Enhanced Inquiry Skills

Reflection by Carl J Wenning
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Science educators generally have identified two variously named categories of scientific intellectual process skills to be developed though appropriate educational practices. While variously named, I'll use rudimentary skills and integrated skills to define this distinction. Rudimentary skills are typically those to be developed by younger children in, say, elementary and middle school. Integrated skills are typically those to be fostered in middle school and high school. Regardless of these definitions and distinctions, all of these scientific intellectual process skills are probably developed at even the high school level, and people continue to develop them throughout thief life times. Here is how some have chosen to list these science process skills (see for example *Science Process Skills: Assessing Hands-On Student Performance,* written by Karen L. Ostlund, Addison-Wesley Publishing Company, Inc. 1992; and *Learning and Assessing Science Process Skills,* Rezba, R J., Sprague, C. & Fiel, R. Debuque, IA: Kendall'Hunt Publishing Co. 4th edition, 2003; see Anton E. Lawson's characterization in *Science Teaching and the Development of Thinking,* Belmont, CA: Wadsworth Publishing Co., 1995).

Rudimentary Science Process Skills	Integrated Science Process Skills
Observing	Identifying Variables
Communicating	Constructing a Table of Data
Classifying	Constructing a Graph
Measuring Metrically	Describing Relationships Between Variables
Inferring	Acquiring and Processing Data
Predicting	Analyzing Investigations
Decision Making 1	Constructing Hypotheses
and according to some:	Defining Variables Operationally
Estimating	Designing Investigations
Collecting Data	Experimenting
	Decision Making 2
	and according to some:
	Developing Models
	Controlling Variables

While most of the science reform movement literature has focused on these skills, it seems that more advanced scientific thinking skills are being overlooked. Clearly, if students are to be more critical thinkers, they probably should possess what I propose calling *enhanced inquiry skills:*

Enhanced inquiry skills are those skills that represent the end-goal of education. The ability to:

Solving complex, real-world problems: Helping students to solve complex problems must be the fundamental reason of why we educate out students in the sciences and other disciplines.

Establishing empirical laws: Student can, by collecting and graphically depicting and interpreting data, establish basic empirical laws.

Synthesizing theoretical explanations: While not essentially different from hypothesizing, providing theoretical explanations is done at a substantially more advanced level. It is fundamentally a synthesis of scientific knowledge, intellectual processes, and mathematics to answer questions that might not be so readily determined via experimentation. For instance, it is hard to evaluate the basis of buoyancy. While students can readily determine the empirical relationship for buoyancy, $B = \rho Vg$, they reason that the buoyant force exists is not readily determined. Theoretical consideration of the possibility of differences between downward pressure at the top of a submersed object and the upward pressure at the bottom of a submersed object, if examined mathematically, can be shown to be the most likely cause of buoyancy. Why the weight of a teacup increases when a tea bag is held suspended in the water, is also an example of providing theoretical explanations.

Analyzing and evaluating scientific arguments: Includes breaking down arguments into their constituent parts, determining the accuracy of scientific statements, evaluating data and conclusions drawn from that data, etc.

Constructing logical proofs: Closely related to analysis and evaluation of scientific arguments, this process flows in the reverse: developing complex arguments from their simpler parts, making scientifically accurate statements, interpreting and drawing conclusions from data, etc.

Generating principles through the process of induction: Inductive processes are generally conceived of as moving from specific observations to their generalization in the statement of principles. Most closely associated with induction is the generation of general principles derived from observations of specific cases.

Generating predictions through the process of deduction: Deductive processes are generally conceived of as moving from general statements of principle to predictions of the specific.

Science teachers employing inquiry practices will want to do more than focus entirely upon the students' ability to derive principles and laws. Science is much more than this, and a variety of activities should be included in the school curriculum to help students develop these enhanced inquiry skills.