Helping Students Make Connections: A Framework for Teaching Physical Science

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Question– What outcome do we want to achieve in students, as a result of participating in our physical science course (or other educational interaction)?

One answer (which we'll focus on in this talk)**–**

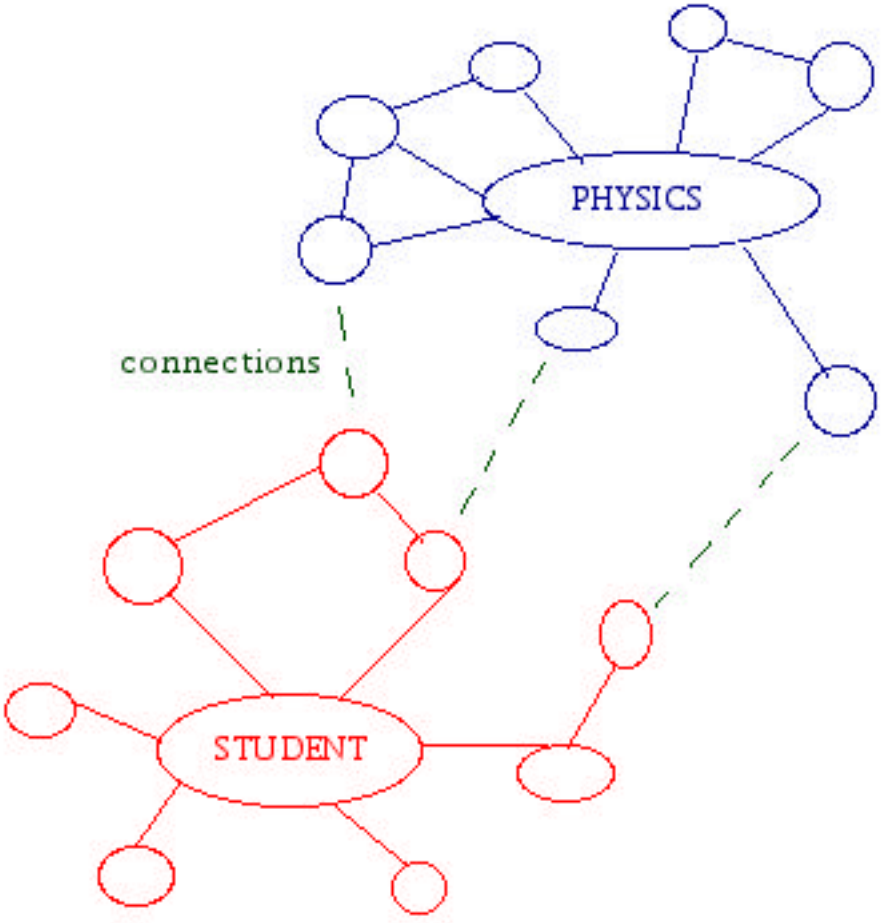
We want to produce a fundamental change in the connections students are aware of between the ideas and methods of physical science, and their own world of experience.

For many students, a standard physics course takes place in an abstract realm to which they have no means of connecting. The material, if learned at all, is repeated back for tests and soon forgotten. It never makes any real contact with their own thoughts and lives, and never gets a chance to mean anything significant to them. For these students, our greatest impact will be on how they view science and whether they're willing to consider it as part of their world, as more than a blind and irrelevant collection of facts. Piling on more information has little effect if we don't actively address this attitude.

Conceptual Framework for Visualizing a "Connections" Course:

Key Elements:

1) Students articulate their own webs of experience/meaning.
2) Coursework is guided by objective of establishing **connections** between students' individual webs and the physics web.
3) Assessment of progress emphasizes connections made, and strength of connections, rather than strictly physics "covered."



Broader Context of Cognition Research:

"Students come to the classroom with preconceptions about how the world works. If their initial understanding is not engaged, they may fail to grasp the new concepts and information that are taught, or they may learn them for the purposes of a test but revert to their preconceptions outside the classroom."

(How People Learn: Bridging Research and Practice, p. 10)

See also the video, "A Private Universe" (available from the Astronomical Society of the Pacific).

Tools to Support this Approach:

- **Journals–** Instrument for students to articulate and modify their personal web of meaning and experience. Allows instructor to assess where connections are (and are not) being made.
    - Recognize that science is one of many systems competing in a marketplace of ideas

- **Questions** generated from (or at least grounded in) students' own experience – EXAMPLES:

    - describe your universe

    - how far away are the stars?

    - distance measurement by parallax

    - how do we measure time?

    - how are we able to see words on a sheet of paper?

Student Comments:

- “I never thought of cosmology in this sense. It is far more profound than I had ever imagined.”

- “I’m in this class because it ties together humanity and the universe, and I’d like to know what others think about what I think, and to see if I’m alone in my thoughts.”

- “‘We had the sky up there, all speckled with stars, and we used to lay on our backs and look up at them, and discuss about whether they was made or only just happened. (Huckleberry Finn)’ -- I liked this quote, because regardless of age, language or religion the night sky is a great mystery. Civilizations across the globe look up at the night sky and play with ideas of how this magnificent event occurred.”

- “So here I am taking a physics class feeling as if it would feel like some medievel form of torture and I love it. I feel as if I’ve discovered a new me! Thank you!”

- “I know that this will be one of those classes to stay with me and motivate me to educate myself further on the subject of the cosmos!”

- “In AP Physics we learn the equations. In this class we learn what they mean.”

Related References:

DiSessa, A. “Unlearning Aristotelian physics: A study of knowledge-base learning,” Cognitive Science 6:37-75, (1982).

Donovan, M. Suzanne, *et al.* How People Learn: Bridging Theory and Practice, National Research Council, National Academy Press, Washington, D.C. (1999). (Chpt. 2, Key Findings). Available on-line: http://books.nap.edu/html/howpeople2/

Duncan, Todd. “Guest Comment: Making physical science courses valuable to nonscientists,” American Journal of Physics 65 (5), pp. 365-6 (May, 1997).

“A Private Universe” (video available from the Astronomical Society of the Pacific).

Fort, Deborah C. “Science shy, science savvy, science smart,” Phi Delta Kappan, 74 (9), pp. 674-84 (May 1993).

A few examples of tools to implement this approach for a cosmology course can be found on-line at: http://www.scienceintegration.org/cosmo_home.html