Risking the Future: A Report on Science and Mathematics Education in the Public Schools

Engineering Alumni Society

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It's a pleasure to join you tonight for what is a kind of homecoming for me. I grew up in Berkeley, earned my Master's and Doctor's degrees on the campus here, and spent several years in University Hall as a vice president in the early 1970s. So coming back to Berkeley really is like coming home, and I'm delighted to find that the Bay Area is still the beautiful and dynamic place I remembered it to be.

A lot of changes have taken place on the educational scene over the past ten years, and none has been more dramatic than the recent upsurge of national concern about the public schools. In 1981 Secretary of Education T. H. Bell asked me to head the National Commission on Excellence in Education, a panel of leaders from education, the coporate and foundation worlds, industry, and private life. The Commission's charge was to respond to that concern by examining the quality of education in the United States. I accepted, but without any certainty that the Commission's work would evoke a broad public response, although I was convinced the subject deserved such a response. To my surprise, the release of the Commission's report last April was met with widespread interest, discussion, and debate among members of the public, educators, and politicians alike. And a number of reports issued before and after ours have validated the Commission's central argument: that the educational foundations of our society are presently being eroded by a rising tide of mediocrity that threatens our future as a nation and a people.

Consider, for example, some of the statistics that were brought to our attention during

our hearings on the condition of the American education:

- International comparisons of student achievement, completed a decade ago, reveal that on 19 academic tests American students were never first or second and, in comparison with other industrialized nations, were last seven times.

- Some 23 million American adults are functionally illiterate by the simplest tests of everyday reading, writing, and comprehension.

- The College Board's Scholastic Aptitude Tests demonstrate a virtually unbroken decline from 1963 to 1980. Average verbal scores dropped over 50 points and average mathematics scores dropped nearly 40 points.

- Many 17-year-olds do not possess the higher order skills we should expect from them. Nearly 40 percent cannot draw inferences from written material; only one-fifth can write a persuasive essay; and only one-third can solve a mathematics problem requiring several steps.

- The proportion of high school students taking a general program of study has increased from 12% in 1964 to 42% in 1979. This is a telling statistic because a general program of study prepares students neither for college nor for work.

There are many, in fact, who believe that the trends in science and mathematics education are cause for special alarm. For instance:

- There was a steady decline in science achievement scores of U.S. 17-year-olds as measured by national assessments in 1969, 1973, and 1977.

- Between 1975 and 1980, remedial mathematics courses in public 4-year institutions increased by 72 percent and now constitute one-quarter of all mathematics courses taught in those institutions.

And Bernard R. Gifford, Dean of Berkeley's Graduate School of Education, has noted some developments that have troubling implications for the future:

- A 1981 National Science Teachers Association survey reported that, nationally, over half of all newly employed science and mathematics teachers in secondary schools were employed on an emergency basis because no qualified teachers could be found.

- Mathematics and science teachers are leaving the teaching profession for jobs in industry at a rate four to five times their rate of replacement.

- Universities are relying increasingly on foreign students to provide new Ph.D.s in engineering, computer science, mathematics, and the physical sciences.[1]

Here in California we have some excellent economic reasons for caring about the state of science and mathematics education in our schools. California's industries and government employ something like one-fifth of the nation's engineers and close to forty-five percent of its computer specialists. Our economy, as you know, rests on a broad technological base that must be not only protected but strengthened if we are going

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1 Bernard R. Gifford, "Addressing the Crisis in Precollege Education," Briefing for the House of Representatives' Democratic Caucus, April 27, 1983.

to maintain our competitive edge in world markets.

Whether or not the nation will face an actual shortage of scientists and engineers over the next decade or so—and there are opinions on both sides—California's continuing need for technical people means that we would do well to pay attention to the trends I've discussed. The California Postsecondary Education Commission has warned that, given the expected decline in traditional college-age students during the 1980s—and most engineering and computer science students are drawn from the 18- to 24-year-old group—we will have to look beyond the now predominantly white male applicant pool if we are to keep up with our economy's need for technically skilled people. When you add to this the fact that increasing numbers of California's school age population will come from minority groups, who traditionally have not qualified for higher education in proportion to their numbers, the urgency of improving education in the schools for all of our young people becomes plain.

Quite apart from the economic concerns I've mentioned is the question of whether it is possible to live a full and rewarding life in our society without some understanding of the technological forces that have shaped not only our economy but also, in many respects, the way we live. Our students cannot possibly be prepared to exercise their responsibilties as autonomous adults or as citizens in a society like ours without at least some grasp of quantitative thinking and some understanding of the ideas and techniques that underpin our technological world. Yet the evidence is that we are not preparing our students for such a world. The National Science Board Commission on Precollege Education in Mathematics, Science, and Technology sums it up this way: "The Nation that dramatically and boldly led the world into the age of technology is failing to provide its own children with the intellectual tools needed for the 21st century."[2]

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2 "Educating America in the 21st Century," National Science Board Commission on Precollege Education in Mathematics, Science, and Technology, p. v.

The problems facing education didn't happen overnight, of course, and they didn't happen without cause. We know at least some of the reasons for the current malaise in education, nationally and in California. The social and educational upheavals of the 1960s, for instance, brought many useful changes to our schools, such as dramatically improved and overdue access to larger numbers of our youth; but they also brought a dilution of the curriculum and a shifting onto the schools of responsibilities that traditionally belonged to the family, the church, and other institutions in our society. The past few decades have also seen the decline of the teaching profession as a respected and rewarding life's work. And despite the dramatic lesson of Sputnik in 1957, during the past ten years or so mathematics and science education has generally received less attention—and less support—than other subjects.

After sifting through the data and mulling over the testimony we heard from many students, teachers, schools officials, parents, and other citizens from throughout the country, the Commission came to three conclusions. First, we became convinced, as I have said, that our educational problems are real enough and serious enough to put the nation at risk, not just in terms of its economic or industrial or military strength but also in terms of the intellectual, moral, and spiritual strengths of our people which knit together the very fabric of our society. A high level of shared education is essential to a free, democratic society and to the fostering of a common culture, especially in a country that prides itself on pluralism and individual freedom.

Second, we decided that one consistent thread in the testimony we heard from students, teachers, administrators, State officials, business leaders, and minority groups alike was a growing impatience wtih the shoddiness in many walks of American life, and the complaint that this shoddiness is all too often reflected in our schools and colleges. As is true with our society generally, we have been expecting less from our students and our schools, and we have been getting it.

Third, the Commission concluded that as a nation we can and must do better. The decline in American education stems more from weakness of purpose, confusion of vision, underuse of talent, and lack of leadership than from conditions beyond our control. What is needed is a strong national commitment to excellence throughout our educational system—not just in certain areas or in certain schools—and a commitment to excellence that is not made at the expense of equitable treatment for all of our students. The twin goals of equity and schooling of high quality have profound and practical meaning for our economy and our society, and we cannot permit one to yield to the other in principle or in practice. For California, which is expected to become the first state in the nation with a population made up predominantly of members of minority groups, the commitment to academic excellence and to educational opportunity is especially important to our welfare as a society and to the individuals who comprise it.

The Commission recognized that the nation's 17,000 school districts are under local control, and so our recommendations for change were framed in terms general enough to be adapted to the needs and requirements of individual schools. We concentrated on five areas where we felt reform was needed most: the amount of time devoted to learning; the content to which students are exposed; the expectations and standards to which they are held; the improvement of teaching; and the importance of leadership. As a first step toward improving those areas, we urged the adoption of what we called the Five New Basics as the core of the modern curriculum. Besides English and social studies, we decided, that curriculum should also include mathematics, science, and computer science—which we considered an essential skill for anyone living in today's advanced technological society. Unless it provides all of our students with a solid grounding in these subjects, the Commission concluded, schooling in America simply is not doing the job it can and must do.

So far I've talked about the public schools and the work of the National Commission

on Excellence in Education in terms of our problems, nationally and within California. I'd like to conclude by talking briefly about some of the opportunities I see ahead, particularly those in which you have an especial interest.

First, the University of California is involved in several promising and innovative programs, about which you may already have heard, to improve mathematics and science education in the schools. The newest is the California Mathematics Project, established by the Legislature and funded by the State Department of Education. The Project's purpose is to strengthen the skills and teaching techniques of current teachers. Five University campuses, including Berkeley, sponsored institutes this past summer in which teachers were able to concentrate on methods of instructional improvement and curriculum development. The Lawrence Hall of Science was recently awarded a half-million dollar grant to extend its highly regarded EQUALS program, a project that has been operating for the past six years or so and that trains teachers, administrators, and counselors to help minority and female students in kindergarten through high school succeed in mathematics. And participants in the Berkeley campus's Cooperative College Preparatory Program work directly with teachers and students in the classrooms of two high schools and six junior high schools in the Oakland area to develop mathematics instruction and curriculum. These are important opportunities to see that education in the schools really does give young people the quantitative skills indispensable to the future study of science.

Second—to speak for a moment about what individuals can do—anyone who wants to help can begin by becoming informed about the problem, something you have already done in part by your presence here tonight. For another, you can work with community groups and businesses on fresh and innovative ways of making a difference in education. A number of cities have "Adopt-a-School" programs in which a local company assists a local school—in one of the business-school partnerships in Houston, for example, chemists and physicists from a leading research and development firm teach science

classes for gifted students as a way of complementing the efforts of regular teachers. California's MESA program—the initials stand for Mathematics, Engineering, Science Achievement—was formed in 1970 with support from the business and education communities to improve the preparation of minority students in these fields and to encourage them to consider science as a career. It now operates in some 125 California high schools as well as in Colorado, New Mexico, and Washington. These and other efforts deserve encouragement and support.

As members of the engineering profession, you have a special opportunity to help. The Commission on Excellence in Education pointed out, for example, that we are facing a serious shortage of science and mathematics teachers in the schools, and that "industrial and retired scientists could, with appropriate preparation, immediately begin teaching in these fields."[3] We also pointed out the important role university scientists, scholars, and professional scientists played in helping to develop textbooks and other curricular materials in the post-Sputnik years, a role you are urgently needed to fill once again. In the words of the report: "We applaud the consortia of educators and scientific, industrial, and scholarly societies that cooperate to improve the school curriculum."[4] These sentiments are echoed in the recent report of the National Science Board on science and mathematics education in the schools, which underscores the fact that professional societies occupy a unique position as a bridge between professional mathematicians, scientists, engineers, and teachers.

The American Association for the Advancement of Science, the American Society of Civil Engineers, the National Society of Professional Engineers—these and similar groups

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3 A Nation at Risk: The Imperative for Educational Reform. Report of the National Commission on Excellence in Education, David P. Gardner, Chair. Washington: U. S. Government Printing Office. April 1983. p. 31.

4 Ibid., p. 27.

have already made important contributions to improving science and mathematics education in the schools through projects designed to help students and motivate teachers. But much remains to be done, and I invite you to think about the problem and about what you can do to join the effort to make our schools as good as they can be and as effective as they must be.

There are many opportunities to help. As graduates of the nation's most distinguished school of engineering, you have had firsthand experience of the difference excellence can make. I hope you will do what you can to bring a similar determination to insist on the best into our public schools. The conclusion of the Commission's report puts it this way:

> It is...the America of all of us that is at risk; it is to each of us that this imperative is addressed. It is by our willingness to take up the challenge, and our resolve to see it through, that America's place in the world will be either secured or forfeited. Americans have succeeded before and so we shall again.[5]

Thank you.

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5 Ibid., p. 36.