Science Education in the United States: What the Scientific Community Can Do

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It is argued that the need to improve science education should be a national priority. Ways are suggested by which the federal government and the scientific community, working together, can address this issue. It is recommended that scientists, engineers, and educators make a significant personal and institutional commitment to participate in science education activities, and that the President of the United States provide the personal leadership to generate a national commitment to the improvement of education at all levels.

IN THIS ARTICLE I WANT TO FOCUS ON A TOPIC THAT IS important to every major challenge the nation faces: the need to improve in a significant way the quality of education in American society. Volumes have been written on this subject; but I will focus only on science education, including scientific and technical literacy of the public at large, and science, mathematics, and technical education for our future work force and for future professional scientists and engineers.

In discussing this topic, I will mention a number of other issues that are related to this central concern: the question of international competitiveness, the need for more minority and women scientists and engineers, and the necessity to have a healthy and vital scientific and technical enterprise in the United States. Some historical perspectives will also be given. Looking at this subset of topics will allow me to suggest ways in which the scientific and technical community and the federal government might work together to address this problem.

Historical Perspectives

Discussions of the appropriate relations between the federal government and the scientific community are not new. The history of the American republic is threaded throughout with concerns and debates about the appropriate role of science in the federal government, as well as the role of the citizenry and elected representatives in setting priorities for governmental support of science.

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In his seminal book, *Science in the Federal Government* (*1*), Hunter DuPree pointed out that these debates began at the nation's birth, during the Constitutional Convention, and that Benjamin Franklin, Thomas Jefferson, and John Adams believed that science could and should be an important factor in the development and growth of the nation. But science presented a number of vexing problems to the young nation of America. Founded on the premise of every citizen being equal or at least potentially equal, the establishment of an aristocracy in any form was anathema to the early American public. In this regard, science was viewed in a somewhat schizophrenic manner. The immediate and visible beneficial applications of science to agriculture, mechanics, geology, the coastal survey, and other areas of national concern were appreciated and supported by the public and by early lawmakers. However, the other image of science—science as a prerogative and exclusive activity of learned men (and I say "men" deliberately)—was viewed with suspicion and often with outright hostility. To many, Thomas Jefferson was the embodiment of this latter image of the scientific person. A clear proponent and admirer of the European Enlightenment, Jefferson was seen by many average Americans as being representative of a European view of science, and learning in general, that seemed inappropriate for this new democracy in the United States.

In his book, *Science in American Society*, George Daniels quotes an early writer who said of Mr. Jefferson (*2*, p. 159), "If one circumstance more than another could disqualify Mr. Jefferson from the Presidency, it would be the charge of his being a philosopher." The term "philosopher" was applied to any learned person who emphasized theory over practice—even to scientists.

The "democratization" or popularization of science in America was greatly developed during the Jacksonion period in American history beginning around 1829. During this period, until about 1860, professional lecturers traveled throughout the nation speaking on "scientific" topics, often accompanied by elaborate and spectacular demonstrations of scientific phenomena (*2*).

Professional scientists, such as Asa Gray, Louis Agassiz, Alexander Dallas Bache, Benjamin Silliman, and others, protested strongly against the view of science presented to the public in these lectures and argued that what the nation needed most was to support scientific investigations and studies by those most competent to carry out such research. These gentlemen also felt that communication among professionals who were actively involved in scientific investigations was more important and necessary than attempts to explain science to the general public. The AAAS played a central role in this debate, and its founders confronted this issue in lively and sometimes acrimonious sessions of the association, often being against the popularization of science (*2*).

It should not be surprising that these kinds of debates and differences of opinion occurred, or that the early scientific professionals in America had views on these matters quite different from those of the public at large. The scientists were attempting to demonstrate their independence from Europe while also demonstrating their professionalism and scientific maturity to their colleagues throughout the learned community in Europe. They felt above all that science in America had to be established on a level to attain worldwide respect and that anything that deviated from this goal could only be detrimental for science. However, given this attitude on the part of leading scientists, it is also not surprising that the public, as represented through its elected officials, saw little need for the federal government to be supportive of such an enterprise, an enterprise that viewed itself as removed from and somewhat disdainful of the lay public.

As has happened many times throughout the history of the nation, real events caused many of these philosophical and theoretical arguments to take on new perspectives. For example, the advent of the Civil War put science and technology in a new light. This was the first American war in which many of the new technological developments were applied. According to Daniels (*2*, p. 265), "The first American use of aerial observation in wartime, the first important use of the telegraph, problems of disease in the mass army, efforts by both sides to use new explosives, and problems of logistics and supply all forced science upon government attention."

As science became more embedded in the government and more useful to the purposes of the nation, the question arose, as it does now, as to the proper coordination and organization of science and scientific advice within the federal government. In 1884 Congress requested the National Academy of Sciences to study the organization of science in the chief countries of Europe and to recommend methods for coordinating the scientific branches of the government. Although the National Academy committee recommended a department of science, Congress rejected this recommendation. The debate over the issue was "passionate and vigorous" (*1*). Some felt that a single department would stifle creativity within the government and would create too large a bureaucracy.

Another camp felt that having a single department representing a special professional interest, that is, science, would make control by Congress more difficult. But the prevailing argument seemed to be that science could only achieve its full worth and value to the government if it permeated the entire federal structure and was not concentrated in a single unit.

Out of these discussions and debates, a clearer sense of the government's role in the support of science and the rationale for that support emerged. This rationale went beyond the government's need for the practical applications of science for civilian or military purposes and argued that the dissemination and promotion of science is healthy for the nation as a whole. Therefore, it is appropriate, legitimate, and necessary that the federal government play a major role in the support of science. It was also recognized and accepted that only the federal government had the resources to support and promote science at the level necessary to maintain a healthy enterprise.

This line of reasoning is familiar to us today. It is essentially the justification we use for the federal government's support of scientific research. In spite of agreement on this fundamental premise by most political leaders and scientists just before the turn of the century, it took another 50 years and two world wars before this principle became fully accepted as a part of the nation's operational and funding structures. The persuasiveness of similar arguments by Vannevar Bush and others led to the establishment of the National Science Foundation, the beginnings of the strong role of science in government mission agencies, and the increasing support of scientific research by the federal government in its own facilities and in universities throughout the nation.

Nevertheless, it is clear that many of the concerns confronted by our founding fathers and the leaders of the country throughout its history—concerns about science and the federal government—are still with us today, perhaps with different shadings and in different contexts, but addressing some of the basic issues.

We still debate how the government should seek out and use advice from the scientific and technical community, how the lay public should be involved in setting priorities for the support of science and the directions in which science should evolve, and how our elected and appointed officials should reflect the public will on these issues. These are not merely philosophical concerns; they have practical consequences for the health and vitality of the nation and its citizens.

Even a cursory reading of the history of the relations between science and the federal government strongly suggests that many of these questions become resolved in times of national crises—wars providing the most vivid example. The Civil War, World War I, and, most notably, World War II created the environment and provided an unassailable rationale—national survival— for the nation to reach a consensus on the issues and to implement practical plans and programs to address specific areas requiring a healthy partnership between science and government.

It seems that no such overarching and universally recognized crisis exists today. We are not at war in the canonical sense. Instead we find ourselves in a period of multi-minicrises that seem to have limited lifetimes, at least as measured by their exposure in the media and the attention given to them by our national leadership. The energy crisis, the trade and budget deficits, acquired immunodeficiency syndrome, and the greenhouse effect are profoundly serious and deeply troubling issues with long-lasting consequences, but not one has provided the coalescing influence concerning courses of action that wars provide.

However, the summation and amalgamation of these "virtual crises," in the quantum mechanical sense, if not resolved, can have detrimental consequences for the health and survival of the nation, consequences equivalent to losing a major war.

One issue does seem to be emerging in the national consciousness to a degree that might provide a coalescing influence for concerted national action. It may also provide an effective meeting point for the federal government and the scientific community to combine resources in joint efforts. I refer to the crisis in American education and, in particular, its effects on the nation's ability to remain competitive in a rapidly changing world.

The Crisis of Education and Competition

It is no longer a matter of serious debate that the United States is losing or has lost its leadership position in many areas of importance to our national economy. Even so, some have argued that traditional areas of heavy industry and manufacturing (where our losses have been greatest) are no longer important for American competitiveness and that our real strengths and hope for the future are those areas where we have a superior advantage, areas that rely on science and technology, the so-called high-tech fields. Proponents of this view point out that American higher education and our system of training scientists in basic and applied research are still superior to any in the world; and, therefore, we should stake our future on our ability to maintain an edge in those industries and areas where technology plays a dominant role and where there is a close connection to research and development.

This argument has merit, but we can no longer take for granted

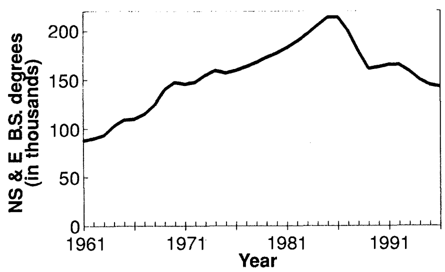

Fig. 1. Natural science and engineering (NS & E) B.S. degrees to U.S. citizens, assuming current participation rates. [Source: National Science Foundation]

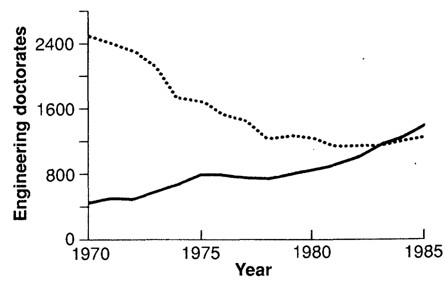

Fig. 2. Engineering doctorates awarded to U.S. citizens (dotted line) and to holders of temporary visas (solid line), 1970–1985. [Source: National Science Foundation]

that our ability to maintain a competitive edge will be sustained by our superiority in high-tech industries. In certain high-tech areas, the Japanese and the new "Asian tigers" have already gained a superior advantage, and that advantage continues to grow. The Japanese now control more than 50% of the world's semiconductor industry and about 90% of the world market in dynamic random access memories, which some argue are the guts and muscle of the microchip industry; in 1986 the United States showed a trade deficit in high-tech areas for the first time (*3*).

Furthermore, we cannot be complacent about the maintenance and long-term health of our scientific and technical base, the area where we continue to have an advantage at the present time. Although the United States spends far more on research and development than any other country, our spending is not always directed in ways that address fundamental areas relating to economic competitiveness. For example, the ratio of nondefense research and development expenditures as a percent of gross national product in the United States actually declined during the period 1980 to 1985, whereas this ratio in Japan, West Germany, and France showed increases (*3*). More than two-thirds of federal R&D dollars in the United States are now spent in defense-related areas. The Department of Defense (DOD) spends about $40 billion annually on R&D, but less than $1 billion on basic research (*4*). To put this number in perspective, the new B-2 "stealth" bombers will cost more than $0.5 billion each. This is more than half of the annual basic research budget of DOD.

There have been numerous analyses and studies of the factors underlying our decreasing competitive posture. No matter how much disagreement there may be with respect to some factors, practically all who have looked at this problem agree on one aspect: our education system needs drastic improvement if we are to maintain a competitive edge in a world that increasingly uses and depends on science and technology.

This topic is no longer discussed only in scholarly magazines or brought to the public's attention through the exhortations of members of the education and scientific community. The magazine *Business Week* devoted a special report to this problem. The leading paragraphs in that report, entitled "Needed: Human Capital" (*5*, p. 100), said:

> Take a trip back to what may be our future. It is the 1851 industrial exhibition at the Crystal Palace in London. Britain is the dominant world power. The U.S. is No. 2 in industry and catching up fast.
>
> Made-in-America reapers, muskets, and tools are the marvels of the show. . . . Worried delegations of British industrialists set sail [to America] to investigate. Their findings? American manufacturing prowess is in large part due to a highly educated work force. The Yankees have an astonishingly high literacy rate of 90% among the free population. In the industrial heartland of New England, 95% of adults read and write. In contrast, just two-thirds of the people in Britain are literate. . . .
>
> Now zip ahead a century or so to the 1980s. The U.S. is the dominant world power, and it is Japan that is No. 2 and closing fast. American CEOs marvel at the quality of Japanese products flooding their markets. They make pilgrimages to Tokyo. Their findings? Manufacturing superiority is being forfeited to the Japanese. And yes, once again, behind the success in manufacturing prowess lies a better-educated work force. In 1988, Japan's functional literacy rate is better than 95%. In America it's down to about 80%.

This article and numerous others point out in graphic ways the importance of having an educated, literate, and competent citizenry in order for a nation to remain economically competitive.

As the report of the Commission on Excellence in Education, "A Nation at Risk," said (*6*, p. 5), "If an unfriendly power had attempted to impose on America the mediocre educational performance that exists today, we might have viewed it as an act of war." The analogy between our present situation and military wars of the past is not as far fetched a comparison as one might at first suspect.

Poor education is a general problem, but of particular importance to scientists are two aspects of this problem. The first has to do with the future supply of individuals who will participate in and contribute to the scientific and technical enterprise, and the second concerns the level of scientific competence and literacy among the public at large. In neither of these areas can we be optimistic for the future unless strong actions are taken now.

Figure 1 shows the number of bachelor's degrees in science and engineering awarded to U.S. citizens since 1961, together with projections through 1996. After reaching a peak in 1986, these numbers have begun to decline. On the basis of this trend, the National Science Foundation projects a cumulative shortfall of more than 400,000 B.S. degrees in science and engineering by the year 2006 (*7*).

Our "trade deficit" extends not only to goods and services but also to human capital. It would be difficult for the United States to meet its present needs for scientific personnel in many areas, were it not for contributions made by non–U.S. citizens. The number of engineering doctorates awarded in the United States to non–U.S. citizens on temporary visas now exceeds the number awarded to U.S. citizens (Fig. 2).

Approximately 25% of Ph.D.'s awarded in all fields of natural science and engineering in 1986 were awarded to non–U.S. citizens. In and of itself this may or may not be a problem, but one must consider that only about half of the foreign nationals remain in the United States after obtaining their degrees. It is argued by many who study the problem that this percentage is likely to decline as growth in the labor markets and the need for scientific and technical personnel increases in the home countries of these individuals.

This decline in participation in scientific and engineering disciplines by Americans is due primarily to the decrease in the number of white American males who are entering these fields. As Michael Heylin, editor of *Chemical and Engineering News*, put it (*8*, p. 3), "Chemistry and much of the rest of science in this country have been working for far too long under an implicit assumption that scientific competence is disproportionately concentrated in roughly 40% of the population represented by white males. It is a handicap that neither science nor the U.S. can any longer tolerate on economic, competitive, moral, or any other grounds."

The problem of increasing our human capital base in these important areas cannot be divorced from the problem of increasing the number of women, blacks, and other minorities. The demographics of the nation alone will dictate that an increasing amount of attention be paid to this particular aspect of the problem. Figure 3 shows the distribution of students ages 5 to 17 in 1982 and the projected distribution in the year 2020. As of now, less than 3% of all practicing scientists and engineers are minorities (excluding Asian Americans), and only about 25% of scientists and about 5% of practicing engineers are women. The "women issue" and the "minority issue" are often treated as different, however similar, problems. This is not strictly true, at least for blacks. The fact that the overwhelming majority of black students in institutions of higher education today are women makes these two issues irrevocably intertwined (*9*).

Using percentages can mask the reality of the situation; the numbers for blacks and Hispanics are more revealing. As of 1985 there were approximately 700 black Ph.D.'s in the physical and mathematical sciences, about 1400 in the life sciences, and close to 500 with engineering doctorates. The numbers for Hispanics are similar (*10*). Even more revealing is the fact that in 1985, of all the Ph.D.'s earned by blacks, there were 503 in education, 205 in the social and behavioral sciences, and 75 in the humanities, but only 7 in mathematics, 3 in the computer sciences, 4 in physics, and 0 in theoretical chemistry, embryology, and statistics (*11*).

Looking to the year 2000 and beyond, we face a serious problem in the number of individuals who can contribute actively to the fields of science and engineering. This gap may be made up by immigrants, but the problem is more than simply quantitative; it is also qualitative. We need to be concerned not only about attracting and retaining more students in areas of science and technology but also about the quality of education being received by all students. If we look at the comparative performance of American students relative to that of their peers in other countries, we see that a great deal needs to be done. Figure 4 shows the performance of 12th and 8th grade students in a number of fields. In no area at the 12th grade level do American students exceed the median.

Jon Miller, a professor at Northern Illinois University, has written extensively on the question of scientific literacy. Miller has developed a fairly sophisticated model to measure scientific literacy. He looks at three measures: (i) the ability of individuals to recognize and understand certain scientific terms and concepts, such as radiation and DNA; (ii) the ability to follow basic levels of scientific reasoning; and (iii) an awareness of certain public policy issues that have a scientific and technical component.

Miller has compared and standardized the results of his surveys from 1957, 1979, and 1985 (*12*). The results indicate that only about 5% of American adults qualified as scientifically literate in 1985. This is less than the 7% found in 1979 and is no improvement over the level measured in 1957. As Miller points out (*12*, p. 30), "The essential point is that the level of scientific literacy in the United States remains low, and that the informal science education efforts of recent years have not produced any measurable increase in scientific literacy."

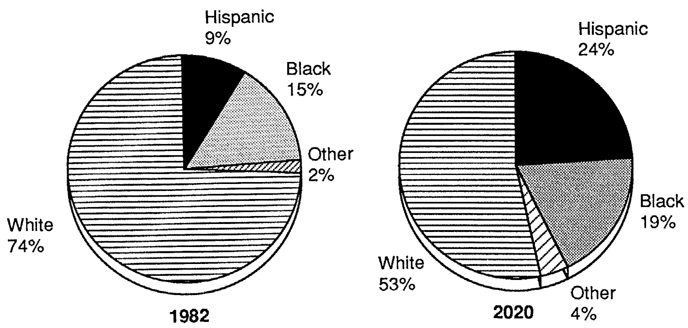

Fig. 3. Distribution of students, age 5 to 17 years old. [Source: National Science Foundation]

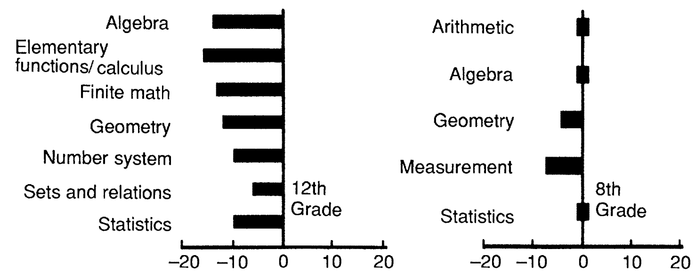

Fig. 4. Performance of 12th and 8th grade U.S. students in a number of fields, showing the difference in percentiles from the international median. [Reprinted with permission of the Rand Corporation]

How can the scientific community and the federal government, working cooperatively, begin to address these issues in a serious manner? Before offering advice to the federal government, I will first address some of the things that we in the scientific community might do.

Of course, science and the federal government are not the only participants in this drama. Private industry and the public at large will perhaps play an even greater role. But what we do in science and government can have a tremendous impact in helping to shape public attitudes, in generating public understanding and support, and in providing ways for industry to be a more active participant in addressing these issues.

Figure 5 illustrates the so-called pipeline, showing the proportion of students at each level who continue on to degrees in science and engineering. At each level there is an opportunity for improvement based on increasing the number entering the pipeline through early-stage programs or by reducing the attrition at various junctures of those who are in the pipeline. As scientists and as educators we, perhaps more than any other segment of American society, should recognize the importance of expanding the throughput of this pipeline and should play a leading role in its expansion.

What Can the Scientific Community Do?

The scientific community cannot really be effective in addressing this and other related problems if we are not healthy and vital ourselves. We need to do all we can to maintain and provide for the continuing health of the scientific enterprise. This can take several forms.

We can solicit more support from the federal government, and we should continue to do this. But this will not be enough, for we must recognize that as the nation attempts to lower the federal deficit, science will be subjected to the same financial pressures that are affecting every other sector dependent on federal support. We still should make a strong case that science, while not exempt from these pressures, ought to be high on the priority list for federal support, and that adjustments or reductions in other areas—for example, one or two fewer B-2 bombers—would be more beneficial to the nation in the long run than inadequate funding that severely undermines our scientific base.

But there are other things scientists ought to do to demonstrate to the federal government and the public generally that the scientific community fully appreciates the financial constraints facing the nation and that we are willing to be a partner in efforts to better manage and allocate the nation's resources. First, we must make serious efforts to develop and establish mechanisms for setting priorities for the support of science and technology. Arguments made both inside and outside the scientific community that we do not know how to set priorities, or that we are unwilling to do so, are not wholly accurate.

We have a visible and admirable track record of setting priorities within scientific disciplines. High energy physicists and materials scientists, as well as astronomers, have made explicit and difficult choices with respect to priorities in their fields over the past decade, choices that have had definite effects on funding within those areas.

We have not been as able or willing to tackle the problem of setting priorities among different scientific disciplines or types of projects, but there is an increased awareness that we must meet this issue head on. Frank Press (*13*) and the National Academies (*14*) have suggested guidelines for establishing such priorities. Dutton and Crowe have put forth another possible idea (*15*), and I am sure that others can be suggested.

But even if we cannot develop a precise scheme for rating and deciding among projects or major areas of science, we should at least be able to develop a framework, sets of questions, and criteria that might be of use to congressional committees and the President in choosing among various levels of support for different projects and activities. At the very least, by engaging in this process in a serious manner, we will have demonstrated a mature and responsible appreciation of the problems that the nation faces.

Second, our credibility would be enhanced if we were to address more openly and directly some of the issues that concern nonscientists, such as the issue of fraud and misconduct in science. I believe the level of fraud in scientific research is exceedingly small, and that misconduct, even vaguely and broadly defined, is also rare. Nevertheless, the contrary perception of some powerful members of Congress has to be taken seriously, and we have to show that we also take the issue seriously.

Some efforts in this regard are under way, such as the report of the AAAS's American Bar Association National Conference of Lawyers and Scientists (*16*), as well as the report of the Institute of Medicine's Committee on Responsible Conduct of Science (*17*).

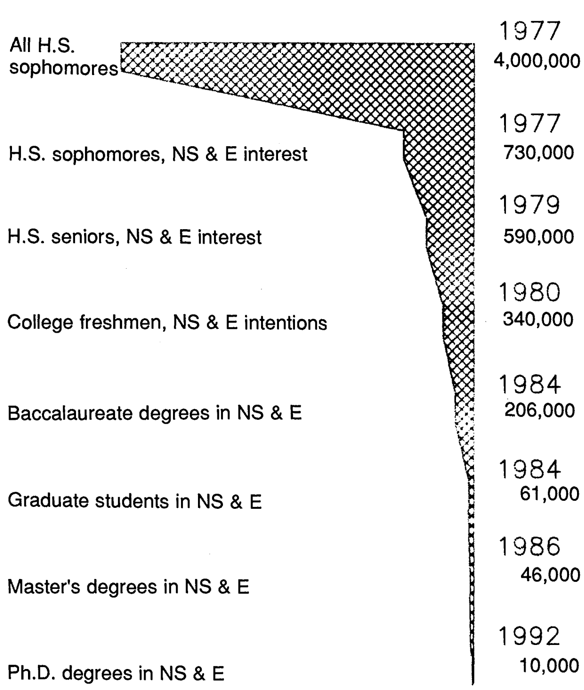

Fig. 5. Illustration of the pipeline, showing the persistence of natural science and engineering interest from high school (H.S.) through Ph.D. degree. [Source: National Science Foundation]

Also, many universities and research institutions have established monitoring, adjudicatory, and disciplinary procedures for dealing with such issues.

A third area requiring more activity on the part of the scientific community is participation in the political process. Our prospects for increasing support for science and for educating legislators about the nature of research would be measurably enhanced if the scientific and technical community were more politically sophisticated and involved, at the local level, not just on the national scene.

As scientists we argue that the public should be more knowledgeable about science and technology in order to be responsible citizens and to be able to make rational decisions in a modern age. The countervailing argument is that we as scientists, technologists, and educators have to become more politically involved if we are to be responsible citizens in a democratic society. The better we can appreciate the problems our representatives face and the constraints under which they operate, the more effective we can be in making our case to them.

The growing interrelation of science, science policy, and the politics of science also has implications for the way we educate and train graduate students. Perhaps scientists would be more knowledgeable and involved if as graduate students they were exposed in a more systematic way to such matters as part of their Ph.D. program. No one wants to divert students from their research, but some time devoted to understanding these issues could be beneficial in the long run.

These then are some of the things we can do within the scientific community that might make us more effective in establishing the case for continued and increased federal support of science. They will all help, but perhaps the most important thing we can do to generate support for science is to show that we are doing our part to address this national crisis in education, at least in the area having to do with science and technology.

We need to make a renewed commitment to addressing the pipeline issue by participating more as individuals and as members of our institutions in activities to improve the quality of science and technology education for future scientists and engineers, as well as for nonscience students. In this regard, the educational system has to be viewed as an integrated one from kindergarten through graduate school.

I would feel more comfortable in offering advice to the federal government and requesting more support for and attention to science if we in the scientific community had begun a few bold initiatives that demonstrated our seriousness in confronting this problem. Let me suggest a few things we might do—highly symbolic things, but nevertheless potentially effective. For example:

1) The AAAS and Sigma XI could ask each of their members, a combined, nonoverlapping membership of approximately 180,000, to contribute a certain number of hours per week to working in some way with local schools, museums, or other organizations in activities and programs designed to improve the level of science and mathematics education. Will this make a difference? I think it would, and I am sure it would be significant in spirit, as well as in substance.

2) The American Physical Society, the American Association of Physics Teachers, the American Chemical Society, and other professional scientific and technical organizations could ask their members in every department in every school in the United States that grants the Ph.D. to make a commitment to double (+1) the number of minority graduates obtaining Ph.D.'s in their disciplines over the next 6 years. (I use the +1 because in most cases, the initial number would be zero, so that doubling it would be meaningless.) In this case, we can think big and act small. A dramatic improvement in the number of blacks and Hispanics in scientific fields could be realized

if we could double the number that have graduated over the past several years.

3) The professional societies could request their members in every college or university to pledge their involvement in efforts to cut in half the attrition rate in their schools of those students who plan to major in science and mathematics but who do not continue in those fields.

4) The professional societies could ask their members on every campus to work with their administrations to establish and operate cooperative programs with local precollege institutions.

5) And the AAAS, the National Academy of Sciences, and the National Academy of Engineering could request each funding agency to include in every research grant some money that would allow for the participation of undergraduates in research-related projects.

With these and other actions being pledged by the scientific community, I believe the case for sustained support of science would be greatly enhanced.

What Can the Federal Government Do?

An indispensable function of the federal government is to provide the financial support that will allow scientists, engineers, and educators to carry out the actions suggested above. Another important role of the federal government is to provide leadership in raising the issue of the critical need to improve the quality of science education, and education generally, to a level of national concern. Such leadership should be exhibited by all of our key elected and appointed officials, but it would be especially effective coming from President Bush. To this end, I sent the following letter, dated 10 April 1989, to the President:

I am writing to you in my capacity as chairman of the board of directors of the American Association for the Advancement of Science (AAAS), the nation's largest general scientific organization. My purpose is to suggest some ways in which the scientific, technical, and educational communities can assist you in achieving the goals of your Administration. As you have stressed in several of your speeches, many of the nation's greatest challenges—international competitiveness, scientific literacy and numeracy, the need for an adequately educated work force, and global environmental problems—involve science, technology, and education. Scientists, engineers, and educators, as individuals and through our societies and institutions, can make significant contributions to the solutions of these problems. We have, over the past several years, already made some progress. For example:

- The crucial need to provide science education for all our citizens, and the need to improve the science curriculum in grades K through 12, is being addressed by major programs sponsored by the AAAS. Project 2061 (named after the date of the return of Halley's Comet) has the ambitious goal of reforming science and math education throughout the nation by involving teachers, school districts, and state educational organizations, as well as professional scientists and engineers, in instituting new approaches to teaching and learning.
- In the United States, less than 6% of the total population has a reasonable understanding and appreciation of scientific concepts and issues. The Scientists' Institute for Public Information is addressing this issue by bringing together members of the scientific and technical communities with members of the press and broadcast media. Its aim is to improve the presentation of scientific and technical issues to the American public and promote a better understanding and appreciation of the major accomplishments, prospects, and controversies of science and technology.
- Our nation's changing demographics and the decline in the number of white American males pursuing careers in science and technology make it of critical importance that we increase the number of women and minorities entering these fields. The Linkages Project of the AAAS reaches into the minority community through volunteer organizations, churches, charitable groups, and the like, where it encourages parents, community leaders, and schools to stress the importance and the accessibility of scientific and technical careers for minority youth. Similar efforts are directed towards encouraging young children, especially girls, to consider careers in science and technology.
- There is a growing awareness within the scientific and technical communities that the budgetary constraints our nation faces dictate an increased importance on setting priorities, including scientific and technical priorities. Proof of this awareness is the recent report of the National Academy of Sciences, which recommends mechanisms whereby your Administration and Congress might begin to develop a framework for setting these priorities.

But these steps are only a beginning. Meeting these challenges requires the combined efforts of the federal government and a healthy, viable, and committed scientific community. I am very encouraged by the statements and commitments you have already made about the critical nature of science and technology in our nation's future. But two further actions on your part would strengthen the partnership between the federal government and science and greatly increase their effectiveness.

Consistent with the statements you have already made, I urge you to institute within the government an effective and responsive mechanism to receive scientific advice, to develop policies affecting and utilizing science, and to provide for the implementation of those policies in the government agencies. To begin, I hope you will appoint a President's science adviser, with an appropriate advisory committee, and with the authority and mandate to establish a means for the coordination of scientific research and its support throughout the government.

On a personal note, Mr. President, I would suggest that you appoint no one as your science adviser who cannot explain to you in a language you can understand the important scientific and technical issues that will confront you. Anyone who says "It is too technical for me to explain it to you" should be replaced immediately!

And finally, Mr. President, recognizing that the implementation of any national policies will require the support of the American people, I urge you to use your "bully pulpit" to speak out on these issues and to develop and articulate the nation's goals in these very important areas, from education and competitiveness to environmental concerns. I encourage you to exercise leadership that will inspire and motivate us all to make a national commitment to the solution of these problems. The American people have demonstrated, throughout our nation's history, a willingness to confront serious national challenges when these challenges are explained and articulated in terms they understand. I can assure you that the scientific community stands ready to work with you and your Administration in addressing these important challenges.

I am pleased that since I sent the letter, Mr. Bush has appointed D. Allan Bromley as his science adviser, a man who certainly meets the criteria I suggested.

REFERENCES AND NOTES

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