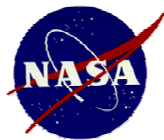


# Scientist Involvement in Education and Public Outreach



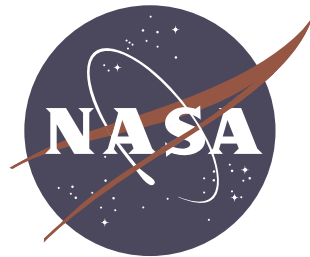
## *Making the Case*



# NASA/NSF Scientist Involvement in EPO

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Research directorates of funding agencies like NASA and NSF are increasingly encouraging (and in some cases requiring) the integration of science and education and greater scientist involvement in Education and Public Outreach (EPO).



## NASA/NSF Scientists Increase EPO Involvement

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- NASA Office of Space Science (OSS) now *requires* every flight project (e.g., Hubble Space Telescope, Mars Pathfinder), to have a significant EPO program, totaling 1-2% of the overall mission budget.
- NASA's Earth Science Enterprise (ESE) is likely to enact a similar policy.
- NSF/GEO is now holding funding competitions for increased geoscience outreach to teachers, students, and the public.

# Goldin Advocates EPO Involvement

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“The NASA Strategic Plan makes it the responsibility of each of our Strategic Enterprises to "embed" education into its program. No longer is it an acceptable practice to say, "we are too busy." Research, knowledge generation and education are all equal components of the NASA mission. We must combine our traditional methods of involving the education community with new and innovative ways so that the impact NASA has on education is greater.”

--Daniel S. Goldin, NASA Administrator, before the  
Committee on Science, United States House of  
Representatives, 28 April 1999



# Colwell Advocates EPO Involvement

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“In science and math education, the links among inquiry, discovery and learning is omnipresent. All researchers - whether at a university, a national lab or circling the Earth in a space station - should link their inquiries with the education of the next generation.”

--Dr. Rita Colwell, Director, National Science Foundation,  
before the House Science Committee, 28 April 1999



# NASA & NSF Advocate EPO Training for Scientists

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“OSS must provide focused opportunities (through workshops or other appropriate means) for training to allow members of the space science research community to become more useful partners in education and effective contributors to the public understanding of science.” --NASA Office of Space Science

Education/Public Outreach Strategy  
Implementation Plan, 1996

“GEO should help sponsor regular workshops for training geoscientists in educational issues that address a range of level of scientists involvement.” --NSF Directorate for Geosciences,  
Geoscience Education Strategy, 1997



# The Need for Improvement - TIMSS

## Third International Mathematics and Science Study (TIMSS)

### Overall Comparative Findings U.S. Performance Relative to the International Average

Content Area	Fourth Grade	Eighth Grade	Final Year of Secondary School	Advanced Math & Science Students
Mathematics Overall	Above	Below	Below	—
Science Overall	Above	Above	Below	—
Advanced Mathematics	—	—	—	Below
Physics	—	—	—	Below

SOURCE: National Center for Education Statistics (1996-1998). For more information visit the TIMSS website: <http://nces.ed.gov/timss>

# The Need for Improvement - Seasons

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- According to NSF's *Science & Engineering Indicators -- 1996*, 53% of a sample population surveyed did not know that Earth orbits the Sun once per year.
- 21 out of 23 randomly selected students, faculty and alumni of Harvard University could not correctly explain Earth's seasons.

# The Need for Improvement - Kansas

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- In August 1999, the Kansas State Board of Education voted 6 to 4 to remove the teaching of evolution from the state standards.
- Scientists are needed to become advocates of sound policies and standards in science education.

# Scientists Rise to the Occasion in Kansas

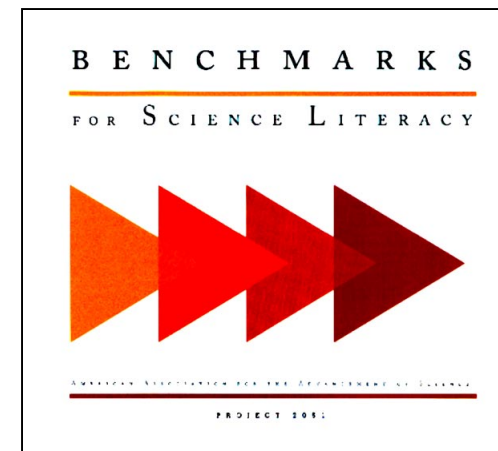
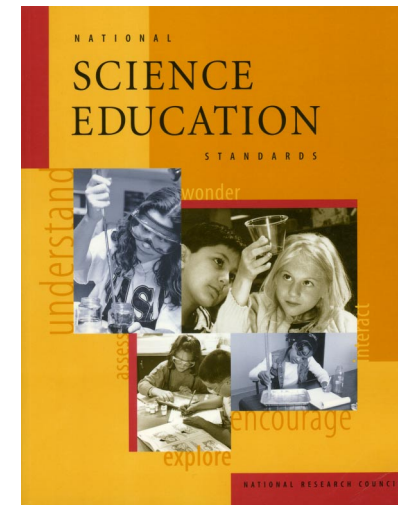
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- “**Scientists** and school board candidates – even the governor – said Kansas would seem embarrassingly backward if the new science standards stayed in place.”
- “**Steve Case, a biologist at the University of Kansas and a leader of the drive to restore evolution to the curriculum** said that he and others brought in speakers like Kenneth R. Miller, a Brown University microbiologist and author of “Finding Darwin’s God: A Scientist’s Search for Common Ground between God and Evolution.”
- “In the election, voters defeated those candidates who last year supported removing the mention of evolution from the state science curriculum.”

Source: “Science Expands, Religion Contracts” by Pam Belluck, *New York Times*, 13 August 2000

# National Science Education Standards

- National Science Education Standards give a consensus of educators and scientists nationwide regarding what students should know and be able to do at different K-12 grade levels in science.
- Standards also address best teaching practices, professional development of teachers, and implementing systemic reform of education.



# Importance of Partnerships - Alberts

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“I now view effective science education partnerships between scientists and precollege education science teachers in a completely different light - as the only hope for lasting systemic change in precollege science education and, therefore, as an important national priority for the United States.”

-Bruce Alberts,

President of the National Academy of Sciences, 1993



# What Scientists Can Contribute

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Scientists offer much that is needed to contribute to the realm of education and public outreach:

- Respect and influence in community
- Deep knowledge of science & scientific process
- Exciting connections to real world exploration
- Access to data and facilities
- Role modeling for students

# Modern Science Education Reform

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- Students as “scientists” with teachers as facilitators of learning
  - Teacher as “a guide on the side” rather than a “sage on the stage”.
- “Inquiry-based” process of learning
  - “The way scientists *do* science rather than the way they were *taught* science.”

# Doing Science: Teaching Science

## Science Method

- Raise fundamental question of interest
- Research what is already known
- Plan & implement experiment
- Reflect on results and how they affect what was known before
- Communicate learning via talks & papers

## Education Analog

- Engage students, establish inquiry
- Assess prior knowledge of students
- Plan & implement a hands-on activity
- Reflect on results and how they affect prior knowledge
- Communicate learning via assessment methods



# Comparing Approaches to Teaching

<b>A Conventional Approach</b>	<b>A Hands-On Approach</b>	<b>An Inquiry-Based Approach</b>
<p>The teacher tells students that trees can be classified by examining their bark and their leaves. She shows pictures of trees in a textbook and asks students to memorize the names of the different types of trees according to the sort of bark and leaves they have.</p>	<p>The teacher tells students that trees can be classified by examining their bark and their leaves. She shows pictures of trees in a textbook and takes students to the park and asks them to match the pictures with the real trees.</p>	<p>The teacher tells students that scientists classify trees by the different features they have. She asks them to come up with ideas for what features would distinguish one tree from another. She takes them to the park to explore their ideas and to make observations and gather data that would help them create their own classification scheme for trees.</p>

# Variety of EPO Roles for Scientists

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- Presentations in a classroom or a public setting are not the only way to contribute to education and public outreach.
- There are many other roles scientists can play in education and public outreach that are suited to a diversity of talents and interests.

# A Sampling of Roles for Scientists in Education

		Nature of EPO Involvement		
		ADVOCATE	RESOURCE	PARTNER
Entry Point	<b>K-12 STUDENTS</b>	<ul style="list-style-type: none"> <li>Participate in PTA</li> </ul>	<ul style="list-style-type: none"> <li>Judge a science fair</li> <li>Answer student email</li> <li>Give tour of research facility</li> </ul>	<ul style="list-style-type: none"> <li>Mentor a student</li> <li>Tutor a student</li> </ul>
	<b>IN-SERVICE K-12 TEACHERS</b>	<ul style="list-style-type: none"> <li>Speak out in support of appropriate professional development opportunities for teachers.</li> </ul>	<ul style="list-style-type: none"> <li>Answer teacher email</li> <li>Present in teacher workshop</li> </ul>	<ul style="list-style-type: none"> <li>Work with a teacher to implement curriculum.</li> <li>Hire a teacher intern.</li> </ul>
	<b>INTRO UNDERGRADUATE SCIENCE TEACHING</b>	<ul style="list-style-type: none"> <li>Speak out in a faculty meeting in favor of attention to educational research that supports the reform of undergraduate science teaching.</li> <li>Support the teaching profession in your science classroom.</li> </ul>	<ul style="list-style-type: none"> <li>Teach a segment of a science or science methods course for pre-service teachers.</li> </ul>	<ul style="list-style-type: none"> <li>Teach an intro science course that applies innovative inquiry-based methods</li> <li>Develop a science course or curriculum in your department for teachers-to-be.</li> </ul>
	<b>SCHOOLS OF EDUCATION</b> (Science Courses for Pre-Service Teachers, Graduate Students, Faculty Members)	<ul style="list-style-type: none"> <li>Speak out in your department or organization in favor of closer ties with Colleges of Education</li> <li>Support the teaching profession in your classroom</li> </ul>	<ul style="list-style-type: none"> <li>Teach a segment of a science course or science methods course for pre-service teachers.</li> <li>Collaborate with education faculty to improve courses on teaching science</li> </ul>	<ul style="list-style-type: none"> <li>Hire a graduate in education as evaluator of an education project</li> <li>Work with an Education professor to develop a new "science methods" course for teachers-to-be.</li> </ul>
	<b>SYSTEMIC CHANGE</b> (District, State, National)	<ul style="list-style-type: none"> <li>Speak out at professional meetings about the importance and value of scientist involvement in systemic change.</li> </ul>	<ul style="list-style-type: none"> <li>Review science standards for science accuracy.</li> </ul>	<ul style="list-style-type: none"> <li>Collaborate on writing or adapting science standards.</li> </ul>
	<b>EDUCATION MATERIALS DEV.</b> (NSRC, EDC, Lawrence Hall)	<ul style="list-style-type: none"> <li>Speak out at a school board meeting for adopting exemplary educational materials.</li> </ul>	<ul style="list-style-type: none"> <li>Review science educational materials for science accuracy.</li> </ul>	<ul style="list-style-type: none"> <li>Collaborate to create exemplary science education materials.</li> </ul>
	<b>INFORMAL EDUCATION</b> (e.g., Science Centers, Scouts, Planetaria, Elderhostels, Amateur Astronomy Groups)	<ul style="list-style-type: none"> <li>Participate on the board of a science center or planetarium.</li> </ul>	<ul style="list-style-type: none"> <li>Review scripts for science exhibit or planetarium show.</li> <li>Serve as a science advisor for an exhibit</li> </ul>	<ul style="list-style-type: none"> <li>Create content for a museum science exhibit or planetarium show.</li> <li>Serve as science coordinator for a scout troop</li> </ul>
	<b>PUBLIC OUTREACH</b> (e.g., NPR, PBS, popular magazines/books/encyclopedias, lecture circuits, public websites)	<ul style="list-style-type: none"> <li>Advocate that quality science news be covered by your local newspapers and television stations</li> </ul>	<ul style="list-style-type: none"> <li>Give a public lecture</li> <li>Review an article or web site on science for accuracy and currency</li> </ul>	<ul style="list-style-type: none"> <li>Collaborate in the production of a PBS television show</li> <li>Write an article for a popular science magazine</li> </ul>
	<b>EPO PROGRAM MANAGEMENT</b>	<ul style="list-style-type: none"> <li>Advocate the involvement of scientists in education and public outreach</li> </ul>	<ul style="list-style-type: none"> <li>Assist a scientist with matching their talents and interests to an EPO project</li> </ul>	<ul style="list-style-type: none"> <li>Design EPO programs with effective partnerships between scientists and educators.</li> </ul>

ADAPTED FROM: "Improving Science Education: The Role of Scientists," Bybee, Rodger W., and Cherilynn A. Morrow, Fall 1998  
 Newsletter of the Forum on Education of the American Physical Society



# Nature of EPO Roles for Scientists

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- **Advocate:** inspires, encourages, gives permission, empowers
- **Resource:** helps when called upon; makes resources available
- **Partner:** works shoulder-to-shoulder, “in the trenches,” with education specialists to create new products or opportunities

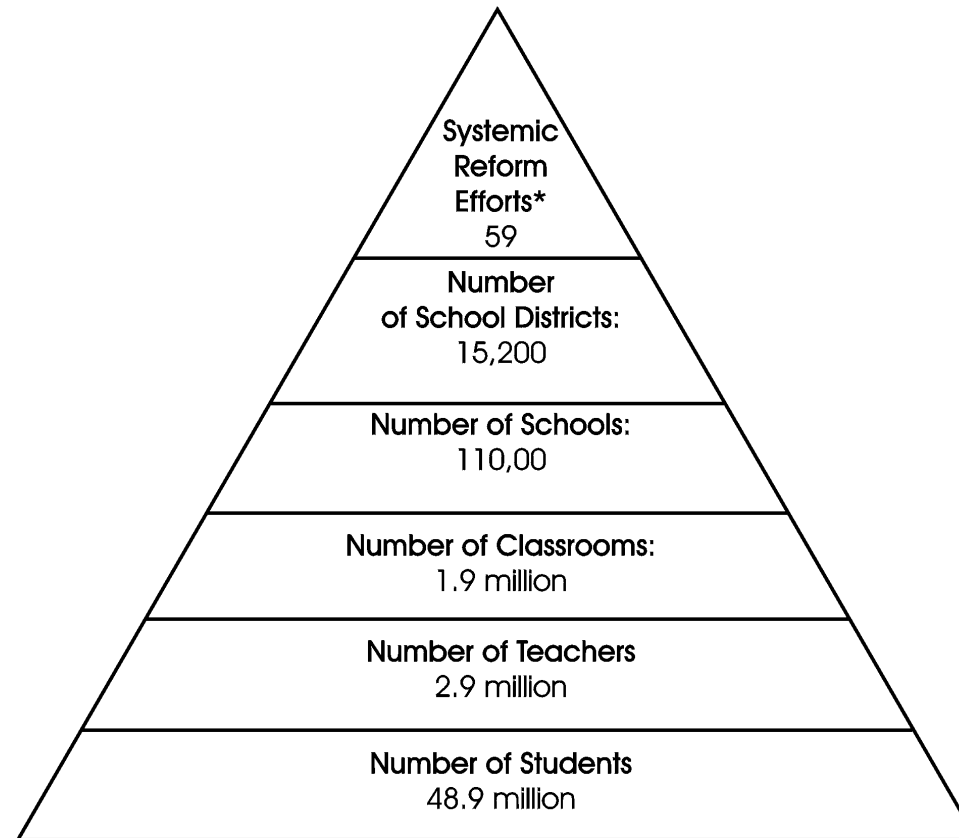
# Classifying Scientists in EPO

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- ◆ **A Tither** - a practicing research scientist who volunteers some of his/her time to EPO -- generally less than 10%
- ◆ **A Part-timer** - a scientist who is paid to do part time research and part time EPO
- ◆ **A Cross-over** - a full time EPO professional who was trained to do scientific research, and now has “crossed over” to the EPO field

# Education Pyramid

## Statistics on the US Education System



Adapted from “Implementing the Office of Space Science

Education/Public Outreach Strategy” (1996)

C.A. Morrow [camorrow@colorado.edu](mailto:camorrow@colorado.edu)



# Defining Formal Education

Provides a sustained opportunity to deepen knowledge and understanding of fundamental ideas and concepts that are useful in contributing to and interpreting the world around us.



# Defining Informal Education



Offers engaging learning opportunities in unique environments (e.g. museums, planetariums, nature centers) that motivate further learning and life long interest.

# Defining Public Outreach

Reaches out to where people may conveniently tune in to hear or see in their everyday lives with information that excites, interest and arouses curiosity (e.g. TV, radio, home computer, magazines).



# Defining Marketing

Primarily intended to market the worth of programs and products to targeted customers or special interest groups.



# Defining News Media Support

ning of wildlife in the United States.”

Bob Johns, deputy assistant director of communications for the Bureau of Land Management in Washington, said Friday, “The bureau just received the demands, and we won’t be able to comment on them until we’ve had a chance to review them thoroughly.”

Wildlife Services people feel ex-

Coolahan believes the aerial gunners comply with the National Environmental Protection Act, or NEPA, and that the shootings are site specific. That means they target offending animals and not all coyotes in the vicinity of grazing sheep.

“A lot of the aerial hunting is done on snow prior to the sheep arriving,” he said. “There was a

But that doesn’t mollify activists like Keefover-Ring, who defends the coalition’s bid to ban the practice.

“All that killing coyotes does is attract others to take their place,” she said. “And because the prey base has a chance to recuperate, the new coyotes have more young with a better chance of surviving. It creates a worse situation.”

**Gates worries**

Since Microsoft is guilty of breaking antitrust laws, flitting into America courtesy of a T that reminds me really wants to his software re thing better. H best is yet to c

Meantime, I are canvassing find out if folks he’s Big Bad B tic predator.

Come the el Microsoft case if George W. B makes good on promise. Rem before the crit primary on G Bush was opin be a better way ing-up Micros

**EPA adds to p**


The Environ Agency is gult tion.

Paperwork p Federal audi is violating the Reduction Act, of reducing the burden on bus years. EPA has additional hou the public. Phe

**GOP directed**

The preside hinges on Cath So believes National Comm Haley Barbour his party: “Th vote in the cou

**Science made simple?**



Steve Groer/News Staff Photographer

Katelyn Swanson, 11, of Blue Springs, Mo., and her brother, Josh Swanson, 8, check out a plasma sphere at the Denver Museum of Natural History. Radio waves break up the neon and argon gas atoms inside the globe. The museum was celebrating National Astronomy Day.

Provides new information for the print, radio, and television media via reporters. Reaches large audiences, and

content can sometimes be adapted for more substantive educational purposes.

## Three C's for Partnerships with Educators

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### ➤ COLLEGIALITY

(find mutual respect with educators; acknowledge their expertise in education and the way it can complement your expertise in science)

### ➤ COMMUNICATION

(do not condescend or try to take over; be very conscious of scientific jargon)

### ➤ COLLABORATIVE SPIRIT

(collaborate rather than compete with educators)

# Ideas to Get Started in EPO

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- Attend workshop for scientists in education (e.g. SSI workshop; <http://www.space-science.org/Education/ResourcesForScientists/Workshops/1.html>)
- Study the National Science Education Standards <http://www.nap.edu/readingroom/books/nse/>
- Contact EPO support orgs. who can facilitate connections with the education community <http://www.hq.nasa.gov/office/oss/education/ecosystem.htm>
- Ask colleagues and/or EPO partners about existing EPO programs involving scientists

# Conclusions

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- There is a strong need to improve science education and science literacy in the US.
- The participation of scientists in collegial partnership with educators and outreach specialists is vital to meeting this need.
- There are a wide variety of valuable EPO roles for a scientist depending on his or her particular talents and interests.