Science Within an Ecology of Mind,

Alternatives in Educational Reform

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In early 1989, the Educational Testing Service and the National Science Foundation each released the results of surveys designed to rate the scientific literacy of Americans. A Los Angeles Times headline from the period captured the perception of the nation: "U.S. pupils near bottom in math, science" compared to pupils in five other countries.[1] The National Science Foundation survey showed that scientific literacy among Americans evidenced startling gaps. For example, fewer than half of all Americans know that the earth circles the sun once in a year. In February of this year, the Educational Testing Service announced the results of a new and broader study comparing American schoolchildren to those in a dozen other countries in mathematics and science. The New York Times headline announcing its results read, "American Children Trail in Math and Science."[2]

In the face of this news, science education at all levels, from kindergarten through the university years, has become the object of intensive re-examination. The National Research Council issued a "stinging criticism" of biology teaching in middle and high schools. Colleges too have come under fire for curricula that are too lax. During the last decade, the faculty of Amherst College, for example, have debated the merits of a science requirement, but have steadfastly refused to adopt either a core or a distribution requirement for its students. As a result, 17% of its students graduate without having taken a single course in either mathematics or science in their four years at Amherst.

The newspaper headlines, the television news features, and the loss of our high-tech edge to other countries such as Germany and Japan, have all led to a climate of fear, if not hysteria, in

the educational community. What are we doing wrong that so many of our citizens are so ignorant concerning the rudiments of science and technology? How can our economy ever hope to revive if technical education in America is slipping from year to year? What can we do to change our system of education so that America is at the top of the surveys?

Responses to the above fall into different categories: 1) the national standards and testing response, 2) the high-tech response, 3) the education-as-business response. The first approach sets goals for scientific literacy, tests selected populations against those criteria of literacy, and then develops curricula to meet the stated objectives. The second approach sees the solution as lying in new educational technologies such as sophisticated interactive multimedia computers. With one of these for every school child, truly competent and equitable education will become available to all children, say its advocates. The third position maintains that the problem originates in the economic basis for education. They maintain that education is a business like any other, and that the rules of a free-market economy should prevail for it as for every other aspect of our commercial life. By giving parents a "choice," then the best and most economical educational product will come to the fore, and the poorest will die, as they rightfully should. These three responses often mingle in various ways, but I would like to treat each of them individually, for I believe that each, while sounding reasonable, offers us an illusory solution to a systemic problem. To begin, one might ask, why did both Germany and Japan decline to participate in recent comparative studies? What does one make of the fact that the study also showed that the top 10% of the students in America do as well as that group in any country? Is the climate of fear in America dictating a set of responses that are not in the long-term best interest of the children we are educating, nor of the nation to which they will eventually contribute?

Standards and Testing

One of the most far-reaching programs espousing the first approach is that undertaken by the American Association for the Advancement of Science in its Project 2061. It offers a three-part response to the crisis in science education. Phase one, already published as Science for All Americans,[3] defines what people should know in science, mathematics and technology. Phase two intends to translate the goals of phase one into several alternative prototype curricula for K-12. These are now under development by six site teams across the country. Phase three has not yet begun, but will take the various curricula developed as part of Project 2061, and market them to school districts all across the nation.

Project 2061 possesses many attractive features: its commitment to "less-is-more" in curricular content, its emphasis on interdisciplinarity (at least between the various sciences), its advocacy of a "teacher-centered" response to the problem, to name a few. Yet, there are others aspects of this response, and they are fundamental to it, that cause concern. First, they center around the basic premise that there is an American crisis in science literacy. The solution to it is then assumed to entail well-defined goals and a plan that incorporates national testing as the means to certify the attainment of those goals. In his recent piece "Standards Can Bite,"[4] Project 2061 director, Rutherford recognizes that standards are in, and says that they are justified. He points to his Science for All Americans, as providing a carefully conceived formulation of those standards. But as Rutherford himself admits, the standards and testing route is strewn with pitfalls.

We have ample experience concerning the educational bankruptcy of this approach to curriculum development. One might term it the Stanley Kaplan concept of curricular design. It

works as follows. Educators wait until the first set of nation tests are given, now scheduled for the fall of 1993. Free-wheeling entrepreneurs use those tests to design cram courses for each age group. And they work. Japan is flooded with thousands of such courses taken by millions of children. Similarly in America the best preparation for MCATs (the standard pre-medical examination) is not found in chemistry and physics courses as offered by our colleges and universities, but in cram-courses offered by various commercial educational enterprises who design curricula for exactly that purpose. Does this mean that colleges are not doing their jobs? Far from it. Most college science curricula are already too heavily determined by what the MCATs choose to test. One continually fights to maintain the integrity and excitement of science in classes populated by students whose primary goal is scoring high on their MCAT exam. Recently a student came to my office to explain why she had failed the last two examinations. She informed me in a reasonable, matter-of-fact tone that since her study time was limited, she had to make a choice. She either crammed for her MCAT exam or studied physics.

Imagine a scenario in which every level of education is dominated by this ethos. Every parent, every child, and finally every educator attends not to education, but to testing, not to the changing needs of childhood, but to the goals set for each year's examination. Gone will be the particularity of each class, the unique voice of the teacher sensitive to the spontaneous interests that arise in the classroom. Instead, instructors will teach from a national handbook, a compendium of the scientific and technical knowledge that they must convey, year after year, test after test. The methods and educational philosophies of cram-course companies will become the model for educational reform. Such a system will fail as long as teachers are decent caring human beings who care more for their children than their paycheck. If they see their young charges suffering under

the yoke of depersonalized standards, they will simply ignore the standards. This makes room for the rise of private cram courses a la Japan, catering, of course, to the moneyed who can afford them. Heavy reliance on standards and testing will inevitably be accompanied by a drift towards cram-course curricula.

That we should have clear educational expectations of our educators and our youth is not at issue. But the concept of refining and enforcing them through extensive standardized national testing at all age levels, is bankrupt. It will cause nothing good, and much that is ill. The root image of education on which this approach is predicated is wrong.

Computers: the Failed Educational Revolution

You would have thought that the past lessons with audio-visual formats would have prepared educators and politicians for the verdict, but it did not. If fact, many still refuse to hear the verdict.

When ushered into classrooms across the nation, computers were heralded as the technological innovation that would revolutionize education at every level, making toddlers into technological prodigies. A decade later, computers are as common as blackboards in most American classrooms, and they continue to multiply as if by magic. Yet the promised revolution has simply not appeared. According to most candid observers, the use of computers in normal classroom instruction has been little short of catastrophic. Alfred Bork, a respected professor of computer science at the University of California, Irvine, put it this way, "So far what we've done is on the level of disaster. The problem is how to get people away from the romance with the technology and how to get them to think about improving learning."[5] Certainly, computers do

offer a new range of possibilities for the educational innovator, but they offer only an incremental increase in options, not a revolution. In fact, if anything, by focusing our attention on educational technology, we have been distracted from the root problems and real solutions to today's educational malaise. Rather than spend time and scarce resources on the human assets we have in teachers and the basic necessities they require in every school district, we have spent tens of billions of dollars purchasing computers that usually do little more than gather dust in the corner of kindergarten and elementary school classrooms.

People educate people. They do so in a rich and varied environment which today includes much in the way of technology. That technologically abundant environment should find its way into classrooms in a thoughtful, appropriate and de-mystifying way. Stop the hype and fanfare about computers. The real revolution in education will only take place when we give to our teachers and children the dignity and attention they deserve. The incentives to do so are less tangible. No IBM or Apple Computer Co. will reap a windfall profit from the professional development of America's teachers. Like today's politicians, big business has become interested in short-term returns on their investments. The long-term return on a capital investment in childhood and teachers is an old-fashioned value that does not sell well at stockholders meetings or at the election polls. Yet only such an investment will meet our educational ills, scientific and otherwise.

The Business of Educating

The argument runs: If students are scientifically and mathematically illiterate, it is because the educational establishment has failed them. In the tough corporate world, companies that

perform poorly close up shop, and others take over their share of the market. Not surprisingly, President Bush, through his Secretary of Education Lamar Alexander, is espousing what will ultimately amount to the privatization of education, making it a responsibility of the business sector. Should this take place, it will mark the end of education as a high spiritual endeavor.

The privatization of education into commercial ventures is sold under the banner of "choice." However, choice can have various meanings, and the basis on which we make choices are, and ought to be, different in different arenas of life. To give a specific example, imagine you are presented with two paintings. On what basis do you choose to purchase one over the other. An art investor will see the painting not as a work of art, but like a piece of real estate whose value is to be judged by comparable sales, and so on. The painting is strictly an economic object to be safely warehoused until a good return on the investment can be made. The lover of art will pay no attention to such economic considerations. Rather he or she will consider its beauty, what meaning it carries, what it would bring into their personal and communal life. To such a person, the "value" of a Van Gogh is independent of the auction price at Sotheby's. In fact, the very commercialization of art violates it. Art is not for rich investor/collectors, nor even for museums, but for people every day of their lives. The old Russian peasant with his revered if faded icon on the wall has the truest relation to art.

As with paintings, so too with education. As a parent I should be free to choose the kind of school that educates my child, but the criteria of "choice," and the options offered to me, should not arise out of "smart" business decisions, but rather as the fruit of cultural and spiritual striving. When art is given over to commercial interests, the result is American television programming. If one wishes for a picture of the choices Americans will have in educating their children if Bush's

privatization of education succeeds, scan the channels of your television set.

Bush offers choice within a free-market model for educational services. By contrast, as parents, our real choice in education must be based on the values, cogency and beauty of the education a particular school offers. The criteria for choice are different in essential ways in the two spheres of life. Education is a cultural, not an economic activity. The forces that drive the one will destroy the other. In the free-market model, the motivation is profit. Goods produced should be manufactured at the lowest possible cost, and sold at the highest profit margin the market will bear. The basis for education can have nothing to do with such considerations. Yes, it must be practical, but the foundations on which education is built are hard-won principles and not profit motive.

In order for education to work, teachers must embody their educational philosophy. It is common wisdom that teachers educate as much or more by who they are than what they teach. This law of education is utterly alien to the economic sphere. A meal served in a restaurant is the same meal regardless of who serves it. Not so in education. The same lesson plan will succeed or fail depending of who teaches it. Like all great art, education must work freely. Parents will then choose on the basis of educational philosophy, on the vision of the child that stands behind the curriculum, in other words, on the basis of truly important considerations.

Such a system of choice is predicated on real options being offered to every parent. In a system of education where tragic educational and financial inequities exist, of the kind documented in Jonathan Kozol's Savage Inequalities,[6] choice is sham. This connects back to the issue of scientific literacy. The educational establishment has failed its children, but foremost in ways not addressed by the reforms above. The much publicized results of comparative tests are telling us

something very important, but in the first place it is not that science education is in dire straits. The good schools in this country educate as well as any in the world. The data show as much. Where we are failing is in the uniformity of educational quality. We spend a greater amount on education than any other country when measured as a percentage of our GNP, but these resources are disproportionately focused on a small cadre of privileged districts and their children. The majority of children, especially in urban areas, fight against extraordinary odds to gain the basic skills and knowledge that would be available to all children in other industrialized nations. Test results in all areas will continue to show the same deficiencies as long as "savage inequalities" exist. None of the three educational reforms address this basic reality, and some will only exacerbate the problem.

From Equity to Ecology

The three approaches to educational reform sketched out above are, obviously, fraught with problems. To begin with I believe they misinterpret the implications of the surveys that have been made. But even if one grants the need for reform in science education, as I do on other grounds, all three are based on erroneous assumptions. The "education-as-business" approach misapplies an economic model to a venture that must be grounded on fundamentally different principles. The second approach mistakes technology for teaching, and so sows a covert distrust of the teacher as the core of the educational process. The first neglects the core of educational research and idealism for the payoff of test-driven curricula. Education is none of these. Yet I do believe that education, and especially science education is in need of major revision.

The first step needed is to move away from a linear, atomistic model of learning in which

one fact and one skill is added to the next step by step, and to embrace an ecology of knowing. The teacher, as artist, should be able to draw on the arts and literature when teaching mathematics and science. Instead of compartmentalizing learning into pre-programmed units on math, physics, chemistry, geography each area of focus would connect with other areas of knowledge in natural and meaningful ways. Instead of viewing the education of the child as something built up brick by brick, a more appropriate metaphor might be a forest or swamp. In them, the many species and conditions of soil, water and light all work together to make-up a robust ecosystem. Educational subjects, like forest species, can only live in relation to others. They each have their own integrity, but the weaving together of diverse subjects is what brings the mind to life. Science in such an ecology of knowing would not be a second culture a la C.P. Snow, nor be ghettoized on college campuses, rather it would become a full participant in the community of mind. With the ecosystem as a metaphor, a whole new geometry of education would arise, one that replaced the monoculture of present education with a true polyculture.

Within this new geometry of education, the teacher is critical. No amount of technology will replace her or him. The child first enters the physical world through its parent at birth. Later, the child enters the communal life of society and mind through the school. The child's teachers are the human doorway through which they can step into that world. The teacher lives what the child will become, she or he is an exemplar of the future. How important, therefore, that the teachers in our schools are nurtured professionally and humanly. Their personal growth is essential to the healthy educational growth of their pupils. Here is where our first investment should be, both materially and spiritually.

Finally, our image of the child, which is central to all educational philosophy, is

impoverished. It needs to be ennobled and expanded in specific and concrete ways. To my mind, the most comprehensive understanding of child development is that underlying Waldorf or Rudolf Steiner education. Science education, both in its curriculum and its methodology, stands to learn much from the decades of experience possessed by Waldorf educators. Their emphasis in the early years on a phenomenology of science, on lively, imaginative participation, on the penetration of technology, are all a refreshing contrast to the concept-driven science curricula common today. Ideas arise out of experience. The concrete needs to precede the abstract, and the sciences should be experienced within the wealth of life, as but another species in the forest of learning.

Instead of reforming our educational enterprise based on misplaced fear of scientific and technical illiteracy, we should gauge its genuine problems. They center around deep-set inequalities in resource management, a covert distrust of the teacher, an impoverished image of the child, and a misapplication of business principles to a spiritual endeavor. Science education does need reform, but it should be grounded on hard-won insights, not fear or profit. Only then will science find its place within a vital ecology of mind.

1. Stanley Meisler, Los Angeles Times, "U.S. pupils near bottom in math, science," (six-country survey by the Educational Testing Service). Feb. 1, 1989, sec. 1, p. 4, col. 1.

2. The New York Times, Feb. 6, 1992, vol. 141, p. A14.

3. Andrew Ahlgren and F. James Rutherford, Science For All Americans, (New York, Oxford University Press, 1990).

4. F. James Rutherford, "Standards Can Bite," 2061 Today, Winter 1992, vol 2, p. 5.

5. Quoted in the New York Times, by Joseph Berger, "How teaching by computer played out," August 8, 1989, p. E7.

6. Jonathan Kozol, Savage Inequalities: Children in America's Schools, (New York: Crown Publishers, 1991).