Innovative astrobiology in education

Mary Ann Kadooka (1), kadooka@ifa.hawaii.edu, Karen J. Meech (1), meech@ifa.hawaii.edu,
Timothy Slater (2), tslater@u.arizona.edu
(1) University of Hawaii, Institute for Astronomy, 2680 Woodlawn Dr., Honolulu, HI, 96822
(2) University of Arizona, Department of Astronomy, Tucson, AZ, 85721 USA

Abstract

The TOPS Astronomy Workshop sponsored by the University of Hawaii Institute for Astronomy
Australian-American brings together secondary teachers from Hawaii, the Pacific Islands, and
continental United States to meet with astronomers to discuss cutting-edge research, work on
curriculum materials and even pilot test activities with student-participants.

By tapping the resources of astronomical organizations, and stimulating interest in the state-
of-the-art technology, this program has been successfully evolving so teachers return summer
after summer for more professional development.

The holistic approach of including archaeo-astronomy and cultural aspects of astronomy plus
surveying in addition to an astrobiology component has encouraged biology and mathematics
teachers' participation, besides those teaching the physical sciences. Exciting outcomes
include a science fair winner for discovering a new variable star, formation of Astronomy clubs
at schools of TOPS teachers, and geometry students plotting planetary orbits. This session will
give highlights of this program and the "snowball effect" of increasing opportunities for
students and teachers such as the Faulkes Telescope educational partnership with Great
Britain and the Research Experience for Teachers.

---

This case study of a professional development program rich with visionary and resourceful
people illustrates an evolution of successful partnerships for educational outreach.

The original TOPS (Toward Other Planetary Systems) program, initiated by Karen Meech,
University of Hawaii Institute for Astronomy professor and researcher, began in 1993 with
seed money from a multiplicity of small grants and ended in 1995 after three summers. Since
1999, it has evolved into a National Science Foundation Teacher Enhancement workshop with
18 days of challenging activities. The thirty teachers are recruited mainly from the state of
Hawaii and the various Pacific Islands, such as Micronesia, Palau, Marshall Islands, and have
also included a few from states such as New Jersey, Texas, Montana and Arizona. With an
initial interest from physics and physical science teachers, the program now attracts biology,
earth science and mathematics teachers. The diversity of backgrounds promotes integration of
all the sciences and enriches the TOPS program. The range of grade levels taught from 7th to
12th promotes the spiraling of concepts from basic introductions of topics to an increasing
complexity of ideas. The success of the TOPS program can be measured by the willingness of
about 30% of the teachers to return summer after summer.

Besides teachers, twenty high school students are able to participate through the generosity of
a private donor who wants young people stimulated to pursue astronomy careers. Over 100
students have participated in TOPS since 1993. In 2002, the Institute for Astronomy agreed to
sponsor the Discovery Channel national science competition winner to attend TOPS.

The TOPS program offers a variety of rich educational activities. Participants feel treated with
the field trip to Mauna Kea Observatories at 13,000 feet elevation, despite nausea, headaches,
and drowsiness experienced. Hiking on the lava beds at the Hawaiian Volcanoes National Park and viewing streaming vents in the craters are enjoyed by the athletically-inclined.

Mauna Kea Observatories in Hawaii (1998, Richard Wainscoat. Used with permission)

Participants in student-teacher teams learned how to set up telescopes and do projects on variable stars, deep sky photography, and Messier objects. The more advanced teams struggled with learning to collect and analyze data using CCD cameras, photometers and spectrographs connected to the telescopes.

Setting up telescopes for lunar photography project.

The surveying of ancient heiaus (sacred sites) to determine astronomical significance and a celestial navigation lecture-discussion fascinated participants. Teams for measuring profiles of structures, surveying with equipment such as total station and theodolite, drawing petroglyphs, and doing site photography were trained before doing fieldwork with a professional archeoastronomer Clive Ruggles from University of Leicester in England. Nainoa Thompson, president of the Hawaii Voyaging Society, lectured at the TOPS banquet on the canoe voyages from Hawaii to Tahiti, and the latest voyage to Rapa Nui, also known as Easter Island.
The Native Hawaiian cultural component was supplemented in 2002 by the Jet Propulsion Laboratory program involving the Native American Lakota Chief Joseph Chasing Horse from South Dakota. He and his wife shared tribal learning bundles that contain articles of significance to be passed down through generations. They are developing educational learning bundles for tribal children to bridge the cultural gaps to be used in the classroom. TOPS participants enjoyed learning astronomy through the Lakota comet legend storytelling outdoors.

Laboratory experiments by NASA's Astrobiology Institute experts has promoted bioastronomy. Students and teachers enjoyed learning about signatures of life with activities to determine if something is alive or not, such as bubbles foaming in a plastic cup. However, experiments on extremophiles thriving in highly acidic environments or temperatures of 0 degrees or of 100 degrees Celsius were not possible, but learning about them proved exciting.

TOPS program promotes public outreach. Besides volunteering annually for the UH IfA Open House and the Ellison Onizuka Science Day, the teachers and students also work with professional organizations to share astronomy ideas. They have given presentations at Hawaii
Science Teachers Association and American Association of Physics Teachers Hawaii section conferences and even traveled to Boston for the 2000 American Association of Variable Star Observers (AAVSO) conference. At the AAVSO conference in July 2002, in Hawaii, conferees enjoyed the Powerpoint talks sprinkled with astronomy songs and skits given by 20 TOPS teachers and students on their telescope projects.

As teachers and students have been sharing their expertise gained from TOPS, other organizations have been reciprocating in-kind services. Hawaii Astronomical Society members have continued to loan their personal telescopes for observing projects and have welcomed them to monthly star parties.

Telescope training by Hawaii Astronomical Society members.

Our TOPS teachers have been invited to be members of the Friends of IfA and to attend astronomy lectures. Networking with organizations has been expanding to include not only teachers and scientists, but the community as well.

Besides the TOPS program, the UH Institute for Astronomy is promoting astronomers mentoring undergraduate students and teachers with the Research Experience for undergraduates (REU) program. The TOPS program has provided a source of enthusiastic and committed teachers with advanced astronomy background to reap maximum benefits from this opportunity. In 2001, two TOPS teachers worked on a Kuiper Belt Object (KBO) recovery project as part of the Lowell Observatory Deep Ecliptic Survey. In summer, 2002, two more teachers are doing research on star cluster images from the Hubble Space Telescope and searching for asteroids. The RET program has given teachers another window into the fascinating world of astronomy research which will encourage student projects.

The student outcomes from TOPS participation have been meeting the goal of improving astronomy education. A 2000 TOPS student won a school district science fair followed by awards at the 2002 International Science Fair. His research resulted in the discovery of a new variable star. A 1999 TOPS student is now majoring in physics at California Institute of Technology and planning to do graduate work in astronomy. Another three seniors from TOPS 1999, 2000, and 2001, worked on a remote observing project using the Lowell Observatory 31-inch telescope in Flagstaff, Arizona, using the automated software developed by astronomer Mark Buie. They now have 750 CCD variable star images to process and analyze. One of them has agreed to continue this research (a challenging proposition for this-now college freshman).
This remote observing endeavor will help with the preparation necessary for student projects in 2003 using the Faulkes Telescope North (www.faulkes-telescope.com) located on the island of Maui and dedicated for education. Donated by the Dill Faulkes Educational Trust, this professional telescope will be shared by students in Great Britain and Hawaii and provide observing time for astronomy projects. Astronomer James Heasley at the UH Institute for Astronomy is collaborating with British colleagues for this program. Another Faulkes Telescope South will be located in Australia.

Currently, the UH Space Grant is part of Space Science Network Northwest (S2N2) (www.spacegrant.hawaii.edu/S2N2info.html), consisting of the northwest section of the US with Alaska and Hawaii. Directed by Jeffrey Taylor, a geophysicist at the Hawaii Institute for Geophysics and Planetology, Hawaii’s team plans to create a database matching NASA research scientists with K-12 classroom teachers for astronomy education, plus informal educators and organizations. Our TOPS educators will be actively involved in this effort.

Finally, NASA Space Telescope Science Institute grant funding for curriculum development is based upon the research projects of IfA astronomers and has given the TOPS teachers an opportunity to be creative and to write materials. The success hinges on the astronomers making time to provide teachers with relevant research articles, actual data and images to be used in student activities. Bridging the gap between current research and basic astronomy has been the challenge. For the research on the Population II star survey, the students will be plotting the partial orbit of a binary star and using modeling to predict its complete orbit. The project on Early Earth Atmosphere is being related to activities on 'Signatures of Life' using spectroscopy.

Public outreach spearheaded by the University of Hawaii Institute for Astronomy is especially crucial for astronomy research for the world. The future of Mauna Kea and Haleakala as ground-based observation sites is tenuous. The archeoastronomy unit in TOPS on the significance of an archeological site in Hawaii has been providing the bridge for an alliance between the native Hawaiian and astronomy communities. The TOPS program has been serving as a valuable conduit for effective astronomy education. Meaningful collaboration among all parties holds the key to the perpetuation of international projects at Mauna Kea Observatories.

Acknowledgements

Grant provided by the National Science Foundation to "TOPS Leadership Teacher Enhancement Program", ESI-9731083; also generous contributions from a local donor to support students.

Grant provided by the National Science Foundation, to "Research Experiences for Undergraduates", AST-9987896.

Grant provided by NASA Space Telescope Science Institute to "Standards-Based Resource Development and Teacher Training", HST-EO-09034.05-A.