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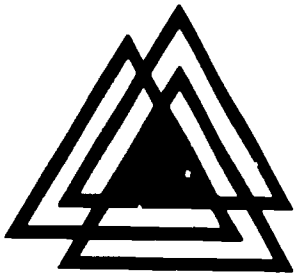
ABSTRACT

Policy documents in the past have called for a science education policy which specifically targets major areas of identified need. This document details three recommendations specifically emphasizing programs which do not require significant new funds. These include: (1) "Federal Leadership: Using the 'Bully Pulpit'," which suggests priorities for the White House and the Department of Education; (2) "Massive Reform of Curriculum Content and Delivery," which suggests programs for the National Science Foundation and others; and (3) "More and Better Science and Technology Teachers," which provides suggestions at the federal, state, and local levels. A table detailing the suggested allocation of federal funds for the years 1990 through 1993 is included. (CW)

A Plan For Action

A Follow-up to the Position Paper "The Present Opportunity in Education."



Triangle Coalition for Science and Technology Education

April 1989

Preface

"A Plan for Action" is a position paper of the Triangle Coalition for Science and Technology Education. It was drafted by Gary G. Allen, Chairperson, Congressional Liaison Task Force, and John Fowler, Executive Director of the Triangle Coalition. The paper has been reviewed and approved by the Triangle Coalition Steering Committee. It is being disseminated pending endorsement by the organizational members of the Triangle Coalition.

This position paper has been developed to provide United States policymakers with a specific series of actions to address the growing crisis in science and technology education. The recommendations are but first and immediate steps toward the goal outlined in the earlier position paper "The Present Opportunity in Education."

The Triangle Coalition is a consortium of 80 major national organizations from three broad sectors: business, industry, and labor; science and engineering; and education. These organizations are joined together to increase the effectiveness and efficiency of their efforts to reform science and technology education.

John M. Fowler
Executive Director

Executive Summary

Earlier we called for a science education policy that specifically targets major areas of identified need. It has become clear that we must now develop "a plan for action."

We recognize that the health of the economy, technological changes, and shifting government priorities will affect our national ability to pursue a coherent set of policy initiatives in education. Also, we have made a special effort to emphasize programs that do not require significant new funds. However, the very magnitude of the challenge the nation faces will call for some new programs and new resources.

Recommendation #1 Federal Leadership: Using the "Bully Pulpit"

This nation and this administration must make its commitment to the reform of science, mathematics, and technology education visible in both word and deed.

A White House Task Force on Science, Mathematics, and Technology Education

To develop a national policy in science, mathematics, and technology education we recommend the formation of a Cabinet-level task force. Its varied responsibilities will include a White House Conference on "Science, Mathematics, and Technology Education for the year 2000."

Priorities in the Department of Education (DOE)

No administration has ever set consistent subject matter priorities over all 26 local school improvement programs. We recommend that the Secretary set an absolute priority on science, mathematics, and technology education activities. In particular, program priorities should be established for women, minority groups, and all "at risk" youth.

Scientific Literacy

A critical priority for reform is to produce "scientifically and technologically literate" adults.

- The National Science Foundation (NSF), working in cooperation with the DOE, should fund an inter-agency task force on "Scientific and Technological Literacy" to develop a consensus definition and articulate plans for inserting this goal into all aspects of the science and technology education reform movement.

Developing High Quality Science and Engineering Professionals

Federal policy must focus on programs to increase the retention of the most competent and committed students at all levels.

- Increased support for graduate training in the sciences and engineering.
- Special support to women and minorities to pursue graduate study.

Recommendation #2 Massive Reform of Curriculum Content and Delivery

What is needed are science curriculums that can be used to bring students at all grade levels, and from all socioeconomic and geographical backgrounds, to an adequate level of understanding and competence in science, We recommend, therefore:

- A new NSF program to stimulate development of:
  - — Curriculums for the whole middle school senior high school span of classes.
  - — Science curriculums tailored to rural and inner-city environments.

— Undergraduate curriculums appropriate for prospective teachers, and for future lawyers, journalists, public relations people, and political scientists.

— Out-of-school science experiences.

Our Top Priority

Increased investments in elementary education must be the nation's number one priority. We recommend:

- A new elementary school science program focussed at the school district level to fund four model programs in each state.
- Amendments to the Dwight D. Eisenhower Mathematics and Science Act to encourage innovations in the delivery of elementary science education.
- An elementary science facilities program that provides resources on a 50 percent matching basis for science equipment in elementary schools.

Recommendation #3 More and Better Science and Technology Teachers

At the Federal Level

- Identify and recognize examples of excellence in pre-service and in-service teacher preparation.
- Provide new incentives within existing NSF and DOE programs to encourage higher education to restructure pre-service programs.
- Commit the NSF and DOE to develop a nationwide "support cadre" of experienced teachers, local curriculum specialists, content specialists, and others.
- Expand NSF in-service and pre-service training programs for elementary teachers.
- Develop a national program to recognize elementary teaching of science and technology.
- Ensure a major commitment to attract and retain young Americans into careers in elementary, secondary, and university teaching in mathematics, science, and technology.

  Current federal student aid is nearly $9 billion in the form of loans, grants, and scholarships. Five percent of this amount should be set aside for special programs to address this priority.

At the State Level

- Broader content requirements for secondary science teachers.
- New state requirements for science content emphasis for elementary teachers.
- State support to colleges and universities to improve pre-service instruction with special emphasis at the elementary level.
- Priority for implementation of new Eisenhower Act provisions for pre-service improvement.

At the Local Level

- Modifying continuing education requirements for elementary and secondary teachers to strengthen their capabilities for science teaching.
- Special salary incentives for excellence in science and mathematics teaching.
- Cooperation, encouragement, and support for "local alliances."

A CLOSING NOTE

Each of the recommendations described requires the nation to invest in goal oriented, critically focussed activities.

Those that persist in the belief that we can continue to educate the next generation as we have the last generation will deny their children and the nation the full opportunity to participate and prosper in the twenty first century. We must educate the present generation before we can the next. This challenge must be given the full weight of public and private sector support and leadership.

A Plan For Action

"We had such a lead on the rest of the world... High Technology is like an escalator. If your work force doesn't understand the technology then you are off the escalator . . .We can't make good parts, that's why we import parts . . .We can't make good scientists, so we import our scientists . . .We don't have a crisis, we have a disaster."
ABC News Special Report, "Losing the Future," 18 December 1988.

OVERVIEW

To paraphrase "Changing America,"* the America we have taken for granted for more than a generation is fundamentally changing. In a nation where more people are old, fewer are young, and an increasing number of those entering both the educational system and ultimately the work force are from minority groups, the educational programs that effectively addressed the needs of the past generation must be re-examined and new strategies invented that address current and future needs.

In our earlier report, "The Present Opportunity in Education," the Triangle Coalition for Science and Technology Education called for a new commitment to a science education policy that specifically targets major areas of identified need. While we have received a great deal of support for that paper's message, it has become clear that we must go further and develop "a plan for action."

The problems we face in science and technology education stem from powerful underlying forces in American society. The nation's schools traditionally have provided a common pathway to economic opportunity, social usefulness, civic responsibility, and personal respect; however, schools today are hard pressed to serve the needs of all students and to achieve national goals for:

- Scientific literacy
- Economic competitiveness
- Competence and leadership in scientific and technical research and development
- Technological advancement.

Our earlier report stated: "New programs must be developed, present programs strengthened, and old strategies, which do not address these critical needs re-examined, to achieve the sharp focus required." We identified five specific areas of need, which we believe should form the basis for the development of a national policy:

- Underrepresented students
- Inadequately prepared teachers
- Crucial subject matter areas
- Pivotal grade levels
- Neglected geographic areas.

* The Task Force on Women, Minorities, and the Handicapped in Science and Technology, *Changing America: The New Face of Science and Engineering* (Interim Report), Washington, D.C., September 1988, p. 3.

NEXT STEPS

A virtual avalanche of stories, reports, and studies the past year continues to underline the need for strong decisive national action. It is clear that this action will rely on cooperative partnerships among all major social institutions, both public and private, with parents, policymakers, and educators. The bulk of the effort and most of the resources required to make significant gains in the decade ahead will continue to be provided and focussed at the state and local level. However, it is equally clear that the federal government must undertake major new responsibilities in the next several years even if significant new resources are not found.

We have examined both programmatic and strategic mechanisms for addressing the policy issues outlined in the position paper. Clearly both short and long term interventions are necessary in an educational system where demographics, geographics, economics, and technology constantly change the routes to and the criteria for success.

At the national level, it is frequently easier to diagnose problems than to reach a consensus on specific choices for action. New policy measures generate unpredictable effects and require both formidable political will and the management of conflicting interests in one of the largest public bureaucracies in the world.

We recognize that the health of the economy, technological changes, and shifting government priorities—none of which can be projected with accuracy—will certainly affect our national ability to pursue a coherent set of policy initiatives in education. With these limitations in mind, we describe below, under three general headings, a series of program responses that we believe should be implemented by the federal government or by state and local governments.

RECOMMENDATIONS

These responses are all directed toward achieving the goal set out in "The Present Opportunity in Education":

> "The nation must set as a goal the development of a broad pool of citizens who are interested and functionally literate in science and its applications in society."

We have made a special effort, in assembling the program suggestions under the general recommendations below, to emphasize programs that do not require significant new funds, but rely for their effectiveness on setting new priorities and redirecting or refocussing existing programs. However, the very magnitude of the challenge the nation faces, if we are to reform science, mathematics, and technology education, will call for some new programs and new resources. In the lists below, we have indicated with an asterisk* (see Figure 1 on p. 10) those programs for which new funds will be required.

Recommendation #1 Federal Leadership: Using the "Bully Pulpit"

The nation and this administration must make its commitment to the reform of science, mathematics, and technology education visible in both word and deed. The presidency provides a "Bully Pulpit" as do the cabinet level positions. The executive branch can set priorities for departments and agencies, provide guidance to Congress, and influence state and local governments and the general public. We recommend that the following actions be taken by the administration to lead the nation toward the needed improvements in science and technology education.

Using the "Bully Pulpit"

Words from the "Bully Pulpit" of the White House could be used to encourage actions at the state level—changes in certification, support for improvement in teacher education, and support for facilities and curriculum development—and at the local level, where public awareness of the dimension of the problem and the consequences of continued poor performance must be raised to obtain community involvement and support.

The White House pulpit should also be used to alert the private sector to opportunities to help in carrying out the necessary programs of reform and

in bringing the power of the national media behind the crusade to create a new constituency for education.

A White House Task Force on Science, Mathematics, and Technology Education

To develop a national policy in science, mathematics, and technology education with step-by-step objectives that various agencies, public and private, can support, we recommend the formation of a Cabinet-level task force on science, mathematics, and technology education.* We suggest that this task force be chaired by the Vice President, and composed of the Secretary of Education, the President's Science Advisor, the Director of the National Science Foundation (NSF), selected business and industry representatives, governors, representatives of national education organizations, and the media/entertainment industry. Their responsibilities will be to:

- Analyze federal programs, set priorities, develop incremental objectives, and establish strong accountability mechanisms for science, mathematics, and technology education for departments and agencies, and facilitate the increase of intergovernmental cooperation.
- Generate public commentary on the issues, and focus attention on the cost in economic competitiveness of weak educational preparation of students and teachers.
- Promote awareness of national needs in science, mathematics, and technology education at the local, state, and national level.
- Set an agenda for a White House Conference* called "Science, Mathematics, and Technology Education for the year 2000," which is to be held in 1989 or 1990. Participants should be drawn from K-12—principals, parents, educators from higher education, local, state and national policymakers, the private sector, and others (estimated cost in Figure 1).
- Address the nation's governors on the subject of science, mathematics, and technology education.

Secretarial Priorities in the Department of Education

A national science education policy must ensure that the nation's young people have the scientific and technological literacy adequate to empower them personally, politically, and economically. In 1989, over $1.1 billion dollars were spent by the Department of Education on the 26 local school improvement programs. Nearly four times this amount was spent on other formal U.S. Department of Education grant programs such as Chapter 1 and Magnet Schools. No administration has ever set consistent subject matter priorities over all these programs, yet the law allows the Secretary of Education discretion in setting program priorities. We recommend that the Secretary set an absolute priority on science, mathematics, and technology education activities. In particular, program priorities should be established for women, minority groups, and all "at risk" youth, rural and inner-city areas, and elementary and undergraduate grade levels.

In addition, the Department of Education should give top priority to programs which:

- Provide support from science, engineering, and mathematics professionals for state and local science and mathematics education reform efforts through programs such as the Dwight D. Eisenhower Mathematics and Science Act.
- Expand informal science learning resources and enhance their contribution to school programs.
- Increase emphasis on hands-on science and mathematics activities as an integral part of Pre-K programs such as "Head Start" and other early elementary programs.

* The Triangle Coalition will confine its recommendations, for the most part, to science and technology education and leave to the mathematicians the task of recommending programs in their field. Mathematics is so crucial to science and technology, however, that this separation loses its logic in some instances and we take the liberty, in this document, of speaking sometimes for mathematics as well as for science and technology.

- Develop special model projects for parents of at-risk children, which build communication and support networks between school and home.

The nation's most pressing needs in science education must be viewed in the context of the national failure to educate the majority of young people to an adequate level of science literacy. All activities undertaken to contribute to the pool of future scientists and engineers should, in part, be evaluated by their contribution to the non-occupational science learning goals of all students. Poor student performance and involvement in science education learning, particularly at higher grade levels, often reflects low motivation on the part of students, modest expectation on the part of parents and teachers, and a curriculum with inappropriate goals and emphasis. The need to address these issues must be highlighted by agency program guidelines.

Scientific Literacy

The critical priority for reform of science and technology education is to produce "scientifically and technologically literate" adults. Achievement of that goal, however, is currently rendered impossible by the lack of consensus on an operational definition of the term. Without this definition, it is not possible to design teaching strategies to move students toward it or testing tools to measure its achievement. The administration must provide, through its lead scientific agency, the National Science Foundation, a process to achieve a consensus on an operational definition of literacy and to measure progress toward its broad achievement.

The American Association for the Advancement of Science's (AAAS) Project 2061, involving panels of scientists, engineers, and technicians in defining the scientific and technological knowledge and abilities that high school graduates should attain has provided this definition. Their conclusions need to be examined and discussed among diverse groups including teachers, psychologists, parents, and the business community.

A national convergence toward an operational definition of scientific literacy goals in this area will impact teaching, teacher training, testing, and textbook content and design. We recommend the following initiatives to move the nation closer to this convergence.

- The NSF, working in cooperation with the Department of Education, should fund an interagency task force on "Scientific and Technological Literacy" to further develop a consensus definition and to articulate plans for inserting this definition as a goal into all aspects of the science and technology education reform movement.

- The NSF, in collaboration with Department of Education, should fund, in selected school districts, the development and implementation of "needs assessment" and measurement tools that would allow schools to measure progress toward the development of scientific and technological literacy among the various components—teacher preparation, teacher and student attitudes, course taking and performance, etc. We recommend that $2 million be invested in this effort during the next fiscal year.

Developing High Quality Science and Engineering Professionals

Government policy in many areas has both a direct and indirect effect on the development of a pool of future scientists, engineers, technicians, and other science based professionals. Government is only one, and in many cases, not the most important of many actors in the system. Two broad, complementary strategies of recruitment and retention have been suggested to address the national need for competent and skilled scientific professionals.

Recruitment. Efforts to expand and deepen the talent pool will be significantly enhanced by implementing the recommendations made in this report. Their success will require working with states, schools, and colleges, along with parents,

teachers, faculty, and other informal providers of science, mathematics, and technology education to achieve a sense of ownership for the renovation and innovation needed at the elementary and secondary level.

Retention (Keeping Students in the Pool). The nation can increase the supply of scientists, engineers, and technicians rather quickly by retaining currently enrolled college and graduate students in science and engineering programs. Attrition rates, particularly among underrepresented populations, are high. Federal policy must focus on programs to increase the retention of the most competent and committed students at all levels. Many factors affect career choice and persistence. The federal government can affect these decisions by providing:

- Increased support for graduate training in the sciences and engineering. Present federal spending on all programs, primarily fellowships and traineeships, is approximately $250 million, with a significant proportion in the health sciences.
  - — We recommend an expansion of graduate fellowships and traineeships in the sciences and engineering by 10 percent per year for five years. This would add $25 million* and 2,000 students each year.
  - — Authorize the mission agencies (Defense, NASA, Energy, Interior, Agriculture) to support an increased level of graduate training. We recommend distributing a pool of $30 million* among these agencies to nurture talent in their respective fields.
- Special support to women and minorities to pursue graduate study. Presently as few as 150 minority students benefit from existing special graduate programs. These targeted programs must be doubled.* Ten percent of existing, non-targeted graduate student programs support should be set aside for women and minorities.
- Tuition aid provided by the government (as compared to stipends) should not be taxed. Congress should clarify any confusion over this issue in the minds of students.

Creating a New Constituency

"Local alliances," broad based community level collaborations to help teachers and schools, have developed, which link various people and resources from business, industry, science groups, professional societies, colleges and universities, nonprofit organizations, and government at all levels. More than 300 such local, regional, and statewide efforts now exist. The benefits are substantial to all participants. These efforts need recognition, seed money, tax credit, and other incentives to strengthen existing programs and stimulate the formation of new ones.

Local communities can be helped to address their educational problems by the following:

- Members of Congress and key staff must be aware of and support state-wide and regional business education collaborations in their areas. Federal personnel in field locations throughout the country could serve on local alliance boards and work to mobilize the involvement of science professionals in the schools.
- Chapters 4 and 5 of P.L. 100-418 should be fully funded to provide support for:
  - — Local partnerships on a matching basis. (Present authorization $20 million*)
  - — The creation of educational partnerships. (Present authorization $10 million*) Specific emphasis should be given to the support and development of state-wide alliances; $2.5 million, $50,000 per state should be set aside for this purpose.

States and local communities can provide support in much the same way as the federal government by supporting present and proposed collaborations and making available seed money for this purpose. Local government and school systems must be encouraged to be involved and responsive to the services and resources made available by this emerging network of new constituents.

Many of the nations largest corporations encourage and support local efforts. Millions of small businesses find their economic goals tied to the

effectiveness of the local education system. Their aggressive support for local school improvement and involvement in efforts to strengthen science, mathematics, and technology education must be strongly encouraged.

Recommendation #2 Massive Reform of Curriculum Content and Delivery

In the year 2000, 85 percent of new entrants to the nation's work force will be immigrants, members of minority groups, and women. These groups have had an especially difficult time mastering school science and entering technical and scientific careers. A group with an even more obvious failure to master the technical tools needed now and in the next century are the dropouts who accumulate in alarmingly large numbers in rural and inner-city areas.

Encouraging all education programs to consider and respond to these groups has not proven effective. The answer is targeted programs to develop curriculums and delivery systems, and school and community structures in local education agencies which have high minority enrollment and clear, measurable and challenging success commitment. We recommend the following targeted programs.

Change the Content and Sequence of the Science Curriculum

The science curriculums in this country are largely set by textbook authors and publishers and neither has the will, the broad experience, nor the resources to make the wholesale changes that are necessary. What is needed are science curriculums that can be used to bring students at all grade levels, and from all socioeconomic and geographical backgrounds, to the level of understanding and competence in science, which will allow them to be politically and economically productive in the modern world. The stimulation and support of curriculum development in the sciences has traditionally been the responsibility of the National Science Foundation. We recommend, therefore:

- A new NSF program, funded at the $10 million* level in the first year to stimulate development of the following curricular models for:
  - Curriculums must be developed for the whole middle school-senior high school span of classes. Ample evidence from research and from foreign experience suggests that our present system of courses, fragmented by discipline and grade level, is less than satisfactory for the college bound, as well as for the general student. "Project 2061," of the AAAS, is producing guidance for content revision and the National Science Teachers Association (NSTA) has begun to work on sequence and coordination. Careful development of these and other models must get underway.
  - Science curriculums tailored to rural and inner-city environments are needed, along with curriculums and materials that meet the needs of women and minority students and fire their interests. Research exists that can be translated into practice in these areas.
  - Undergraduate science courses and/or curriculums that are appropriate for prospective teachers, and for future lawyers, journalists, public relations people, and political scientists are needed.
  - Out-of-school science experiences must be developed and encouraged. It is increasingly clear that science and mathematics learning are shaped, in part, by out of school experiences in the community and in the home. Too many children lack the opportunity to experience the excitement associated with these activities. Increased support must be given to informal science education including science centers, museums, fairs, camps, and television. Yearly program support for these efforts through the NSF should be increased by $30 million* over the next 2 fiscal years.

Our Top Priority

Elementary education is especially critical given both the goal of a broad pool of citizens who are interested and functionally literate in science, and the national need for a deep pool of persons compe-

tent to become American leaders in scientific research and development. The exposure of students to science at this level has remained limited despite the widely acknowledged concern for elementary education. Increased investments in elementary education must, therefore, be the nation's number one priority for additional funds. These new investments must be shaped by a clear strategic plan, which is designed to implement initiatives that maximize the impact of federal dollars. We recommend the following initiatives at the elementary level:

- A new elementary school science program administered by the Department of Education and focussed at the school district level should be put in place to fund four model programs in each state in order to provide incentives for teachers and schools to increase student achievement in science, mathematics, and technology education. Each elementary science innovation grant would total $75,000 with two in each state in the first fiscal year, and four the second—first year cost $7.8 million, second year cost $15.6 million.*

  A program such as this offers an excellent opportunity to put into practice the recommendations of the report "To Secure Our Future: The Federal Role in Education" by the National Center on Education and the Economy, which calls for all federal funds for the disadvantaged to be combined at the local level and used in similar model school programs.

- Amendments to the Dwight D. Eisenhower Mathematics and Science Act to encourage bold initiatives to support innovations in the delivery of elementary science education including large scale demonstrations of technology-based approaches, specialist systems, and similar new approaches. The expertise of the military and high technology business in information processing should be put to work in this area. Initial funding would be $50 million.

- An elementary science facilities program that provides resources on a 50 percent matching basis for science equipment in elementary schools. Over one third of all elementary science classes are taught in classrooms that have no science facilities, and over half report their facilities are inadequate. Such a program would not purchase computers and software. Initial funding for this grant program would be $50 million.* Priority would be given to schools serving minority populations and to schools in inner-city and rural areas.

- Double the funding for the "Star School Program" in FY 90 to $40 million.*

- The NSF should also stimulate the development of alternative mechanisms for publishing innovative materials including software and other nonprint items unlikely to be supported by established publishers.

All of the development efforts in science and technology education must be done in close coordination with the more advanced efforts to reform mathematics education, since mathematics is so crucial to science learning. This is especially important at the elementary level where mathematics acts as a "critical filter" in the pipeline to further science and mathematics courses. The NSF, as the major funder of curriculum development, should accept a responsibility to ensure coordination between new science curriculum experiments and developments in mathematics education.

Recommendation #3 More and Better Science and Technology Teachers

The large proportion of under-qualified science and mathematics teachers presents a critical challenge at the middle school and high school level. A series of steps must be taken to address this critical need.

At the Federal Level

The following steps should be taken at the federal level to improve mathematics and science teachers:

- Identify and recognize examples of excellence in pre-service and in-service teacher preparation. Provide special attention to the states with the most teachers entering science-related fields and colleges and universities with exceptional programs.

- Provide new incentives within existing NSF and Department of Education programs to encourage institutions of higher education to restructure pre-service programs, therefore, giving special weight to institutions that are committed to implementing the recommendations made by the Holmes Group in Tomorrow's Teachers.

- Commit the NSF and Department of Education to a strategy to develop a nationwide "support cadre" of experienced teachers, local curriculum specialists, content specialists, and others who act as resources to middle and high school teachers in the sciences. At the elementary level, the development of instructional resource specialists and change advocates at the district and state levels must be supported.

- Expand NSF in-service and pre-service training programs for elementary teachers with an additional $50 million* in the next fiscal year, and $20 million* growth for the next 5 years to reach an annual investment of $150 by 1995.

- Develop a special national program at the Department of Education to encourage, reward, and recognize elementary teaching of science and technology—"Secretary Awards"—$2 million* per fiscal year.

- Ensure a major federal commitment to attract and retain young Americans into careers in elementary, secondary, and university teaching in mathematics, science, and technology. The problem is especially acute for women and minorities, where the number entering science and mathematics teaching is small and the best and brightest choose careers in other areas.

- Provide a combination of scholarships and loans to support the completion of quality teacher preparation programs. Loans could be forgiven at a rate of 20 percent for every year of teaching in a public school or university. Increased rates of forgiveness might be considered for teaching in schools that meet certain guidelines for enrollments of at-risk students.

Priorities for this program would include the need for:

— Elementary teachers with strong content preparation in science, mathematics, and technology.

— Middle school teachers with solid interdisciplinary training in science, mathematics, and technology.

— Secondary teachers with degrees in science, mathematics, or technology who are able to teach a core of subject matter for all students, along with the content depth to teach advanced science and mathematics courses.

— University educators with graduate degrees in science, mathematics, or technology, sensitive to the need for training teachers and developing precollege curricula.

Current federal student aid is nearly $9 billion in the form of loans, grants, and scholarships. Five percent of this amount, set aside for special programs to address these priorities, would have a significant effect on the nation's children.

At the State Level

Federal leadership can help bring about important action at the state level including:

- Broader content requirements for secondary science teachers.

- New state requirements for science content emphasis for elementary teachers.

- State support to colleges and universities to improve pre-service instruction with special emphasis at the elementary level.

- Priority for in-state plans for implementation of new Eisenhower Act provisions for pre-service improvement.

At the Local Level

Change must occur at the school district level and can be encouraged by local actions such as:

- Modifying continuing education requirements for elementary teachers to include science courses; for secondary teachers, requirements to include retraining that strengthens their capabilities to do out-of-field teaching.
- Special salary incentives for excellence in science and mathematics teaching.
- Cooperation, encouragement, and support for "local alliances" that assist teachers and schools by involving a constituency of business, industry, and the community in school science, mathematics, and technology education support and improvement.
- Interchange of ideas within the professional and leadership communities of scientists and educators.
- Evaluation and assessment of progress in science, mathematics, and technology education.
- Documentation, collection, and dissemination of model program information.
- Continued innovations in materials and instruction.

A CLOSING NOTE

Each of the recommendations described requires the nation to invest in goal oriented, critically focussed activities. The success of these initiatives depends, in part, on the continuing support by various federal agencies—notably the Department of Education and the National Science Foundation—of activities that provide the foundation for all reform efforts. Such activities must include:

An appropriate response to the challenges posed by these recommendations will require a systematic effort to develop in the public, as well as in the policymaker, a deeper understanding of the need for, and the content of, the changes and improvements called for in our education system. This will be a formidable task, which will need constant attention from the "bully pulpit" of the federal government.

Those that persist in the belief that we can continue to educate the next generation as we have the last generation will deny their children and the nation the full opportunity to participate and prosper in the twenty first century. We must educate the present generation before we can the next. This challenge must be given the full weight of public and private sector support and leadership.

Figure 1. New Federal Funds Required to Implement Recommendations (1989 Dollars—All Figures in Millions)

National Science Foundation	FY 90	FY 91	FY 92	FY 93
Scientific Literacy	2	2	5	5
Graduate Fellowships	25	25	30	30
Targeted Graduate Support	10	10	15	20
Curriculum Development	10	12	15	15
Informal Science Education	15	30	30	30
In-service & Pre-service Teacher Training	50	70	90	110
Subtotal	112	149	185	210
Department of Education				
Local Partnerships				
a. Support	20	20	25	25
b. Creation	10	10	10	10
Elementary Science Improvement Amendments	50	50	75	75
Elementary Innovation Grants	8	16	16	16
Elementary Science Facilities	50	50	60	60
Star Schools	20	20	25	25
Elementary Teacher Recognition	2	2	2	2
Subtotal	160	168	213	213
Other Agencies				
Executive Office of the President (Conference and Task Force)	2	2	2	2
Mission Agencies	30	30	35	40
Subtotal	32	32	37	42
TOTALS	304	349	435	465

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The Triangle Coalition for Science and Technology Education is a 501(c)3 nonprofit organization housed at NSTA, which serves as its fiscal agent. The Triangle Coalition staff operation is headed by Dr. John Fowler, Executive Director. 5112 Berwyn Road, 3rd Floor, College Park, MD 20740, (301) 220-0870.