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# Spaceflight-relevant stem education and outreach: Social goals and priorities<sup>☆</sup>



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## ABSTRACT

This paper is based on a presentation and conference proceedings paper given at the 65th International Astronautical Congress. The paper addresses concerns in education and public outreach (EPO) in science, technology, engineering and mathematics (STEM). The author serves as a Director of a US statewide NASA-funded Space Grant Consortium, with responsibilities to coordinate funding for undergraduate scholarships, graduate fellowships, and program awards. Space Grant is a national NASA network of STEM EPO programs including over 1000 higher education, outreach center, science museum, local government, and corporate partners. As a Space Grant Director, the author interacts with a variety of levels of STEM literacy and sophistication among members of the public. A number of interactions highlight the need for STEM EPO leaders to speak directly to a variety of social goals and priorities. Spaceflight is largely seen as an appealing and potentially desirable STEM application. However, members of the public are often unclear and ill-informed regarding relative expense, relative benefit, and relative breadth of domains of expertise that are relevant to the spaceflight enterprise. In response (and resulting in further disconnects between STEM specialists and the public), focused STEM professionals frequently over-emphasize their own technical specialty and its priority *in general* because of its importance *to that professional*. These potential divides in the attempt to share and connect STEM related goals and priorities are discussed as an elaboration of invitations to discuss spacefaring in “futures forum” contexts. Spaceflight can be seen as addressing a combination of “actualization” and “aspirational” goals at social and societal levels. Maslow’s hierarchy of needs distinguishes between “basic needs” and “actualization” as a higher-order need. Another aspect of spaceflight is aspirational—it speaks to hopes and desires for levels of flexibility and capability at the societal level. One analogy is the marketing of premium brand luxury items, at lower cost and larger volumes, to larger segments of the population. STEM EPO activities should not be directed solely at the “rocket science” applications of technology and engineering capabilities. Additional effort is needed to connect spaceflight experiences and examples to broader STEM needs, social priorities, and local contexts.

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## 1. Introduction

Entrepreneurs, researchers, and scholars in the areas of science, technology, engineering and mathematics (STEM) are essential to the development and sustainability of modern technological society. However, there is a considerable gap in the US regarding public awareness and understanding of how STEM research is conducted, the role of STEM findings in their daily lives, and the quality of US STEM education. A recent report from the Pew Research Center [1], based on a poll of representative samples of the US population (2002 responses) and members of the American Association for the Advancement of Science (3748 responses), has highlighted a number of these gaps. Apart from differences in opinion about specific issues (such as genetically modified foods, climate change, and energy use), critical gaps between the public and AAAS members have been uncovered regarding STEM education, STEM research and practice, and public knowledge about science.

An additional element of concern uncovered in the Pew report regards the limited public understanding of STEM (particularly science), and significant barriers in improving public awareness and knowledge of STEM topics. A primary barrier identified by AAAS members (75% of respondents identified as a “major reason”) is the limited quality and quantity of K-12 STEM education. While there are perceived barriers regarding the forms of media treatment of STEM topics, a more considerable concern is the lack of public interest in STEM (57% of respondents identified as a “major reason”). A telling issue identified in the poll of AAAS members is the perception that too few scientists attempt to communicate their findings to the public or the media.

This paper is intended to present an operational example of NASA-supported researchers conducting STEM research in a public setting. This example addresses many of the concerns raised in the Pew report, and highlights several important aspects of “STEM interpretation” for interactions with the general public. The research team, known as FINESSE (Field Investigations to Enable Solar System Science and Exploration), has been funded as part of NASA’s Solar System Exploration Research Virtual Institute (SSERVI). The FINESSE team’s five-year award has a specific focus on planetary science to examine volcanism and impacts affecting features and processes on solar system bodies such as the Moon, Mars and its moons, and asteroids. Planetary science is the clear scientific focus of the FINESSE project. However, the design and execution of FINESSE also enabled a strong education and public outreach (EPO) focus, despite significant reductions in project budget.

The author of this paper is a participant in this research team, although not a specialist in the areas of planetary science, volcanology, or impact effects. However, as the Director of a NASA-funded STEM education program, the author has an additional research and administrative role related to the EPO mission of NASA.

The goal of this paper is to examine the experiences of the FINESSE team in conducting STEM engagement and increasing public awareness and knowledge in a particular

NASA research area. Additional lessons learned are highlighted regarding gaps between the public and research specialists, as well as strategies for reducing these gaps. The following section provides an overview of the STEM interpretation experience of the FINESSE team; following sections address the needs of scientists and engineers for balancing research and EPO missions. A critical aspect of the author’s and the FINESSE team’s experience emphasizes the importance of effective communication with the public, despite gaps in understanding between scientific experts and public STEM educational exposures.

## 2. A day in the park

Wednesday, August 6, 2014 was designated as “Media Day” for the FINESSE team of researchers working at a National Monument and wilderness site in the US National Park Service (NPS) system. The NPS site that is hosting the FINESSE team is Craters of the Moon National Monument and Preserve (CRMO), which is known for its substantial and unique volcanic flow and planetary science features. (It should be noted that the CRMO site was used during the Apollo program to train astronauts in the areas of planetary science and selenology.) The scenario presented below is a real, and unexpected, microcosm of the dual role of STEM researchers also working to perform EPO roles for the general public.

### 2.1. The Visitors’ Center scenario

As a member of the research team is preparing field notes before the start of the formal presentation program in the Visitors’ Center, a group of CRMO park visitors ask what he is doing. The visitors are surprised to learn that the research is being funded by NASA and that one of the goals of the research team is to study volcanic and impact processes of general importance to planetary scientists.

At the end of the interaction, one of the visitors offers the researcher a business card—the visitor is an architect in a moderate sized city in the US West, and is eager to find role models for underrepresented minority students in STEM education. Other members of the visitor group remain curious about why NASA is conducting field geology research in Idaho, and when the US is likely to return to the Moon or travel to Mars or an asteroid. Although the research team member is not a geologist or planetary scientist by training, he is able to link together the issues of field teams studying volcanic flows and ejecta patterns to the challenges of maintaining team safety and coordination effectiveness while performing spaceflight operations.

Back in the Visitors’ Center, the theater is already starting to fill for the scheduled presentation. Visitors from around the US (and motorcycle caravan groups from Europe) have a variety of questions that they hope will be addressed during the presentation. The research team member who had spoken with the visitors outside is the third of the presenters during the scheduled talk time. The talk involves discussions of the history of the volcanic activity in the region (and the Native American/First Nations legends of that activity), as well the current

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