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Pathways to space: A mission to foster the next generation of scientists and engineers ☆

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ABSTRACT

The first education project funded under the Australian Government's Australian Space Research Program (ASRP), *Pathways to Space* was a unique project combining education, science communication research and research in astrobiology and robotics. It drew upon the challenges of space exploration to inspire students to consider study and careers in science and engineering.

A multi-faceted program, *Pathways to Space* provided hands-on opportunities for high school and university students to participate in realistic simulations of a robotic Mars exploration mission for astrobiology. Its development was a collaboration between the Australian Centre for Astrobiology (University of New South Wales), the Australian Centre for Field Robotics (University of Sydney), the Powerhouse Museum and industry partner, Cisco.

Focused on students in Years 9-10 (15-16 years of age), this program provided them with the opportunity to engage directly with space engineers and astrobiologists, while carrying out a simulated Mars mission using the digital learning facilities available at the Powerhouse Museum. As a part of their program, the students operated robotic mini-rovers in the Powerhouse Museum's "Mars Yard", a highly accurate simulation of the Martian surface, where university students also carry out the development and testing of experimental Mars roving vehicles. This aspect of the program has brought real science and engineering research into the public space of the museum.

As they undertook the education program, the students participated in a research study aimed at understanding the effectiveness of the project in achieving its key objective – encouraging students to consider space related courses and careers.

This paper outlines the development and operation of the *Pathways to Space* project over its 3-year funding period, during which it met and exceeded all the requirements of its ASRP grant. It will look at the goals of the project, the rationale behind the education and science communications research, the challenges of developing such a multi-faceted education project in collaboration with several partners and the results that have already been achieved within the study.

1. Introduction

In 2009, the Australian Government established the Australian Space Research Program (ASRP), with the objective of developing "Australia's niche space capabilities, by supporting space-related research, innovation and

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skills in areas of national significance or excellence" [1]. Under the auspices of the Department of Industry, Innovation, Science, Research, and Tertiary Education[1], the ASRP program disbursed a number of 2-3 year project grants in two "streams": space education development projects and space science and innovation projects. The education grants were intended to support student projects and space education activities, including international education opportunities and the establishment of national space education programs and centers of expertise for space education.

Pathways to Space was the only education project to be funded in the first round (all four rounds were merit-based and competitive), securing a grant of just under AUD $1million in 2010. It was designed as both a pilot and a showcase.

A unique project combining education, science communication research and research in astrobiology and robotics, *Pathways to Space* drew upon the challenges of space exploration to inspire students to consider study and careers in science and engineering. Focused on students in Years (Grades) 9-10 (15-16 years of age), *Pathways* was designed to investigate whether exposing students to real scientific and engineering research outside the classroom (in this case, in robotics and astrobiology) would make a positive impact on their future studies and career choices.

The development of the project was a collaboration between the Australian Centre for Astrobiology (University of New South Wales), and the Australian Centre for Field Robotics (University of Sydney), the Powerhouse Museum and industry partner, Cisco. The Australian Academic Research Network (AARNet) was also a significant contributor to the technical development of the project.

Physically hosted at the Powerhouse Museum, in Sydney, *Pathways* consisted of two main facilities: the digital studios of the Museum's *Thinkspace* digital learning center, which were outfitted for the project with a telepresence system, to enable the students to directly converse with scientists, engineers and other students beyond the confines of the Museum; and the "Mars Yard", a scientifically accurate 140 m^2 recreation of the Martian surface (analogous to the Mars Yard rover development facility at NASA's Jet Propulsion Laboratory), with an associated robotics lab. This facility, funded by the ASRP grant, is the largest Martian surface simulation in any public space in the world.

2. Background to the project: student decline in continuing science education beyond age 16

The shared vision of the *Pathways to Space* partners was to create and test a single idea: bringing real scientific and engineering research and education together in a public space, using the inspirational context of Mars exploration, would encourage high school students to consider space-related courses and careers (the key objective of the project). From the outset the aim was to achieve a student-focused space education program with a strong element of evaluation so that we could understand the effectiveness of our project in meeting its key objective. Science engagement at high school is an international problem in the developed world, but perhaps more so in Australia where students can totally switch off science at such a young age.

Pathways to Space was based on the evidence available in the literature at the commencement of the project, relating to the best approaches to science outreach. However, we found little data internationally to indicate which techniques and programs are the most effective in science outreach[2] [2,3]. No data were available as to the effectiveness of science education and outreach projects similar to the *Pathways* concept.

An Australian government research report in 2008 (Ainley et.al.) [4] confirmed that there had been a 30-year decline in participation in senior secondary school science (Years 11-12 – 17-18 years of age). For example, in 1979 almost 30% of Year 12 students studied physics. By 2007, less than 15% did so. Similarly, an Australian Academy of Science report in 2011 [5], revealed that 30 years ago 94% of students were enrolled for senior science. Today only 51% choose to do so.

This disengagement with wanting to continue science studies is underscored by Thomson and DeBortoli [6] who, in 2008, demonstrated that 15-year-old Australian students scored lower than the Organisation of Economic Cooperation and Development average on general interest in science learning, enjoyment of science learning, the importance of doing well in science, and future motivations to study or work in science.

In 2010, Lyons and Quinn [7] demonstrated, with a survey of almost 4000 high school students, that student interest in science is about the same as it was 30 years ago. Of those choosing not to undertake senior science, 66% could not picture themselves as scientists. Lyons had previously shown, in 2006 [8], that Australian students believe science is not associated with creativity, the real world, technology, or the future. Other studies also support the conclusion that students in general have a negative view of Australian school science [9,10].

Australian high school students are able to end their formal science education in Year 10. This means that Australian students, by the age of 16, can elect to undertake no further formal education in science, either at school or university. The Program for International Student Assessment data shows that in Australia the further a student lives from a city, the further behind they are in science [11]. Students can be up to two years behind, depending how far away from a city they are. Consequently some Australian students leave school with a knowledge of science equivalent to Year (Grade) 8, or approximately age 14.

The evidence from the literature demonstrates that school science bears little resemblance to how science actually works [12]. This accords with the results of a small

[1] Now restructured among several Australian Government Departments.

[2] This situation is undoubtedly driven in part by the fact that funding for projects and funding for evaluation are usually two different types of grant (education project funding and research funding).