Summer Ballooning Workshop for High School Teachers and Students

Bernhard Beck-Winchatz
DePaul University, STEM Studies Department, Chicago, IL 60614

During the summers of 2011 and 2012 DePaul University held month-long high-altitude ballooning workshops for seven high school teachers and 28 high school students. These workshops were part of a NASA-funded collaboration between the Chicago Public Schools, the Adler Planetarium, and four universities. Each partner institution's workshop focused on a particular area of NASA science as a context for engaging the teachers and students in open-ended research activities. Here we will describe the collaboration with CPS and the university and planetarium partners, and the implementation of the summer workshops.

I. Introduction

THE Chicago Public Schools *Capstone Course for Space Science* is a collaboration between the Chicago Public Schools, the Adler Planetarium, Loyola University, Northwestern University, the University of Chicago, and DePaul University. It is funded by a K-12 Competitive Grant from NASA and provided approximately 40 high school teachers and 160 of their students with intensive summer research experiences based on archival NASA data and high-altitude balloon flights. Many of the students also continued their research during the school year and presented it at the Chicago science fair. Using results and materials from the workshops, the five partner institutions and teacher participants are currently (summer 2012) developing a capstone course that will provide CPS seniors with the opportunity to take a fourth year of laboratory-based science.

Each university and the planetarium held two month-long summer workshops in 2010 and 2011 for up to four teachers and 16 students, which were based on different areas of NASA science: At the Adler Planetarium (Co-I Karen Carney), students and teachers used data from the Lunar Reconnaissance Orbiter to investigate the properties of different regions of the lunar surface, such as the possibility of frozen water in permanently shaded craters. At Loyola University (Co-I David Slavsky), students and teachers engaged in research related to the search for extrasolar planets using archival data from the Kepler mission. This included, for example, the investigating photometric evidence of extrasolar planets, and determining their sizes and orbital periods. The workshops at Northwestern University (Co-I Steven McGee) focused on Earth's climate and climate change. Participants used data from Jason-1, Grace, Terra, and Quicksat for their research projects. At the University of Chicago (Co-I Donald York), teachers and students studied the interstellar medium and the birth and death of stars using data from the Far Ultraviolet Spectroscopic Explorer (FUSE), Hubble Space Telescope (HST) and Sloan Digital Sky Survey (SDSS). At DePaul University (Co-I Bernhard Beck-Winchatz), participants studied properties of Earth's atmosphere and near space environment by developing scientific payloads and launching them on weather balloons.

II. Ballooning workshops at DePaul University

The teacher participants at each site were selected competitively by the Chicago Public Schools Department of High School Teaching and Learning. Each of the selected teachers then recruited 3-5 students from his or her school. The seven teachers who participated in DePaul's workshop were Katherine Rehak (Whitney Young High School), Steve Farr (Bogan High School), Lynn Frosig (Hubbard High School), Josh Vanderjagt (Farragut Academy), Nina Hike Teague (Curie High School), Jennifer Stites (Hancock High School) and Janet Branson (Clark High School). The workshops took place from July 5-30, 2010 and from July 5-August 5, 2011. Participants met daily from 9:00 AM-4:00 PM. The NASA grant provided stipends for both teacher and students.

A. Student research projects

Each of the seven teams carried out multiple high altitude research projects. In 2010 the teams from Whitney Young and Bogan carried out near-space cosmic ray experiments. Whitney Young investigated magnetic cosmic ray shields and the effect of cosmic ray exposure on a charged capacitor as well as the germination of seeds. The team from Bogan high school tested the effect of lead and copper shields on the count rate measured by a Geiger counter. Both teams programmed Nearsys BalloonSats to record the Geiger counter data. The team from Hubbard investigated the

effect of near-space conditions on sound by recording and analyzing the sound of a piezo siren. They also created video recordings of ultraviolet beads, marshmallows, and party balloons. Farragut Academy tested the effect of near space on antibiotic efficacy and E. coli viability. The teams conducted three launches on 7/14/10, 7/22/10, and 7/27/10. At the end of the workshop each team created a poster about its research, which the members presented at a student research symposium at Loyola University on 7/30/10.

In 2011 Curie High School investigated the effect of near space conditions on the speed of sound by measuring the travel time of ultrasound pulses reflected off the inside walls of their pod. The Curie students also measured stratospheric ozone concentrations by monitoring color changes of Schoenbein paper and eco badges, took near-infrared images of corn and soy fields and correlated them with plant samples taken from these fields, and investigated the effect of near space conditions on algae and pill bugs. The team from Hancock High School investigated the effect of cosmic rays on Deinococcus radiophilus bacteria and on crickets. Clark High School investigated the effect of near space on plants, microbes, and worms. Each of the three teams also built a Nearsys BalloonSat Mini and a Nearsys "weather station" with temperature, pressure, and humidity sensors. The students conducted three launches on 7/14/11, 7/26/11 and 8/2/11, and gave poster presentations of their research at a student symposium held at Northwestern University on 8/5/2012.

III. Capstone Course

During the summer 2012, teachers who have participated in the workshops and staff from each of the five sites are developing a modular capstone course. High school students in Chicago have to complete a minimum of three years of laboratory-based science. Approximately 10,000 seniors (one third of the population) chose to enroll in a fourth year science elective. However, there are very few elective options in science for students other than Advance Placement courses. Our capstone course is intended to fill this void. It will contain an astronomy component based on the content of the workshops at the Adler Planetarium, Loyola University, and the University of Chicago, and an earth science component based on the workshops at Northwestern University and DePaul University. The course will focus on big ideas in earth and space science as well as science and engineering process skills, and will be aligned with the Next Generation Science Standards. It will include a course syllabus, lesson plans, a pacing guide, and assessment materials. Course materials will be made available through the CPS Department of High School Teaching & Learning website.

IV. Program Evaluation

Program evaluation is performed by Center for Evaluation and Education Policy (CEEP) at Indiana University led by Adam Maltese. Workshop data was collected through interviews with staff from each site, site visits, and online surveys. The interviews were conducted both by phone and in person. The site visits and classroom observations were conducted during both workshops in 2010 and 2011. Students, teachers, and staff completed online surveys at the beginning and the end of each workshop. Student surveys included items related to student attitudes/interest in STEM, and perceived program impact. Teacher surveys included perceptions of student performance and interest/attitudes, and self-reported impact on teacher content knowledge. CEEP will also evaluate the materials that will be developed for the capstone course.

V. Supporting NASA's Goals in Education

NASA funded the *Capstone Course for Space Science* project as part of a competitive K-12 grants program that awarded grants to public school district and other organizations involved in K-12 science education. Supporting innovative programs that engage students in NASA-themed STEM activities and that also improve teachers' ability to engage and stimulate their students is a high priority for NASA. In its recently released 2011 strategic plan [1], NASA identifies the need to attract and retain students in STEM disciplines along the full length of the education pipeline as one of its major educational goals. In their 2011 NASA Education Recommendation Report [2], an education design team comprised of education experts from NASA Headquarters and several NASA Centers identified teacher training as the most critical type of program for achieving NASA's education goals. High-altitude ballooning programs have played an important role in NASA's education program. For example, the BalloonSAT High Altitude Flight Student Competition (BHALF) is a competition for students from grades 9 to 12 held annually at NASA Glenn Research Center [3]. Colleges and universities across the country have initiated ballooning programs with funding from NASA's National Space Grant College and Fellowship Program. While the focus of these programs is typically undergraduate education, several groups have branched out to K-12 [4,5,6]. Our program contributes to NASA's goals in K-12 STEM education by providing opportunities for the students to participate in hands-on NASA-related research. The opportunity to work on a college campus for one month and interact with

faculty and students also exposes them to career opportunities in STEM disciplines. In addition, it provides teachers with extended and intensive training in scientific methods and ways to integrate student research into the curriculum.

VI. Conclusion

DePaul's high altitude ballooning summer workshops in 2010 and 2011 have provided hands-on research opportunities for seven high school teachers and 28 of their students. The workshops were part of a NASA-funded partnership with the Chicago Public Schools, which also included workshops at three other universities and the Adler Planetarium that focused on archival data from NASA missions. We found that ballooning is an ideal vehicle for engaging high school students in research. The ballooning platform is compatible with a wide variety of student experiments. All aspects of preparing, launching, tracking, and recovering a balloon are attainable for high school students. The students can carry out balloon missions almost independently, with minimal interference by the instructors. There were a few important challenges: (1) Because the workshops were part of an official Chicago Public Schools program, we had to use a CPS approved bus company for the chase. This added a significant additional cost to each launch. (2) Adapting the intensive all-day workshop activities to a typical school year schedule with short lessons and integrating them into the capstone course is challenging. (3) It is difficult to organize balloon launches with participation by multiple high schools during the school year. (4) Many students have to work during the summer, so it may be more challenging to recruit students in the future if generous funding for stipends is not available.

References

[1] National Aeronautics and Space Administration, "Strategic Plan, NP-2011-01-699-HQ," URL: http://www.nasa.gov/pdf/516579main_NASA2011StrategicPlan.pdf, 2011

[2] National Aeronautics and Space Administration, "Education Recommendation Report, NASA/SP-2011-581," URL: http://www.nasa.gov/pdf/536766main_NASA-Education-Recommendation-Report-v15-web.pdf

[3] Snyder, D., Keynote Presentation, 1st Academic High Altitude Conference, 2010

[4] Hladun, M. V. and Flaten, J. A., "Expanding High-Altitude Ballooning to Middle Schools (A Space Grant Precollege Project)," Proceedings of the 2nd Academic High Altitude Conference, pp. 109-117, 2011

[5] Halligan, E. A. and Dornbush, J. L., "High Altitude Ballooning: An Opportunity to Take STEM Education Higher in the Secondary Classroom," Proceedings of the 2nd Academic High Altitude Conference, pp. 118-124, 2011

[6] Nelson, M. E. and Lazere, M., "Bridging College Students and K-12 Students Together through High Altitude Ballooning" Proceedings of the 2nd Academic High Altitude Conference, pp. 146-149, 2011

Acknowledgments

Support for this project was provided by NASA K-12 Competitive Grants Opportunity contract number NNX09AH88A.