Educating Americans for the 21st Century

Why?

Between the late 1960s and the early 1980s, the numbers of high school students enrolled in Algebra, Geometry, Algebra II, Biology, Chemistry, and General Science declined. Standardized test scores and the percentage of high school graduates also declined. High school graduates seemed to have an inadequate understanding of mathematics, science, and technology. It was believed that this situation could damage the country's economic strength and military security.

It was recognized that continuing to provide students with a 1960s education would not prepare them for the workplace of the 21st century. In addition, all students need a solid education in mathematics, science, and technology.

What?

In response to this situation, the National Science Board, in 1982, appointed a Commission on Precollege Education in Mathematics, Science, and Technology. *Educating Americans for the 21st Century* is the report that was produced by that Commission.

Numerous other reports, including *Science and Engineering Education for the 1980s and Beyond* and *A Nation at Risk: The Imperative for Educational Reform* had already called attention to the problem. The purpose of this report was to suggest solutions and to estimate the cost of the proposed solutions. The report set out a challenging goal:

> "By 1995, the Nation must provide, for all its youth, a level of mathematics, science and technology education that is the finest in the world, without sacrificing the American birthright of personal choice, equity and opportunity" (p. v).

Who?

The Commission consisted of 20 members and was co-chaired by William T. Coleman, Jr., former U. S. Secretary of Transportation and Cecily Cannan Selby, former Dean of Academic Affairs and Chair, Board of Advisors, North Carolina School of Science and Mathematics. The other 18 members consisted primarily of faculty, deans, and presidents of universities, although there was one high school teacher, one industry leader, and Bill Cosby.

Specifically, commission members were:

William T. Coleman, Jr., *Senior Partner O'Melveny and Myers, Washington, D.C., New York, NY, Los Angeles, CA, and Paris, France; former U. S. Secretary of Transportation in the Ford Administration,* ***Co-Chair***
Cecily Cannan Selby, *New York, NY; former Dean of Academic Affairs and Chair, Board of Advisors, North Carolina School of Science and Mathematics,* ***Co-Chair***
Lew Allen, Jr., *Director, Jet Propulsion Laboratory and Vice President, California Institute of Technology; former Chief of Staff, U. S. Air Force*
Victoria Bergin, *Associate Commissioner of Education for the State of Texas*
George Burnet, Jr., *Chairman, Nuclear Engineering Department, Iowa Sate University; former President, American Society of Engineering Education*

William H. Cosby, Jr., *Entertainer/Educator*
Daniel J. Evans, President, *The Evergreen State College; former Governor of the State of Washington*
Patricia Albjerg Graham, *Dean, Graduate School of Education, Harvard University*
Robert E. Larson, *Chief Executive Officer, Optimization Technology, Inc.; former President, Institute of Electrical and Electronics Engineers*
Gerald D. Laubach, *President, Pfizer, Inc.*
Katherine P. Layton, *Teacher, Mathematics Department, Beverly Hills High School*
Ruth B. Love, *General Superintendent, The Chicago Board of Education*
Arturo Madrid II, *Professor, Department of Spanish and Portuguese, University of Minnesota; former Director, Fund for the Improvement of Postsecondary Education, U. S. Department of Education*
Frederick Mosteller, *Chairman, Department of Health Policy and Management, School of Public Health, Harvard University*
M. Joan Parent, *President, National School Boards Association*
Robert W. Parry, *Distinguished Professor of Chemistry, University of Utah; former President, American Chemical Society*
Benjamin F. Payton, *President, Tuskegee Institute*
Joseph E. Rowe, *Executive Vice President, Research and Defense Systems, Gould, Inc.; former Provost for Science and Engineering, Case Western Reserve University*
Herbert A. Simon, *Richard King Mellon University Professor of Computer Science and Psychology, Department of Psychology, Carnegie-Mellon University; Nobel Laureate in Economics*
John B. Slaughter, *Chancellor, University of Maryland, College Park; former Director, National Science Foundation*

Conclusions

The report concluded that dramatic change was needed. The report grouped its recommendations into six categories:

1) Building a new national commitment
2) Pointing the direction for widespread dramatic change
3) Solutions to the teaching dilemma
4) Improving what is taught and learned
5) The promise of the new information technologies
6) Informal education

Building a new national commitment

(1-a) At the national and state levels, councils should be formed which will develop educational goals, monitor progress toward those goals, make recommendations, and generate public support. Local school boards should communicate with school administrators, local officials, business and industry leaders, and parents to facilitate change.

(1-b) The federal government should finance and maintain a national assessment mechanism. The assessment should measure higher-level skills such as students' "ability to write for a purpose, apply higher-level problem-solving skills, and analyze and draw conclusions, rather than minimal basic skills such as the rote memorization of facts" (p. 12).

Assessments should build on work done by the National Assessment for Educational Progress and allow for comparisons across states and districts.

(1-c) Each school district should identify and eliminate discriminatory barriers to full educational opportunity. Students' achievement should not be limited by gender, race, ethnic background, or socioeconomic status. School districts should implement programs in mathematics, science, and technology that reach all students.

Pointing the direction for widespread dramatic change

(2-a) "Top priority must be placed on retraining present teachers and recruiting and retraining teachers in mathematics, science and technology so that they all will be of high quality" (p. 22).

(2-b) "Top priority must be placed on providing increased and more effective instruction in mathematics, science and technology in grades K-6" (p. 22).

(2-c) Students should spend more time in school studying mathematics and science. The school day, week, and/or year must be substantially lengthened.

(2-d) Local school districts should establish exemplary schools or programs in mathematics, science, and technology. "The Federal government should appropriate funds to aid the establishment by local communities of at least 1,000 such exemplary schools at the secondary level and at least 1,000 such schools at the elementary level throughout the country" (p. 25).

(2-e) The Department of Education and the National Science Foundation should foster a national network of exemplary programs in mathematics, science, and technology.

Solutions to the teaching dilemma

The report recognized that "The teacher is the key to education" (p. 27). Several issues related to teachers were identified:

- Severe shortages of mathematics, science, and technology teachers exist in many areas of the country.
- In 1980-81, about 4% of teachers in these areas left the profession.
- During the 1970s, the SAT scores of education majors declined.

Recommendations for improving the quality of teachers:

(3-a) State governments, universities, and science museums should cooperate in developing teacher training programs in mathematics, science, and technology. The federal government should provide funding for these teacher training programs.

(3-b) "States should adopt rigorous certification standards for incoming mathematics and science teachers" (p.31). Teacher education programs should increase admission, curriculum, and graduation standards.

(3-c) States should establish alternative certification systems for professionals who wish to teach. "States should modify certification requirements for [individuals] who are qualified in the subject matter but lack certain education credits" (p. 33).

Recommendations to improve working conditions:

(3-d) School systems should explore ways to increase compensation for high quality mathematics, science, and technology teachers. States, school boards, and teacher unions

should "carefully examine current working conditions, salary levels, issues of comparability, length of the work day/week/year, tenure provisions, promotion procedures and other factors that are important aspects of teacher compensation" (p. 34).

(3-e) Governments should reward teaching excellence without requiring teachers to leave the classroom.

(3-e) Local school systems, industry, the military, and government should furnish summer or part-time employment for teachers of mathematics, science, and technology who wish to supplement their income.

(3-f) States should develop at least one regional training center for supporting mathematics and science teachers.

Recommendations to improve classroom conditions:

(3-g) Rigorous student discipline policies should be adopted.

(3-h) Teachers need reasonable class sizes to manage.

Recommendations to increase student involvement:

(3-i) Normed achievement measures should be effectively used to direct academic activities.

(3-j) Teachers should use classroom time for purposeful, substantive content.

(3-k) Teachers should assign specific homework on a regular basis.

(3-l) Schools should curtail social promotion.

Improving what is taught and learned

(4-a) Students should spend more time studying mathematics, science, and technology. "In grades K-6, a minimal daily allocation of 60 minutes per day for mathematics and 30 minutes for science should be required….A full year of mathematics and of science and technology should be required each year in grades 7 and 8" (p. 39).

(4-b) All high-school students should take at least three years of high-school level mathematics (including a year of algebra) and three years of science (including one semester of computer science).

(4-c) Colleges and universities should raise entrance requirements in mathematics and science. "Such college requirements should include four years of high school science, including physics, chemistry, and one semester of computer science, four years of mathematics, including a second year of algebra, and coursework covering probability and statistics" (pp. 40-41).

(4-d) High school guidance counselors should be more carefully selected and trained, due to their important roles of advising students in course selection, career planning, and their role in helping end race and gender discrimination in high schools.

(4-e) The curriculum needs to be reviewed to help students become problem solvers and not just technicians. At the elementary level, instruction should help students understand the arithmetic operations and when they are used, including the use of mental arithmetic. At the secondary level, the curriculum needs to be reviewed in light of the capabilities of new technologies. In addition, because geometry is important for all students, the tradition of studying geometry in a single year should be challenged.

(4-f) The National Science Foundation should take a leadership role in curriculum evaluation and development in mathematics, science, and technology. "The National Science Foundation should set up a process to evaluate existing curricula, identify good curricula,

disseminate information, act as a clearinghouse and promote the development of guidelines for new curricula as necessary" (p. 46).

The promise of the new information technologies
There are three educational uses of computers:

- Learning about computers
- Learning through computers (e.g., drill-and-practice, diagnostic testing, question-and-answer tutorials)
- Learning with computers (e.g., Microworlds, educational games, spreadsheets, simulations)

Recommendations by the commission regarding technology:

(5-a) The National Science Foundation should promote the use of technology in schools by determining needed initiatives, supporting prototype demonstrations, and supporting research on the integration of educational technologies with the curriculum.

(5-b) "States should consider establishing regional teacher education and computer centers for the demonstration of and training in new technologies" (p. 55).

(5-c) The national and state education councils recommended by this Commission should work with local school districts to develop goals and plans to increase use of technology in schools.

Informal education

(6-a) "Youth organizations, museums, broadcasters and other agents of informal education should cooperate with school districts and each other to provide a rich environment for early and continued learning and motivation outside of the schools" (p. 59).

(6-b) Television shows such as "3-2-1 Contact" are an "important and cost-effective vehicle of informal learning and should continue to receive substantial Federal investment and support" (p. 60).

(6-c) Television stations should be required to broadcast some educational programming for children.

(6-d) The federal government should help finance museums that have a science, mathematics, or technology focus. These museums should "offer a full range of activities and opportunities to pursue science hobbies, teacher-training programs, weekend and evening programs for parents and children, and opportunities for 'hands-on' experience" (p. 61).

(6-e) Private industry and businesses, the military, and other governmental agencies should allow children to tour their facilities to see science and technology in operation.

How the nation should finance needed educational improvements in elementary and secondary school mathematics, science and technology

(7-a) "The President should immediately establish a Council on Educational Financing, which would examine the methods through which the Nation could marshal the resources to implement the Commission's recommendations" (p. 66).

Supporting Materials

The main report includes five exhibits:

1) A listing of programs developed by states, local entities, or professional associations that were reviewed by the commission
2) A suggestion for topics in various courses and criteria for inclusion
3) Costs of recommended initiatives
4) Ideas for enhancing teacher compensation
5) A listing of ways and programs to use computers in schools.

A second volume contained 11 source documents reporting on activities supported by the commission or conferences/papers:

- The Mathematical Sciences Curriculum K-12: What is Still Fundamental and What is Not
- A Revised and Intensified Science and Technology Curriculum, Grades K-12 Urgently Needed for Our Future
- Integrating Concepts of Engineering and Science into Instruction in Grade Levels K-12
- Fundamentals in Precollege Technology Education
- Report of Educational Technology
- Research on Cognition and Behavior Relevant to Education in Mathematics, Science and Technology
- Results of a 50-State Survey of Initiatives in Science, Mathematics, and Computer Education
- Magnet Schools
- An Assessment of Programs that Facilitate Increased Access and Achievement of Females and Minorities in K-12 Mathematics and Science Education (Summary)
- A Case Study of Lyons Township High School (Summary)
- Business' Role in Precollegiate Education

Significance of *Educating Americans for the 21st Century*

Educating Americans for the 21st Century recommended that the National Science Foundation "take the leadership role in promoting curriculum evaluation and development." In the late 1980s and early 1990s, the NSF did in fact promote curriculum reform in mathematics.

References

Coleman, William T., Selby, Cecily Cannon, et al. (1983). *Educating Americans for the 21st Century: A plan of action for improving mathematics, science and technology education for all American elementary and secondary students so that their achievement is the best in the world by 1995.* Washington D.C.: National Science Foundation.