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The Emperor Has No Clothes: Critically Analyzing the Scientific Literacy

My graduate mentor, Ron Good, taught me to closely examine ideas that are widely accepted by the entire science education community. He argued that given the diversity of philosophies and perspectives found in science education, if an idea is agreeable to all, then the idea may not have a very clear meaning. I think *scientific* literacy is such a notion. Yes, scientific literacy seems to be fundamental to the work of most science educators, but NOT the work of most science teachers. In this essay, I urge us to examine why.

A success

Sometime in the 1980s the pendulum of science education swung back to the notion that scientific knowledge needs to be useful to the everyman (or, more accurately, everyperson). As described so eloquently in Project 2061:

> *Education has no higher purpose than preparing people to lead personally fulfilling and responsible lives. For its part, science education—meaning education in science, mathematics, and technology—should help students to develop the understandings and habits of mind they need to become compassionate human beings able to think for themselves and to face life head on. It should equip them also to participate thoughtfully with fellow citizens in building and protecting a society that is open, decent, and vital. America's future—its ability to create a truly just society, to sustain its economic vitality, and to remain secure in a world torn by hostilities—depends more than ever on the character and quality of the education that the nation provides for all of its children.*

This notion, that scientific knowledge should be useful for everyone, not to become scientists, but to allow them to "participate thoughtfully with fellow citizens", to "build and protect a society", "to develop understandings and habits of mind needed to think for themselves", is a powerful one. It forces us as educators to consider the utility of the knowledge we are teaching, past the notion that "we always teach this in biology" or "they'll need this when they go onto college chemistry." We must begin to ask question such as: Will these concepts help students make sense of their worlds? Are students learning science in a meaningful way? Can they apply what they are learning? With this as a goal we can no longer to teach to the five percent of our students who may be targeted for a science career, instead, this goal forces us to go about our work in a way that science be made available to everyone, as again was describe in that moving preface to Project 2061:

> *The set of recommendations constitutes a common core of learning in science, mathematics, and technology for all young people, regardless of their social circumstances and career aspirations. In particular, the recommendations pertain to those who in the past have largely been bypassed in science and mathematics education: ethnic and language minorities and girls.*

The goal of scientific literacy for all requires us to radically reconceive what is done in classrooms. It forces to us to look at what we teach, how we teach, and who we teach. It motivates us to examine our assumptions about who can and should learn science and the kind of learning we as teachers can count at sufficient. The goal of scientific literacy forces us to go beyond standard teaching practices, it requires research that allows us to better support all students in developing useful, meaningful knowledge and causes us to continually search for ways to make our teaching more congruent for students from all backgrounds and languages. I understand that this goal makes the act of teaching science so much more difficult on a day-to-day, classroom level, but so much more important and rewarding on the ultimate, societal level. We teach science well, we employ research-based methods, and we continually seek to improve our craft because all our students need a meaningful grasp on the fundamental scientific concepts that are required to make sense of their worlds.

My vexation

Although the goal of scientific literacy does problematize the act of science teaching, few beyond the community of science educators share this goal. Most members of the American public still think of science as something only a limited number of students (usually white boys) will be interested in and only a fewer number of students will excel in. Science is thought by many as an educational luxury that should be made available to a few when more pressing matters are attended to. Many preservice teachers enter the profession with this mindset, as they hope to teach that reified group of students that are able to grasp the complexities of science.

The Notion of Scientific Literacy

What is the problem with this? The view of science as so difficult for most and so dispensable for many excuses a wealth of ineffective teaching practices. It allows us to teach poorly, as we only expect a subset of our students to do well. It allows us to dwell on the arcane in our teaching, because science is not seen as something that is applicable to one's life. It allows us to ignore the needs of culturally and linguistically diverse students, as traditional science is a white, European construct. In short, when scientific literacy fails to replace the goal of teaching science to produce a handful of scientists, we stop analyzing our teaching and its impact, and we allow ourselves to take solace in the small number of our students who move onto sciences at the university. Ultimately, we produce a generation without the fundamentals of science needed to make informed personal and societal decisions.

My vexation is that this clarion call heard within the science education community is muted or distorted as we move outside the boundaries of our community. We must admit that outside of our small science education community and teachers that work within this community, the norm is to teach and learn science to produce new scientists. I suggest that we can no longer afford to bemoan the absence of literacy in the thinking of most classroom teachers. We must begin to ask *why* this idea has been translated so poorly. Following the admonition described at the outset of this essay, I suggest that much of the fault lies with the notion of scientific literacy itself. Yes, the vast bulk of science educators have taken this notion and worked it into the fabric of their philosophy of science teaching. But I argue that the notion itself is so vague, so poorly defined, that the inclusion of literacy has required virtually no change in the philosophies of many. In Piagetian terms, it has been assimilated into the prior schema for science teaching and learning, a process that required virtually no changes in our teaching and learning goals. This vague and ambiguous notion has had such little impact outside of our community for the same reasons that it has had little real, meaningful impact within our community. By meaning so many different things to so many educators, *scientific literacy* has come to mean very little at all.

I urge us as a community to have frank discussions about what scientific literacy should and should not include. We, ourselves, need to set the boundaries of this construct, solidifying the notion into a firm construct, one that can shared in a more informative, useful manner outside of our community, one that can be insightful in shaping the work of others involved in science education. To begin this discussion (and working from the notes from our careful editors), I offer the work of DeBoer [Journal Of Research In Science Teaching, 37, pp. 582-601 (2000)] and his nine goals for science teaching:

1. Teaching and Learning About Science as a Cultural Force in the Modern World.
2. Preparation for the World of Work.
3. Teaching and Learning About Science That Has Direct Application to Everyday Living.
4. Teaching Students to be Informed Citizens.
5. Learning About Science as a Particular Way of Examining the Natural World.
6. Understanding Reports and Discussions of Science That Appear in the Popular Media.
7. Learning About Science for its Aesthetic Appeal.
8. Preparing Citizens who are Sympathetic to Science.
9. Understanding the Importance of Technology and the Relationship Between Technology and Science.

DeBoer, himself, seriously questions if all these goals are attainable. I agree, and suggest that, as we consider K-12 science instruction, with its attendant increasingly diverse student demographics combined with the ever magnifying effects human activity has on our natural world, we should focus our efforts primarily on:

1. Teaching and Learning About Science That Has Direct Application to Everyday Living.
2. Teaching Students to be Informed Citizens.
3. Learning About Science as a Particular Way of Examining the Natural World.

Clearly, these goals are debatable. Indeed, they need to be debated. It is time for an honest conversation about our emperor to begin.