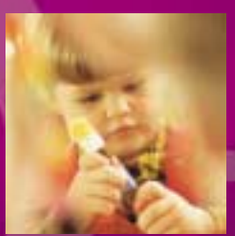
Leading Science Education Reform



National Science Resources Center

THE NATIONAL ACADEMIES Smithsonian Institution

The Leader

IN SCIENCE EDUCATION REFORM

THE NATIONAL SCIENCE RESOURCES CENTER IS COMMITTED TO ESTABLISHING EFFECTIVE SCIENCE PROGRAMS FOR ALL STUDENTS. THE NSRC EMPLOYS STRATEGIES THAT ARE INFORMED BY RESEARCH, INCORPORATE BEST PRACTICES, AND LEVERAGE CHANGE THROUGH THE DEVELOPMENT OF STRATEGIC PARTNERSHIPS.

Established in 1985, the NSRC is an organization of the Smithsonian Institution and the National Academies. Through its parent institutions, the NSRC has actively engaged the scientific, engineering, and education communities in all of its programs.

THE IMPETUS FOR REFORM

Our Beginning

In 1983, the National Commission on Excellence in Education published an open letter to the American people. Their report, *A Nation at Risk*, stated, "Our once unchallenged preeminence in commerce, industry, science, and technological innovation is being overtaken by competitors throughout the world." The report called special attention to how far American students lagged behind the rest of the developed world in science and mathematics education.

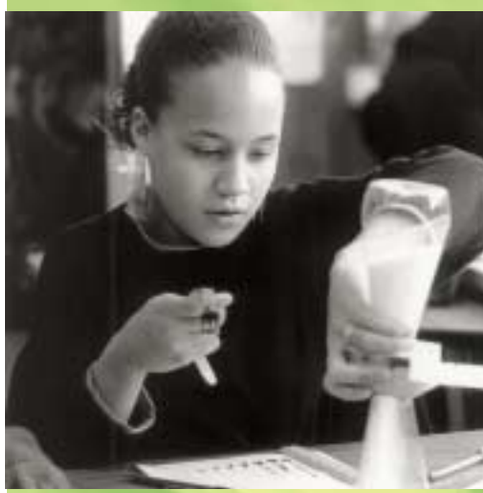
The authors of the report urged that our nation's education system:

- Educate scientifically and mathematically literate young people who are able to participate effectively as citizens in the 21st century
- Prepare a work force with science and technology backgrounds
- Train scientists and engineers who can keep the United States competitive internationally

In 1985, the leaders of the Smithsonian Institution and the National Academies decided that their institutions should play a major role in addressing this critical problem. Together, they established the National Science Resources Center to improve the learning and teaching of science in the nation's school districts.

"The Smithsonian is deeply committed to excellence in science education and is making a significant contribution to the improvement of science education for our nation's youth through the work of the National Science Resources Center. We will continue to support, with the National Academies, the important work of the Center."

David L. Evans
Under Secretary for Science
Smithsonian Institution



"I view the National Science Resources Center as a major national and international resource for empowering teachers, scientists, and school districts."

Bruce Alberts
President
National Academy of Sciences
Chair
National Research Council

OUR CORE VALUES

The Student
Students learn science best when they participate in developmentally appropriate experiences that build upon their prior knowledge and help them develop new concepts and skills.

The Teacher
Competent teachers using effective curriculum increase the potential for improved student achievement in science.

The Curriculum
Research-based curriculum materials are necessary if competent teachers are to increase student achievement.

The School District
School districts must develop a strategic approach that is based on research and focused on systems thinking.

The Education and Scientific Communities
The scientific and education communities are critical to the establishment of effective science programs.

NATIONAL SCIENCE RESOURCES CENTER

AN ORGANIZATION OF THE

Smithsonian Institution and The National Academies

The establishment of the NSRC by two of the nation's most prestigious institutions provides the United States with a unique resource for catalyzing change in science education.

THE SMITHSONIAN INSTITUTION THE DIFFUSION OF KNOWLEDGE

In the early part of the 19th century, James Smithson bequeathed his fortune to found the Smithsonian Institution "for the increase and diffusion of knowledge." The Smithsonian fulfills that mission in many ways, including promoting innovation, research, and discovery in science. In addition, the Smithsonian is deeply committed to its outreach to the public.

Educators, parents, and community organizations are attracted to the NSRC programs because of the Smithsonian's prestige and credibility. The Smithsonian provides the NSRC with support for space, operations, and management. With the National Academies, the Smithsonian facilitates access to expertise and resources from the world's largest museum complex, its research, archives, and extensive library system.

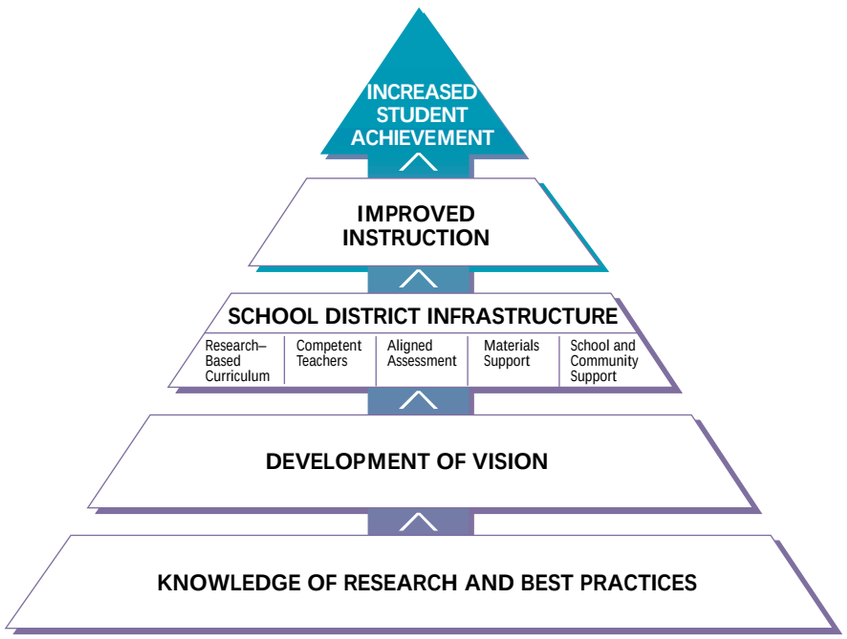
THE NATIONAL ACADEMIES ADVISERS TO THE NATION

The National Academies is comprised of the National Academy of Sciences, the National Academy of Engineering, the Institute of Medicine, and the National Research Council. Four national academies combine to work outside the framework of government to ensure independent advice on matters of science, technology, and medicine. Knowledge of research and application of best practices are critical to the development of effective NSRC programs. Both the Academies and the Smithsonian provide the NSRC with access to research and scientific and engineering expertise to inform its services and products.

Advancing Student Achievement in Science

The NSRC's core values, theory of action, and science education reform processes are based on research in cognitive development, theories of organizational change, and the impact of program activities on student achievement. An in-depth understanding of the unique culture of school systems further enriches this philosophy.

THE NSRC THEORY OF ACTION



The NSRC developed this theory of action to guide school districts in the process of establishing research-based science education programs that result in improved instruction and increased achievement for all students.

The NSRC has tested its theory of action with hundreds of school districts. The Program Evaluation and Research Group of Lesley University in Cambridge, Massachusetts, has conducted an external evaluation of the theory. The evidence from this study indicates that the majority of participating districts have made significant progress in adopting challenging curriculum, reforming professional development programs for teachers, and establishing efficient materials support systems.

MAKING AN IMPACT ON STUDENT ACHIEVEMENT

Delaware school districts base their elementary science instructional program almost entirely on the NSRC's elementary science instructional materials — the Science and Technology for Children (STC) curriculum program. In 2001, 87% of Delaware students at the end of grade three met or exceeded the new state performance standards for science. At the end of grade five, 70% met or exceeded the standard. This was an increase of 63% from the previous year. Virtually all Delaware school districts have attended an NSRC Elementary Science Strategic Planning Institute that prepared them to base their science programs on research and best practices.

Gaston, G., Wood, R., Collette, J. (2002) Delaware Smithsonian Project Report: Building on Success to Improve Our Children's Future, 1995–2002 Update. Unpublished report.

Achievement test results from the Valle Imperial Project in California indicate that students enrolled in research-based science programs, such as STC, perform better on nationally normed science tests than students enrolled in programs that use a traditional textbook approach.

Klentschy, M., Garrison, L., & Amaral, O.M. (2002) Valle Imperial Project in Science (VIPS): Four-Year Comparison of Achievement Data, 1995–1999. Unpublished manuscript.

Programs and Services

NSRC CENTERS OF EXCELLENCE FOR SYSTEMIC REFORM

Leadership and Assistance for Science Education Reform (LASER) Center
Informed leaders representing both the education and scientific communities have a critical role in improving the quality of science education. For this reason, the NSRC LASER Center works with school districts, academic institutions, corporations, and museums to plan, implement, and sustain effective science education reform programs.

Professional Development Center
In order to be effective, every teacher must have a conceptual understanding of important science content and pedagogical knowledge. The NSRC Professional Development Center provides a portfolio of services and products for improving the learning and teaching of science.

Curriculum Development Center
An effective curriculum is essential for teachers to teach and for students to learn. The NSRC Curriculum Development Center develops, distributes, and evaluates curricula and other teaching tools for educators. All curricula developed or recommended by the NSRC are inquiry-based and have undergone a rigorous research and development process.

LEADERSHIP AND ASSISTANCE FOR SCIENCE EDUCATION REFORM (LASER) CENTER

The LASER Center uses the NSRC theory of action and offers a portfolio of services and products to help school districts, academic institutions, and state departments of education plan, implement, and sustain effective science programs. The LASER Center builds on almost two decades of NSRC experience to improve science education with hundreds of school districts.

Implementation and Institutionalization of Reform

Services and resources which provide district and community leaders with access to information, resources, and assistance needed to implement and sustain an effective program.

- Academies, Institutes, and Workshops
  - Curriculum piloting, selection, and adoption
  - Professional development for novice, competent, and expert science teachers
  - Establishing material support systems
  - Assessment strategies
  - Building administrative support
  - Building community support
  - Achieving literacy through science

Initiation of Reform

The processes and resources which educate strategic leadership teams about the research and best practices needed to establish an effective infrastructure, and develop a strategic plan based on this information.

- Strategic Planning Institutes
  - K–6 science education
  - K–8 science education
  - Middle school science education
  - Higher education

Building Awareness for Reform

Programs which provide school district, community, state, and national leaders with experience and knowledge about effective science learning and teaching, and the infrastructure needed to support the vision.

- Shared Vision Conferences
  - National and state government officials
  - Local school districts and community officials
  - Academic leaders
  - Business and industry leaders
  - Museum and science technology centers

Developing Leadership Capacity for Reform

The processes and resources designed to educate scientists, engineers, teachers, school administrators, and community leaders about research and best practices.

- Faculty internships at Institutes and Academies
- Faculty roles at Shared Vision Conferences

PROFESSIONAL DEVELOPMENT CENTER

Through the work of the Professional Development Center, which is informed by research and best practices, teachers gain a conceptual understanding of the science content and pedagogical knowledge needed to teach effectively. Teachers learn to assess what students know, to actively engage them in scientific investigations, and to show them how to apply their knowledge and skills to new situations.

Stages of Expertise

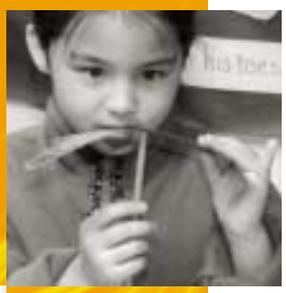
The NSRC's professional development center programs work with teachers as they build on their knowledge and skills through the various stages of expertise.

NOVICE > ADVANCED BEGINNER > COMPETENT > PROFICIENT > EXPERT

- Overview Sessions
  Beginning with the NSRC middle school curriculum, overview sessions consist of an introduction to the NSRC and its philosophy, a summary of the process used to develop the curriculum, a hands-on experience representative of the goals of the curriculum, and an overview of the complete program.

- Curriculum Workshops
  These workshops familiarize educators with the fundamental science concepts addressed in specific instructional units, review strategies needed to implement inquiry-centered science in the classroom, and teach effective classroom management techniques.

- Content Courses
  The NSRC works in partnership with academic institutions to offer content courses contextualized to specific curriculum materials. These courses provide teachers with hands-on experiences for extending and enriching their conceptual understanding of the content and opportunities for modeling inquiry-centered learning and teaching.



CURRICULUM DEVELOPMENT CENTER

The NSRC has developed two comprehensive science curriculum programs for K–8 students: the elementary program, Science and Technology for Children® (STC), designed for students in grades K–6; and the middle school program, Science and Technology Concepts for Middle Schools™ (STC/MS), designed for students in grades 6–8.

The NSRC also maintains a collection of more than 5,000 teaching resources related to K–8 science education. This collection is housed in the Smithsonian's Arts and Industries building. These resources are available in print and on-line through the NSRC Web site.

STC AND STC/MS SCIENCE CURRICULUM PROGRAMS

Grade Level		Life and Earth Sciences		Physical Sciences and Technology	
STC	K–1	Organisms	Weather	Solids and Liquids	Comparing and Measuring
	2	The Life Cycle of Butterflies	Soils	Changes	Balancing and Weighing
	3	Plant Growth and Development	Rocks and Minerals	Chemical Tests	Sound
	4	Animal Studies	Land and Water	Electric Circuits	Motion and Design
	5	Microworlds	Ecosystems	Food Chemistry	Floating and Sinking
	6	Experiments with Plants	Measuring Time	Magnets and Motors	The Technology of Paper
STC/MS	6–8	Human Body Systems	Catastrophic Events	Properties of Matter	Energy, Machines, and Motion
	6–8	Organisms — From Macro to Micro	Earth in Space	Light	Electrical Energy and Circuit Design

Note: All STC units can be used at one grade level above or below the level indicated on the chart. STC/MS units can also be used at grade 9.

Elementary Science Curriculum

- Science and Technology for Children (STC)
  Designed to achieve scientific literacy by providing children with opportunities to learn age-appropriate concepts and skills and acquire scientific attitudes and habits of mind in the life, earth, and physical sciences, STC is an innovative, comprehensive 24-unit K–6 curriculum. Field-tested in school districts nationwide, the curriculum is being used in thousands of elementary school classrooms throughout the United States. This curriculum is also available in Spanish.
- *STC Meets the Standards*
  This publication presents a detailed explanation of how STC correlates with the National Science Education Standards.
- STC Teacher Instructional Videos
  Videos accompany all STC units. In each tape, a master STC teacher demonstrates how to set up and use the materials.
- *Resources for Teaching Elementary School Science*
  This annotated guide provides teachers, curriculum specialists, teacher trainers, and parents with information on science curricula, museum science programs, and other science resources at the K–6 level.

Middle School Science Curriculum

- Science and Technology Concepts for Middle Schools (STC/MS)
  Designed for students in grades 6–8, STC/MS is a comprehensive middle school science curriculum that builds on the STC units.
- *Guide to Probeware and Computer Applications for STC/MS*
  A supplement to the STC/MS curriculum, this guide contains probeware and computer technology applications that allow students to use more sensitive equipment during lab experiments. These applications may replace or enhance labs in individual STC/MS modules.
- *Resources for Teaching Middle School Science*
  This annotated guide provides teachers, curriculum specialists, teacher trainers, and parents with information on science curricula, museum science programs, and other science resources at the 6–8 level.

NSRC CURRICULUM

- Aligned with the National Science Education Standards of the National Research Council
- Developed using a rigorous research and development process
- Field-tested with diverse student populations representing urban, rural, and suburban districts throughout the country
- Provides age-appropriate opportunities for children to expand their conceptual understanding of important science ideas, acquire problem-solving and critical-thinking skills, and develop positive habits of mind toward science
- Offers students opportunities to apply newly learned concepts and skills to their everyday lives, and to integrate science with other areas of the curriculum
- Incorporates opportunities for reading and reflection, discussion and analysis, and writing and independent study
- Incorporates assessment tools and the critical implementation needs of both teachers and districts
- Assessed by an external evaluator and reviewed by master teachers, scientists, and engineers to ensure its scientific integrity and educational effectiveness

A RESOURCE TO

School Districts, Museums, Professional Organizations, and Parents

Each facet of society has the responsibility to guarantee that children grow up with the ability to engage actively with the natural and technological world around them. By learning to evaluate evidence and make decisions based on critical thinking and scientific reasoning, today's children will be better prepared to succeed in tomorrow's world. The NSRC works with school districts, museums, organizations, parents, and other stakeholders to ensure that leadership development programs, curriculum and instructional materials, and professional development programs are in place to realize this goal.

WORK IN CONCERT WITH THE NSRC TO:

Become an Advocate

- Develop a shared vision in your community
- Develop leadership skills for reforming science education
- Educate stakeholders about effective science learning and teaching programs for all students

Form Local and State Partnerships

- Create alliances to assess district and statewide needs and design strategies for implementing and sustaining programs that will lead to student achievement in science

Contribute to the Professional Development of Teachers

- Help to develop programs that familiarize teachers with effective learning and teaching programs
- Assist with the design and delivery of professional development programs for current and future teachers of science

Design and Prepare Curriculum

- Help develop, revise, and disseminate research-based K–12 science instructional programs

A RESOURCE TO

Corporate America

Corporate America knows that today's student is tomorrow's employee and citizen. Whether the student grows up to become an auto mechanic or a biochemist, science and mathematics knowledge and skills will be critical to that employee's success. Corporations and other organizations, therefore, have devoted considerable resources to support the progression of systemic reform of science education throughout the country. Many of these companies have formed strategic partnerships with and have been investing in the NSRC's work for more than a decade.

WORK IN CONCERT WITH THE NSRC TO:

Become an Advocate

- Serve as a key leader in the national movement to improve the way science is taught and learned
- Join the nationwide learning network of more than 4,000 leaders working to improve science education programs based on research and best practices

Partner With Local School Districts

- Work with school districts to help improve their science programs and implement systemwide change
- Serve as a faculty member at institutes, working conferences, and workshops
- Sponsor a local school district's attendance at institutes and academies

Contribute to Curriculum Development

- Serve as a technical adviser to develop, revise, and disseminate elementary and middle school instructional materials

Become Involved With International Science Education

- Help bring a global perspective to science education in the United States and improve science education internationally

CORPORATE AND FOUNDATION COALITION

The NSRC created a Corporate and Foundation Coalition to leverage corporate America's collective expertise to improve the teaching and learning of science in our nation's schools. The Coalition's working agenda is to create programs and processes whereby corporations can work in concert to:

- Research best practices for inquiry-based science teaching
- Fund research to validate the impact of research-based science education
- Identify, publish, and disseminate information on corporate and foundation contributions to K–16 science learning and teaching

A RESOURCE TO

Academic Institutions

The NSRC and institutions of higher education work collaboratively to improve science education. Through the NSRC, scientists, engineers, and educators from our nation's colleges and universities have access to two of our nation's most prestigious academic institutions — the Smithsonian and the National Academies.

WORK IN CONCERT WITH THE NSRC TO:

Become an Advocate

- Speak out as a key education leader on the need to improve the way science is learned and taught
- Join in the nationwide learning network of more than 4,000 leaders working to improve science education programs based on research and best practices
- Develop articles for journals, newsletters, and other publications to advance science education reform nationally and internationally

Partner With Local School Districts

- Work with local school districts to assess and improve their science programs based on research and best practices
- Serve as a faculty member at science education strategic planning institutes, working conferences, and workshops

Contribute to Higher Education Reform Programs

- Work to improve programs for teachers of science and the teaching of science
- Serve as a faculty member at institutes, working conferences, and workshops

Participate in the Professional Development of Teachers

- Collaborate with teacher leaders in professional development programs to learn about effective science learning, teaching strategies, and resources
- Assist with the design and delivery of professional development programs for current and future teachers of science

Design and Prepare Curriculum

- Serve as a technical adviser to develop, revise, and disseminate elementary and middle school instructional materials

A RESOURCE TO

Other Nations

The NSRC extends its work internationally through the National Academies and the InterAcademy Panel (IAP). The IAP is a global network of more than 80 science academies designed to help its members develop the tools they need to participate in science policy discussions taking place beyond university classrooms and research laboratories. Members of the IAP share the belief that they have much to learn from one another and that through communication links and networks created by IAP activities, all academies will be able to raise both their public profile among citizens and their influence among policy makers.

The IAP forges partnerships among its member institutions and works closely with other scientific organizations, including the International Council for Science. The IAP is a significant force in the global effort to reform science education. By sharing the NSRC's experiences with science education reform in U.S. schools, we can help initiate and accelerate reform efforts in other nations, with benefits to citizens all over the world.

WORK IN CONCERT WITH THE NSRC TO:

Become an Advocate

- Develop a shared vision and educate stakeholders about effective science learning and teaching programs for all students

Assist in Strategic Planning

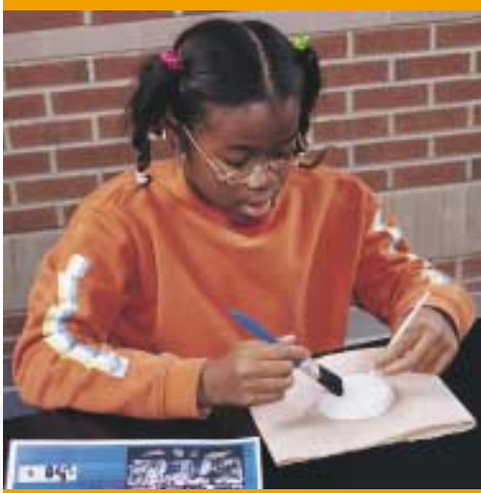
- Participate in workshops demonstrating inquiry-centered teaching to scientists and educators who are interested in using the NSRC model for their own reform efforts
- Use the inquiry-based model to assess current needs and design strategies for implementing and sustaining programs that will lead to student achievement
- Develop country-specific strategic plans for science education reform
- Benefit from the experience and expertise of more than 4,000 leaders working to improve science education programs based on research and best practices

Participate in the Professional Development of Teachers

- Engage in professional development programs for teachers to become familiar with effective science learning, teaching strategies, and resources
- Assist with the design and delivery of professional development programs for current and future teachers of science

Design and Prepare Curriculum

- Serve as a technical adviser to develop, revise, and disseminate elementary and middle school instructional materials



NSRC WORKS WITH INTERNATIONAL GROUPS TO:

- Build awareness for a new vision of effective science learning and teaching, and for the required support systems
- Share national and international institutions' experiences
- Highlight the responsibilities and roles of scientists and engineers
- Explore the role of science academies in science education reform
- Identify strategies for international cooperation in this endeavor

Our Future

"Let us teach our children to read, write and cipher – but let us also help them explore something of how the material world works. Children need to sense through hand, eye, and mind the limits of what can be done, and how even within stern natural limits new opportunities can open."

Philip Morrison
Professor Emeritus
Massachusetts Institute of Technology

Phylis Morrison
Specialist
Elementary Science Education

Excerpted from the keynote address for the National Science Resources Center's 1989 Elementary Science Leadership Institute

OUR SPONSORS

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Bristol-Myers Squibb Foundation, Inc.
Carolina Biological Supply Company
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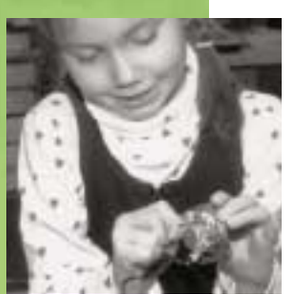
The Dow Chemical Company Foundation
DuPont
Hewlett-Packard Company
The Lucent Technologies Foundation
Merck Institute for Science Education
The Robert Wood Johnson Foundation
The Shell Oil Company Foundation



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THE NSRC IS AN ORGANIZATION OF:

THE NATIONAL ACADEMIES
Advisers to the Nation on Science, Engineering, and Medicine

Smithsonian Institution