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The Impact of and Lessons Learned from NITARP, the NASA/IPAC Teacher Archive Research Program

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Abstract. NITARP, the NASA/IPAC Teacher Archive Research Program, gets teachers involved in authentic astronomical research. We partner small groups of educators with a professional astronomer mentor for a year-long original research project. The teams echo the entire research process, from writing a proposal, to doing the research, to presenting the results at an American Astronomical Society (AAS) meeting. The program runs from January through January. Applications are available annually in May and are due in September. The educators' experiences color their teaching for years to come, influencing hundreds of students per teacher. This program differs from other programs we know of that get real astronomy data into the classroom in three ways. First, each team works on an original, unique project. There are no canned labs here! Second, each team presents their results in posters in science sessions at an American Astronomical Society meeting alongside other researchers' work (participants are not given a "free pass" because they are educators or students). Third, the "product" is the scientific result, not any sort of curriculum packet. The teachers adapt their project and their experiences to fit in their classroom environment. NITARP changes the way teachers think about science and scientists. More information is available online at `http://nitarp.ipac.caltech.edu/`.

1. NITARP Overview

NITARP, the NASA/IPAC Teacher Archive Research Program, was started in 2009, built on the model established by (and lessons learned from) the Spitzer Space Telescope Research Program for Teachers and Students started in 2005. NITARP partners small groups of educators with a professional astronomer as a mentor for a year-long original research project. The teams follow the entire research process, from writing a proposal, to doing the research, to presenting the results at an American Astronomical Society (AAS) meeting.

Our goal is to give teachers an authentic research experience so that they understand more about how science really works. We use real astronomical data from archives housed at the Infrared Processing and Analysis Center (IPAC), which includes ground- and space-based missions and surveys, and which contain primarily (but not exclusively) infrared data. Each team does a unique new project; we have had teams study objects ranging from relatively close young stars to far-flung galaxies from the early Universe at wavelengths from the ultraviolet to the sub-millimeter.

We select teachers from a national competitive application process; four times as many people applied as we had positions for 2012, and five times as many applied in

2013. Ideal applicants are already familiar with the basics of astronomy (e.g., know what a magnitude is) and quantitative measures of astronomical data (e.g., what is a FITS file), but have not yet done research. Most of the participating educators are high school teachers, but eighth grade, community college, and informal educators also participate.

No school would hire a football coach who had never played the game, and yet most science teachers have never done real scientific research. Our model of providing genuine scientific research experiences works and should be extendable to other sciences.

2. Primary Program Components

Each team consists of three or four educators, a mentor teacher who has been through the program before, and a scientist mentor. Participants work to develop a science research project, execute their project, write it up, and present it—all within 13 months. Educators (and their scientist mentors) attend a start-up workshop at a winter AAS meeting (most recently January 2013). They learn about their science, their tools, how AAS meetings work, and how astronomers present results. The NITARP program pays for teacher travel. The team works remotely to write a proposal. The teams must use some of the wealth of data housed at IPAC: data from the Spitzer, WISE, Kepler, and other missions are housed at IRSA, NED, and/or NExScI. To collaborate, the teams work remotely using teleconferences and Internet-based resources such as the NITARP wiki, etc. The proposal is reviewed by a committee of astronomers and educators. The teams receive comments and rewrite their proposal, if necessary, in response. The proposals are posted on our website. The teams meet for three or four days at IPAC to work on their projects. Funding permitting, each teacher brings up to two students to this visit; students must be heavily involved in the project. The NITARP program pays for teacher/student travel; teachers may bring up to two more students using their own money. They work together remotely before and after the trip, using online resources. They present results of the project in posters at AAS meetings. Each team presents at least one science and one education poster; these are also posted on our website. Funding permitting, each teacher brings up to two students with NITARP funding; they may also bring up to two more students using their own funding. Thereafter, educators serve as NASA and NITARP ambassadors, providing 12 hours of professional development workshops, talks, etc. Some serve as mentors to the rest of the NITARP community of teachers and students. We now have 80 teachers who have been through the program, and they want to do more!

3. Challenges (Lessons Learned the Hard Way)

Finding the right teachers. Teachers have to be savvy educators and reasonably knowledgeable in astronomy, but not yet experienced doing research.

Finding the right scientists. Scientific mentors need to be patient. They need to see this work as a partnership of equals. They need to come up with a project that can be done within 13 months by people who do not know how to program computers. A project needs to have multiple "exit points" such that something substantial can be presented at the AAS meeting no matter what happens.

Travel logistics. Teachers are bringing minor students on long trips who are not biologically their own. Government travel rules require some outlay of cash, creating stress on teachers.

Working remotely across time zones. Scientists do this all the time, but teachers do not. The teams use email, the NITARP wiki, etc. to facilitate communication within the team. School email systems are often broken in one way or another, occasionally necessitating work-arounds. NITARP teams need regular (weekly or biweekly) telecons to succeed.

Software installation. We use common or free software; some schools put severe limitations on software installation.

Keeping it all together. The program is long. Between the summer visit, through the start-of-year chaos in September, there is often brain-drain. The teams just review things again in the fall to make sure things stick better.

Finding funding! We are often too science-oriented for outreach proposals and too outreach-oriented for science proposals. NITARP is funded largely out of discretionary money at present. You can subsidize a team too! Contact the authors for more information.

Closing the loop. It is hard to get teachers to tell us what they did to "share the wealth" after their intensive participation year. We know they are getting out there and sharing, but we need to be persistent to find out what they are doing.

Sustaining a community of trained educators. We now have 80 educators who want more science, more data, and more resources. We have started a "continuing education" series of web-based tutorials for 2013.

Measuring this experience. NITARP is a complex program, and requires careful and labor-intensive evaluation. Each team and each year is unique. The impact of the program may be felt most intensively 6, 12, or 18+ months after the intensive year is done. We have embarked on a careful study of the 2013 teams.

4. Impact, By the Numbers

Since 2005, through August 2013, we have had 38 science posters, 40 education posters, and eight refereed journal articles come out of NITARP projects. Eighty teachers have participated from 33 states. About 250 different students (grades 7–13) have travelled to the AAS meetings and/or Caltech.

The following statistics are based on a survey conducted in 2013 of 40 alumni spanning 2005–2013 (~50% of alumni, so multiply numbers by about two to approximate total impact).

- About 181 student trips.
- About 752 students at home who did not travel but worked on aspects of the project (average ~20 per educator).

- Approximately 3,650 students worked on smaller aspects of the projects (average ∼100 per educator).
- About 6,500 students benefitted from skills and resources the educator learned about via NITARP (average ∼183 per teacher).
- Approximately 10,700 students have been taught by NITARP educators *per year* —research in other fields suggests that simply being taught by a science teacher who has done real research has an impact on the students' learning (Silverstein et al. 2009).
- Around 2150 other educators were reached with NITARP messages and information, from "scientists are normal" through working with teachers on NITARP projects (average ∼60 per teacher).
- Schools with NITARP teachers are 70% public and 30% private.
- Schools with NITARP teachers have between 0–65% of students receiving free or reduced-price lunches; we are not just reaching elite students.

5. Selected Quotes from Participants

- "This program has opened many doors for all of us. It has been the greatest experience in my life and my students' lives."
- "The NITARP program ranks at the top of the dozens of professional development programs in which I have participated."
- "As a result of this program... my life has been altered forever. I will never be the same educator I was before."
- "My NITARP experience is giving me opportunities to teach/engage with students/parents/community members in ways that I would not be able to otherwise."
- "My NITARP experience made my science department realize that we need to bring the use of real data into our curriculum. [Because of NITARP,] I am now working with my department chair to bring a research component into all our science classes."
- "[Because of NITARP,] I now design lessons with the goal of getting students to do more of their own searching for answers, instead of being "handed" that information by teachers in lecture or PowerPoint presentations. It is so much more exciting."
- "As a result of this program, I am inspired to include real data in my astronomy course. [...] My focus on incorporating real science into my classroom has inspired other teachers in my department to do the same and generally improved the level of science teaching at my school."

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References

Silverstein et al. 2009, Science, 326, 440