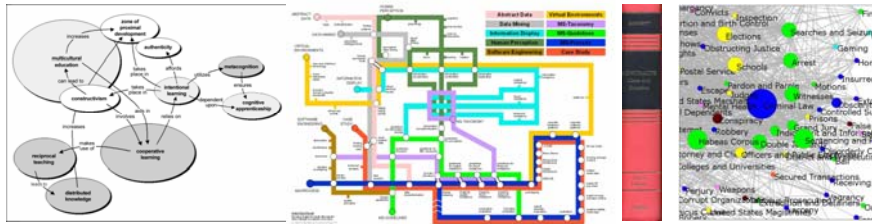


Educational Knowledge Domain Visualizations: Tools to Navigate, Understand, and Internalize the Structure of Scholarly Knowledge and Expertise



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Mapping Humanity's Knowledge
and Expertise in the Digital Domain
at the 101st Annual Meeting of the Association of American
Geographers, April 6, 2005



Bridging the Practices of Two Communities

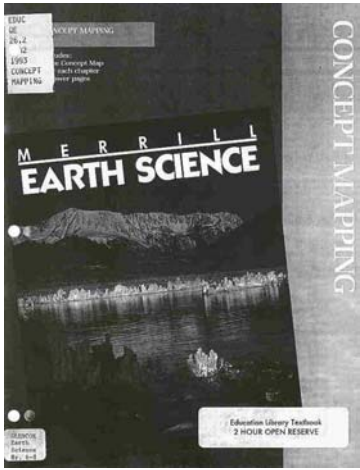
- Domain Maps are widely used in the field of education. (Also called: mind maps, pattern notes, brain patterns, spider maps, networks, semantic maps, semantic networks, and semantic webs.)
- Called Concept Maps.
- Differ from domain maps produced by information scientists as to scale and method of production.
- Each community has something to offer the other.

Current Practice in Education

- “[L]earning best begins with a big picture, a schema, a holistic cognitive structure, which should be included in the lesson material[.]”
- “[T]he designers’ task is to develop a big picture and emphasize it[.]” (West et al., (1991). *Instructional Design: Implications from Cognitive Science*. Englewood Cliffs, New Jersey: Prentice Hall, p. 58).”
- This is done with concept maps.

Semantic Network Theory of Learning

- Human memory is organized into networks consisting of interlinked nodes.
- Nodes are concepts or individual words.
- The interlinking of nodes forms knowledge structures or schemas.
- Learning is the process of building new knowledge structures by acquiring new nodes.
- When learners form links between new and existing knowledge, the new knowledge is integrated and comprehended.

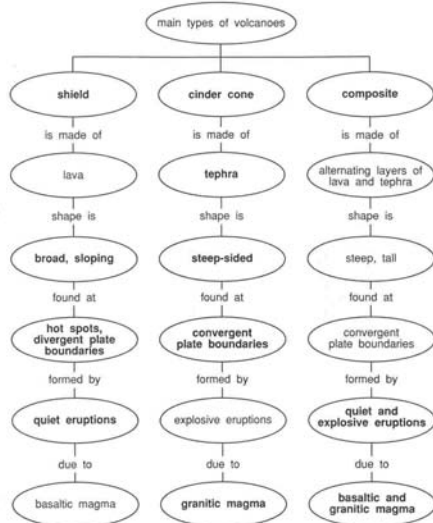


GRADES 6-8

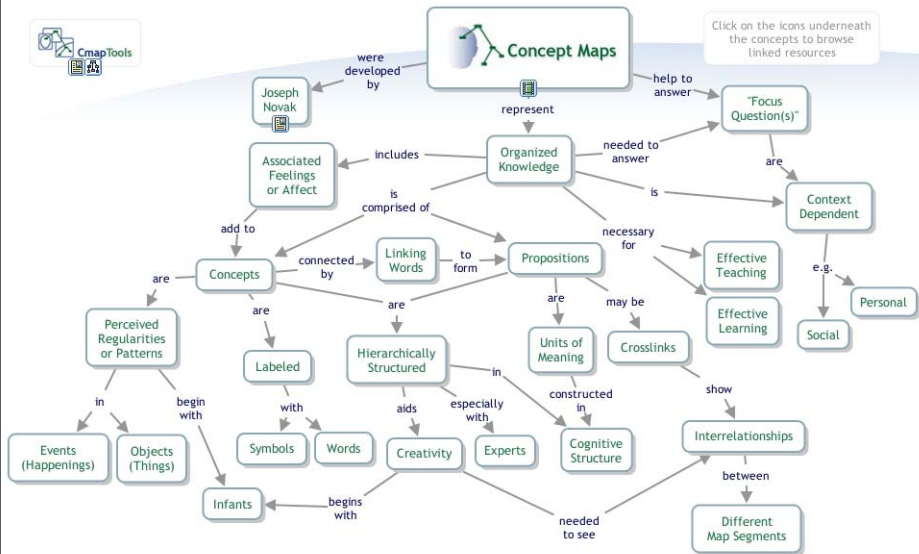
Feather, Ralph M. Jr., Snyder, Susan Leach & Hesser, Dale T. (1993). *Concept Mapping*, workbook to accompany, Merrill Earth Science. Lake Forest, Illinois: Glencoe.

Volcanoes

Fill in the incomplete concept map on the characteristics of different types of volcanoes. Use the information in Section 15-3 of your textbook to help you.

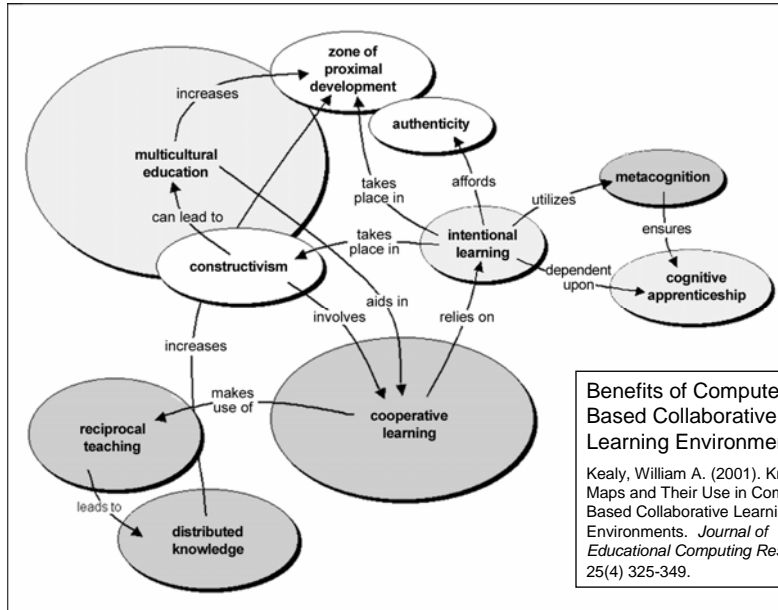


Concept Map Produced by Cmap Tools



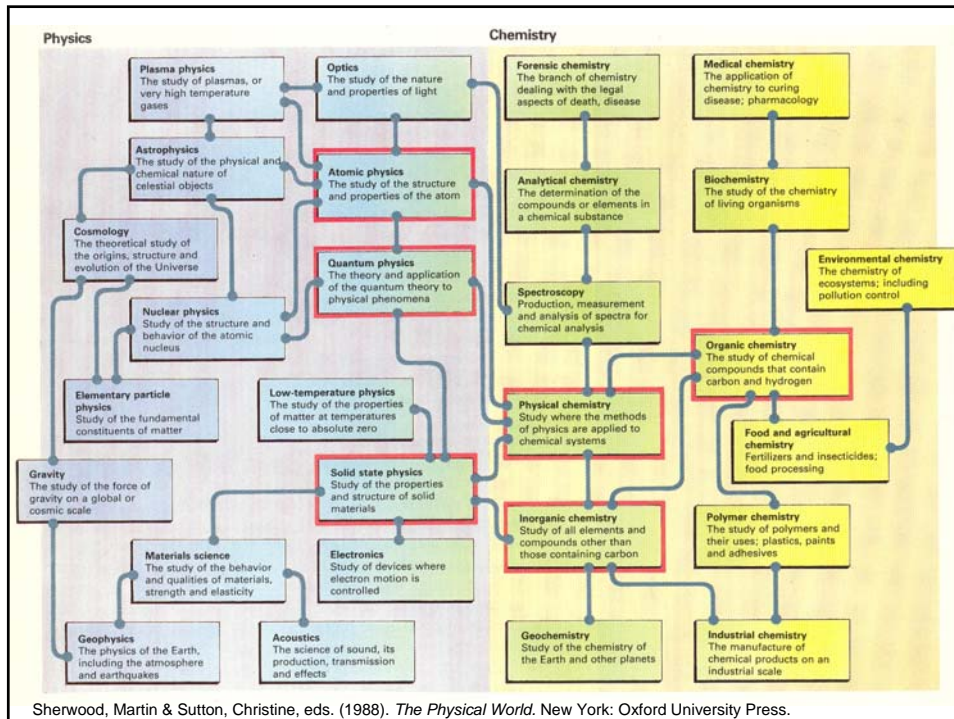
Created by Joseph Novak and rendered with CMapTools. <http://cmap.ihmc.us/>

Concept Map Created With Rigor



Benefits of Computer-Based Collaborative Learning Environments

Kealy, William A. (2001). Knowledge Maps and Their Use in Computer-Based Collaborative Learning Environments. *Journal of Educational Computing Research*. 25(4) 325-349.



Elements of Concept Maps

- (1) **shapes or nodes**--representing core elements of a concept
- (2) **connectors or links** between the shapes or nodes
- (3) **connecting words**--that describe how two nodes are related, and
- (4) **patterns**--such as a hierarchical or circular ordering of the nodes

Benefits of the Big Picture

- Provides a structure or scaffolding that students may use to organize the details of a particular subject.
- Information is better assimilated with the student's existing knowledge.
- Visualization enhances recall.
- Makes explicit the connections between conceptual subparts and how they are related to the whole.
- Helps to signal to the student which concepts are most important to learn.

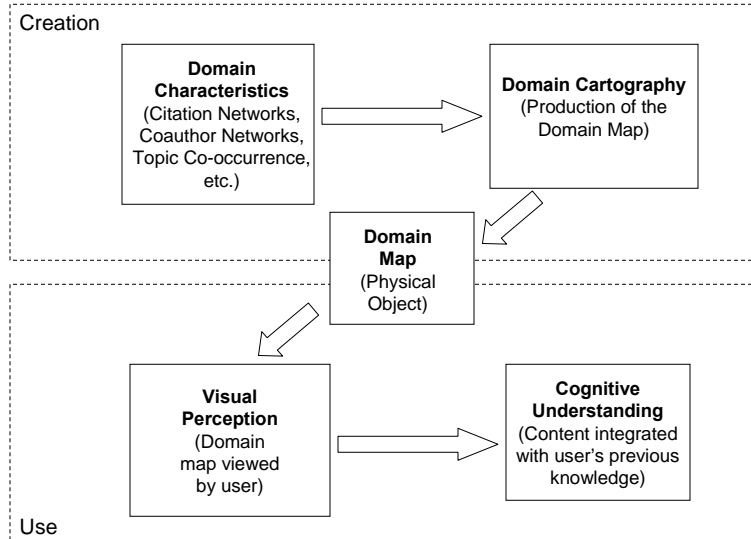
Education → KDVis

- Educational community places more emphasis on explicit connections between nodes and labels for the type of connection.
- Use of action phrases such as “gives rise to,” and “causes.”
- Explicitly labeled connections, linkages, or notion of causality are largely missing from KDVs.
- Also often missing are clearly defined, bounded regions for cognitive chunking and assimilation.

KDVis → Education

- Automated techniques for data harvesting, data processing, and information visualization.
- Larger scale, really ‘Big Picture,’ domain maps (all of science). (See physics & chemistry map).
- Can market our contribution as concept maps, an educational tool with which educators are already familiar.

Process of KDV Creation and Usage



Spatial Representations of Domains

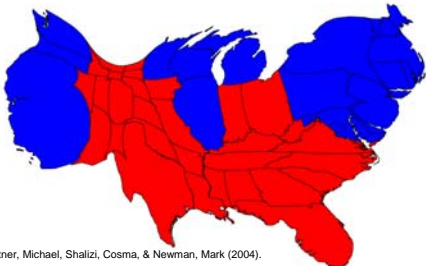
Composed of Two Parts:

- Spatial Substrate
- Thematic Overlay

True for:

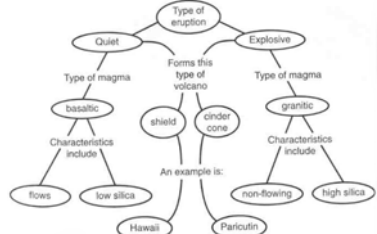
- Thematic Maps (cartography)
- Concept Maps (education, psychology, wayfinding)
- KDVis (information science)
- Metro Map Metaphor Information Spaces (information science)

Thematic Map



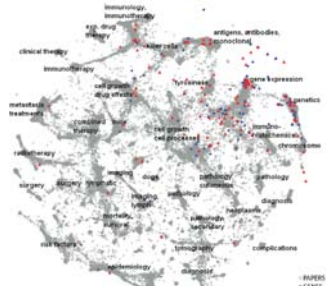
Gastner, Michael, Shalizi, Cosma, & Newman, Mark (2004).

Concept Map




Feather, Ralph M. Jr., Snyder, Susan Leach & Hesser, Dale T. (1993). Concept Mapping, workbook to accompany, Merrill Earth Science. Lake Forest, Illinois: Glencoe.

KDVIs



Boyack, Kevin W., Mane, Ketan K. and Börner, Katy. (2004). Mapping Medline Papers, Genes, and Proteins Related to Melanoma Research. IV2004 Conference, London, UK, pp. 965-971

Metro Map Metaphor



Nesbitt, Keith V. (2004). Getting to more Abstract Places using the Metro Map Metaphor. (IV'04). IEEE.

Comparison of the Spatial Representations of Information

Map Type	Substrate			Overlay
	Usage of nodes & edges	Rigorous spatial layout	Labeled connections (causality, equivalence, similarity, etc.)	
Thematic Maps	rarely	yes	no	yes
Concept Maps	yes	very rare	yes	yes
Knowledge Domain Visualizations	yes	yes	rarely	yes
Metro Map Information Spaces	yes	potentially	no	yes

The End



Paper Available:

- Hook, Peter A. and Börner, Katy. (in press) Educational Knowledge Domain Visualizations: Tools to Navigate, Understand, and Internalize the Structure of Scholarly Knowledge and Expertise. In Amanda Spink and Charles Cole (eds.) *New Directions in Cognitive Information Retrieval*. Springer-Verlag.

<http://ella.slis.indiana.edu/~pahook/product/05-educ-kdvis.pdf>