

**DESIGNING, IMPLEMENTING, AND EVALUATING THEMATIC, INQUIRY-BASED, STANDARDS-ALIGNED PROFESSIONAL DEVELOPMENT EXPERIENCES FOR EDUCATORS THROUGH NASA MISSION EDUCATION AND PUBLIC OUTREACH.** A. J. P. Jones<sup>1,2</sup>, B. C. Hsu<sup>1,2</sup>, L. V. Bleacher<sup>1,2</sup>. <sup>1</sup>NASA Goddard Space Flight Center, 8800 Greenbelt Road, Greenbelt MD 20771, andrea.j.jones@nasa.gov <sup>2</sup>Lunar and Planetary Institute, 3600 Bay Area Blvd, Houston TX 77058.

**Introduction:** The The 5-day pilot workshop of the Lunar Workshops for Educators professional development series sponsored by the Lunar Reconnaissance Orbiter (LRO), called the Lunar Institute for Teachers, was held at NASA Goddard Space Flight Center in July 2010. The Lunar Institute for Teachers provided educators of grades 6–12 with a rich, immersive experience in lunar science thematic, inquiry-based materials aligned with national standards that demonstrate lunar science concepts, and the preparation to incorporate this information and materials into their educational environments. Evaluations orchestrated by Dr. Jacob Noel-Storr from the Rochester Institute for Technology and collected throughout the workshop series are continually being used to improve LRO workshops. The design, implementation, evaluation, and improvement of the LRO professional development workshop series can serve as an example to other professional development providers when planning and implementing science workshops.

**Workshop Goals:** The first step in designing a professional development experience is to set specific measurable goals that lead to enhanced student learning and achievement [1]. The overarching goals and outcomes for the LRO workshop series are stated in Figure 1. Each of these goals has associated measurable evaluation questions [2].

**Figure 1: Project goals and outcomes for the LRO professional development workshop series [2].**

Teachers participating in LRO programs of professional development and using the LRO formal education module with their classes will gain:

- a) Abilities in supporting an inquiry driven science classroom as described in the National Science Education Standards (NSES) Teaching Standards
- b) Understanding of their own and their students' misconceptions about topics related to lunar science
- c) Confidence and ability in using technology components in their teaching (for example accessing and using LRO data) as described in the National Educational Technology Standards (NETS) Teaching Standards

A further goal of the LRO workshop series is to reach audiences underserved with respect to NASA

workshops, and share lunar science with them in meaningful ways.

**Design and Evolution:** The LRO Lunar Workshops for Educators were designed based on best practices outlined in the latest pedagogical research of science and mathematics professional development [e.g. 1, 3, 4, 5, 6]. The workshops will be continually refined based on evaluation results, experience, and continued assessments of student and teacher needs, following a model similar to the Original Professional Development Design Framework outlined by [7].

**Lunar Workshop for Educators**  
Sponsored by the Lunar Reconnaissance Orbiter mission

**June 20–24, 2011**  
**Herrett Center for Arts and Science**  
**Twin Falls, ID**

The coldest place in the Solar System – measured, the most precise and complete topographic map of the Moon – created, a lost lunar spacecraft – found, astronaut footprints – traced! All of this and more has been made possible because of the Lunar Reconnaissance Orbiter (LRO).

In this workshop, educators of grades 6–12 will:

- Learn about the latest discoveries in lunar science and exploration
- Reinforce your understanding of lunar science concepts
- Interact with lunar scientists and engineers
- Work with real LRO data
- Learn how to bring this data and information to your students using hands-on activities aligned with your state and national standards
- Visit Craters of the Moon National Park to learn geologic concepts you will apply to the Moon

Laptops are strongly encouraged for participation in this workshop.

For more information and to register, visit <http://lunar.gsfc.nasa.gov/education.html>

**Figure 2: Example advertising flier for workshop.**

**Methods:** Through the LRO workshop series, educators throughout the United States learn about lunar science, exploration, and how our understanding of the Moon is evolving with new data from lunar missions. Participants work with LRO data and learn ways to incorporate these data into their educational environments using inquiry-based, hands-on activities. Each activity is specifically designed to address national standards, with local state standards also indicated at each workshop site, so they can easily be incorporated

into existing science curricula. Educators are exposed to new science results through interactions with lunar scientists and engineers, and review and reinforce basic lunar science concepts, with special attention paid to student and teacher misconceptions. Participants develop learning communities through shared learning experiences, reflection, problem-solving, and discussions. Where possible, workshops include field trips that expose teachers to NASA or other science facilities, or strengthen their understanding of geology.

The workshops begin with a test of participants' current state of knowledge. New information and materials are presented, and then educators are guided through activities. All activities are led in an inquiry-based teaching style educators can replicate with their students. Participants are provided with time for reflection and discussion of the subject matter and activities, and are encouraged to consider possible obstacles their students may encounter when learning this material. They engage in problem-solving strategies for overcoming these obstacles. Time and instructional support is allotted for teachers to consider and discuss how they can best convey the new material to their students within their existing curricula; future participants will be required to bring their curricula to workshops to facilitate this process.

**Extension:** The professional development experience extends beyond the 5-day intensive workshop. A relationship is maintained with participants through quarterly follow-up sessions to a) determine the extent to which they are implementing the lunar science information and activities in their educational environments; b) monitor the responses of students, colleagues, administrators, or others to the materials; and c) provide additional guidance if needed. During follow-up sessions, participants share successes and struggles with implementation and provide support to one another, share strategies, and problem-solve, further developing the learning community they constructed during the summer workshop.

Past participants are invited to return to later workshops as instructional assistants. There they share important reflections and strategies with new participants on their experiences incorporating new lunar science content and activities into their classrooms. This peer-to-peer instruction reinforces the understanding of the veteran participant, gives them further ownership of the material, and provides valuable practical information to new participants from experienced counterparts.

Educators earn continuing education or college credits for their successful participation in the professional development experience.

**Results:** Educators who participate in the LRO Lunar Workshop for Educators series have the opportunity

to get current scientific data into the hands of their students, further strengthening the students' interest in and understanding of science, technology, engineering, and mathematics (STEM) content and careers. Participants return to their school districts with thematic, inquiry-based materials aligned with local state and national standards that they understand how to share with their students, and enhanced background science content knowledge. As a result of the workshop, participants reported feeling a renewed excitement about the Moon, and more confidence in teaching lunar science to their students [2].

The Evaluation Summary Report prepared by Noel-Storr indicates that the pilot workshop was successful, and met the intended short-term outcomes for the teachers; long term outcomes will be addressed in a future report [2]. Noel-Storr recommended key aspects of the workshop that should be maintained (such as providing opportunities for teachers to learn software that allows their students to conduct research projects) and aspects that could change (such as including more activities that stress the importance of using mathematics in science).

**Summary:** The LRO professional development workshop series is a successful, effective model of a scientific professional development experience for educators. Its content and structure is based on sound scientific principles, pedagogical research, and best practices, and the series has been reviewed and approved by NASA Headquarters [8]. We will report more details of the LRO pilot workshop, progress of the participants since the workshop, evaluation criteria and expanded results from the Evaluation Summary Report, and discuss how feedback will be incorporated into upcoming lunar workshops.

**References:** [1] Loucks-Horsley S. et al. (2003) *Designing Professional Development for Teachers of Science and Mathematics, 2<sup>nd</sup> Ed*, Corwin Press, Inc., Thousand Oaks, CA. [2] Noel-Storr J. (2010) *RIT Insight Lab* Report #ESR-NLIT-20101130. [3] Alfieri L. et al. (2010) *J. Ed. Psych.* doi:10.1037/a0021017. [4] Baumfield V. (2006) *Oxford Review of Education*, 32, 2, 185–196. [5] Darling-Hammond L. (2000) *Education Policy Archives*, 8. [6] Heller J. I. et al. (2001) *Annual technical report to the Stuart Foundation*, San Francisco: WestEd. [7] Loucks-Horsley S. et al. (1998) *Designing Professional Development for Teachers of Science and Mathematics*, Corwin Press, Inc., Thousand Oaks, CA. [8] Hsu, B. C. (2010) LRO EPO Implementation Plan, submitted to NASA Headquarters for LRO Senior Review.