

A breathless rush through...

# **Pedagogy 101 and Standards 101**

**IAGLR School for Scientists 2007**

Rosanne W. Fortner, Director, COSEE Great Lakes  
Steve Stewart, Michigan Sea Grant

# Pedagogy

- 📖 from the Ancient Greek *παιδαγωγέω*; literally, "to lead the child"
- 📖 the art, science or theory of being a teacher, generally refers to strategies of instruction



# The experts speak...

I believe that education must be conceived as a continuing reconstruction of experience, that the process and the goal of education are the same thing.

I believe that education, therefore, is a process of living and not a preparation for future living.

*-- John Dewey, My Pedagogic Creed*

The teacher is not only a communicator but a model. To communicate knowledge and to provide a model of competence, the teacher must be free to teach and learn.

*-- Jerome Bruner, The Process of Education*

Constructivism

Alternative conceptions [naïve, mis-, etc]

Conceptual change

No Child Left Behind [NCLB]

Hands-on activity

Learning styles

Multiple intelligences

Right brain - left brain

Learning cycle

Cooperative learning  
Constructivism

## Keywords



# Tabula rasa

- 📖 The conception of a learner's mind as a blank slate [aka "if you tell them, they will know!"]
- 📖 Good teachers don't just deliver information.
  - They **PACKAGE** it for consumption by people with different learning styles and experiences.
  - They **GUIDE** the consumption for incorporating into mental maps.



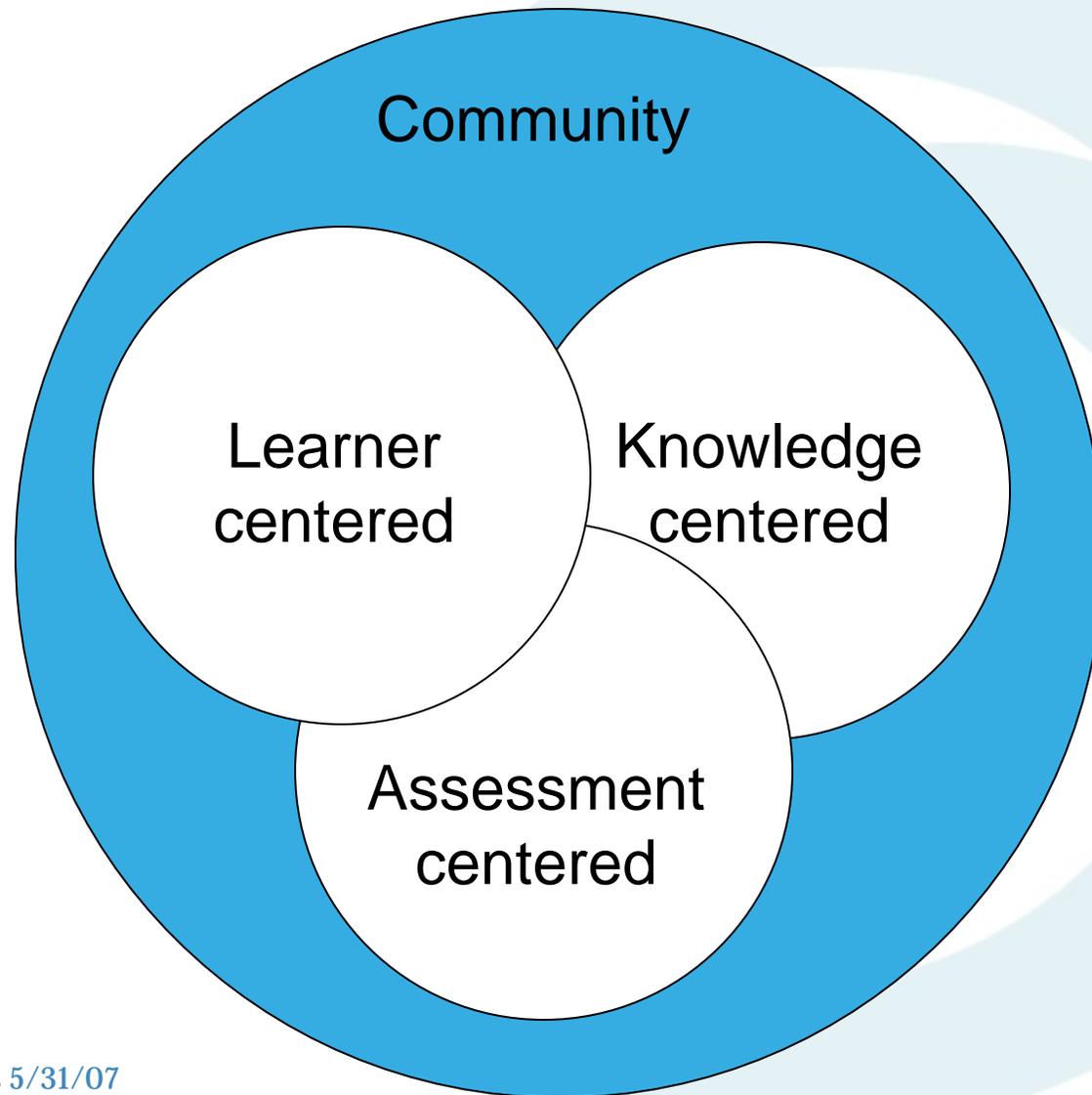
# Learning for retention

"One must learn by doing the thing, for though you think you know it, you have no certainty until you try." - Sophocles, 400 BC



(National Training Laboratories, Bethel, Maine)

# Perspectives on learning environments



# Piaget: developmental stages

- 📖 Swiss biologist and psychologist Jean Piaget (1896-1980): a highly influential model of child development and learning based on the idea that the developing child builds cognitive structures to incorporate new experiences
- 📖 Four developmental stages
  - Sensorimotor [birth - age 2]
  - Preoperational [age 2-7]
  - Concrete operations [age 7-11]
  - Formal operations [~age 11-15]



# Constructivism

- 📖 a philosophy of learning: by reflecting on our experiences, we construct understanding of the world we live in.
- 📖 We generate personal "rules" and "mental models" to make sense of experiences.
- 📖 Learning is the process of adjusting mental models to accommodate new experiences.



# Guiding principles of constructivism

- 📖 Learning is a search for meaning. Learning must start with the issues around which students are actively trying to construct meaning.
- 📖 Meaning requires understanding **wholes** as well as parts. And parts must be understood in the context of wholes. Therefore, the learning process focuses on primary concepts, not isolated facts.
- 📖 To teach well, we must understand the mental models that students use to perceive the world and the assumptions they make to support those models.
- 📖 The purpose of learning is for an individual to construct his or her own meaning, not just memorize the "right" answers and regurgitate someone else's meaning.
- 📖 Assessment of the learning process provides students with information on the quality of their learning.



# Learning styles



- 📖 Individuals perceive and process information in very different ways
- 📖 How much individuals learn has more to do with whether the educational experience is geared toward their style of learning than whether or not they are "smart."
- 📖 Should not ask, "Is this student smart?" but rather "How is this student smart?"
- 📖 Concrete versus abstract perceivers
- 📖 Active versus reflective processors

# Multiple intelligences

📖 Theory developed by psychologist Howard Gardner: people perceive and understand the world with different sets of skills to find and resolve problems they face.

- Verbal-Linguistic
- Logical-Mathematical
- Visual-Spatial
- Body-Kinesthetic
- Musical-Rhythmic
- Interpersonal
- Intrapersonal



📖 Impact on curriculum, instruction, assessment

# Right brain / Left brain

- 📖 Sides of the brain control two different "modes" of thinking; suggests that each of us prefers one mode over the other.

Left brain	Right brain
logical	random
sequential	holistic
rational	intuitive
analytical	synthesizing
objective	subjective
Looks at parts	Looks at wholes

# Best Practice for Science Teaching

- 📖 Hands-on activities, student inquiries
- 📖 Focus on underlying concepts
- 📖 Questioning, thinking, problem solving
- 📖 Application of science to contemporary issues
- 📖 In-depth study of a few thematic topics
- 📖 Curiosity about nature; positive attitude toward science for all students
- 📖 Integration of language arts and math in science
- 📖 Collaborative small-group work
- 📖 Teacher as facilitator of investigative steps
- 📖 Evaluation focused on concepts, processes, attitudes

**Note: LECTURE isn't on the list!**

# The Learning Cycle

<b>5E Learning cycle</b>	<b>7E Learning cycle</b>
	elicit
engage	engage
explore	explore
explain	explain
elaborate	elaborate
evaluate	evaluate
	extend

Use to construct a lesson for maximum impact



Switching gears

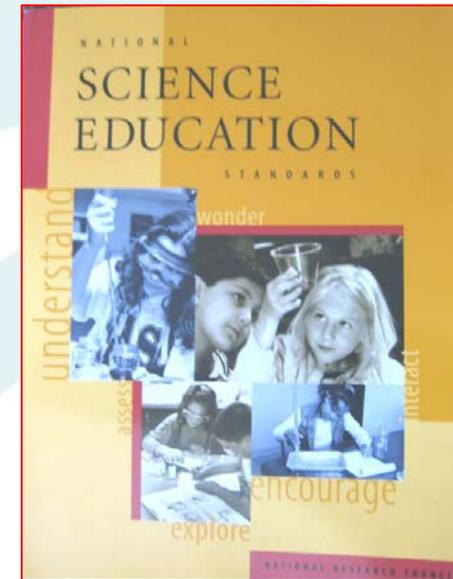
# Standards for the Science Curriculum

# Rationale for Standards

- 📖 Science for all [science literacy]
- 📖 Goals for school science
  - Experience richness and excitement of knowing natural world
  - Use science in personal decision making
  - Engage in public matters of science and technology
  - Increase opportunities in careers
- 📖 Emphasize need for changes in
  - Content -- “less is more”
  - Instruction -- inquiry based
  - Assessment -- depth preferable to recall

# National Science Education Standards

- 📖 National Research Council of NAS, 1996
- 📖 Model for US states
- 📖 Model for other countries
- 📖 Iterative development over 2 years by scientists, teachers, higher education, administrators



## Benchmarks for Science Literacy

- 📖 AAAS, Project 2061
- 📖 Equally credible, better supported by products
- 📖 Internal structure unwieldy



<http://www.project2061.org/publications/bsl/online/bolintro.htm>

# Components of Standards

- 📖 **CONTENT** of science curriculum
  - Earth/space, Life, Physical Sciences
  - Science and society; history of science
  - Science inquiry
  - Science as a way of knowing

In the  
classroom

📖 **Professional Development**

📖 **Science Teaching**

📖 **Science education program**

📖 **Science education system standards**

# Uses of Standards

- 📖 Structure sequence of science learning
- 📖 Demonstrate relevance of curriculum components
- 📖 Show accountability to disciplinary goals
- 📖 Design content of achievement tests ←
- 📖 For scientists: awareness of school levels of learning science, background for context
- 📖 For curriculum developers: materials must match Standards for credibility

# References cited

1. Cognition & Technology at Vanderbilt
2. <http://www.funderstanding.com/constructivism.cfm>  
[Funderstanding: Consulting company to industry designing products and services that understand learning and children -- IBM, PBS, MetLife, etc]
3. Howard Gardner, Frames of Mind: The Theory of Multiple Intelligences.
4. AAAS Project 2061 Benchmarks for science literacy  
<http://www.project2061.org/publications/bsl/online/bolintro.htm>
5. Standards: see Links handout for National, state, Canada
6. NRC, 1999. How people learn. National Academy Press.