Fostering Ecologically Valid Clarity about What Counts as "Scientific Literacy"

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VEXATION

When not single-mindedly focused on STEM education workforce demands, the science and science education establishment often proclaims that we need a global citizenry that is able to make pervasive, consequential science-related decisions in their everyday lives and that is able to substantially participate in science-related policy deliberations in the multi-faceted contexts of civic life in informed ways. That is, the need for cultivating pervasive scientific literacy among the citizenry as a whole is as pressing as it ever has been—and arguably more pressing than ever. The *National Science Education Standards* document gives us an operating focus for this goal of science education: scientific literacy is the "knowledge and understanding of scientific concepts and processes required for personal decision-making, participation in civic and cultural affairs, and economic productivity" (NRC, 1996, p. 22). However, it is readily apparent that the science education enterprise lacks field-wide, fundamental theoretical clarity and consensus about the very notion of *scientific literacy*.

I want to mention a few experiences that have highlighted and informed this issue for me. In a crowded research symposium held at NARST perhaps 8 years ago, a large panel of researchers described a multifaceted set of theoretical images for what each of them thought count as "scientific literacy." I was startled, puzzled, and angered by the lack of theoretical and empirical clarity about such a fundamental issue—what knowledge, practices, and dispositions help people to act in scientifically literate ways in matters of personal and societal consequence. How could we, as a field, be in such an ambiguous position? A few years later I was participating in a panel where the competing aims of science education were similarly put on the table. In response to my suggestion that we need to focus more attention on scientific literacy in everyday matters, a colleague responds undercutting my position while keeping the focus on abstract conceptual knowledge: "Well, we certainly can't just focus on 'simple' utilitarian goals in science education." Really? Whose interests are being served in our endeavors? A recent discussion with an NSF program officer brought home the same balkanized set of positions: he confided that internal program-related discussions among staff are also muddled by competing images of what would make the public more literate in science (e.g., "if only the public understood the history of science…", "if only they understand the abstract concepts of science…"). And yet, people need to make a host of pragmatic decisions in everyday life (e.g., to make an informed healthcare decision, to mitigate damage to the natural environment, to understand the safe use of mechanical systems, to highlight the limitations of scientific research). How can we do informative research on the ground and conduct synthetic analyses as a field to help turn the field toward a more scientifically informed and vitally useful telos for science education—a shared, grounded image for scientific literacy.

Which Scientific Competencies Matter in Everyday Life? Do people with a deep understanding of core science concepts navigate the earth in a more scientifically informed way? What intellectual practices serve people well outside of the classroom? Does the social capital of learners help explain how they navigate the world in scientifically informed ways? Does knowledge about the scientific enterprise itself give people an upper hand on literate participation in the world? When is it productive to composite local knowledge and exogenous disciplinary knowledge about the natural world into a contextually-sensitive solution to a problem encountered? In other words, what science should all citizens know? What knowledge should all non-science track students learn? Our six science competencies (or consensus "learning strands"; Bell, Lewenstein, Shouse & Feder, 2009) might be used as a guiding framework for understanding what constellations of competencies inform situated scientific literacies, but we lack any field-level consensus account of what knowledge, practices or social capital count as a foundational basis for the different faces of scientific literacy.

Theoretical Ambiguity. The science education research literature offers at least ten different theoretical accounts of scientific literacy (e.g., Laugksch, 2000), ranging from the deep understanding of critical, core concepts; to the nature of scientific thinking; to an understanding of the history, philosophy, and sociology of technoscience; and so on. What conceptual models align with what contextual facets of everyday life? As a field, do we need all of these models to cover the terrain of everyday life, or are a subset of the models substantively comprehensive in understanding situated scientific literacy. I believe we lack this fundamental clarity of guiding purpose in our field—and are left in ill-defined and unresolved disputes over the goals and ends of science education. I take this range of different theoretical models for scientific literacy to be the result of:

(a) *An Increasingly Complex Learning Ecology*—a variegated landscape of everyday life moments that are relevant to scientific literacy across our culturally diverse society (cf. Lee, 2008),

(b) *Competing, Balkanized Theoretical Perspectives*—different values and theoretical assumptions associated with what it means to be a literate individual, as well as

(c) *Profound Empirical Research Gaps*—significant empirical ambiguity about what knowledge is actually used to engage in scientifically literate actions in the world.

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To develop field-wide clarity on relevant and productive conceptual models for scientific literacy, I believe we need to pursue two lines of activity: (1) develop and conduct a less common kind of research program while also (2) engaging in sustained field-wide synthesis.

Filling Research Gaps. A strong argument can be made that the theoretical ambiguity about what should count as scientific literacy is driven by a significant gap in empirical research. We have a very limited number of studies that help us understand what scientific knowledge, practices, dispositions, social capital, and credentials people draw upon, refine, and contextualize as they navigate through disparate everyday science decisions and problem spaces that they encounter. That is, we lack ecologically valid empirical documentation of situated moments of scientific (il)literacy from across any significant breadth of life circumstances present in contemporary society. Instead, we have accounts of science literacy learning that are strongly context bound (e.g., single site classroom studies) and are frequently focused on artificial or hypothetical problem contexts and are not authentic moments that call upon scientific literacy (cf., Cole, McDermott & Hood, 1978).

We know that people learn across the varied social contexts in which they participate in complex ways that are still not well understood (Bell et al., 2009). It is surprising that we lack such fundamental literatures that might provide us with a rich, finely differentiated understanding of what competencies or capital serve individuals in scientifically informed living. How do philosophers of science navigate everyday decisions and policy contexts related to science? How do bench or field scientists fare? For citizens that have learned to participate in complex science-related policy issues, what knowledge and networks do they leverage? Are the children of individuals with professional credentials in a science field raised in a way that cultivates their scientific literacies? The field should embark on the aggressive cross-setting ethnographic documentation and analysis of the scientific literacy learning and situated action of diverse constituents in society—starting with individuals who have specialized credentials in science-related fields and who have established reputations for leveraging science in sophisticated ways (e.g., voluntary experts in specific fields of activity). Rich case studies of situated scientific literacy would inform which conceptual models match particular classes of everyday life activities.

Field-wide Synthesis Project. In conjunction with the results of the new program of research outlined above, we need to initiate a field-level synthesis that maps particular conceptual models of scientific literacy to a broad range of everyday contexts and activities. One of our best intellectual processes for cultivating field-level scientific progress is the consensus panel and report process associated with the National Academies / National Research Council. This proposed effort would convene a relevant interdisciplinary group of scholars from the following fields: science education (conceptual change, history/philosophy of science, informal education, cultural studies, feminist theorists), health psychology, learning sciences, cognitive development, public understanding of science, behavioral micro-economics, and perhaps others. I would imagine convening such a group and engaging them in a multi-year consensus process with the following charge:

(a) To work toward field-wide consensus on the role of different scientific literacies as part of the current science education enterprise in relation to the diverse contexts of everyday life,

(b) To gauge the depth and relevance of empirical literatures that might relate to scientific literacy in the broad but have never been synthesized (e.g., environmental stewardship, scientific thinking, technoscience education, health literacy, understanding the nature of science, etc.),

(c) To learn about the educational approaches and effects of international efforts that have given heightened national attention to scientific literacy (e.g., in the United Kingdom),

(d) To explore the viability of identifying scientific competencies given the current state of research that could serve as the platform for scientific literacy learning expectations (e.g., six-strand learning progressions for scientifically informed living), and

(e) To chart a research terrain that would provide empirical, theoretical, and substantive clarity about scientific literacy and highlight promising directions for cultivating it.

The lack of theoretical clarity about scientific literacy is a profound social equity issue. It is crucial to better understand the multiple roles of scientific competence in everyday life in order to promote social equity and progress. By more tightly coordinating our efforts, the venture described will increase the social capital that can support scientific literacy broadly throughout the science education enterprise.