Setting the Stage

The NASA Science Mission Directorate Education Program:
Sharing the Adventure with the Student

Laura Peticolas, University of California-Berkeley
Theresa Schwerin, Institute for Global Environmental Strategies
Stephanie Shipp, Lunar & Planetary Institute
Denise Smith, Space Telescope Science Institute
Science and Science Education Go Hand-in-Hand

Denise Smith
Lead, Astrophysics Science Education and Public Outreach Forum
Sharing the Adventure with the Student: **NASA Science** is an Essential Piece of the STEM Puzzle

- Inspiration
- Exposure
- Role Models
- Unique Science Content
- And More…
NASA advances its goals through a wide-range of partners
Missions and Research Programs Seek Answers to Fundamental Questions

Earth Science
Heliophysics
Planetary Science
Astrophysics

To share the science, the story, and the adventure of NASA’s scientific explorations of our home planet, our Sun, the solar system, and the universe beyond... providing a direct return on the public’s investment in NASA’s scientific research.
Scientists bring...

- Knowledge of Earth and space science
- Knowledge of research and data
- Knowledge of STEM career paths

Educators bring...

- Knowledge of science education pedagogy
- Knowledge of audience needs
- Knowledge of education standards

Scientist-Educator Partnerships are the Cornerstone of SMD Education
Students, educators, and the public are able to participate in the practice of science called for by the National Research Council (2012) and embodied in the Next Generation Science Standards (2013).

Cutting-edge science and technology are carried into schools and public programming in a way that is accurate and meets audience needs.

This partnership has become so deeply engrained, that many feel it epitomizes NASA’s social contract with the nation.
Current, Accurate, Audience-Focused Resources are **Needed and Used**

Hubble’s Amazing Space:

- Uses Hubble’s discoveries to reinforce key science concepts and process of science
- ½ million teachers per year; 6 million students per year
- Selected by more than half State Departments of Education; used in all 50 states
Students, Educators, and the Public Participate in the Practice of Science

**MY NASA DATA** - over 200 classroom-friendly Earth science datasets and tools; 100+ peer reviewed lessons; ~80,000 unique visitors annually; 60,000 back links

High school student publishes paper about his research using THEMIS data

*Science* magazine selected the Mars Student Imaging Project as one of the top inquiry-based education modules in the U.S.

Educators fly side-by-side with scientists on SOFIA
Scientists are Engaged in Education in Meaningful Ways

Aquarius Mission: Concept mapping workshops and tools helping ocean scientists represent and communicate science
A Nationwide, Coordinated Community of Practice

Laura Peticolas
Lead, Heliophysics Science Education and Public Outreach Forum
SMD Education Spans the Spectrum

Curriculum Support

Exhibits & Shows

Professional Development

Student Activities

Research Experiences

Out-of-School-Time & Community Events
SMD Education Leverages a Highly Skilled Community of Practitioners

<table>
<thead>
<tr>
<th>Choices</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Informal education experience (museum, park, library, afterschool, etc.)</td>
<td>86.00%</td>
</tr>
<tr>
<td>Ph.D. scientist</td>
<td>85.00%</td>
</tr>
<tr>
<td>K-12 teaching experience (any grade)</td>
<td>78.00%</td>
</tr>
<tr>
<td>Higher education teaching experience</td>
<td>77.00%</td>
</tr>
<tr>
<td>Electronic media development/Information technologies experience</td>
<td>77.00%</td>
</tr>
<tr>
<td>STEM experience in the private sector</td>
<td>42.00%</td>
</tr>
<tr>
<td>preK teaching experience</td>
<td>12.00%</td>
</tr>
</tbody>
</table>

SMD education leads have deep, significant experience in NASA STEM: 71% have > 6 years (41% > 10 years)
Community of Practice Levels of Participation: A Common Picture

outsiders

observers

occasional

experts

core group

leaders
coordinators: Forums

active

beginners

transactional

clients: students, educators

sponsor: NASA SMD

Credit: Adapted from slide by Etienne and Beverly Wenger-Trayner (http://wenger-trayner.com/resources/slide-forms-of-participation/)
Characteristics (Wenger-Trayner):

• **Our Domain** is **SMD science education**
  – Community is interested in how to best incorporate NASA Science as a meaningful part of the National Science Education landscape while understanding how to navigate NASA culture, requirements, & needs.

• **Our Community** is **coordinated primarily by Forums**
  – Community is maintained through virtual and face-to-face meetings, an online workspace, shared resources on NASA Wavelength.

• **Our Practice** in being **effective SMD science education leads**
  – Experiences, stories, tools, ways of addressing challenges lead to understanding how best to do SMD science education
Forums **Maximize Cohesion, Effectiveness, Efficiency**
Across a Nationwide Community of Practice

- Organize collaborations between programs to **reduce duplication**
- Enable sharing of **best practices**
- Align products to **national education standards**
- Create and maintain **NASA Wavelength** education product catalog
- Help disseminate program **metrics and evaluation findings**
Underlying SMD Efforts is the Application of Best Practices

As a community of practice we work together to:

• Identify and raise awareness of existing body of best practices and educational research, including audience needs

• Organize distance learning and face-to-face professional development opportunities for NASA science education professionals
Putting Research into Practice: Curriculum Support Resources & Professional Development

Stephanie Shipp
Lead, Planetary Science Education and Public Outreach Forum
Leveraging NASA Science to Inspire, Engage, and Educate Students in STEM
SMD education materials are standards-based, field-tested and evaluated

Development involves SMD Education Professionals, SMD Scientists, Audience Members

- **Needs Assessment**
  - Determine needs of target audience
  - Evidence-based literature review
  - Identify national education standards

- **Make a Design Plan**
  - Identify measurable goals and objectives
  - Develop a logic model

- **Make a Prototype**
  - Create a prototype
  - Development team reviews prototype
  - Ensure pedagogical and scientific accuracy
  - Ensure alignment to national education standards

- **Pilot Test**
  - Provide a completed version for a small target audience testing or review
  - Revise as necessary

- **Field-Test**
  - Test with a representative sample of external users
  - Revise as necessary

- **NASA Product Review**
  - NASA Earth and Space Science Education Product Review carried out by the Institute for Global Environmental Strategies (IGES)

- **Dissemination To Partners**

- **Impact**
  - Summative evaluation
  - Learning outcome study
  - Impact study/follow-up
  - Adoption by State Departments of Education, school districts, colleges of education, and professional education associations

- **Reach**
  - Formal Education
  - Teachers
  - Students
  - Informal Education

**NASA Education Product Review Criteria Include:**
- Relevance and Accuracy
- Alignment to national education standards
- Effective instructional practices and appropriate student assessment

* Graphic: Space Telescope Science Institute Design Process
Design driven by audience needs and research-based best practices for digital libraries

Multiple pathways through the collection, that are meaningful for educators
Create custom collections through list-building and share through social media and Atom feeds.
NASAWavelength.org

Connect to broader NASA family of multimedia, science news and images

Learn in-depth information about using resources in the classroom through the blog

- NASA Multimedia
  - NASA Apps
  - ScienceCast
  - eClips
  - Image of the Day

- NASA Science News
  - 21W (Northwest Pacific)
  - Satellite Views Early Thanksgiving Travel Trouble Areas in U.S.
  - Satellite Movie Shows Massive Great Lakes Snowstorm

Recent Blog Posts

Strand Maps - Making Your Path Through Wavelength

Wavelength has a great feature that you may not know about - strand maps. Strand maps are not intended to prescribe a particular curriculum or instructional strategy, instead, they offer a framework to inspire creative curriculum design. Using the strand maps in this way first requires a quick primer on reading the strand maps, which is what this blog post is all about.

Read More

- Read All About It: Science News for your Class
- Inspiring Wonder in Our Universe
- Your Students Can Fly Along With NASA Scientists
- What's STEM Got To Do With It?
- Soar Through Earth Science with NASA Airborne Campaigns
- Happy Anniversary, Aura!
- IBEX: Mission Science for Students with Dyslexia
- School's Out!
- Exploring Earth with Citizen Science - The GLOBE Program

See all blog entries
Five Highest Rated Reasons to Attend a NASA K-12 Professional Development Experience

1. Learning Ways to Use NASA Resources with Students
2. Accessing NASA’s Imagery and Science
3. Discovering Cutting Edge Scientific Work Done by NASA
4. Receiving Science Content from a NASA Scientist
5. Acquiring NASA Resources (Print/Electronic)

Source: 2013 Survey on Teacher Professional Development by NASA SMD Cross-Forum K-12 Working Group
http://smdepo.org/post/5656
Our community of practice works together and with educators to identify **audience needs** and to tailor professional development that leverages NASA science, community expertise, and education research to meet those needs.
Leveraging: NASA Master Teachers Education Ambassador Model

- **Tier 1** educators participate in week-long professional development workshops.
- **Tier 2** educators participate in day-long professional run by tier 1 educators.
- **Students** taught by Tier 1 and Tier 2 educators
- Often **multi-mission** collaborations
- Classroom educators and out-of-school educators
SMD Education Programs Have Built a Broad Range of High Impact Partnerships
SMD EPO Programs Have Built a Broad Range of **High Impact Partnerships**

Reached 4 million+ visitors through this NASA - National Park Service - US Fish and Wildlife Service Partnership
Our Audiences Reflect the Diversity of Our Nation

“Congratulations to these women that have gotten to NASA — and especially being Spanish and Panamanian. Yes, we can! Yes, we can!”

Collaborations with holders of cultural knowledge leads to renewed student interest in own culture and science

Scientists and educators empowered to serve their community.
Purposes of Evaluation:
• Characterize and communicate
• Inform decisions
• Improve design and implementation
• Ensure quality
• Demonstrate impacts

Types of Evaluation (Very Broadly):
• Peer reviews, program reviews, and analyses
• Formative (Needs assessments, Implementation)
• Summative (Outcomes, Impacts)
Rigorous reviews, evaluation, and data-driven decisions

• Mission-embedded programs and programs funded via solicitations are expected to include evaluation plans.

• SMD convenes external review panels to evaluate its programs according to rigorous criteria.

• Mission plans undergo rigorous review at mission key decision points.

• SMD programs report data and metrics to NASA through annual reports, data calls, Office of Education infrastructure.
Evaluation Shows Gains in Awareness, Knowledge, and Understanding

- GPM-enhanced STEM lessons increased students’ understanding of core curriculum concepts (e.g., water cycle, global energy budget, and hurricanes) equal or better than students in comparison classes. GPM “Survivor” Outdoor Education Module showed statistically-significant increases in understanding, facilitators reported students were “highly engaged.”

- High-school teachers participating in the week-long NLSI Unknown Moon Institute demonstrated significant gains in content knowledge.

- McREL learning outcome study shows that students using STScI’s Planet Impact would score statistically higher than a control group on a standardized test.
Development of Skills, Interest, and Engagement in STEM

83% enrolled in or completed a degree program reported majoring or minoring in a STEM subject.

Reinvented my understanding of science. The program has given me the confidence to pursue a career in science.

Collaboration with NSF-funded iGETT enables two-year colleges to meet workforce needs for geospatial skills. 90% of faculty remained fully engaged over the three-year project. 70% report increased student interest; increased interest in enrolling in more geospatial tech courses, and understanding of career opportunities.

At the end of every single day, I felt stronger not only about RS [remote sensing], but also about how to TEACH RS.
Evaluation Shows Knowledge Gains and Curriculum Use in Many Train-the-Trainer Programs

- **Tier 1 teachers** in the MAVEN Educator Ambassador program showed significant increases in their understanding of core curriculum concepts (e.g. gravity, sizes, atmospheric composition, and importance of magnetic fields of Earth and Mars.)

- **Tier 2 teachers** in the Heliophysics Educator Ambassador program indicated that they focus on heliophysics content for an average of 10 instructional hours annually, primarily as a supplemental resource and share heliophysics-related materials and ideas with an average of 141 students in a typical year.

- **Students** who participated in the Beyond Einstein Explorers' Program activities showed an increase in understanding of astronomical concepts and the tools used by astronomers to study the Universe.
An Effective Return on Investment

“The NASA Science Mission Directorate programs are to be commended for their close integration with the science missions of NASA and for their use of partnerships to bring educational expertise into their work.”


http://smdepo.org/page/5324
# SMD Education Contributes to Federal Priorities

<table>
<thead>
<tr>
<th>Federal Strategic Plan</th>
<th>SMD Education Programs</th>
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<tbody>
<tr>
<td>Improve STEM Instruction</td>
<td>The SMD community reported working with more than 34,000 K-12 educators in FY12 alone. Including the reach of SMD curriculum support materials and work with master teachers, the impact is far greater.</td>
</tr>
<tr>
<td>Increase and Sustain Youth and Public Engagement in STEM</td>
<td>In FY12, the SMD community reported working with over 680,000 K-12 students. Numerous SMD partnerships greatly extend SMD’s impact within and beyond the classroom.</td>
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<tr>
<td>Increase Students Graduating with STEM Degrees</td>
<td>SMD materials and programs engage students at critical junctures in the STEM pipeline. Example studies show increased interest in / continued pursuit of STEM.</td>
</tr>
<tr>
<td>Better Serve Groups Historically Underrepresented in STEM Fields</td>
<td>SMD programs are designed and implemented in partnership with a wide range of underserved groups.</td>
</tr>
<tr>
<td>Enhance Graduate Experiences</td>
<td>NASA’s scientific research programs provide direct STEM experience to participating undergraduates, graduate students, and postdocs.</td>
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</table>
The Bottom Line: NASA Science is an Essential Piece of the STEM Puzzle
To the SMD EPO Community:
Thank You!

Learn More About SMD EPO Program Impacts
http://smdepo.org/page/5324

Find SMD Education Materials
http://nasawavelength.org
Explanatory Guide to SMD EPO Evaluation Factors

NASA SMD Education Product Review
http://nasareviews.strategies.org

Science and Science Education Go Hand-in-Hand:
The Impact of the NASA Science Mission Directorate Education and Public Outreach Program
By Smith, Peticolas, Schwerin and Shipp
http://smdepo.org/post/6378

NASA SMD EPO Policy (SPD-18)
http://science.nasa.gov/media/medialibrary/2012/03/01/SPD-18_Mission_EPO_Policy.pdf