



Next Generation Scientists: Creating Opportunities for High School Students Through Astronomical Research

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Abstract

Through various opportunities and experiences with extracurricular scientific research, primarily astronomical research, with programs like NASA/IPAC Teacher Archive Research Project (NITARP), and the Mars Exploration Student Data Teams (MESDT), we have noticed a change in our learning style, career path, and general outlook on the scientific community. We strongly believe these kinds of opportunities should be made available to many other high school students. The purpose of our poster is to emphasize the importance of providing high school students opportunities to explore different styles and methods of learning. We believe that a basic high school education is not enough to expose young adults to the scientific community and create enough interest for a career path. As a result, we suggest that more of these programs and opportunities should be offered to a greater number of students of all ages, allowing them to explore their passions, develop their understanding of different fields, and determine the paths best suited to their interests. Within our poster, we emphasize how these programs have specifically impacted our lives, what we hope to see in the future, and how we hope to attain the growth of such opportunities. We include proposals such as: increasing outreach programs, expanding the exposure of young students to the sciences, both in the classroom and out, and allowing high school students to participate in active scientific research. Spreading these opportunities to directly interact with the sciences in similar manners as that of professional scientists will allow students to discover their interests, realize what being a scientist truly entails, and allow them to take the first steps into following their career paths.

MESDT: Overview

MESDT is a competition style research program for high school and junior college students. Teachers from schools across the US lead teams of students to conduct research on an area of Mars. Participants listen to teleconferences led by scientists in the field and then create a PowerPoint presentation for a competition in April. The winners of the competition are invited to present their findings to scientists at Arizona State University and NASA's Applied Physics Laboratory in Maryland. We participated in MESDT during 2012/13, 2013/14 and are continuing with it in the present 2014/2015 academic year.

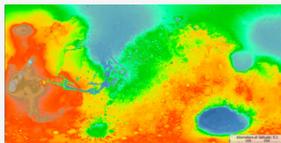


Hannah working on MESDT research 2013



Hannah and Madie working on MESDT research 2013

- Teams are made up of students from schools across the US.
- Each team picks a scientifically interesting region of Mars that would be conducive for a future mission landing, based on the area's ability to provide information about its mineral composition, the possibility of life, and its geography.
- The chosen area must also have terrain that is possible to land a rover on, or a landing site nearby with access to the research site.

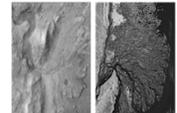


CRISM map of Mars

- Students then do research on the chosen area to determine the target area's probability to sustain life. Based on information from programs such as Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) and Java CRISM Analysis Tool (JCAT), students can look at geography and mineral composition to determine if this is possible.
- At the conclusion of their research, a presentation is developed and presented to the committee of Mars scientists.

MESDT: Student Reactions and Benefits

- We were confused at first, but eventually grew to be more independent and confident with our research skills.
- Participating in the program over multiple years showed an overall growth in our abilities to do research as well as recognize areas where improvement was necessary.
- Working with real scientists provided us with a more authentic experience which emphasized the importance of effort and attention to detail.
- By giving students the reins, the independent structure of the program allowed us to pursue and develop our own interests and make authentic discoveries. Often, students who are given too much instruction by teachers never explore what they might find on their own.



The photo to the left shows a river like structure on Mars flowing into what seems to be a delta. The picture on the right of Russia's Lena River delta shows how similar certain parts of Earth and Mars are.

Part of our work from the final MESDT presentation 2013

"Our teacher gave us the basic rules, and just let us go. In the beginning, we had no idea where to start. We were supposed to pick a topic of research and I remember being so used to teachers telling me every single thing I had to accomplish and everything I wasn't supposed to do or try. This project taught me that you will never get a checklist in a scientific career. There are no answers yet, and it's up to you to figure them out. This is why I have trouble with the way students are taught in school. It's easy to get an A when you have everything you're supposed to do as a checklist, but there is no learning in that. You can't fail at something that's already done for you."

- Hannah

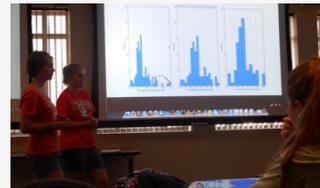
NITARP: Overview



Students at Caltech learning computer programming 2013

- Small groups of teachers and students from all over the US each partnered with a research astronomer.
- Our team used Python programming to analyze data on star formation in NGC 281.
- Our team was split up between East and West sides of the nebula to look at different types of formation.
- Everyone learned Python programming, DS9 and APT.
- Teleconferences were held for teachers throughout the year long NITARP program.
- Students and teachers met at Caltech to learn the basics of the analysis programs and get to know their team.
- Research was conducted during the summer with the use of Skype, Dropbox, python, Excel, DS9 and APT.
- Posters were created by each team of their data analysis and presented at the 2014 AAS in Washington, D.C.

NITARP allows students and teachers from high schools across the US to engage in astronomical research with help from some of NASA's top scientists. Our group was taught the basics of star formation, how to gather archived data and how to analyze that data with the use of tools such as Python, DS9, and APT, that were used to conduct research on star formation in NGC 281, a young star forming region in Cassiopeia. We participated in NITARP during the 2013 calendar year.



Students present histograms produced using Python programming of the photometry full-width half maximum during a session discussing source selection at Caltech in 2013.

NITARP: Student Reactions and Benefits

- We received positive, helpful feedback from both the Caltech visit and the AAS meeting experience.
- Going through the entire research process was extremely beneficial to us, as we were able to see everything that goes into a research project.
- We also saw the interaction between science, math, english and communication skills, and how each of these categories is just as important as the others in the field of astrophysics.
- Most students agreed that a lack of communication was present during the entirety of the project due to the spread of team members across various states. However, this became an important obstacle to overcome and is often seen in many research projects at the professional level.

"Here, I've learned that yes, physics and math are the fundamentals of astrophysics, but everyone is just as clueless as the next. We're all trying to find answers and the only way we can get to those answers is if we use the tools we've been given to try, fail, and try again."

- Hannah



Students at AAS meeting 2014



Scientist, teachers and students preparing for American Astronomical Society poster session 2014

"The most important thing I discovered at the AAS meeting was how close knit and accepting the astronomical community truly is. I think often the sciences are made out to be highly exclusive. You must be a genius in order to make any meaningful discoveries, and there is a lot of deeply entrenched competition between scientists. But, experiencing the AAS conference has shown me that not only do people from around the country collaborate with one another to perform research, they also have a wonderful alacrity to explain their findings to everyone, no matter their intelligence level [...]"

- Madie

Future work

As an astronomy club, we are continuing to find research projects that we can work on and learn from. We plan to continue our work with MESDT on another presentation for 2014/2015. In January 2015 we will work with the International Asteroid Search Campaign for our second campaign.

We plan to continue to promote these opportunities by participating in public outreach programs within our community. We will specifically advertise them in the Bozeman Public School system through presentations we plan to give to science classes. We are working to write up our experiences for submittal to the AAPT journal The Physics Teacher.

On an individual basis, both Hannah and Madie intend to work toward a career in astrophysics with the hope of becoming involved in astronomical research while in college.

Conclusion

- The incredible opportunities and experiences gained through our involvement in these programs has given us the inspiration to continue with the sciences. We believe that this sort of opportunity should be made widely available to others as well.
- Offering us, as high school students, the opportunity to get involved with scientific research has greatly enhanced our ability to: think scientifically, accept failure, be resourceful, be organized, work collaboratively, effectively time manage, communicate well and so forth. We believe that others could benefit similarly from these kinds of experiences.
- Previously separated subjects, like math, science, and writing, were all combined and connected through these programs. This allowed us to develop a better appreciation for all subject matters and understand how they are all intertwined.
- As in our own experiences, future high school students going through these kinds of programs may be uncertain of what they may be interested in doing in the future. These programs have helped us to discover if scientific research is something we hope to pursue. We believe that others could have similar experiences, opening their eyes to career paths.
- Giving us the opportunity to interact with the sciences not only educated us about the field, but also enabled us to open our minds to the nature of life beyond high school, where grades are out-weighed by ideas, and the willingness to fail is a necessity for future success.

"As we presented our research, I noticed the amount of respect I received from people who were clearly more experienced and more educated than me. This prompted me to pursue a career in astrophysics and possibly a degree in computer science; regardless of my grades or GPA in high school. This experience allowed me to regain confidence in my dedication, and know that I can be respected in the area which allows me to succeed."

-Hannah



Hannah and Madie pose for the newspaper, 2014

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