Inquiry-based Teaching Workshop
GK-12 Program

GK-12 Workshop
2008
Louis Keiner

Learning Objective for this week

At the end of this week, you should be able to

- Motivate the kids
- Create and organize inquiry-based labs,
- Teach to higher levels of thinking
- Incorporate various learning strategies to address different learning styles,
- Effectively utilize available technologies for teaching
- Incorporate state and national standards into an inquiry based lesson plan
- Utilize multidimensional assessment concepts and techniques to assess student learning

What do students learn in science in public schools?

Sixth Grade

Topics:

- Scientific Inquiry
- Structures, Processes and Responses of Plants
- Structures, Processes and Responses of Animals
- Earth's Atmosphere and Weather
- Conservation of Energy → Craig

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Seventh Grade

Topics

- Scientific Inquiry
- Cells and Heredity
- Human Systems and Disease
- Ecology – the Biotic and Abiotic Environment
- Chemical Nature of Matter

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Eighth Grade

Topics

- Scientific Inquiry
- Earth's Biological History
- Earth's Structure and Processes
- Astronomy: Earth & Space Systems
- Forces and Motion
- Waves

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High School
Academic Area Standards

Physical Science
Biology
Chemistry
Physics
Earth Science

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2005 Physical Science Academic Standards

1. Inquiry
2. Structure and Properties of Matter
3. Properties and Classification of Matter
4. Chemical Reactions & Chemical Compounds
5. Nature of Forces and Motion
6. Nature, conservation, & transformation of energy
7. Nature and properties of wave

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2005 Biology Academic Standards

1. Inquiry
2. Structure and Function of Cells
3. Flow of energy within and between living systems
4. Molecular basis of heredity
5. Biological Evolution and Diversity of Life
6. Interrelationships of organisms with the biotic and abiotic components of their environments

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Physics Options

- In physics, there are 5 mandatory standards:
  1. Inquiry
  2. Forces
  3. Energy
  4. Electricity and Magnetism
  5. EM Radiation and Waves
- And 5 optional ones (do 2)
  6. Sound
  7. Optics
  8. Nuclear and Modern Physics
  9. Fluid Mechanics
  10. Thermodynamics

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Chemistry Options

In chemistry, there are 6 standards. Each standard contains mandatory indicators (which will apply to all courses) and additional indicators. Depending on the intent of the course, additional indicators should be selected.

1. Inquiry
2. Atomic Structure
3. Classification of Compounds
4. Chemical Reactions
5. Phases of Matter
6. Properties of Solutions

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Earth Science

The earth science standards are written for an "upper level' course in accordance with the national standards. It is assumed that students who enroll in earth science have completed physical science and biology.

- Inquiry
- Structure of the Universe
- Internal and External Dynamics of the Earth
- Dynamics of the Atmosphere
- Freshwater and Oceanic Systems
- The dynamic relationship between Earth's conditions over geologic time and the diversity of its organisms

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Question

- What was the best course you took in High School?
  - What made it so good?
- What was the worst course you took in High School?
  - What made it so bad?

Seven Principles for Good Practice:

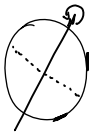
1. Good Practice Encourages Contacts Between Students and Teachers
2. Good Practice Develops Reciprocity and Cooperation Among Students
3. Good Practice Uses Active Learning Techniques
4. Good Practice Gives Prompt Feedback
5. Good Practice Emphasizes Time on Task
6. Good Practice Communicates High Expectations
7. Good Practice Respects Diverse Talents and Ways of Learning

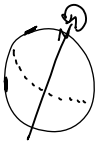
(Chickering, American Association for Higher Education, 1987)

How do students learn?

Write down on a piece of paper the answer to the following question:

- Why do we have seasons?





Cognitive Principles

1. The constructivism principle
2. The context principle
3. The change principle
4. The individuality principle
5. The social learning principle

Adapted from Redish, "The Implications of Cognitive Studies for Teaching Physics" *Am. J. Phys*, 1994

The constructivism principle

Students construct mental patterns to make sense of the information that they receive.

Corollaries:

1. The goal of science teaching is to have students build the proper mental models for doing science.
2. It is not sufficient for students to "know" the relevant correct statements of science.
3. Mental models must be built. People learn better by doing than by watching something being done.

The constructivism principle

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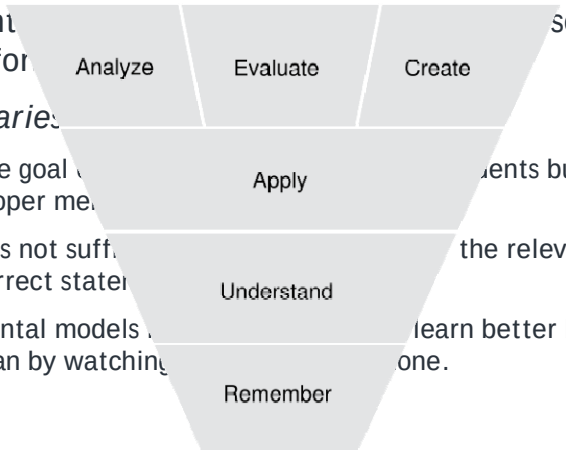

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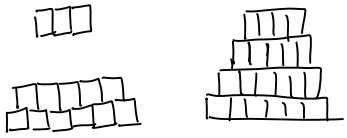
The context principle

What students construct depends on the context of the learning and what they previously knew or think they know.

Corollaries:

1. The student is not a tabula rasa (blank slate). Each one comes to us having had experiences with the physical world and having organized these experiences into mental models.



The change principle

Changing a student's incorrect ideas or patterns of association is difficult but necessary before correct learning can take place.

Corollaries:

- In order to change an existing mental model the proposed replacement must have the following characteristics:
  1. It must be understandable.
  2. It must be plausible.
  3. There must be a strong conflict with predictions based on the existing model.
  4. The new model must be seen as useful.

The social learning principle

For most students, social interactions during the instructional process lead to increased learning.

Corollaries:

1. Explaining concepts to someone else forces students to express their mental models

Break for activity

The individuality principle

Students exhibit significant variations in learning styles, which must be considered by the instructor in order for all students to learn.

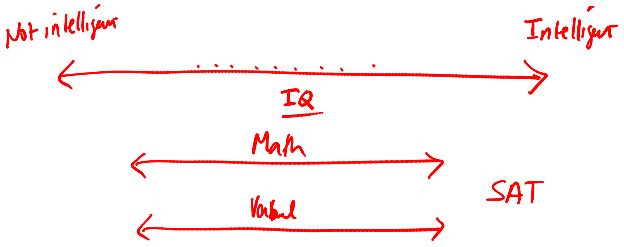
Corollaries:

1. People have different styles of learning.
2. There is no unique answer to the question: What is the best way to teach a particular subject?
3. Our own personal experiences may be a very poor guide for telling us what to do for our students.

Multiple Intelligences

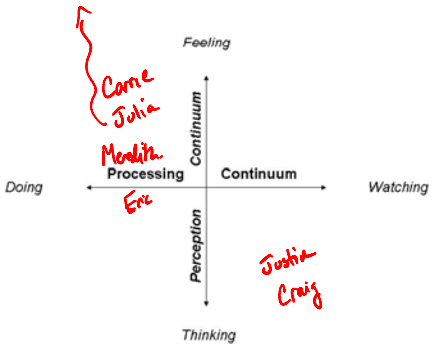
- Howard Gardner

Thumbnail summary: He theorized that instead of on 'intelligence,' there are multiple intelligences, and that we all use one or two for the most effective learning.



Learning Styles:

Kolb's Experiential Learning Model



Perception Continuum
Processing Continuum

http://www.nwlink.com/~donclark/hrd/styles/kolb.html

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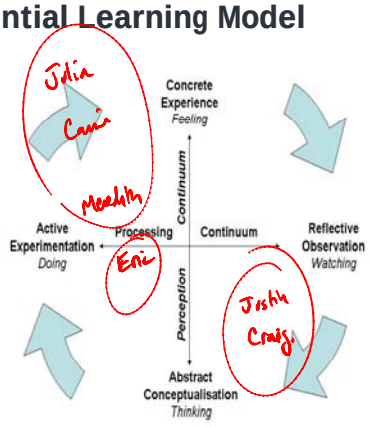

Processing Continuum: Our approach to a task, such as preferring to learn by doing or watching.
Perception Continuum: Our emotional response, such as preferring to learn by thinking or feeling.

http://www.nwlink.com/~donclark/hrd/styles/kolb.html

Types of Learners in Kolb's model:

- **Diverging** (concrete, reflective) - Emphasizes the innovative and imaginative approach to doing things. Views concrete situations from many perspectives and adapts by observation rather than by action. Interested in people and tends to be feeling-oriented.. Likes such activities as cooperative groups and brainstorming
- **Assimilating** (abstract, reflective) - Pulls a number of different observations and thoughts into an integrated whole. Likes to reason inductively and create models and theories. Likes to design projects and experiments.
- **Converging** (abstract, active)- Emphasizes the practical application of ideas and solving problems. Likes decision-making, problem-solving, and the practical application of ideas. Prefers technical problems over interpersonal issues.
- **Accommodating** (concrete, active) - Uses trial and error rather than thought and reflection. Good at adapting to changing circumstances; solves problems in an intuitive, trial-and-error manner, such as discovery learning. Also tends to be at ease with people.