Precollege Education: The Critical Issues in Science and Math Training

Editor's Note: Following are excerpts from a speech by Bassam Z. Shakhashiri at the Pyramid Conference held in Chevy Chase, Md. The conference was organized by 18 educational, scientific, and engineering societies and focused on pre-college science and math education. Shakhashiri is assistant director for science and engineering education at the National Science Foundation.

I am convinced that the critical issues of precollege education in science, mathematics, and technology must be dealt with in the best ways we have available to us. And if what is available to us is not effective, we must *create* and *invent* approaches that are effective.

Meaningful, collaborative efforts among academic institutions, the private sector, and government must be launched immediately in order to build on the current national concern about science and math education.

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I strongly believe that we now have a situation which is more critical and more consequential than what we had in the immediate post-sputnik era. For one thing, there are more of us now in the United States than there were 25 years ago. So, the sheer magnitude of the problem in terms of having more students to teach and needing more qualified teachers is one difference.

Of course, we must have an adequate number of scientists and engineers coming through the pipeline if we are to maintain our economic strength, national security, and advanced technological society. The most consequential difference between now and 20-25 years ago is that we live in a more technological society than we did in the post-sputnik era. And it is the science and math education of the non-specialists that requires our special attention.

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We must involve scientists and engineers in projects which lead to improved quality of science, math, and technology education at all educational levels. We must bring together scientists, engineers, and educators to apply results of new research from the cognitive sciences area. We know more about learning now than what we knew 10-15 years ago.

In teaching science, engineering, and mathematics we should be aware of how the learner acquires knowledge and mastery of physical concepts and mathematical manipulations. It is absolutely essential that scientists and engineers become more involved in the science and math that their children are learning in school.

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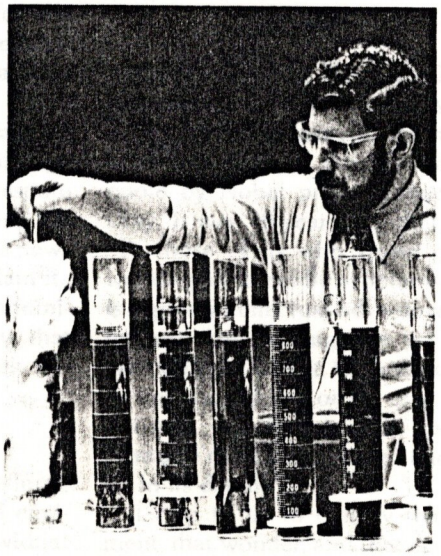
The education enterprise in this country is a trillion dollar operation. The National Science Foundation currently has a budget of about $100 million for education programs. How can we possibly solve the nation's problems in science and math education with such funds? Obviously, we can't. What we *can* do is play a strategic leadership role.

The federal role is one of leverage in terms of working with educational institutions, both public and private, *and* with the private sector to provide meaningful opportunities for teachers to upgrade their knowledge of the subject matter, to learn how to adapt or even adopt new educational technologies to strenghten their teaching, and to have continuing education programs dealing with both subject matter content and pedagogy.

NSF can help catalyze existing *good* programs and can also help initiate new programs in collaboration with educational institutions and the private sector.



Bassam Z. Shakhashiri

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With the advice and assistance of industrial leaders, I intend to appoint an industrial scientist on my staff at NSF. Such a person would help in establishing policies to foster productive collaboration among colleges and universities, industry, local and state education agencies, and NSF. This collaboration would be aimed at enriching, enhancing, and strengthening education in science, math, and technology at all levels.

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During this fiscal year, we are emphasizing the elementary and middle school/junior high school years, although not to the exclusion of high school. We strongly believe that it is in these early years that the foundation is laid for later interest in mathematics, science and technology. U.S. elementary schools are woefully lacking in good math and science teaching in the elementary years.

By the time student reaches high school, he or she has generally lost interest in these fields. We hope that we can find a way to have some effect on the training experiences of elementary school teachers, to try to reinvigorate the teaching of mathematics, science and technology at this level.

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But school science and technology courses cannot provide all the science information citizens will need throughout their life to understand a changing world. All of the many reports issued over the past several years agree on the importance of the public's understanding of science and technology.

We live in an age when every new car uses a computer chip to control the ignition. Every newspaper contains articles about toxic waste disposal, use of pesticides, food additives, nuclear power and genetic engineering.

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Not too many years ago society generally believed that technology would find

ways to solve all our problems. The promise of technology is great. However, absolute faith in technology is foolish. New research and technological innovations bring negative impacts, no matter how positive their overall consequences might be. Our tasks as scientists and engineers extend beyond research and transmitting knowledge.

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I submit that our greatest challenge is to extend learning opportunities so that all individuals can continue to expand their knowledge and understanding of science. Improving science teaching is crucial, but it's not enough. Our adult population also needs to learn new science concepts.

We need not only skilled scientists, engineers and technicians, but managers and decision makers who understand the nature and implications in their fields. And we need a citizenry that can follow and weigh the progress and implications of science and technology—a public whose interest and enthusiasm can last beyond the momentary thrill of a moon landing or a Saturn fly-by.

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Science centers and museums attract phenomenal attendance—almost as many people attend science museums as all other museums combined. The total attendance of 150 million per year is equal to the box-office attendance of baseball, football, and basketball combined! Why? Because they give people meaningful experiences that appeal to the senses, emotions, and intellect.

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It is part of the business of our professional societies to encourage and support better science reporting for the public. However, we cannot leave these kinds of efforts to our professional societies alone.

Those of us responsible for teaching and research in the sciences and engineering must take on the added responsibility for informing and involving the public, for it is our research that is news and we're the ones who can explain it.

. We have to learn how to communicate through the media and how that differs from communicating with fellow scientists and engineers.

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In addition to the institutional efforts, I believe that each scientist and engineer must take on some individual responsibilities aimed at improving education and public understanding of science in our local communities.

If every person in this room spent six to eight hours every month out in the community the impact would be enormous. I ask each of you to commit some time to consider the following four challenges:

1. Spur your professional organization local section to conduct expanded programs in technology and engineering education. Be specific in what you suggest and help implement the project. In addition to programs to recognize outstanding students and teachers, you could offer a mini-course at the local high school or your local section could adopt-a-school; tutor students or become a mentor; establish an extracurricular science, or computer club at your local high school; help develop an exhibit or film and lecture series for your local library or museum.

2. Make a presentation to 6th, 7th, and 8th grade students in your area. Emphasize the process of science and engineering, and the benefits of both to society. Those are the years when lifelong attitudes toward science and engineering begin to develop.

3. If you are active in a local civic or service organization plan an engineering or science program. It takes a little imagination and a lot of commitment, but it will strengthen science and engineering education at the local level and increase public understanding and support.

4. Take an editor or a newspaper reporter out for lunch. Let them know about your interests and concerns, especially as it relates to science and technology coverage. Your talk to the local Engineering Association might make an Op Ed piece in your local paper.

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There has never been anything dispassionate about the scientist's or engineer's search to unravel the mysteries of the universe. I am reminded of a quote by Nobel prize winner Harold Urey. It was 40 years ago that he said, "To those of us who spend our lives working on scientific problems, science is a great intellectual adventure of such interest that nothing else we ever do can compare with it. We are attempting to understand the order of a physical universe vast in extent in space and time and most complicated and beautiful in its detail."

It's up to us to convey that excitement, that wonder, and that dedication. It demands our best efforts.