High-Level Advocacy

“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, 1993
  
  President, National Academy of Sciences
Modern Science Education Reform

• 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.”
Standards Contain Fundamental Concepts

- Systems
- Cycles
- Energy Transfer
- Forces & Motions
- Pattern & Scale
- Science as Inquiry
Goals of Science Education

- **Content Knowledge** [fundamental concepts]
- **Process Skills** [skills of inquiry: observing, measuring, collecting data, analyzing data, reasoning, drawing conclusions from evidence]
- **Connections** to other disciplines, society, life
- **Intellectual confidence, enthusiasm** for life-long learning, and **curiosity** about the world.
Variety of EPO Roles for Scientists

• 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.
Types of EPO Support from Scientists

- Advocacy for positive change
- Content advisor/reviewer
- Speaking/presenting/teaching
- Access and use of data/resources/facilities
- Content creation (writing, images, web design, etc)
- Curriculum or course development

Adapted from “The Diversity of Roles for Scientists in K-14 Education & Public Outreach” by Cheri Morrow camorrow@colorado.edu
**Tithers** - practicing research scientists who volunteer some of their time to EPO -- less than 10%

**Part-timers** – scientists who are paid to do part-time research and part-time EPO

**Cross-overs** - full time EPO professionals who were trained to do scientific research, and now have “crossed over” to EPO

Adapted from “The Diversity of Roles for Scientists in K-14 Education & Public Outreach” by Cheri Morrow camorrow@colorado.edu
**Advocates**: inspire, encourage, give permission, empower

**Resources**: help when called upon; make resources available

**Partners**: work shoulder-to-shoulder, “in the trenches,” with education specialists to create new products or opportunities

Adapted from “The Diversity of Roles for Scientists in K-14 Education & Public Outreach” by Cheri Morrow camorrow@colorado.edu
Excerpt from "A Framework for Developing Education & Public Outreach Programs Associated with Scientific Research Programs" by Cheri Morrow, June 2000
What IS E/PO?

Formal Education
- Teacher Workshops
- Project ASTRO
- Curriculum
- Textbooks
- Astro 101 courses
- classroom
- Smaller audience
- More contact time
- Deeper understanding

Informal Education
- Museum exhibits
- Eclipse tours
- Star parties
- Field trips
- Events
- “unique”

Public Outreach
- Encyclopedia entries
- TV/radio programs
- Web chats
- Popular books
- Magazine articles
- home
- Larger audience
- Less contact time
- Shallower understanding

Adapted from “A Framework for Developing Education & Public Outreach Programs Associated with Scientific Research Programs” by Cheri Morrow, June 2000
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).

Informal Education: Engaging opportunities in unique environments (e.g. museums, planetariums, clubs) to motivate life-long interest and learning.

Formal Education: Provides a sustained opportunity to deepen knowledge and understanding of fundamental ideas and concepts (e.g. degree and certificate programs).
E/PO Venn Diagram

Formal Education  Informal Education  Public Outreach

Display booths, Pins, Stickers, Patches, Mugs, Bookmarks, Postcards, etc...
Press releases, Press conferences, Press kits for reporters, video clips, etc...

Adapted from "A Framework for Developing Education & Public Outreach Programs Associated with Scientific Research Programs" by Cheri Morrow, June 2000
What E/PO is NOT

- Coasters
- Wall paper
- Door stops
- Tchotchkes
- Press releases, press conferences, or yet another ... mission poster, sunspot exercise, redundant web site...

Courtesy Heidi Hammel
## Sample EPO Roles — Examples from the *Roles Matrix*

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<th>Resource</th>
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<tr>
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<td>Review standards</td>
<td>Co-write standards</td>
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<td>Mentor for scouts</td>
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<td>Write popular book</td>
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<td>Ed sessions at science mtgs</td>
<td>EPO scientist for flight mission</td>
<td>Serve as EPO lead: co-design EPO plan</td>
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Adapted from *"The Diversity of Roles for Scientists in K-14 Education & Public Outreach"* by Cheri Morrow camorrow@colorado.edu
Phil Scherrer

Stanford University

Research Professor of Physics:
- PI for MDI on SOHO spacecraft
- PI for Magnetic Imager on SDO
- Director of Wilcox Observatory

~ 5% time devoted to EPO:
- 1 public lecture per year
- 1 time per month with 4H club
- Encouraging staff participation

QUOTE FROM HIS PROFILE:
“As the PI of a major project, take EPO not simply as a duty, but embrace it as a key part of your activities. With a larger project you actually have an opportunity to make a big impact.”

Adapted from Profiles of Scientists in EPO. This one by Preston Dyches and Cheri Morrow. See http://ssibroker.colorado.edu/broker/PROFILES.htm
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Adapted from “The Diversity of Roles for Scientists in K-14 Education & Public Outreach” by C. A. Morrow
The Monotillation of Traxoline

It is very important that you learn about traxoline. Traxoline is a new form of zionter. It is monotilled in Ceristanna. The Ceristannians gristerlate large amounts of fevon and then bracter it to quasel traxoline. Traxoline may well be one of our most lukized snezlaus in the future because of our zionter lescelidge.

Directions: Answer the following questions in complete sentences.

1. What is traxoline?
2. Where is traxoline monotilled?
3. How is traxoline quaselled?
4. Why is it important to know about traxoline?

Attributed to Judy Lanier
Guidelines for Public Speaking –
devised by C. A. Morrow

• **A = Audience** (Know it, Care about it)

• **B = Big Picture** (Background, Basics, Begin at the Beginning, Relevance, Use Frameworks of Understanding)

• **C = Communication Skills**
  - Language
  - Interactivity
  - Visuals
  - Excitement/Enthusiasm

Excerpt from Morrow, Cherilynn A. "How Scientists Can Become Involved in Education and Public Outreach”, Abstracts of the NOAA Postdoctoral Program in Climate and Global Change meeting in Steamboat Springs, CO, June 2002. Contact camorrow@colorado.edu for a copy of this page-long abstract.
The Sun in 5 Different Types of Light

1. Visible
2. UV
3. EUV
4. EUV/X-ray
4. X-ray

from the SOHO Website

6,000 degrees K
Gary Rottman

- University of Colorado
- Senior Research Scientist:
  - Associate Director of LASP
  - PI for the SORCE mission
  - PI for the SOLSTICE instrument
- No fixed pattern to time on EPO:
  - oversight of EPO partnership to develop school outreach program
  - occasional public lectures/tours
  - writing popular articles
  - advocacy for team doing EPO

QUOTE FROM HIS PROFILE:
“EPO is part of the job, and I must say that is it probably one of the more enjoyable pieces of it. When you do it, you find all these people that are bright-eyed, eager and excited about what you do.”

Adapted from Profiles of Scientists in EPO. This one by Preston Dyches and Cheri Morrow. See http://ssibroker.colorado.edu/broker/PROFILES.htm
The Laboratory for Atmospheric & Space Physics
University of Colorado, Boulder
**Sample EPO Roles – Examples from the *Roles Matrix***

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Adapted from “The Diversity of Roles for Scientists in K-14 Education & Public Outreach” by C. A. Morrow
David Alexander

- Lockheed Martin (soon Rice U.)
- Staff Physicist:
  Working on solar flares, coronal mass ejections, coronal heating, and mission concepts.
- EPO time supported by Lockheed:
  - EPO lead for YOHKOH mission
  - Creator/facilitator of Solar Week
- QUOTE FROM HIS PROFILE:
  “Partnering with teachers or other education professionals tends to be mutually rewarding and often fun. Combining your strengths... is a good recipe for an enjoyable and fruitful collaboration that has a better chance of having a meaningful impact.”

Adapted from Profiles of Scientists in EPO. This one by Preston Dyches and Cheri Morrow. See http://ssibroker.colorado.edu/broker/PROFILES.htm
Common Cultural Differences Between Scientists and Teachers

• Intellectually confident/arrogant
• Competitive
• Critical
• Less socially adept
• Confronts problems
• Assigns credit carefully for colleagues’ ideas

• Less intellectually confident
• Collaborative
• Appreciative
• Good social skills
• Works around problems
• Borrows good ideas freely from colleagues

Excerpt from Morrow, Cherilynn A. and Dusenbery, Paul B. “Workshops for Scientists and Engineers on Education and Public Outreach”, Preprint: Session Proceedings from the COSPAR Scientific Assembly, Houston, TX, October, 2002. Contact camorrow@colorado.edu for a copy of this paper.
Defining “PARTNER-ship”
devised by C. A. Morrow

- **P** = Personal & Professional Development**
- **A** = Appreciation – express it!
- **R** = Respect – partners’ expertise, cultural differences
- **T** = Trust – safety to reveal what you know & don’t know
- **N** = Needs – time constraints, meeting education standards
- **E** = Enjoyment – fun and satisfaction
- **R** = Responsibility – to each other and to learners

Solar Week is a week-long series of web-based educational activities designed to spark the interest of pre- and early teen girls in science by direct interaction with female scientists at the forefront of solar research.

http://www.lmsal.com/YPOP/solarweek/
### Sample EPO Roles — Examples from the *Roles Matrix*

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Adapted from “The Diversity of Roles for Scientists in K-14 Education & Public Outreach” by C. A. Morrow
George “Pinky” Nelson

★ Western Washington University

★ Director, Sci, Math & Tech Education
  - ex-solar physicist and ex-astronaut
  - ex-Associate Dir. for UW Space Grant
  - ex-director for AAAS Project 2061

★ Full time on EPO:
  - coordinating 10 scientists in support of teacher prep program
  - forming an applied research group
  - teaching every quarter

★ QUOTE FROM HIS PROFILE:
  “Scientists who get involved in EPO should help people learn the science that they themselves know, and their effort must be tempered by knowledge of educational research…Do your homework…Talk to educators…Read the literature…Forget developing materials for teachers. You don’t have the time or expertise. Neither do teachers. Leave that job to the professionals.”

Adapted from Profiles of Scientists in Education & Public Outreach. This profile by Preston Dyches and Cheri Morrow. See http://ssibroker.colorado.edu/broker/PROFILES.htm
Atlas of Science Literacy:

Atlas is an exciting new resource that presents conceptual connections among the ideas and skills that serve as goals for student learning.

They graphically display how students might develop in their understanding of topics such as gravity, natural selection, and statistical reasoning from kindergarten through grade 12.

http://www.aaas.org/project2061/
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Adapted from “The Diversity of Roles for Scientists in K-14 Education & Public Outreach” by C. A. Morrow
Cherilynn Morrow

- Space Science Institute, Boulder CO
- Manager for Education & Public Outreach
  - ex-solar physicist [HAO, Cambridge]
  - ex-Associate Dir. for CO Space Grant
  - ex-Visiting Scientist at NASA HQ
- Full time on EPO:
  - EPO workshops/resources for scientists
  - NASA OSS EPO Broker in the West
  - workshops for educators on science
  - development of instructional materials

QUOTE FROM HER PROFILE:
“I was looking for a career path that would integrate more of my personal interests in music, movement, poetry, and outdoor adventure... The biggest challenge used to be lack of respect from scientific colleagues who thought less of me for “wasting” my PhD in science on envisioning and managing EPO programs. These days this sentiment seems to be less prevalent, but it’s still out there...”

Adapted from Profiles of Scientists in Education & Public Outreach. This profile by Preston Dyches and Cheri Morrow. See http://ssibroker.colorado.edu/broker/PROFILES.htm
“I have a very strong feeling that science exists to serve human welfare. It’s wonderful to have the opportunity given us by society to do basic research, but in return, we have a very important moral responsibility to apply that research to benefiting humanity.” – Walter Orr Roberts
A collection of informal education activities and resources for kids ages 6-13 developed by Morrow, Dyches, and Wilkerson
For more info about *Kinesthetic Astronomy*, click on “K-12 Curriculum” at [http://www.spacescience.org](http://www.spacescience.org) or contact camorrow@colorado.edu
The Space Weather Center

A 700 sq. ft. traveling exhibit developed in collaboration between the Space Science Institute of Boulder, CO and several Sun-Earth Connection missions based at NASA/GSFC.

Currently at the Challenger Center in Peoria, AZ
I know why... there’s a sun up in the sky...
It’s space weather
Since the Sun and Earth been together....
It’s solar wind all the time

Sun’s a-flare...plumes and prominences everywhere....
Stormy Weather
Sunspots play in pairs, yea together....
And solar wind all the time...the time...Yes, solar wind all the time...

Then a CME (solar storm) burst from the Sun to get me
When it hit the earth magnetic storms, they met me
All I did is pray the lord above will let me
See northern lights once more

Sun shines on... Solar cycles come and gone...It’s space weather
Since the Sun and Earth been together...
It’s solar wind all the time... Yes, solar wind all the time
Space physicist Robert Hoffman of GSFC participates in a classroom visit as part of the Space Science Institute's annual 4-day education workshop for scientists.
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Adapted from “The Diversity of Roles for Scientists in K-14 Education & Public Outreach” by C. A. Morrow
We’re now looking for a few good reviewers and field testers!
## Sample EPO Roles — Examples from the Roles Matrix

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Adapted from “The Diversity of Roles for Scientists in K-14 Education & Public Outreach” by C. A. Morrow
“If scientists make the right connection, they can do something important and valuable without a huge investment of time. With SECEF, we have the contacts and capabilities to make connections with the education world as we’ve never had before. I find that it’s possible to invest 10% of my time and get a lot out of that 10%.

Although we already often feel over-subscribed, and EPO seems like “yet another thing to do,” much can be done with good arrangements by those who know the EPO business…I hope more people will look into contacting NASA’s EPO organizations to see how they can work together with whatever commitment constraints they have.”

Janet Luhman
Space physicist, UC Berkeley

Adapted from Profiles of Scientists in Education & Public Outreach. This profile by Christy Edwards and Cheri Morrow. See http://ssibroker.colorado.edu/broker/PROFILES.htm
The Sun-Earth Connection Education Forum (SECEF) is one of four NASA OSS Education Forums that coordinate EPO activities between OSS missions.

SECEF is based both at UC Berkeley and GSFC

http://sunearth.gsfc.nasa.gov/
“HOOKS” for LEARNING ABOUT THE SUN

TOTAL SOLAR ECLIPSES

Source: High Altitude Observatory Archives
“HOOKS” for LEARNING ABOUT THE SUN

SPACE WEATHER EFFECTS ON EARTH

Courtesy Dan Baker
Sun-Earth Day 2003
Live From the Aurora
NASA Sun-Earth Connection Education Forum

Auroras: Living with a Star
February 11
Live web-cast for museums from Poker Flats
Feb 21-22 & Mar 1-2

Sun-Earth Day
Live From the Aurora
March 18

Scientist’s Participation and Registration for Sun-Earth Day 2003

http://sunearth.gsfc.nasa.gov/suneartday
"HOOKS" for LEARNING ABOUT THE SUN

VENUS Transit 2004

Courtesy SOHO and the NASA Sun-Earth Connection Education Forum
“HOOKS” for LEARNING ABOUT THE SUN

ARCHEO-ASTRONOMY

Courtesy SOHO and the NASA Sun-Earth Connection Education Forum
NASA OSS EPO Broker/Facilitators

- Northeast – Cary Sneider
- East – Nitin Naik
- Southeast – Cass Runyon
- North – Lynn Narasimhan

- Southwest – Robbie @ LPI
- West – Cheri Morrow
- Northwest – Julie Lutz

http://ssibroker.colorado.edu/Broker/Brokers/
Resources for Scientists in Education

This section is for scientists and science managers doing education education managers in scientific research programs.

Educators working in partnership with scientists.

http://spacesscience.org/Education/ResourcesForScientists
White Papers on CD/Web

- A Framework for Planning EPO Programs Associated with Scientific Research Programs
- The Diversity of Roles for Scientists in K-14 Education and Public Outreach
- What are the Similarities Between Scientific Research and Science Education Reform?
- Misconceptions Scientists Often Have about the K-12 National Science Education Standards

Published in *Astronomy Education Review*:

http://www.aer.noao.edu

See http://www.spacescience.org

[See Quick Links menu at bottom of page; Click on “Papers on EPO”]
LIFE TRAJECTORY*
- Need a good launch
- Assists & influences needed
- Non-linear paths possible
- Multiple paths are possible
- Multiple destinations of interest
- Own impetus also matters

EDUCATION “PIPELINE”
If you don’t feed through to a PhD then you “leaked out”.

The idea of “life trajectory” vs. “pipeline” was first introduced to C. Morrow by Richard Shope of JPL. This slide represents Morrow’s interpretation of Shope’s original idea.
The Joy of Solar Physicists in Science Education

Hats off to these and other solar scientists in EPO!

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