Why Teach Science Using an Inquiry Approach?

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Inquiry Teaching

- "Science teaching has suffered because science has been so frequently presented just as so much ready-made knowledge, so much subject matter of fact and law, rather than as the effective method of inquiry into any subject matter."
  - John Dewy, 1910

Traditional Approach

(Expository)

- Arguments in favor:
  - Faster
  - Easier
- Arguments in opposition:
  - Teacher seen as an authority figure
  - Treats subject matter and methods separately
  - Rarely allows for understanding of the nature of science
  - Problem solving alone is too simplistic a view of science

Inquiry-oriented Methods

- Gets students to do science by following steps inherent in the scientific process
  - Observing
  - Defining a problem
  - Hypothesizing
  - Identifying and controlling variables
  - Collecting and interpreting data
  - Drawing conclusions
- Strengthens higher-order level thinking skills
  - Inquiry students outperform expositor student in test of higher level thinking (Lott, 1983)
  - Inquiry students, though covering less subject matter, perform equally well when low-level cognitive processes are assessed (Lott, 1983)

Traditional vs. Inquiry

- Traditional practices:
  - Emphasizes knowledge of facts, laws, and theories
  - Utilizes labs as verification exercises
  - Emphasizes application of knowledge
- Inquiry practices:
  - Emphasizes the understanding of the nature of science
  - Integrates labs into course discussion (contextual learning)
  - Emphasizes higher level cognitive skills
- Which would you see as being better for preparing the next generation of students?

Role of the Teacher

- Encourages thinking, questioning, and discussion
- Encourages debate/discussion
- Provides a variety of levels and paths for investigation
- Works as a fellow investigator
- Avoids appeals to authority
- Maintains an atmosphere conductive to inquiry
- Places emphasis on “How do I know the material of this course?” rather than “What must I know in this course?”

Role of the Student

- Makes observations, collects and interprets data
- Formulates hypotheses, creates and conducts experiments
- Works out relationships of cause and effect
- Relates independent and dependent variables
- Uses reasoning ability
- Draws conclusions on the basis of data
- Defends conclusions on the basis of data

Effective Environments

- **The learner-centered classroom**
  - Focus on students learning rather than teacher teaching
- **The knowledge-centered classroom**
  - Student learning is based on evidence
- **The assessment-centered classroom**
  - Student thinking is made “visible”
- **The community-centered classroom**
  - Students work cooperatively to find answers to questions

Perceived Problems

- Time and energy
- Too slow
- Reading to difficult
- Risk too high
- Tracking
- Student immaturity
- Teaching habits
- Sequential text
- Discomfort
- Too expensive

Costenson, K. & Lawson, A.E. (1986). Why isn't inquiry used in more classrooms? *American Biology Teacher, 48*(3), 150-158.

Research based claim 1: *

- **Understanding science is more than just knowing the facts.**
- A framework for teaching the nature of science. *Journal of Physics Teacher Education Online*, 3(3), March 2006, pp. 3-10.
- Assessing nature-of-science literacy as one component of scientific literacy. *Journal of Physics Teacher Education Online*, 3(4), Summer 2006, pp. 3-14.
- Scientific epistemology: How scientists know what they know. *Journal of Physics Teacher Education Online*, 5(2), Autumn 2009, pp 3-16.

* Claims based on *Inquiry & the National Science Education Standards*

Research-based claim 2:

- **Students build new knowledge and understanding on what they already know and believe.**
- Dealing more effectively with alternative conceptions in science. *Journal of Physics Teacher Education Online*, 5(1), Summer 2008, pp 11-19.

Research-based claim 3:

- **Students formulate new knowledge by modifying and refining their current concepts and by adding new concepts to what they already know.**
- Dealing more effectively with alternative conceptions in science. *Journal of Physics Teacher Education Online*, 5(1), Summer 2008, pp 11-19.

Research-based claim 4:

- **Learning is mediated by the social environment in which learners interact.**
- Engaging students in conducting Socratic dialogues: Suggestions for science teachers. *Journal of Physics Teacher Education Online*, 4(1), Autumn 2006, pp. 10-13. (with Thomas W. Holbrook and James Stankevitz).
- Whiteboarding and Socratic dialogues: Questions and answers. *Journal of Physics Teacher Education Online*, 3(1), September 2005, pp. 3-10.

Research-based claim 5:

- **Effective learning requires that students take control of their own learning.**
- Experimental inquiry in introductory physics courses. *Journal of Physics Teacher Education Online*, 6(2), Summer 2011, 2-8.

Research-based claim 6:

- **The ability to apply knowledge to novel situations, that is, transfer of learning, is affected by the degree to which students learn with understanding.**
- For primary research findings about all these claims, see Making the Case for Inquiry (Chapter 6) in the book *Inquiry and the National Science Education Standards: A guide for Teaching and Learning*, *Center for Science, Mathematics, and Engineering Education (2000).*

Secondary Sources

- *Project 2061: Science for All Americans*
- *National Science Education Standards*
- *Inquiry and the National Science Education Standards*
- *How People Learn: Brain, Mind, Experience, and School*
- *How Students Learn: History, Mathematics, and Science in the Classroom*