Science Ed: What we haven't done the past 50 years and what we should do in the next 50

"Is Our Past Our Future? Thoughts on the Next 50 Years of Science Education Reform in the Light of Judgments on the Past 50 Years" was the Paul F-Brandwein lecture given by F. James Rutherford at the 2005 National Science Teachers Association meeting in Dallas. Having served in the milieu of science education in positions ranging from high school teacher to Assistant Secretary of Education, coauthoring Harvard Project Physics, and directing Project 2061, Rutherford was uniquely positioned to address this subject, and he didn't particularly like what he saw.

"We have not achieved what we ***should*** have, what we ***could*** have," he said in regretting that we have not "sustained improvements in the quality of K-12 science education in America," though he added that "it cannot be attributed to a lack of effort." There were some positive responses to the challenge to American scientific capability by the Soviet launch of ***Sputnik***, in the form of Harvard Project Physics and PSSC (which celebrated its fiftieth anniversary this year), but they were not sustained. Already in the 1970s reports were again bemoaning the inadequacy of American and science and mathematics education, and they haven't stopped since.

When Rutherford looks back over the course of American science education in the last 50 years, he finds that little has changed, except that textbooks have become bloated. "Over the years material was added, little ever subtracted," he said. "Topics were added, and then more topics; more and more subtopics added to topics; and words, words, words. . . Textbooks became encyclopedic without the organizational advantages of good encyclopedias." He gave as an example "111 technical terms found in two chapters on cells in a typical high school biology textbook -- of which only 12 were deemed important enough by a national panel of biologists to appear in ***Science for All Americans*** (reviewed in our Fall 1989 issue) and ***Benchmarks for Science Literacy*** (reviewed in our Winter 1994 issue), both publications of Project 2061.

As the teaching of science has changed little, so also has the preparation of science teachers changed little as well. And while Rutherford cites the effect of computers as a design tool for structural change in other fields, he sees no such effect in education, though he does show how the software accompanying Project 2061's ***Designs for Science Literacy*** allows for computer-aided design of curricula to meet the Project 2061 ***Benchmarks***.

What particularly seemed to disturb Rutherford was the consequences of the failures of American science education -- that "most people, including those who took [a] high school biology course in which evolution was taught, do not understand the claims made by the theory, the evidence for it, . . . or even what a scientific theory is." Rutherford also laments "that years of school science has done little to separate people from their superstitions" and that "in the midst of today's frantic test mania, the science tests being used are narrow and reward memory more than understanding."

When Rutherford tried to ascertain causes for what was not achieved in American science education during the past half century, he came up with three reasons -- "misguided responses to calls for reform, lingering professional shortcomings, and, above all, the discontinuity of effort." Among the misguided responses, he cited finger-pointing, short-term cure-alls, quick fixes, and "bandwagons." Among the shortcomings he found "parochialism that leads us to believe that learning goals and curricula have to be home grown" and "the absolutist view that there is a 'best' . . . to be had." "But the most debilitating of these shortcomings," he went on, "was our ***failure to invest enough of our intellectual and financial resources in building a trustworthy knowledge base***."

"In my judgment," Rutherford said, "our greatest failure over the past 50 years with regard to science education reform was our *lack of persistence*." Instead of the "sheer doggedness" which he said "was needed in the face of the need for reform," the pattern had been that "a national crisis arises, science education reform begins -- crisis fades, reform stalls -- new crisis arises, new reform begins -- new crisis fades, new reform stalls. . . . Moreover, this lack of persistence . . . was made more debilitating than it might have been by memory loss. Instead of building on what had worked best in previous reform splurges, each new reform set out in new directions."

Having surveyed the past half century of American science education, Rutherford then turned to the next half century and outlined a four-point program of what he would like to see:

1. "*Create a means for fostering and sustaining public support for reforming science education."* The need for this, he maintained, is that "the quality of our future . . . depends on our ability both to attain a high level of science literacy nationwide and to produce a sufficient number of scientists and engineers."

2. *"Clarify and harmonize learning goals."* "Substantial progress" had already been made in this by Project 2061, Rutherford felt.

3. "Focus science education reform on three long-term institutional goals: the transformation of school curricula, materials, and operation; the transformation of teacher education; and the building of a sophisticated research enterprise."

4. *"Set up a multifaceted system for periodically monitoring and reporting progress toward the long-term goals."*

To achieve this program, "schools in the future will be operated year around; have flexible, goal-directed curricula that are designed and monitored using computers; employ computers (and associated technologies) as an integral part of the teaching armamentarium; and textbooks will have given way to other kinds of print material, and radically reduced in size and changed in function, or dispensed with altogether. Moreover, the nature and employment of teachers in the future will be characterized by diversity."

In addition to a body of teachers whose diversity matches that of their students, Rutherford envisions changes in the training of these teachers. He foresees a seven-year teacher training

program that would provide preparation in both disciplinary and pedagogical content and include a year of internship. A smaller number of teacher training institutions meeting rigorous standards will train these teachers, who will have six years to earn tenure after they receive their credentials. Teacher credentials would be valid in all states, and teaching experience for salary purposes will be honored in all states. Participation in TIAA-CREF would allow teachers to carry their retirement plan with them wherever they go and thus increase their mobility. Teachers could also aspire to be faculty leaders or teacher specialists. Doctorates in science would be granted only by departments which have a program of substantial and sustained science education research. Teaching positions at all levels will become more highly regarded and sought after.

The full text of Rutherford's Brandwein Lecture is available in the *Journal of Science Education and Technology*, **14**(4) 367-386 (Dec 05).