2008 AAAS/Subaru Essay Writing Competition for K-12 Educators, Finalist Essay

Turtle Haste
National Board Certified Teacher Early Adolescent Science
James Monroe Middle School
Albuquerque, NM
Grade 8

Middle School Students and Scientists Collaborating in Research through Electronic Communication

Science fair is an activity that many middle-school students are required to engage in. Prior to eighth grade, students had been limited in their exposure to long-term research of detailed topics. In fact, when deciding on a science fair project, I overheard one student state, "Just do the flower one where colored water comes up through the stems. It's easy." My goal this year was to promote serious long-term study by encouraging student collaboration with professional scientists through the use of technology.

Using the idea that student projects could be collaborative, I proposed an idea to measure shadows. Two students decided specifically to measure the length of a shadow cast by a one-meter stick at noon once a week between November and winter solstice. I suggested that students use solar noon, when the sun is at its highest point in the daytime sky, for more accuracy. Students then used online resources to learn the difference between solar noon and noon on the clock. Not only did they understand the difference, but they generated a spreadsheet with the daily solar noon times for their location to use throughout the project.

When asked where in the world they would like to compare and share data, I offered that I might be able to get several of my scientist friends to collaborate. This excited students. We used a world map and located my friends and discussed what students thought each location might contribute to the project. One of the students even asked if I knew someone on the "continent of science." I e-mailed several people I had learned about through blogs I follow (I am an armchair Antarctica buff), lectures I have attended, and the editor of the *Antarctic Sun* (http://antarcticsun.usap.gov/), the U.S. Antarctic Program's electronic newspaper, with requests for help. Several e-mails later, we had five collaborators in Antarctica, one location being the Amundsen-Scott South Pole Base. Students shared their solar noon resources and solicited cooperation from each scientist by stating what they were studying and how to collect the measurements. I became the "hub," acting as the e-liaison between students and scientists.

Students became involved in the activities on the stations by visiting webcams and tracking weather through the U.S. Office of Polar Program's links to the stations. Encouraged by the enthusiastic involvement of the scientists, one student specifically enjoyed trading photos and learning about life on the different research stations. Students developed methods for communicating their project to the larger community through the school newsletter, local newspaper, and on the International Polar Year Blog (http://www.ipy.org/index.php?/ipy/detail/studying_sun_shadows_around_the_world/). This was most exciting as it allowed students to communicate further with the researchers and present their project more formally. In discussing their project with the media, students stated that they enjoyed the opportunity to interact with

scientists using e-mail and felt that their research was valued.

In their hypothesis, the students stated: "This experiment will illustrate the relationship of the amount of direct sun Albuquerque, New Mexico gets compared to Palmer Station and Amundsen-Scott Bases between November and winter solstice in 2007. This experiment is expected to show that the closer the location is to the equator, the shorter the stick shadows will be. The results will come out this way because the earth rotates around the sun closest to the equator making those locations have more direct sun. Furthermore, over the course of the experiment, the shadows cast by the meter stick being measured will shrink in length." Although the students stated the relationship of proximity to the equator and shadow length correctly, their interpretation of direct solar angle and the length of the shadows becoming smaller was not. I realized that the apparent misconception of the earth rotating around the sun at the equator and the description of how the shadow length was based on proximity to the equator would be an excellent opportunity to further investigate solar angle, planetary motion, and that the collaborative process would be extremely useful in assisting students in their learning.

Instead of initially correcting their hypothesis, I waited for several weeks of data before I asked how their data compared to their initial idea. One of the students stated, "Well, it's wrong, because my shadow length is longer each time." The other stated she didn't understand why the weekly measurements demonstrated there was a slow 20 centimeter increase of shadow length in Albuquerque and a shortening of one meter at the South Pole and 10 centimeters at Palmer Station. In discussing the angle of isolation, I realized that students were working with the misconception that the earth moves closer to the sun in different seasons. We referred to images in a textbook but discovered that these only promoted the misconception. One student of the team became frustrated with her inability to visualize how her results were demonstrating something different than what she hypothesized. We used standard physical models, but like textbook images, the light striking the models supported the misconception. Only after students had engaged in regular e-conversations with the South Pole Shadow Team did their understanding of direct and indirect solar angles become clearer.

Our main collaborator at the Amundsen-Scott South Pole Base suggested that we calculate and compare the angle of the sun from our measurements as compared to the published angles to help us understand. Although our collaborator suggested a website of published solar angles based on latitude and solar noon, it was far too complicated for students to understand. They were still interested in exploring his suggestion, though. In looking for an explanation, they had better luck with links from Wikipedia and online Encarta in locating information that they could understand.

In order to learn how to calculate the solar angle using the Pythagorean Theorem based on their measurements, I recruited the advanced math teacher who spent time working with students and checking their calculations. Once students began to work with angles, I was able to introduce how the angle of the sun was different at different latitudes and varied seasonally. The change in understanding was stated by students in their conclusion: "This demonstrates that our hypothesis was inaccurate because in the winter the shadows

2008 AAAS/Subaru Essay Writing Competition for K-12 Educators, Finalist Essay

were becoming longer as the earth approached solstice, regardless of the location in the northern hemisphere. This is a result of the 23-degree axial tilt of the earth. The shadows are longer in the winter because the tilt causes the angle of the sun to be less direct. At the South Pole, the shadows will always be overall longer since it is farther away from the direct angle of the sun regardless of the season."

One of the students had an opportunity to call the South Pole Shadow Team and ask questions. These ranged from global warming, learning more about the team members, and asking questions like, "Did you want to be a scientist when you were young?" The student was excited to learn that the team was going to continue the measurements until spring equinox when the sun sets for the year and expressed hope that their project might be somehow used in the future by others. In addition, the student was able to discuss the physical set up problems they experienced and solicit similar observations from the South Pole team because the summative conclusion had been sent ahead for scientists to review prior to their conversation. The student shared the information with her partner and used it in revising the conclusion when discussing experimental flaws. These comments were then forwarded to other collaborators for review. The student went on to state that talking directly with the scientists helped her learn how concerned scientists really are about global warming and how they are working together to study it.

Using electronic communication, I was able to facilitate a real collaborative research experience for eighth-grade students. This project has not only facilitated student learning and enthusiasm, but received positive support from researchers, who through their interaction have welcomed students as contributing members of the scientific community. By the way, there is already a list of international participants for the spring equinox data set!