop tools and server software from http://cmap.ihmc.us/
- public servers available for schools that don't have a dedicated server

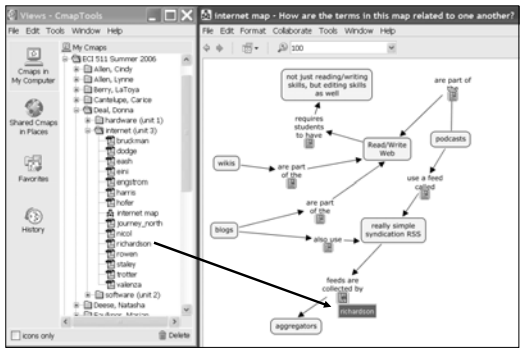
Interface and Student Folders



Creating Concepts and Propositions

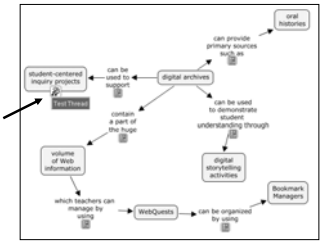


Justifying Concepts/Relationships w/ Resources



Collaborative Options

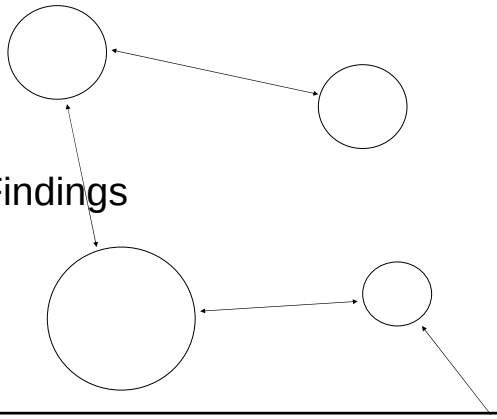
- synchronously edit maps with the support of chat
- asynchronously edit maps with the support of discussion boards attached to concepts or propositions



Collaborative Options

- asynchronously edit maps with the support of "knowledge soups"
- share claims with a small or large group

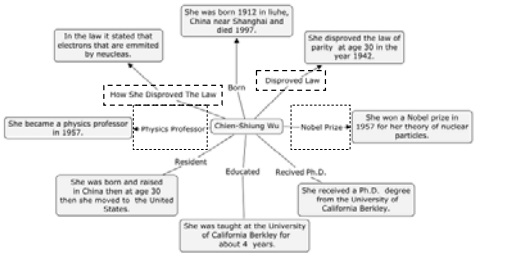
Findings



Thinking Skills Exhibited

- success classifying terms
- difficulty identifying specific pairings

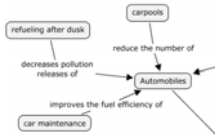
Map/ Reading	n	Mean # Concepts Classified Correctly	Mean # Concept Sets Identified	Mean # Correct Propositions	Mean Post-Test Score	Mean Pre-Post Gain
1. Energy (337 words)	21	13.8/15 (92%)	6.4/9 (71%)	6.5 (9)	5.9/7 (84%)	2.6
2. Population (1275 words)	20	13.7/17 (81%)	2.2/6 (37%)	4.9 (13)	4.7/7 (67%)	1.5
3. Pollution (890 words)	18	13/16 (81%)	2.5/6 (42%)	10 (12)	4.9/7 (70%)	2.8

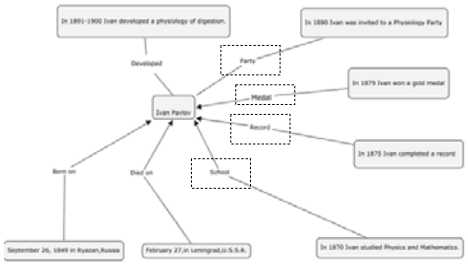


- issues with star or string maps that tie each sub-concept back to main idea, without chunking two or more ideas together

Understanding of Relationships

- some students better at map "language"
- encourage students (and teachers) to write a sentence with two concepts (i.e., think of concepts as nouns and propositions as verbs or action words)
- the sentence should run in the direction of the arrows
- otherwise, many will repeat/restate concepts in place of a true "relationship" statement





- issues with directionality of arrows, flow of relationships (more technical than conceptual?)

Influence of Reading Level

1-way ANOVA indicates significant differences in proposition writing and test gain at different reading levels

Map/ Reading	n	Reading Level	Mean # Concepts Classified Correctly	Mean # Concept Sets Identified	Mean # Correct Propositions	Mean Post-Test Score	Mean Pre-Post Gain
1. Energy (337 words)	6	2-3.9	14.5/15	6.8/9	6.8	5.3/7	2.2
	12	4-5.9	13.2/15	6.2/9	6.1	6.1/7	2.8
	3	6+	14.7/15	6.7/9	7.3	6.3/7	2.3
2. Population (1275 words)	5	2-3.9	9.6/17	2.0/6	2.8*	2.3/7*	0.4*
	12	4-5.9	10.6/17	2.1/6	5.3*	5.3/7*	2.3*
	3	6+	13.3/17	3.0/6	7.0*	5.3/7*	0.7*
3. Pollution (890 words)	5	2-3.9	12.2/16	1.8/6	4.6*	4.0/7	2.0
	10	4-5.9	12.5/16	2.6/6	6.8*	5.5/7	3.4
	3	6+	14.0/16	3.3/6	9.3*	4.7/7	2.0

Concept Learning

- t-tests comparing each pre-test to post-test revealed significant differences in gain for each

	n	Pre-Test	Post-Test	2-Tailed P
Map 1. Energy	21	3.5/7	5.9/7	<0.0001
Map 2. Population	22	3.3/7	4.4/7	0.0194
Map 3. Pollution	17	2.4/7	5.0/7	<0.0001

- mean class test score across all 3 tests was 72.7% (17/22 students > 70%)
- all 5 students < 70% were reading +2 grades below level

Concept Learning

- no significant differences in test gain between 6th grade mappers and 7th grade non-mappers (control class)
- we attempted to create a test that would measure understanding of relationships in the readings, expecting mappers to excel
- we may have failed in this attempt--students' individual test scores were not significantly correlated with the number of concepts or relationships identified
- thus, tests and maps may have measured different skills (discrete facts versus patterns)

Collaboration

- we intended for our students to develop maps individually
- what emerged was a very collaborative classroom, with students regularly observed talking with one another about map content
- 50% of students reported talking to others at least some (5-8 times/day); only 11% reported never talking to others about their maps
- only 11% of students reported they would like to work alone, while 72% reported they would like to work with one other person on future maps

Collaboration

- not only peer-peer collaboration, but also instructor/researcher-student collaboration
- common questions... how to spell words, where to locate a term in a reading, where a term should go on a map
- hints provided, not answers...
- "Which forms of energy are listed here in your reading?" and "So where should those go on your map?"
- "I think there might be something else that goes here."

Motivation, Interest

- 50% of students reported they "loved it," 33% "liked it," and 17% thought it was about the same as other school work
- when asked to choose between regular readings or readings with Cmap, 66% reported they would "definitely like to use Cmap," 28% would "probably like to use Cmap," and 11% indicated no preference

Ease of Use

- 60% of students reported they almost never used concept maps, thinking maps, or bubble maps prior to the study
- after only 1 day of training, 83% of students rated the difficulty of creating new concept boxes in Cmap and drawing arrows between concepts as somewhat or very easy
- 67% rated proposition writing between concepts as somewhat or very easy
- only 33% rated finding the pre-selected terms in their readings as somewhat or very easy (modified strategy--circle terms before mapping)

Resources

- download slides online at: http://kevoliver.com/pdf/ncetc.pdf
- Cmap, http://cmap.ihmc.us/