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THE PURSUIT OF SCIENCE LITERACY: PUTTING FUNDAMENTAL IDEAS OF SCIENCE INTO THE CLASS ROOM

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THE PURSUIT OF SCIENCE LITERACY: PUTTING THE FUNDAMENTAL IDEAS OF SCIENCE INTO THE CLASSROOM

WILLIAM H. SCHMIDT

1. The concepts of coherence, focus, and rigor have been found to be important aspects of the mathematics curriculum that is related to students learning (Cogan, Wang, & Schmidt, 2001; Promoting Rigorous Outcomes in Mathematics and Science Education, 2012; Schmidt, Wang, & McKnight, 2005) Nonetheless, the way towards greater focus and coherence in science has not been nearly as obvious as it was for mathematics. At the encouragement of the National Science Foundation (NSF), we took a step back to "start from scratch" and to identify a way forward towards coherence in science education. This led to the convening of a panel of distinguished scientists to address the issue of how to bring instructional coherence to K-12 science education. The result of the multi-year collaborative effort was the identification of the *8+1 Fundamental Science Ideas* (Schmidt et al., 2011). All of the participating scientists were NSF award recipients well known in their field of science, and many were also recipients of significant science and science education related awards. Among the distinguished members of this panel were:

- *Leon Lederman*, physicist, Nobel Laureate, former Director of Fermi National Accelerator Laboratory, Founder of Illinois Mathematics and Science Academy;

- *Audrey Champagne*, chemist, AAAS Fellow, professor, Department of Chemistry and Department of Educational Theory and Practice, SUNY Albany;

- *Carl Pennypacker*, astrophysicist, 2010 Prix Jules Janssen recipient, founder Hands-On Universe (HOU), involved in the Nobel Prize winning research related to the expansion of the universe, Lawrence Berkeley National Laboratory;

- *Simon J. Billinge,* physicist, Brookhaven National Laboratory, professor, Columbia University;

- *Paul Williams*, biologist, founder of *Fast Plants* and *Bottle Biology*, professor, University of Wisconsin Madison;

- *Roland J. Otto,* physicist, Berkeley Center for Cosmological Physics, Teacher Academy Director;

- *Paula Heron,* physicist, professor, Physics Department, University of Washington;

- *Jay Pasachoff*, astronomer, director of Hopkins Observatory, Field Memorial Professor of Astronomy, Williams College, 2003 Honorary Member of the Royal Astronomical Society of Canada;

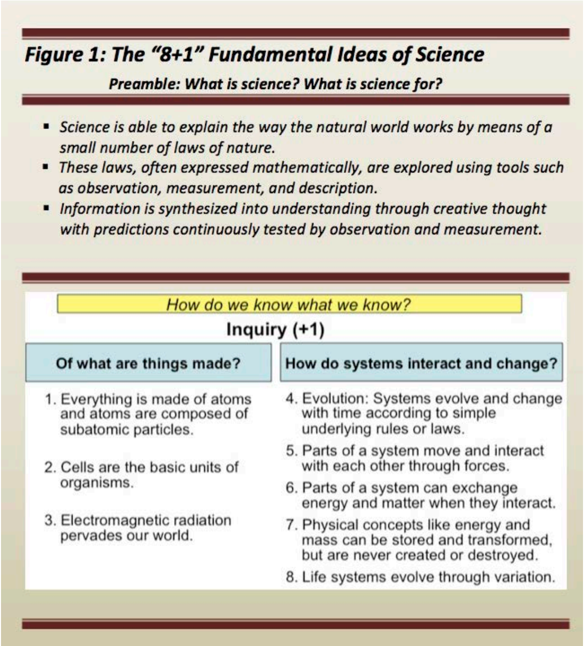
- *Lillian C. McDermott*, physicist, AAAS Fellow, APS Fellow, professor, Director of the Physics Education Group, University of Washington;

- *Richard Hake,* physicist, hard-core condensed-matter-physics professor, Indiana University.

What is the 8+1?

2. Three questions organize the *8+1 Fundamental Ideas* (see Figure 1): how do we know what we know; of what are things made; and how do systems interact and change? The "*+1*", "Inquiry" responds to the first question and is intended to evoke such essential ideas as probability, scientific reasoning, scales, measurement, and orders of magnitude.

Figure 1. The "8+1" Fundamental Ideas of Science



Note: Consequently, the "+1", "Inquiry", parallels and is more fully specified by the science and engineering practices of the National Research Council's (NRC) Framework's Dimension 1 and also, to some extent, by the Framework's Dimension 2 crosscutting concepts. The "+1", "Inquiry", reminds teachers and students that the NRC Framework's Dimension 1 practices are products of an inquisitive mind, that is willing to ask questions with an intent to make sense of observed natural phenomena.

3. The eight *Fundamental Ideas* respond to the two questions that appear in the blue boxes of Figure 1. We propose that these eight are a representation of the small number of ideas by which science can explain the way the natural world works. They were designed specifically to help create coherent science instruction and as such were defined at a deep-structural level spanning various fields of science.

4. Imagine that students become familiar with these *Fundamental Ideas* in a simple way as their teacher makes them explicit during their first science lessons. In subsequent years, more complex yet grade-appropriate versions of the *8+1 Fundamental Ideas* are made explicit in science lessons so that these become a foundation for understanding increasingly complex issues of science. We believe that the result will be a science literacy that is not merely cluttered with the facts of various science disciplines but informed by a theoretical epistemology that allows science literate adults to comprehend a changing world by applying these more robust science ideas (National Research Council, 2000; 2005; Beck & McKeown, 1989). This is the vision of science instruction the project intends to embed in the instructional design tool to be made available to all K–8 science teachers.

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