

DREAM Lunar Extreme Program and Workshop: An Effective Afterschool Program for High School Students. L. V. Bleacher¹, W. M. Farrell¹, N. Gross², and H. Weir³ ¹NASA Goddard Space Flight Center, 8800 Greenbelt Rd., Greenbelt, MD 20771 (Lora.V.Bleacher@nasa.gov), ²Boston University, ³Science Systems and Applications, Inc..

Introduction: Dynamic Response of the Environment at the Moon (DREAM) is one of seven U.S. teams comprising the NASA Lunar Science Institute (NLSI). The goal of DREAM scientists is to reveal, advance, and test the extremes of the solar-lunar environmental connection and the surface-gas-plasma environmental systems at the Moon [1]. DREAM's education and public outreach (E/PO) efforts seek to advance the understanding of students, educators, and the public that the Moon is not the stagnant "dead" body that it is commonly considered to be.

Lunar Extreme Programs and Workshops: DREAM's E/PO program has focused heavily on providing high school students and teachers with opportunities to interact directly with scientists. The primary components of the program have been a semester-long Lunar Extreme Program (LEP) and a subsequent Lunar Extreme Workshop (LEW) in both 2011 and 2012. The goals of each LEP and LEW were to increase student understanding of the Moon as a dynamic place and to increase awareness of the process of science and the types of science, technology, engineering, and mathematics (STEM) careers available to them.

Each LEP was designed to be an afterschool program so as to increase the flexibility of its use. The LEP syllabi, consisting of resources and activities pertaining to the Sun, Moon, space weather, impact cratering, and other relevant topics, were developed with the assistance of a high school physics teacher. The syllabi were also mapped to the National Science Education Standards [2] and the American Association for the Advancement of Science Benchmarks for Science Literacy [3]. During each LEP, students independently read and reviewed the resources in the syllabus on their own at home. Their progress and understanding was checked during discussions with their larger student/teacher team during regular meetings. Meetings were supplemented with hands-on or computer-based activities and Webinars with DREAM scientists and others. The Webinars provided the opportunity for students to virtually "meet" science team members before interacting with them in person at a LEW. The Webinars also gave DREAM team members an opportunity to provide context within the DREAM framework for the syllabus topics while also introducing students to STEM careers.

After completing the LEP, student and teacher teams attended a LEW along with the DREAM team. The LEWs provided an opportunity for DREAM scien-

tists to present the results of their integrated modeling efforts to each other as well as the student and teacher participants. In this way, student and teacher participants were able to interact directly with scientists and to experience the process of science in action while also being exposed to STEM careers and content.

2011 LEP and LEW: The first LEP took place from January through June 2011. Two student/teacher teams participated, one located at Eleanor Roosevelt High School in Greenbelt, MD and another at Seton-Keough High School in Baltimore, MD. Each team consisted of one teacher and five students. Teams met once a week for sixteen weeks. Dr. William Farrell (DREAM PI) visited each school in person to kick off the program. Student teams also participated in Webinars with DREAM E/PO and science team members, as well as other scientists. Webinars were archived and made available to the teams for additional review as needed.

The first LEW was held at Goddard Space Flight Center (GSFC) on June 20-23, 2011. This LEW focused on the effects of a major solar storm on the lunar surface. In addition to hearing from and interacting with DREAM scientists during the LEW, students and teachers also presented their observations and interpretations of the May 1998 solar storm data being used by the DREAM team in their models, solved problems on ion landing locations and sputtering rates in polar craters and presented the results, toured GSFC, interacted with non-DREAM scientists during GSFC's annual "Science Jamboree", interacted with engineers working on technologies related to DREAM science, and heard from an undergraduate intern coordinator about NASA's intern programs and how to apply.

2011 Survey Results. The students were surveyed about their LEP and LEW experiences at the conclusion of the LEW in June. For the LEP, students reported enjoying the Webinars with scientists the most; however they also wished it had been more interactive. As for the LEW, the students reported that they most liked watching scientists interact with each other during the workshop. They also indicated a desire for more interactivity and mentioned that some of the presentations were too technical for them to follow. Overall, the students rated the combined LEP/LEW experience as valuable because it allowed them to see how science is done and what it is like to be a scientist. Students unanimously said they now view the Moon differently (as more dynamic) than before the LEP and LEW. 67% of the students said that they are now con-

sidering a career in STEM as a result of their experience. 78% of the students said that they would recommend the DREAM LEP/LEW to other students.

2012 LEP and LEW: The 2012 LEP ran from August to November. The associated LEW took place at NASA Ames Research Center from November 6-8. One team, consisting of ten high school students and one teacher, was selected from Valley Christian High School in San Jose, CA. The team met every other week after school for discussion and instruction centered around the theme of the effects of impacts at various scales on the Moon. Like the previous LEP, students read and reviewed the resources suggested within the syllabus on their own before meeting with the team for further discussion, activities, and Webinars with DREAM scientists. A local DREAM scientist also visited Valley Christian High School to meet and talk with them in person about the impact process and his career path.

Based on student feedback from the 2011 LEW, the 2012 student team attended the workshop on just the last day, thus reducing saturation from overexposure to a large number of technical presentations. In addition to hearing an overview of the previous days' results, the students engaged in open discussion with scientists about the results, learned more about what it is like to be a scientist and the different pathways for doing so, interacted with NLSI leadership, completed a hands-on activity that introduced the Monte Carlo method, observed a cloud chamber to see the effects of cosmic rays in action, and toured several facilities at Ames, including the UV spectrometer lab for the Lunar Dust and Atmosphere Environment Explorer (LADEE) mission and the lunar dust toxicity lab.

2012 Survey Results: Students reported that the most enjoyable aspect of both the 2012 LEP and LEW was being able to meet and interact with a variety of scientists. What they least liked was the short length of the overall program. Again, students unanimously indicated that they now see the Moon as more dynamic than before their participation in the LEP and LEW. Like the participants of the 2011 LEP and LEW, 67% of the 2012 students said that they are now considering a career in STEM as a result of their participation in the DREAM LEP and LEW.

Summary: The DREAM LEP brought together high school students, their teachers, and DREAM scientists for a semester-long, largely virtual, afterschool program in both 2011 and 2012. Each LEP was then followed by a face-to-face workshop, a LEW, with DREAM scientists. Based on feedback from the first LEW in 2011, the DREAM E/PO team modified slightly the LEW for 2012 by reducing the time the students were exposed to highly technical presentations. While that time was not completely eliminated,

it was reduced and technical information reformatted to reduce oversaturation.

Based on the results of surveys issued to students at the end of each workshop, the DREAM LEP and LEW appear to be effective mechanisms for increasing high school understanding of the Moon as a dynamic place and for increasing students' interest in STEM careers. Students greatly appreciated the repeated and direct interactions they had with DREAM scientists throughout the LEP and LEW. These results demonstrate the value of scientist involvement in E/PO efforts.

References: [1] Farrell W. M. et al. (2012) *JGR*, 117, E00K04. [2] National Committee on Science Education Standards and Assessment; National Research Council (1996) *National Science Education Standards*, National Academy Press. [3] AAAS (1993) *Benchmarks for Science Literacy*, Oxford University Press.