

The Rhetoric of Science Education Reform

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But few scientists care to comment on the other side of the science-public equation. There's plenty of evidence to suggest that the public's misunderstanding of science is equaled - or perhaps surpassed - by science's ignorance about the public.
(Tom Siegfried, 1999, *The Dallas Morning News*)

Sometimes I wonder, when has there ever *not* been reform movement in science education? Leon M. Lederman, Nobel Prize-winning physicist, brings us one of the more recent reform efforts. His Project ARISE (American Renaissance in Science Education) promotes a "physics first" reorganization of the secondary school science curriculum. He correctly observes that, "99 percent of our high schools teach biology in 9th (or 10th) grade, chemistry in 10th or 11th grade, and, for survivors, physics in 11th or 12th grade" and then suggests that this arrangement "is alphabetically correct, but by any logical scientific or pedagogical criteria, the wrong order" (Lederman, 1999, n.p.).

Lederman later acknowledges the sentiment to which I allude. With the ever-present concept of reform, his ideas could easily be reduced to yet another, "TYNT - 'this year's new thing'". Unfortunately, and in spite of all the good reasons there are for supporting a "physics first" reorganization of the secondary school science, the public has good reason to do just that - TYNT. There are four reasons that I can think of.

To begin with, most members of the public do not like "school bashing." The Gallop Polls continue to show that though people have concerns about education, they tend to think that their particular schools are just fine. Professor Lederman's rhetoric is relatively mild, but even phrases like "obsessed with local control" and "awesome resistance of school systems to change" are counterproductive in the public square. Don't beat up on local control of school. The public is not going to relinquish local control of schools and we should all be glad for that. As annoying as local control can be at times, it is a foundation stone in our democracy.

But there is a more serious problem with the public when it is university scientists pointing the finger of blame at the K-12 schools. Can't you just hear the proverbial person on the street saying, "Well, Professor Lederman, if you and your colleagues have such good ideas, why aren't you showing the way for the K-12 schools by first reforming the way universities teach science?" The problem is credibility. It is no secret that the natural sciences at the universities draw fewer students to start with, than do other disciplines, and the natural sciences have higher dropout rates amongst those who do enroll as majors (Greene, 1997; Seymour & Hewitt, 1997; Hoke, 1993; Wild, 1997). For the lay public (not for future scientists), the weakest link in science education is at the university level, not the K-12 levels. And, given that a Nobel Laureate receives his or her greatest esteem from university faculty, it would seem natural to use that esteem to promote teaching reform at the university.

A second reason that much of the public is often deaf to the latest pleas for reform is that such pleas are often tantamount to hysteria mongering. According Professor Lederman (1999, n.p.) and certainly many others, the need in science education for "drastic reform is compelling." Why? Because "there is a growing realization that schools are not preparing their students to cope with the world into

which they will emerge" (Lederman, 1999, n.p.). This sounds all too familiar. It was not so very long ago that *Sputnik* was being used to arouse a sleepy public to American weaknesses in science and mathematics, and the great need for education reform. Well, we beat the Soviets didn't we? But I guess all those multi-million dollar NSF projects were not enough, because we then learned about a new threat - the *economic* threat posed by Japan and the Asian Tigers! The remedy was of course more and better science, mathematics and technology education. Then came the meltdown of Asian banks and their associated economies. The USA, on the other hand – and its low scores on international science and mathematics tests notwithstanding – is the midst of a history making economic expansion.

Again, the problem that confronts would be reformers, is the problem of credibility. Last year, a story ran in *The Chronicle of Higher Education* titled, "Scientists Attack the Federal Budget with the Politics of Calculated Panic" (Greenberg, 1999, A72). Greenberg points out that,

In 1991, Leon M. Lederman, in his inaugural address as president of the American Association for the Advancement of Science, warned that "our current capability for research is only about one-third what it was in the late 1960s -- a golden age whose achievements the nation is still profiting from."

Greenberg counters that,

In fact, from 1968 to 1991, federal support for science conducted at colleges and universities rose from \$ 1.5-billion to \$ 10.2-billion -- a real gain of \$ 8.4-billion, according to the National Science Foundation. The increase was accompanied by healthy growth in the number of research papers by U.S. scientists, which rose from 103,778 in 1973 to 142,334 in 1991.

Greenberg then noted that,

The depiction of science as a frail orphan stands in contrast to the billions in support reliably supplied by the federal government for decades.... Extravagant rhetoric has worked so long and so well for science that it has become the norm. The danger is that when credibility crumbles, it'd difficult to restore.

That article was about money while the subject at hand is curriculum change, but the point stands.

Reformers make claims that appear extravagant to the public leading to a loss of the reformers' credibility (see Gibbs & Fox, 1999).

I think that most reform efforts are well intended by those who propose them. The third reason, however, that the public is justified in rejecting large-scale reform efforts is that many reformers simply lack a good understanding of how schools work and the role that schools play in our economy.

There is an alternative view which questions why, after more than three decades on the reform agenda, elementary science teaching continues to disappoint. Is it because we haven't found the right 'formula' or could it be that we have an imperfect understanding of the problem and unrealistic expectations for the solution?" (Wallace & Louden, 1992: 508)

If there are problems with school science – and I certainly think that there are – the answer is not finding the right formula be it "physics first" or anything else.

Here is an example of what I am getting at. Professor Lederman (1999) proudly tells us:

of over 70 schools (that we know about) around the nation that have been using this "physics first" sequence for upwards of a dozen years. Uniformly, their stories are of great praise for the new sequence.... We stress that this is a design for all students, work-bound, liberal-arts-college-bound, or science-and-technology-bound. The schools that are "doing it right" report greatly expanded enrollments in fourth-year electives and Advanced Placement science courses.

I have no doubt that this claim is true. I also have no doubt that I could easily find 70 schools who use the traditional "alphabet approach" with equal success. Of course, a good curriculum makes a difference, but the greater factor for school success is the commitment that the school community brings to (almost) whatever curriculum they implement. To put it bluntly, reform of the science curriculum is a relatively minor contribution in comparison to reform that builds a cohesive, enthusiastic school community.

The fourth reason for the public's lukewarm reception of science reform ideas is related to the issue of understanding schools and education. Too

often science curriculum reform efforts involve a tacit conflict of interest. Martin Eger (1989), a physicist, put it very well. There are the interests "of" the science community, and then there is the public's interest "in" science. It is in the interest of the science community to promote science and the promotion often takes the form that our well being is dependent upon science. For example,

In a nation whose people depend on scientific progress for their health, economic gains, and national security, it is of utmost importance that our students understand science as a system of study, so that by building on past achievements they can maintain the pace of scientific progress and ensure the continued emergence of results that can benefit mankind (National Academy of Science 1984, p. 6).

The public knows that science is important but I think the public also knows that many other cultural and social factors are at least as important to our well being. In this regard, David Landes', *The Wealth and Poverty of Nations: Why Some Are So Rich and Some So Poor*, should be required reading, and of course Alexis de Tocqueville's *Democracy in America*. One should be careful not to oversell science.

To put this another way, in promoting science education reform, one must be careful not to promote a "science first" reform. But that appears to be what is happening when one reads that a new science,

reform comes with a new need for continuous professional development, for weekly meetings of the science and math teachers to improve coherence, design laboratory work, find the connective inquiries that entangle and unify the disciplines. And wouldn't it be a natural next step to invite in the history teachers, the teachers of arts and literature, to help develop those connections of the fields of learning that the biologist E. O. Wilson calls "consilience"? (Lederman, 1999, n.p.)

Richard Rorty's comment on Wilson's notion of consilience is apropos: "As we pragmatists see it, there can and should be thousands of ways of describing things and people-as many as there are things we want to do with things and people - but this plurality is unproblematic" (1998, p. 30). The point is we don't all agree that those connections

that Professors Wilson and Lederman wish to make are worth making. Moreover, rather than seeing science as something others might want to emulate and join in with, and history and the social sciences as subjects that *might be* inserted into a science curriculum (Lederman, 1999), we could ask the scientists to join some of our humanistic discussions on culture and look for ways to structure science within the context of culture. That might be a way of easing the problem of having students come away from science class thinking that science is a subject primarily relevant at school rather than relevant to the real world of nature (Cobern, Gibson, & Underwood, 1999).

Some years ago Alexander Calandar published a wonderful short piece titled, *The Barometer Story: A Problem in Teaching Critical Thinking*. The story is about a young physics student who was asked to solve a problem involving a barometer. The clever student found *many* ways to solve the problem but none was the solution intended by his professor. Likewise, there are undoubtedly many ways to solve science curriculum problems. "Physics First" is a good solution. There are also good STS solutions. There are good philosophy/history oriented solutions. There are others. Even the traditional "alphabet" approach to science curriculum can work; one should remember that some students find the life sciences inherently more interesting than the physical science. Personally, I favor looking at some of the old "Nature Study" curriculum ideas. But, both pragmatism and experience suggest that the public's lukewarm response to single focus, large-scale curriculum reform efforts is a wise response.

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