A "Road Map" for Science Education

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By designing their own "Mission and Technology Road Maps" to discover and explore neighboring planetary systems, groups of elementary and high school students learned new lessons in science, math, and engineering and offered NASA a few lessons, too.

In January 1995, NASA encouraged scientists to recommend a long-term national strategy ("road map") for the Exploration of Neighboring Planetary Systems (ExNPS). Unknown to NASA, the Road Map process also provided an educational adventure for teenagers attending the Advanced Astronomy Camp at the University of Arizona Observatories. For a full week (June 24-July 1, 1995), these students became scientists and engineers developing Road Maps through problem-solving and observing sessions at the 40- and 60-inch telescopes on Mt. Lemmon. The resulting student recommendations have been presented to NASA Administrator, Mr. Dan Goldin.

Astronomy Camp and Project WHEEL

The 28 Astronomy Campers consisted of 9 women and 19 men (ages 13-18) from 10 states, France and Mexico. All were strongly recommended by their teachers and had completed at least Algebra II or Geometry. Nevertheless, a pretest revealed that 50% could not correctly explain the phases of the moon, 80% did not understand the causes of the seasons, and 67% had misconceptions about the nature of light.

As in NASA's Road Map process, the Campers attended workshops. Hands-on activities about light, basic astronomy, and planetary systems helped overcome their original misconceptions. Each day presented new techniques for discovering extrasolar planets, and each night students applied that technique at the telescopes. The Campers considered direct detection of planets and attempted to image, both by eye and with electronic CCDs, the Martian satellites Phobos and Deimos. They also studied indirect detection of planets through astrometric, Doppler, and eclipse techniques and used the telescopes to measure the orbital motion of Pluto, brightness changes of variable stars, and the redshift of a distant galaxy.

During the week, elementary discussions gave way to more complex topics: Adaptive optics, interferometry, gravitational lensing, brown dwarfs, pulsar planets, etc. We even considered spectroscopic methods to detect oxygen life signs in planetary atmospheres and were

privileged to operate the Sub-Millimeter Telescope (10-meter aperture) on Mt. Graham to map CO_2 in the atmosphere of Mars.

The process of recommending Road Maps to NASA generated great enthusiasm among the Campers. Throughout the remainder of this article Ms. Elizabeth Waterhouse explains her own impressions and how she passed on this enthusiasm to school children near her home.

I will never be able to precisely explain what I felt that night of my catharsis. Raised as an only child in Suburbia New York, I had been ignorant to the beauty of my home, the fragile beauty of this planet earth. Yet, on the evening of June 24th 1995 I saw the night sky of Arizona, the elusive darkness festooned with diamond chiffon. Hope and truth were abundant; I was a part of an esoteric, powerful, and magnificent world.

My week at Astronomy Camp was a turning point in my life. The learning process culminated in an opportunity to collectively devise and present papers delineating visions of NASA's future. It was this experience in Arizona which both intensified my love of astronomy and heightened my reverence for the cosmos.

My Road Map team (Timothy Bowers, Jason Lee, Rick St. Clair, and Mike Rouse) enjoyed heated debates on such issues as how to define life, what types of planets to look for in our search, and how to determine the most efficient process of locating life. Camp had created an environment where curiosity was catered to and questions were always significant. Such opportunities instill a love for learning. This effect of astronomy, this impregnation of divine wonder, should ultimately be NASA's primary goal as they move on towards the twenty-first century.

Student Recommendations to NASA

On the last afternoon of Camp, three student teams presented Road Map proposals. Although some voiced concerns about monetary resources being potentially wasted in a fruitless search, most students endorsed this research program and proposed solutions to the funding problems.

Some of their recommendations are:

1. NASA must initiate an international effort to receive necessary funding and spark public interest. It should lead an effort to improve scientific education and inform children about NASA's search for life. Make all data accessible to the public.

2. Invest in improved technology for BOTH ground- and spaced-based search methods. Create new and more accurate computer programs to allow computers and robots in space to use tools to correct optical and other technical problems. Test this new technology on a lunar space station.

3. Launch a high-resolution interferometer to the cool region around Jupiter to seach for Earth-like spectra in extraterrestrial planets.

After leaving Astronomy Camp, I shared my knowledge in a teaching program in the small town of Newtonville, New York. Titled Project WHEEL (Workshop Highlighting Exploratory Experiences in Learning), this program was provided for intellectually advanced students in fourth through sixth grades in the North Colonie Central school system. The topic of this year's workshop was "Prove It".

Beginning with the question, "Is there life in outer space and if so how would you prove it?", I guided the children through the scientific method in completing their own group Road Map. Next, I spoke on NASA's preliminary Road Map, illustrating the concepts of spectroscopy, barycenters, astrometry, gravitational lensing, and interferometry. Finally, I asked each student to write a letter explaining either what he or she had learned or what they recommended that NASA pursue in the future.

The results of this experience were astounding. As I read the simple letters, I realized I had inspired most students with a new interest! Only two of the forty students did not support the Road Map quest. Seven students expressed interest in pursuing a career or camp experience involved with space, and thirteen others wished to learn

more about NASA's work.

Recommendations included:

"I would like to see Nasa cancel the shuttle program, as much as we have benefited from it, it costs money and it would be cheaper and safer to use satellites for research. " (Tim McDonald)

"Go to other planets." (Joey Burns)

"I would like to see Nasa build a new kind of spacecraft. " (Matt Lockwood)

"I think that N.A.S.A. should work hard to try to discover life and other planets. They should send something or someone into a Black Hole." (Jake Boland).

Perhaps the short yet poignant comment of one student best illustrates the impact of my short presentation:

"Dear NASA,
I think that you should keep exploring. It is very important. I hope that I could come. Sincerely, John Cowan"

Ironically, as I look back on my school education I am amazed at how I am devoid of an official astronomy background. If this situation is common, how can NASA expect the next generation of adults to appreciate the Space Program?

A Road Map for Education?

Ultimately, NASA's success depends on public support. To ensure the long term success of the ExNPS Road Map, we believe NASA should develop an associated Road Map for science education, emphasizing real learning and participation for all ages, especially grades K-8. In our experience these students have great enthusiasm for science and technology and can understand many concepts generally taught only in high schools or colleges.