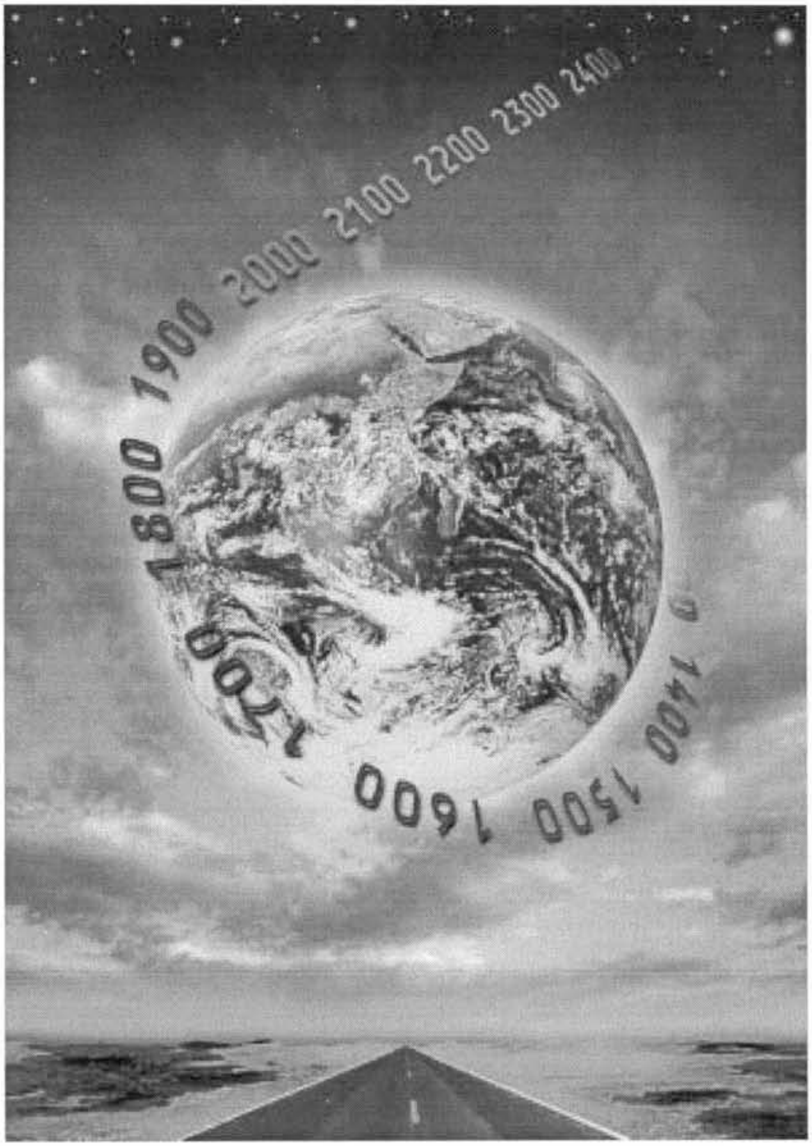
PREPARING FOR THE 21ST CENTURY



THE EDUCATION IMPERATIVE

NATIONAL ACADEMY OF SCIENCES
NATIONAL ACADEMY OF ENGINEERING
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Background

Since Abraham Lincoln approved the Congressional charter of the National Academy of Sciences in 1863, the Academy complex—now made up of the National Academy of Sciences, the National Academy of Engineering, the Institute of Medicine, and the National Research Council—has been advising government about the impact of science and technology on society. The Academy complex provides independent advice to government by appointing committees of experts who serve without compensation, asking these committees to prepare draft reports by consensus, and subjecting these drafts to rigorous independent scientific review before release to ensure their quality and integrity. To avoid potential conflict of interest and bias, careful attention is given to the composition and balance of study committees.

As the 21st century approaches with science and technology assuming increasing importance in society, the Governing Board of the National Research Council has synthesized, summarized, and highlighted principal conclusions and recommendations from recent reports to inform decisions in a number of key policy matters. The resulting series of papers do not address all the intersections of science and technology with public policy, but they do address some of the most important. They are directed to federal administrators, members of Congress, university administrators, leaders of nongovernmental organizations, and all others involved in the development and implementation of public policies involving science and technology.

This paper discusses policies affecting science, mathematics, engineering, and technology education. Education is a relatively new focus for the Academy complex, and many of the recommendations in its reports on the subject are just now beginning to influence educational policy, school programs, and classroom practice. Many interesting issues regarding education are likely to be addressed in the future as the efforts of the Academy complex continue.

This document, with direct links to the text of all reports cited herein, is available on the Internet at **http://www2.nas.edu/21st.** A box at the end describes other ways to obtain information on the Academy complex and the topics discussed in this paper.

PREPARING FOR THE 21st CENTURY

THE EDUCATION IMPERATIVE

To be prepared for today's workforce, informed about important issues, and able to understand the complex world in which we live, all Americans must have a solid *education in science, mathematics, and technology.*

Introduction

The education that many students receive in science, mathematics, and technology is not adequate for a world that is being transformed by scientific and technological advances. People have to be familiar with the basic concepts of science, mathematics, engineering, and technology to think critically about the world and to make informed decisions about personal and societal issues. Literacy in these fields is essential also for an appreciation of the rapid expansion of human knowledge—surely one of the great adventures of the 20th century.

Another motivation increases the sense of urgency: today, an understanding of science, mathematics, and technology is very important in the workplace. As routine mechanical and clerical tasks become computerized, more and more jobs require high-level skills that involve critical thinking, problem-solving, communicating ideas to others, and collaborating effectively. Many of these jobs build on skills developed through high-quality science, mathematics, and technology education. Our nation is unlikely to remain the world leader without a better-educated workforce.

Several key objectives set forth in Academy complex reports can help guide the actions of all those involved in developing and implementing public and institutional policies regarding education. Among these objectives are the following:

- **Encourage teachers, curriculum-developers, school administrators, government officials, and college faculty to build on the national standards in science and mathematics in seeking higher levels of performance from all students in grades K to 12.**
- **For all undergraduates, provide access to excellent programs in science, mathematics, and technology that provide direct experience with the methods and processes of inquiry.**
- **Evaluate undergraduate departments and programs against explicit educational goals with assessments that are as rigorous as those applied to research.**
- **Balance the rewards accorded teaching, research, service, and professional activities so that teaching is enlivened by investigation and faculty are rewarded for the full range of scholarly activity.**
- **Foster change through leadership that builds a consensus concerning educational improvements and**

Bringing Science into the Classroom

Gerald Stancil embodies the rich potential of science, mathematics, engineering, and technology education. He received his PhD in physical chemistry from Johns Hopkins University in 1976. Today he is a high-school physics teacher in Orange, New Jersey. When he came to Orange High School, there was one physics class with 13 students. Today, there are three physics classes with 75 students.

Dr. Stancil is doing what he wants to do, but he had to overcome several obstacles along the way. Graduate school did not cultivate the skills and abilities he now uses most—communication skills and social skills. He entered the high-school classroom through a New Jersey program called Alternate Route, set up specifically to attract people with graduate degrees to public-school teaching.

He believes that PhDs can make a great contribution to precollege education. As a black man, he also is able to serve as a model for minority-group students, who might have little understanding of how to approach a career in science and engineering. And he does not have to make a financial sacrifice to do what he is doing, because people with PhDs teaching high school make salaries comparable with the median salaries at most universities.

For more information:

- *Reshaping the Graduate Education of Scientists and Engineers,* Committee on Science, Engineering, and Public Policy, 1995 provides the support needed for improvements to take root and spread.

- Require that students seeking admission into universities and colleges take tests that include evaluation of their ability to conduct scientific inquiry, rather than relying on current standardized tests of their knowledge of science and mathematics.
- Expand the use of education and training grants to provide financial support to graduate students.
- For graduate schools, set institutional standards for time to degree, enforce them, and inform students of time-to-degree and other career-related information before they enter a program.
- Emphasize the importance of building a true system of postsecondary training to replace the piecemeal approach characteristic of past efforts.

K-12 Education Should be Based on National Standards

The education in science and mathematics that students receive from kindergarten through 12th grade forms the foundation of this nation's scientific, mathematical, and technological literacy. Some outstanding things happen in science classrooms today because extraordinary teachers do what needs to be done despite conventional practice. Many generous teachers spend their own money on science supplies, knowing that students learn best by investigation. These teachers ignore vocabulary-dense textbooks and encourage student inquiry. They also make their science courses relevant to students' lives, instead of trying to prepare the students simply for another school science course. But that situation is not found in many schools. The implementation of the National Science Education Standards will highlight and promote the best practices of extraordinary teachers and give them the recognition and support that they deserve. School principals who find money in their budgets for field trips, parents whose bake-sale proceeds purchase science equipment, and publishers who are pioneering authentic assessments despite the market for multiple-choice tests will also be recognized and encouraged.

Over the last decade, the National Research Council and the National Council of Teachers of Mathematics, responding to calls for higher levels of science and mathematics achievement, developed national standards for what all students should know and be able to do in these subjects. The standards reflect a broad consensus that has emerged through the extensive efforts of thousands of teachers, scientists, mathematicians, engineers, and educational experts across the nation. In addition to containing content standards that describe the subject matter that all students should master, the standards outline what teachers of science and mathematics at all grade levels should know and be able to do and the new kinds of assessments that are needed to test what all students should know and understand.

A curriculum is the way content is organized and presented in the classroom. The standards do not mandate a specific curriculum: the content embodied in the standards can be organized and presented with many different emphases in many different curricula. Nor do the standards imply that all teachers should pursue a single approach to teaching;

Science as Inquiry: An Example of a K-12 Education Standard

The Science as Inquiry *content standard* indicates that "as a result of their activities in grades 5-8, all students should develop: (1) abilities necessary to do scientific inquiry; (2) understandings about scientific inquiry." What does this mean in terms of knowledge? Take "understandings about scientific inquiry" as an example. The standard indicates that by the time students complete 8th grade they should know the following *fundamental concepts:*

- Different kinds of questions suggest different kinds of scientific investigations.
- Current scientific knowledge and understanding guide scientific investigations.
- Mathematics is important in all aspects of scientific inquiry.
- Technology used to gather data enhances accuracy and allows scientists to analyze and quantify results of investigations.
- Scientific explanations emphasize evidence, have logically consistent arguments, and use scientific principles, models, and theories.
- Science advances through legitimate skepticism.
- Scientific investigations sometime result in new ideas and phenomena for study, generate new methods or procedures for an investigation, or develop new technologies to improve the collection of data. All these results can lead to new investigations.

For more information:

- *National Science Education Standards,* National Committee on Science Education Standards and Assessment, 1996 different teachers can use many different strategies to develop the understandings and abilities described in the standards.

The standards point toward a kind of teaching different from that common in many K-12 classrooms today. The teacher serves as a coach for the development of skills, such as the ability to engage in problem-solving and inquiry. The students engage in collaborative learning that includes the synthesis and integration of different types of data and analysis, and communicating the results. The benefit of learning *skills* as opposed to only learning *knowledge*—learning *how* as opposed to learning *that*—is best exemplified in sports and music. It is difficult to imagine teaching basketball or piano-playing by lecture alone, and it should be just as difficult in the case of science and mathematics.

How can students best learn these skills? Students can conduct an *investigation.* For example, a teacher wants students to develop an understanding of variables and how and why to change one variable at a time. This inquiry-process skill might be imparted in the context of physical science subject matter. The teacher asks students to build a pendulum that swings at six swings per second. She does not tell students that the number of swings depends on the length of the pendulum, but creates an activity that awakens their interest and encourages them to ask questions and seek answers. She then encourages them to look for applications of this science knowledge beyond the classroom. Students keep written records of their science activities, and the teacher helps them to develop the skills needed to communicate effectively.

All students, not just high-achieving ones, should be exposed to much more science than the minimum that most students are exposed to today. High-achieving students should be able to pursue science and mathematics as fully and rapidly as their talents permit.

The standards underscore the need for teacher professionalism in science and mathematics education. Better preparation in science and mathematics, recognition and support of effective teaching, continuing education in science and mathematics, and permanent links of teachers to universities, professional organizations, and other science-rich institutions can all help to create the necessary level of professionalism.

Assessments of learning (the tests that students take) have a powerful influence on education policies and practices. Appropriate assessments do more than measure factual knowledge. They assess what is important to learn, not just what is easy to measure. They enhance learning and good instructional practice. And they support every student's opportunity to learn. These principles should guide efforts to construct assessments that measure whether the

Education and Technology

If you want to see the future of education, don't watch children in the average classroom. Watch children play a video game. You'll see them engaged, excited, interacting, and learning—even if it's only about how to get to the next level of the game. Because of their immersion in this computerized world, children absorb information differently from their parents. Instead of following information passively from beginning to end—as people tend to do with television shows, newspapers, and books—children interact with the new technologies.

Schools now have an opportunity to apply the information technologies that are so effective outside the classroom for educational purposes. Taking advantage of these new technologies will require profound changes in the roles of teachers, students, and schools. Instead of being the repository of knowledge, teachers will be guides who help students to navigate through electronically accessible information. They will use the new technologies to build networks with each other, with parents and students, with academic and industrial experts, and with other professionals.

Turning opportunity into reality requires four important changes:

- Industry must develop educational devices from comparatively low-price game hardware and software, thereby dramatically lowering the costs of educational technology.
- Communities and government should include technological change when setting the agenda for systemic change in education.
- Software-makers must tie the content of their products to quality information and to the national education standards as they are implemented.
- Teachers must receive extensive training in how to use emerging information technologies.

Computers will not solve all the problems of education; many difficult issues will remain. But the new information technologies provide an unprecedented opportunity to reexamine how we educate our children.

For more information:

- *Reinventing Schools: The Technology is Now,* National Academy of Sciences, National Academy of Engineering, 1995 standards are being achieved. (A-1)

The national standards in science and mathematics are an essential resource for improving the education received by the 40 million students enrolled in America's elementary and secondary schools. **Policymakers should encourage teachers, curriculum-developers, school administrators, government officials, and college faculty to build on the national standards in science and mathematics in seeking higher levels of performance from all students. (A-2, A-3, A-4)**

For more information on K-12 science and mathematics education:

- A-1. *Measuring What Counts: A Conceptual Guide for Mathematics Assessment,* Mathematical Sciences Education Board, 1993
- A-2. *National Science Education Standards,* National Committee on Science Education Standards and Assessment, 1996
- A-3. *Everybody Counts: A Report to the Nation on the Future of Mathematics Education,* Mathematical Sciences Education Board, 1989
- A-4. *The Role of Scientists in the Professional Development of Science Teachers,* Committee on Biology Inservice Programs, 1996

Undergraduate Education Should Include Scientific Inquiry

Weaknesses of science and mathematics education at the K-12 level have counterparts at the undergraduate level. Although undergraduate education continues to produce the highly motivated and capable students who will become the scientists, engineers, and mathematicians on whom our society so heavily depends, many undergraduates take little or no science, mathematics, or engineering courses in college. In many institutions, science and mathematics do not contribute to the core of a liberal education. And unrewarding experiences in first-year undergraduate science or mathematics courses often dissuade students from taking more.

Given the importance of science, mathematics, engineering, and technology in our society, an undergraduate education that does not include exposure to those subjects is incomplete. **All undergraduates should achieve high levels of literacy in science, mathematics, and technology by having access to excellent programs that provide direct experience with the methods and processes of inquiry. (B-1)**

The Challenge of Diversity

Hispanics and nonwhites now account for almost one-third of the US population under age 18, and the fraction is growing. Recent increases in the numbers of elementary-school children are accounted for almost entirely by Hispanics and Asians, two groups that are themselves diverse.

Children from all backgrounds are capable of achieving at high levels and should be encouraged and taught to do so. Yet many children, including many minority-group children, are plagued by inequities in their prospects for success. For example, estimates of the number of students with limited English proficiency range from 2.3 million to much higher. Of the children enrolled in Head Start, 20% speak a language other than English.

The preschool years are a particularly important time for children whose cultural and educational backgrounds do not correspond with the norms and expectations that they will encounter when they start formal schooling. Because educational attainment is a cumulative process, practices and expectations that impede a child's progress during the preschool and early elementary-school years can be particularly detrimental. Early-education settings can and should be designed to approach diversity as an asset that can be used to prepare all students for citizenship in an increasingly diverse society.

For more information:

- *Cultural Diversity and Early Education: Report of a Workshop,* Board on Children and Families, 1994

Achieving that objective requires that departments and institutions be much more explicit in defining their missions. New instructional models—monitored by self-assessment and feedback from alumni and employers who hire college graduates as well as from students—can improve the educational experiences of all undergraduates. Unlike the situation in research, there is no tradition of evaluating undergraduate teaching or learning other than through student course evaluations. **Departments and programs should be evaluated against explicit educational goals with assessments that are as rigorous as those applied to research. (B-1)**

Most important, departments and institutions must align faculty rewards more closely with their total missions. **The rewards accorded teaching, research, service, and**

Research on Learning

Cognitive research is providing important new insights about the most effective ways to conduct education and training. For example, simulating real-world conditions can be valuable during training, but the teaching of abstract principles also plays a role, especially in helping people to acquire skills that can be applied broadly. Training programs that include varied situations with general skills allow learners to adapt to new situations that they might encounter on the job.

Specific learning techniques also have received high marks. Cooperative or team learning, for example, can be more effective than individual learning for some (not all) topics and tasks. In contrast, interactive games used in training have not proved effective for learning complex concepts over longer periods. Research helps teachers understand better how to educate and train students effectively.

For more information:

- *Learning, Remembering, Believing: Enhancing Human Performance,* Committee on Techniques for the Enhancement of Human Performance, 1994

professional activities must be balanced so that teaching is enlivened by investigation and faculty are rewarded for the full range of scholarly activity. (B-1) There is room for a greatly revised and expanded view of teaching—one that brings it closer to scholarship and demonstrates the real (if often neglected) linkages between teaching and research.

Change in undergraduate education will require energetic leadership. **The leaders in our colleges and universities should foster change by helping to build a consensus concerning educational improvements and by providing the support needed for improvements to take root and spread. (B-1, B-2, B-3)** Government agencies that support research should also develop explicit policies concerning these educational issues.

Our colleges and universities have important roles in supporting the profound changes in K-12 science and mathematics education called for by the national standards. For example, learning science through hands-on inquiry not only is the best way for students to gain an understanding of science throughout their K-12 years, but also should be an important focus for introductory college courses. **Colleges and universities should have as part of their admission policies a requirement that students take tests that include evaluation of their ability to conduct scientific inquiry, rather than relying on current standardized tests of their knowledge of science and mathematics. (B-1, B-3)** If we do not reward what we value, high-school teachers will continue to be pressured to teach to the present national examinations, which inhibit inquiry and are a very poor match for the national standards. Finally, future teachers of science must experience inquiry in college to be able to use these techniques to maximal advantage in the classroom. These students deserve special attention and encouragement as we work as a nation to increase the talent and diversity of our K-12 teachers.

The guidance from the National Research Council studies mentioned here are just the preliminary activities of a continuing effort by the NRC to evaluate the quality of the country's undergraduate science and engineering education and recommend the changes needed to improve that education.

For more information on undergraduate education in science, mathematics, and engineering:

- B-1. *From Analysis to Action: Undergraduate Education in Science, Mathematics, Engineering, and Technology: Report of a Convocation,* Center for Science, Mathematics, and Engineering Education, 1996
- B-2. *Engineering Education: Designing an Adaptive System,* Board on Engineering Education, 1995
- B-3. *Moving Beyond Myths: Revitalizing Undergraduate Mathematics,* Committee on the Mathematical Sciences in the Year 2000, 1991

Graduate Education Should Focus on Student Needs

Science, engineering, and society are all changing in ways that have important implications for the graduate education of scientists and engineers. For example, graduate education traditionally has focused on preparing students for jobs in academe. But today well over half of all doctoral recipients go to work in nonacademic settings, where they often need to call on a wide array of skills. Graduate students therefore require exposure to the broad range of experiences desired by both academic and nonacademic employers.

Policymakers and institutions can take several steps to improve graduate education. First, there should be a better balance in the various grants that are used to support graduate students (fellowships, research and teaching assistantships, and training grants). The heavy reliance on research assistantships for graduate-student support has tended to make the needs of research projects, rather than students' education, paramount. **Education and training grants should be used more often to provide financial support to graduate students than is the case today. (C-1)** These grants could be awarded competitively to institutions and departments that work to enhance the versatility of students, both through curricular innovation and through more-effective faculty mentoring to acquaint students with the full array of employment options. It is recognized that a heightened emphasis on education and training grants could reduce the funds available for research assistantships.

Second, time to degree should be controlled. The median period between receipt of a bachelor's degree and a PhD in science and engineering has risen to more than eight years, an increase of two years since 1960. The reasons for this increase are largely unknown, but some of it might be a result of students' working as highly specialized research assistants in ways that do not directly contribute to their education. **Each institution should set its own standards for time to degree and enforce them. It should also inform its students of the average time to degree and other career-related information before they enter graduate school. (C-1)**

Third, the lack of accurate, timely, and accessible data on employment trends, careers, and sources of student support is a serious flaw in the graduate-education system. A national database that covers such issues as financial aid, time to degree, and placement rates—including information gathered and disseminated through the Internet—could help students and their advisers to make informed decisions about professional careers. (C-1) Such a database, which should be designed and managed by the research community, could be used both by students and by their advisers to learn more about graduate programs and possible career tracks.

The ultimate measure of success in graduate education is the extent to which all students are well prepared for their careers. Graduate education needs to be designed with a focus on student needs, and it should prepare students for an increasingly interdisciplinary, collaborative, and global job market. Successful programs have a focused, realistic mission and a positive learning environment that supports a wide array of career options. Adapting to new realities will require substantial change on the part of faculty, but it can have many benefits for departments, students, and society.

For more information on graduate education:

- C-1. *Reshaping the Graduate Education of Scientists and Engineers,* Committee on Science, Engineering, and Public Policy, 1995

Continuing Education Requires More Coherence

With a workplace that is rapidly changing, education can no longer be seen as occupying just the first portion of a person's life. Formal education must prepare people for a lifetime of learning.

The need for postsecondary training is particularly acute among the 75% of American adults who do not hold college degrees. Today, they receive postsecondary training through an uncoordinated assemblage of two-year colleges, trade schools, vocational-technical schools, on-the-job training, and other institutions. The quality of training provided by

What Do Employers Think of PhD Science and Engineering Graduates?

A survey of employers of those with science and engineering PhDs indicates that although they are generally pleased with the result of US graduate education, they have some specific concerns as to breadth, versatility, and skill development. In particular, employers do not feel that the current level of education is sufficient in providing skills and abilities to the people that they are interested in employing, particularly in

- Communication skills (including teaching and mentoring abilities for academic positions),
- Appreciation for applied problems (particularly in industrial settings),
- Teamwork (especially in interdisciplinary settings).

They are also concerned that the graduate-education system—although acceptable for the past employment world—is less and less acceptable in today's more global world.

For more information:

- *Reshaping the Graduate Education of Scientists and Engineers,* Committee on Science, Engineering, and Public Policy, 1995

The Two-Year College in Science, Mathematics, Engineering, and Technology Education

Nearly 40% of undergraduates are enrolled in two-year colleges, and a substantial amount of science, mathematics, engineering, and technology instruction occurs at this level. Focusing just on mathematics, for example, two-year colleges account for nearly 40% of all undergraduate mathematics course enrollments, with 90% of that instruction being below the calculus level. Nearly 10% of US students who receive doctorates in the mathematical sciences began their undergraduate studies in two-year colleges.

For more information:

- *Moving Beyond Myths: Revitalizing Undergraduate Mathematics,* Committee on the Mathematical Sciences in the Year 2000, 1991

these institutions is mixed. Processes for quality assurance are undeveloped. And linkages to employers are often weak (with the exception of on-the-job training). Rather than a postsecondary training system, the United States has a piecemeal collection of training opportunities that sometimes work well for some people. The federal government, with its proliferation of programs and lack of a coherent approach, bears part of the blame for this situation. Some states have begun to restructure their programs to address workforce development systematically and effectively. These efforts are not universal, however, and are hampered by continued fragmentation at the federal level.

In an ideal postsecondary training system, people who want to obtain or advance in specific jobs would know what kind of training is valued by employers and where to find it. They would have the information necessary to select occupations that match their skills and interests. They also would have information about the likely demand for workers in various fields.

For their part, employers would know about and value the skills that workers have acquired through a training program. Employers would have ready access to information about the existing and future supply of trained workers and would be able to let training institutions know what their needs are.

Government at all levels can focus attention on linking the various partners in postsecondary training in ways that provide coherent and high-quality training opportunities for people at various stages in their working lives. **Policymakers need to emphasize the importance of building a true system of postsecondary training, rather than continuing the piecemeal approach that has characterized past efforts. (D-1)**

Information is another important consideration. There is an absence in this country of readily available and integrated information systems that would help both potential trainees and employers to obtain needed training services. Putting good information in the hands of these consumers so that they can make informed choices can improve the efficiency of the training marketplace and serve as an indirect means of ensuring accountability and oversight.

For more information on postsecondary education:

- D-1. *Preparing for the Workplace: Charting a Course for Federal Postsecondary Training Policy,* Committee on Postsecondary Training and Education for the Workplace, 1994

Conclusions

The American educational system has responded to great challenges in the past. It has navigated the transition from an agricultural to an industrial society, it has greatly increased access at the K-12 and college level, and it has built a system of graduate education in the sciences and engineering that is widely viewed as a world model.

Education in the United States is largely decentralized. Authority and accountability are vested predominantly at the local and state levels. Although not formally approved and recognized as such, this country already has national examinations for college entry and a national curriculum for K-12 science and mathematics education that is determined largely by these tests and by the books produced by major textbook publishers. The science curriculum demands a superficial knowledge of such a wide variety of topics that the understanding and excitement of science are lost. And most of our high-school graduates fail to acquire the analytic, problem-solving skills that they need to succeed in the modern workplace. Coordinated efforts by all those involved in the educational system are needed to help move science and mathematics education toward world-class goals.

For the last decade, experts have been describing and defining the essential elements of science, mathematics, engineering, and technology education. The challenge now is to ensure that policymakers and educational leaders across the nation are aware of the needs and possibilities and are encouraged to begin the next phase of work—implementation—in school districts and universities around the nation.

The challenge facing education today is more varied than past challenges. It encompasses the rapidly increasing diversity of the nation's population, the growing internationalization of commerce and culture, the explosive development of information technologies, and other great technical and social transformations. There is no simple, universal prescription for success. But a focus on high standards for all, coupled with recognition of the need for versatility in the face of change, can help to prepare all students for the demands of the 21st century.

For Further Information:

The World Wide Web site **http://www2.nas.edu/21st** includes up-to-date versions of all the documents in this series and on-line versions of the reports referred to in this document.

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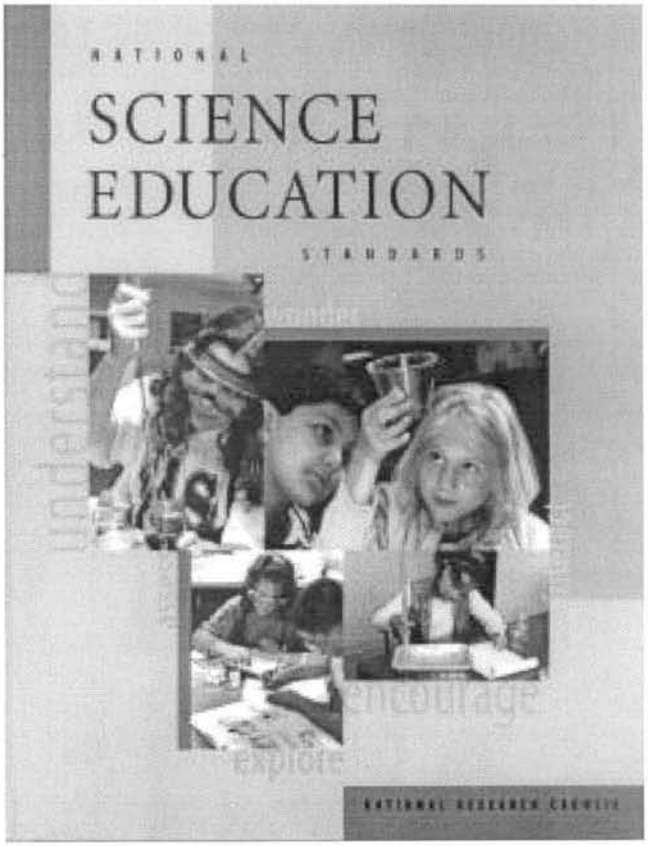

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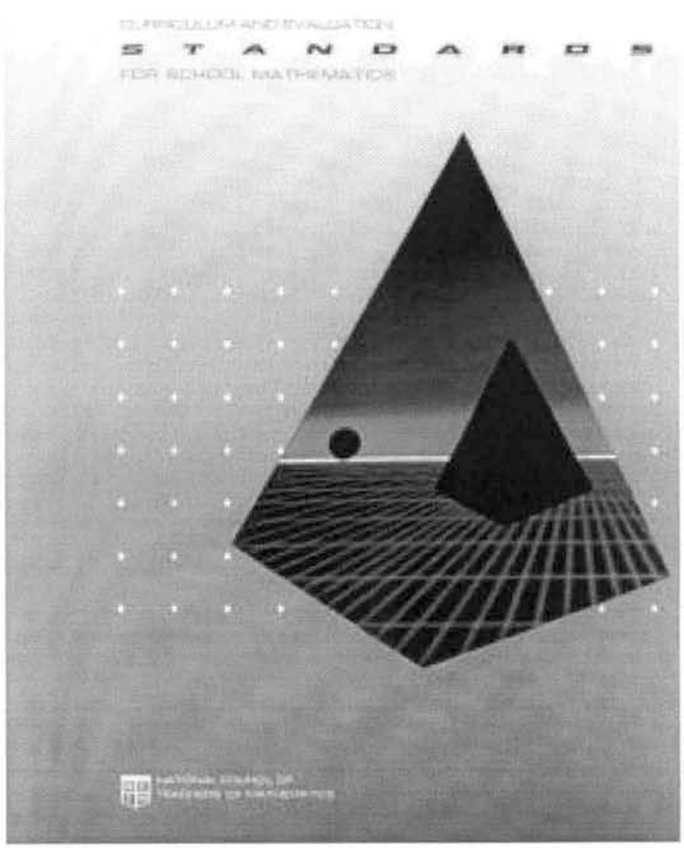

WEB SITE:
http://www.nctm.org

The **National Academy of Sciences** (NAS) is a private, nonprofit, self-perpetuating society of distinguished scholars engaged in scientific and engineering research, dedicated to the furtherance of science and technology and to their use for the general welfare. Under the authority of the charter granted to it by Congress in 1863, the Academy has a working mandate that calls on it to advise the federal government on scientific and technical matters. Dr. Bruce M. Alberts is president of the NAS.

The **National Academy of Engineering** (NAE) was established in 1964, under the charter of the NAS, as a parallel organization of distinguished engineers. It is autonomous in its administration and in the selection of members, sharing with the NAS its responsibilities for advising the federal government. The National Academy of Engineering also sponsors engineering programs aimed at meeting national needs, encourages education and research, and recognizes the superior achievements of engineers. Dr. William A. Wulf is interim president of the NAE.

The **Institute of Medicine** (IOM) was established in 1970 by the NAS to secure the services of eminent members of appropriate professions in the examination of policy matters pertaining to the health of the public. The Institute acts under the responsibility given to the NAS in its congressional charter to be an adviser to the federal government and, on its own initiative, to identify issues of medical care, research, and education. Dr. Kenneth I. Shine is president of the IOM.

The **National Research Council** (NRC) was organized by the NAS in 1916 to associate the broad community of science and technology with the Academy's purposes of furthering knowledge and advising the federal government. Functioning in accordance with general policies determined by the Academy, the Council has become the principal operating agency of both the NAS and the NAE in providing services to the government, the public, and the scientific and engineering communities. The Council is administered jointly by both Academies and the IOM. Dr. Bruce M. Alberts is chairman and Dr. William A. Wulf is interim vice-chairman of the NRC.