AC 2007-919: STEM-RELATED K-12 OUTREACH THROUGH HIGH-ALTITUDE BALLOON PROGRAM COLLABORATIONS

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STEM-Related K-12 Outreach through High-Altitude Balloon Program Collaborations

Abstract

A university that develops a program with the capability to launch, chase, and recover helium-filled high-altitude balloon satellites (BalloonSats) enables a number of undergraduate research possibilities. The program faculty and the undergraduates served can also form the engine of an exciting and effective vehicle to perform K-12 outreach related to science, technology, engineering, and math (STEM). Nearly identical to weather balloons, low-weight BalloonSats can affordably carry student experiments literally to the edge of space. When the outreach effort is extended and a partnership between the university program and a K-12 classroom forms, the outreach can be transformed from a series of "fire and forget" activities into a genuine, standards-based, educational component.

This paper describes the collaboration between Oregon Institute of Technology's (OIT's) BalloonSat program (LaunchOIT) and Ferguson Elementary School in Klamath Falls, Oregon (Ferguson School). LaunchOIT is an affiliate of Oregon NASA Space Grant Consortium's[1] (OSGC's) "LaunchOregon" BalloonSat program. The paper presents some history relating to LaunchOIT, the enabling underpinnings of the OSGC, the OIT-Ferguson School collaboration structure (including some data related to student participants and performance), the benefits of the program collaboration, and how the program looks to sustain itself, particularly considering the auspices of NASA's educational mission as exercised through the National Space Grant College and Fellowship Program[2] (Space Grant) efforts.

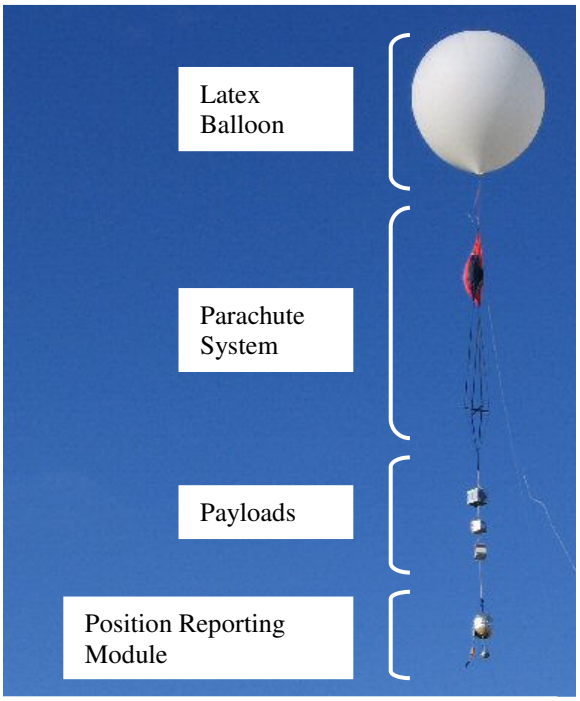
Introduction

Near-space, though not legally defined, has been referred to as the region between 65,000 feet and 325,000 feet[3] above the Earth. A BalloonSat launch can routinely and relatively inexpensively take an experimental payload into near-space to altitudes exceeding 80,000 feet and, with additional resources, to even higher altitudes that can eclipse 120,000 feet. Access to near-space presents exciting possibilities for undergraduate research in engineering and engineering technology. With a university partner that can serve as a "space operations expert", K-12 classrooms can also go on a "journey to the edge of space" through collaboration that centers on a high-altitude balloon launch.

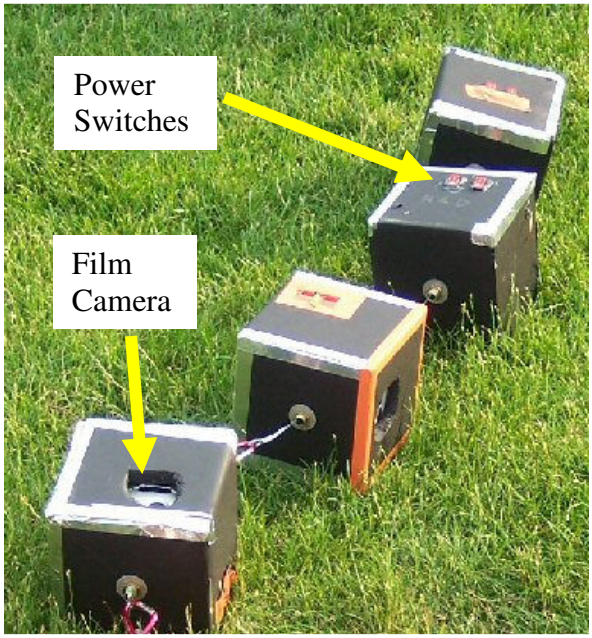
OIT has collaborated with Ferguson School since the fall of 2004. The collaboration has since grown into a semi-formal program themed and named, "To the Edge of Space". Using the capabilities developed through its university-level LaunchOIT program, OIT students and faculty provide the BalloonSat "vehicle" (see Figure 1a), as well as launch and tracking services, for Ferguson School. Elementary students develop experiment payload projects (see Figure 1b) in class and then go through an internal process to select which project or projects will fly on a particular year's BalloonSat mission. The payloads are concrete outcomes of the math and science inquiry education that the students receive in the classroom throughout the year. Past payload experiments have investigated temperature, pressure, ozone, and visible light in near-

space. This all culminates in a BalloonSat mission where the entire Ferguson School class has the chance to participate in the launch activities, while a subset of students acutally participate in the chase and recovery activities. Indirect participants have included Ferguson School parents and interested non-LaunchOIT faculty.

The BalloonSat vehicle "stack" uses a helium-filled latex balloon to carry payloads into near-space. The balloon will expand on its ascent and rupture at an altitude determined by the size of the balloon and its fill-volume at launch. A greater fill-volume will increase the ascent rate as well as decrease the maximum altitude achieved. An amateur radio transmitter is coupled with a Global Positioning System (GPS) receiver to form a BalloonSat position reporting module. GPS latitude, longitude, and height above sea-level are reported. The radio formats the GPS information into Automatic Packet/Position Reporting System (APRS®)[4] packets. The APRS information is received by one or more chase teams that is/are equipped with amateur radio receivers that can decode the APRS/GPS information. The decoded GPS position information is fed into a computer-based moving map. The map software that OIT currently uses is APRSPoint,[5] a system that utilizes the Microsoft MapPoint map database. The moving map position helps the chase teams track the BalloonSat during its ascent and descent which ideally leads to system recovery after touchdown. A parachute system brings the descending BalloonSat back to Earth at a controlled speed, typically 10-15 miles per hour at touchdown.



(a)



(b)

Figure 1. (a) BalloonSat vehicle stack (b) Typical student payloads

The recurring cost of a launch includes the costs of the balloon and the helium. The dollar amount is typically $60 for a 1000 gram latex balloon and $130 for the helium. So, a BalloonSat launch can be performed for under $200. (There are hidden costs such as transportation expenses.) The non-recurring costs are vested in the LaunchOIT program. (This is typically on

the order of $900-$1,000, not including the balloon. In addition, tracking units installed in chase vehicles require a $400-$500 amateur radio unit each, plus some sort of laptop computer.) The 1000 gram balloon will consistently loft a BalloonSat system, which must legally weigh less than 12 pounds, to altitudes between 80,000 and 90,000 feet. For public safety reasons, the 12 pound limitation is required by, Federal Aviation Regulation (FAR) Part 101 – MOORED BALLOONS, KITES, UNMANNED ROCKETS AND UNMANNED FREE BALLOONS, Subpart D – UNMANNED FREE BALLOONS.[6] The recurring costs of the student payload experiment packages will vary depending on the student ideas. Although special, more costly, measurement instruments have been used, payloads are typically constructed using everyday materials. The bottom line is that payloads can be constructed for a cost that is inline with other classroom science projects. In spite of any cost issues, To the Edge of Space affords an invaluable opportunity for elementary school students to participate in real science that addresses educational standards, and to be engaged with "live" college students and professors on a real project. The launch activity in particular, provides a rich learning environment that brings together in active collaboration elementary school, high school, and college students. These students simultaneously work along side college professors and public school teachers as well as parents. Everyone benefits.

University-Level Balloon Programs

Funded and managed by the National Aeronautics and Space Administration (NASA), the OSGC is one of 52 national consortia that compose the Space Grant Program. OIT is one of 18 OSGC affiliate members across the state of Oregon that includes higher education institutions, community colleges, and informal educators. In support of NASA's mission to explore and discover and to inspire the next generation of explorers to meet the growing workforce need, OSGC is tasked with providing educational and research opportunities to students in aerospace-related disciplines including STEM education.

Space Grant's mission is to:

- Establish a national network of universities with interest and capabilities in aeronautics, space, and related fields.
- Encourage cooperative programs among universities, aerospace industry, and federal, state, and local governments.
- Encourage interdisciplinary training, research, and public service programs related to aeronautics, space science and technology.
- Recruit and train professionals, especially women, and underrepresented minorities, and persons with disabilities, for careers in aerospace related fields.
- Develop a strong science, mathematics, and technology education base from elementary through university levels.

Core OSGC programs include graduate fellowships, undergraduate scholarships, NASA center internships and mentorships, undergraduate research-based programs, and K-12 outreach programs. University and community college partners provide the student and faculty base to which NASA higher education programs are aimed. Informal educators and K-12 partners provide the opportunity to expand the influence of the NASA programs into the pre-college

student pipeline, engaging students early in their academic experience and inspiring them to choose career paths in the aerospace-related fields.

In June 2006, NASA provided The NASA Education Strategic Coordination Framework: A Portfolio Approach,[7] outlining the strategic plan, implementation, and evaluation of the agency's education efforts. As identified in the Education Strategic Framework "pyramid" (see Figure 2) there are four categories of involvement: *Inspire, Engage, Educate, and Employ*; each level of education becoming more focused at progressively higher levels of the framework. Providing the broadest impact at the base of the pyramid, the *Inspire* category creates awareness among the public using informal education and outreach activities. Individual investment increases at the *Engage* level where participants are identified and targeted. The third level, *Educate*, targets student and pre-service and in-service educators using NASA resources to develop and enhance specific STEM knowledge and skills. Implementation at the *Educate* level uses NASA elementary and secondary education to supplement formal classroom instruction. At the university level, the education category includes developing university curricula to support the NASA mission using student-built instruments. At the apex of the pyramid, the *Employ* category targets and develops individuals in preparation for employment in areas needed to meet NASA's mission and strategic goals. This includes employment with NASA, academia, aerospace-related industry, or teaching within the STEM fields.

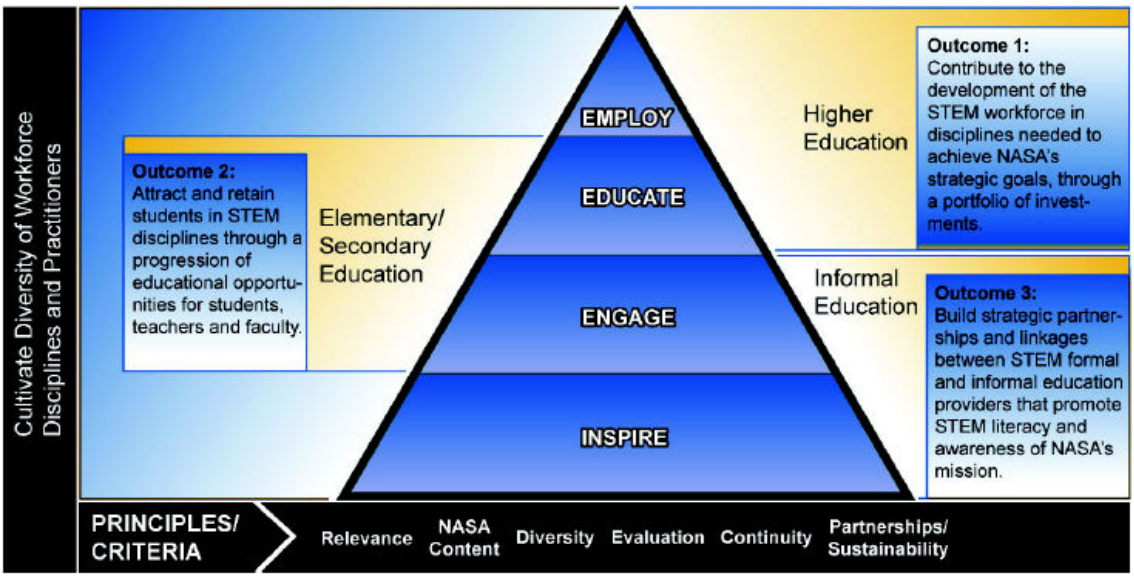


Figure 2. The NASA Education Strategic Coordination Framework
(Taken from < http://education.nasa.gov/pdf/151156main_NASA_Booklet_final_3.pdf >)

The inclusion of higher education institutions, informal educators, and K-12 partners in the national network positions the 52 Space Grant consortia to effectively speak to all four levels of NASA's Education Strategic Framework pyramid. OSGC's undergraduate research programs are specifically directed at the *Educate* level of the Education Strategic Framework pyramid to target students already in STEM disciplines using NASA resources. OSGC's BalloonSat program, LaunchOregon, is a cost-effective program that provides hands-on opportunities to undergraduate students and researchers to experience a near-space environment using a weather balloon-like platform. A success at the undergraduate research level throughout Oregon, the

LaunchOregon program realized greater potential benefits by reaching into both the *Inspire* and *Engage* categories of the framework pyramid. Implementation of the program in the K-12 classroom, such as with the OIT-Ferguson School collaboration, broadens the impact of the program by effectively targeting both students and pre-service/in-service educators and ultimately strengthening the NASA education pipeline. The LaunchOregon K-12 outreach effort effectively demonstrates science in the classroom and addresses NASA's education mission goals to *inspire* and *engage* the next generation of explorers.

Similar K-12 outreach programs resulting from BalloonSat projects have been implemented across the country. Two examples of sustained programs are the Changes in Altitude program sponsored by the Arizona Space Grant Consortium and the Youth Exploring the Stratosphere! (YES!) at New Mexico State University.

Sponsored by the Arizona Space Grant Consortium, the Changes in Altitude Balloon Satellite Program is for fifth through 12th grade teachers and students in support of the Phoenix Mission Education/Public Outreach (E/PO) efforts. The goal of the program is to establish elements of a small weather balloon satellite program at each participating school that can be sustained by the school district at minimal cost. Teachers are selected through a competitive process and receive training at a BalloonSat workshop. Once trained, the educators pull together student teams to design, construct, launch, and recover small balloon payloads that measure pressure, temperature, and humidity.

Northern Arizona University (NAU) staff and volunteers from Arizona Near Space Research (ANSR) organize all launch activities associated with Changes in Altitude. All workshop, travel, and room and board fees are covered by the Arizona Space Grant Consortium except for a $65/student participation fee paid prior to the launch. The Changes in Altitude program guarantees four launches over two years with different student teams and follow up to discuss the results of the launch.

The Youth Exploring the Stratosphere! (YES!) from the New Mexico State University Physical Science Laboratory provides a BalloonSat launch outreach opportunity to primary and secondary school students. The NASA Balloon Program Office (BPO) provides an annual NASA sponsored balloon flight that includes student experiment packages from New Mexico schools on each flight. YES! is built around the balloon flight opportunity and focuses on student education and understanding before, during and after a flight. Students launch 'Ping Launchers' or ping pong balls containing mini payloads aboard the balloon flight. The payloads are returned to the students along with a certificate including flight information.

Outreach programs built around a BalloonSat program such as Changes in Altitude, YES!, and LaunchOregon address a sponsor's mission to increase STEM-related opportunities for students by providing intentional, hands-on science-based inquiry in the classroom. The OIT-Ferguson School To the Edge of Space collaboration addresses NASA's education mission by implementing a purposeful program that provides continuity from one education level to the next.

LaunchOIT Balloon Program

The Space Grant high-altitude balloon program originated with the Colorado Space Grant Consortium to support the National Space Grant Student Satellite Program, "Crawl, Walk, Run, Fly".[8] Crawl, Walk, Run, Fly was based on the concept of starting small and building to eventually fly student-built hardware, representing the 52 Space Grant consortia, to Mars. The implementation of a balloon workshop by Colorado Space Grant entitled, "Starting Student Space Hardware Programs"[9] provides the opportunity for faculty, staff, and students to design, construct, launch, and recover balloon satellite payloads aboard a high-altitude weather balloon launched to the edge of space. Participants walk away from the workshop with hands-on experience and enough information to implement the program at their institution.

After an OIT faculty member attended the Starting Student Space Hardware Programs workshop, OIT started its balloon program in 2002-03. One of the original goals was to encourage a multidisciplinary program that involved students, faculty, and staff. It was envisioned that program participants would be involved through class-related and extracurricular projects and functions. Another goal was to provide a vehicle for carrying out outreach that would in some way address NASA's educational mission. Approximately 26 students, faculty and staff were inspired and took up the call.

As mentioned previously, OSGC supports programs that impact university curriculum with the intention of preparing graduates for employment in the aerospace industry. However, while balloon-related classes were offered at OIT, they were non-academic classes that were structured as planning and work sessions that prepared for a high-altitude balloon launch. The real project deliverables were produced through non-related, degree-program design courses.

The early non-flight related functions included document and project management, publicity and website maintenance, etc. The original flight-related functions were tied to junior and senior design course sequences. Project students came from degree programs that included mechanical and manufacturing engineering technology, electronics engineering technology, and computer and software engineering technology. While some of the individual components of the flight system checked-out and served as deliverables for the individual design courses during the 2002-03 academic year, an integrated, functional flight system never materialized. An early technical challenge was an attempt to implement a custom balloon position reporting radio communication module. This system never functioned reliably and a high-altitude balloon launch was not attempted. Without a launch attempt, interest and participation in the program waned. Participation during the 2003-04 academic year dwindled to two advisors and two very occasional students.

A breakthrough occurred in 2004. Several things happened to reignite the program. In the spring, the OSGC planned for an educational outreach activity at the 2004 Oregon State Fair, held during the late summer, and decided to include a high-altitude balloon launch as part of the activities. OIT was invited to be one of the launch participants and ended up being the sole launch provider, collaborating with students from Oregon State University and Southern Oregon University. A new faculty member joined the program and a decision was made to use common off-the-shelf (COTS) components. Two additional program faculty attended the early summer

2004 Starting Student Space Hardware Programs workshop, and a new student joined the program and made himself available for early summer development. These changes led to a successful launch, and subsequent recovery, from the state fair in Salem, Oregon.

This success laid the foundation for all of the follow-on activities currently part of LaunchOIT. LaunchOIT activities can be categorized in three areas: (with examples of activities)

- Undergraduate research components
  - Achieving Oregon's highest balloon altitude
  - Developing an expandable and extensible balloon telemetry and tracking system
  - Incorporating redundant position reporting systems

- Educational components
  - Annual "Journey of the Edge of Space" engineering technology/science course
  - NSF Chautauqua short course for college teachers

- Outreach components
  - High school science class experiments
  - "To Infinity and Beyond" middle school tethered balloon launch
  - OSGC LaunchOregon affiliate workshop
  - Pre-college "Graduation Really Achieves Dreams" ("GRAD") balloon workshop
  - "To the Edge of Space" K-12 collaboration

The Journey to the Edge of Space course is an engineering technology course intended for the non-engineering, non-engineering technology major. It was first offered during spring term 2005. Past non-technical majors included management, applied psychology, communications, and others. OIT has a general education (GE) requirement of 12 science/math credits, where at least 4 of those credits must be in a lab-based science course. This course has been co-listed as an ENGT 207 (engineering technology) course and a PHY 207 (physics) course. Content addresses some matters of atmospheric science with hands-on lab work in support of a BalloonSat experiment payload. Non-technical majors, then, can satisfy part of their GE requirements through this course.

Because Journey to the Edge of Space is a non-major science/technology course, it contains significant outreach potential. In the first year, LaunchOIT was able to successfully recruit high school students from local schools and home schools. Some high school students were able to take advantage of OIT's Advanced Credit Program (ACP) which offers a significantly reduced tuition. In addition, OIT's Pre-college program offered full-tuition scholarships for high school girls. As a result of these factors, nine high school students enrolled in the course, six of which were female.

In the spring of 2006, only one high school student enrolled, however, the To the Edge of Space K-12 collaboration made way to expand elementary teacher participation. The Journey to the Edge of Space course played a key role in that expansion. During that term, three elementary school teachers enrolled in the course. One of the teachers was the primary collaborator at Ferguson School and the other two teachers were new recruits into the To the Edge of Space

collaboration. These three teachers are working with the 87 fifth grade students currently involved in BalloonSat-facilitated education.

The current LaunchOIT program faculty are Dr. Tim Brower (Mechanical Engineering; Mechanical and Manufacturing Engineering Technology, Claude Kansaku (Computer Engineering Technology), Jamie Zipay (Electronics Engineering Technology).

"To the Edge of Space" Program Collaboration Structure and Activities

The To the Edge of Space collaboration originated in 2005 when a Ferguson School teacher's class participated in an OIT launch. The teacher had witnessed an outreach-based BalloonSat launch at a local high school during the fall of 2004 and was so awed by the project that she asked a LaunchOIT faculty advisor if her fifth grade class might be able to attend a launch. In addition to being granted permission to watch a launch, the students were invited to build and attach a payload to the BalloonSat stack and to participate in the chase and recovery.

The LaunchOIT faculty presented a PowerPoint to the class that explained the project. He answered student questions, and left them an open-ended challenge to create a payload that would be within given weight and size constraints. Students were encouraged to conduct an experiment of their own choosing as part of their payload.

The students worked in teams, applying their inquiry skills to create a payload that would protect its interior from freezing, would not be too airtight, and would have an ozone-measuring test strip attached. The final launch payload was chosen from those constructed by the teams after pros and cons of each design were discussed. Because the students had no sophisticated data collecting equipment, the interior temperature of the box was tested by filling a glass vial with water and twisting on a cap. Tests were run on the design by placing the vials in the school freezer.

The 32 students were invited to witness the launch, while eight students were chosen to participate in the chase and recovery of the BalloonSat by drawing eligible names out of a hat. "Chase" students were transported in a donated rental car driven by their teacher and followed the balloon's progress in a caravan of cars, while they used a handheld GPS unit and a road atlas to chart progress.

The specific educational standards that To the Edge of Space addresses at the elementary school level are presented in Table 1. Along with the NASA-space influence, the experience does well to serve STEM-related education goals.

Table 1. Educational standards "To the Edge of Space" addresses

SCIENCE
Physical Science:
MATTER: Identify substances as they exist in different states of matter.
FORCE: Identify examples of gravity exerting force on an object.

SCIENCE (cont.)

Earth and Space Science:

Understand changes occurring within the lithosphere, hydrosphere, and atmosphere of the Earth.

Describe weather in measurable quantities including temperature, wind direction, wind speed, and precipitation.

Scientific Inquiry:

Other CCG:

1. Understand that scientific knowledge is subject to change based on new findings and results of scientific observation and experimentation.
2. Describe the role of science and technology in local, national and global issues.
3. Understand the relationship that exists between science and technology.
4. Understand the process of technological design to solve problems and meet needs.

MATHEMATICS

Calculations and estimations:

1. Compute fluently and make reasonable estimates

Statistics and Probability

1. Select and use appropriate statistical methods to analyze data.
2. Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them.

SOCIAL SCIENCES

Geography:

1. Understand the spatial concepts of location, distance, direction, scale, movement, and region.
2. Use maps and other geographic tools and technologies to acquire, process, and report information from a spatial perspective.
3. Locate major physical and human features of the Earth.

CAREER-RELATED LEARNING STANDARDS

Problem-solving: Apply decision-making and problem-solving techniques in school community, and workplace.

Communication: Demonstrate effective communication skills to give and receive information in school, community, and workplace.

Teamwork: Demonstrate effective teamwork in school, community, and workplace.

TECHNOLOGY

Access, organize, and analyze information to make informed decisions, using one or more technologies.

Design, prepare, and present unique works using technology to communicate information and ideas.

ENGLISH/LANGUAGE ARTS

Reading:

1. Analyze words, recognize word, and learn to read grade-level text fluently across the subject areas.
2. Listen to, read, and understand a wide variety of informational and narrative text across the subject areas at school and on own, applying comprehension strategies.
3. Increase word knowledge through systematic vocabulary development.
4. Find, understand, and use specific information in a variety of texts across the subject areas to perform a task.
5. Demonstrate general understanding of grade-level informational text across the subject areas.
6. Develop an interpretation of grade-level informational text across the subject areas.

Writing:

1. Pre-write, draft, revise, edit, and publish across the subject areas.
2. Communicate supported ideas across the subject areas, including relevant examples, facts, anecdotes, and details appropriate to audience and purpose that engage reader interest; organize information in clear sequence, making connections and transitions among ideas, sentences, and paragraphs; and use precise words and affluent sentence structures that support meaning.
3. Investigate topics of interest and importance across the subject areas, selecting appropriate media sources, using effective research processes, and demonstrating ethical use of resources and materials.

To the Edge of Space is an exciting modality to address these educational standards. The enthusiasm and engagement of students were so great that the Ferguson School teacher asked and was invited to participate again the next year. A level of continuity was created as previous fifth grade students were invited to serve as "veterans" while in the sixth grade.

Students moving into sixth grade that were involved in the program as fifth graders were called on to present their PowerPoint presentation at the fall parent meeting of the current fifth grade students. They again presented their project to the current students before these fifth graders began the design stage of their own project. During the presentation, the teacher heard science concepts that had been remembered by the sixth graders for a year without having been reviewed. The hands-on, authentic science approach to learning appeared to have strong merit. Further investigations are being made to see if the learning also made a difference in state science test scores.

Once the satellite payloads were constructed, the sixth grade students returned to judge the projects and make suggestions for final designs of both the payload and the experiment. These students were so excited about returning to the fifth grade classroom to judge and present, that it has become a tradition, and a strong point of continuity.

LaunchOIT's primary involvement is to be the launch operations provider. The university team of students and faculty advisors provide the BalloonSat vehicle and primary ground tracking equipment and services. They direct the fill and release of the balloon while engaging as many participants as possible, including the elementary school students and even their parents. The LaunchOIT team performs the primary tracking function, though the elementary school chase group has used the tracking equipment. However, the primary chase decisions are made by the LaunchOIT team. Once the BalloonSat has landed, the LaunchOIT team leads the recovery effort.

The To the Edge of Space collaboration is expanding at the elementary school level. Support for the elementary portion of this project has been primarily in the form of a $10,000 Toyota Tapestry grant. The grant enabled the program to take a giant leap forward. The funding allowed the students to have access to equipment such as computers, cameras, GPS units, HOBO® data loggers,[10] journals, maps, software, trade books, and building supplies. Onset Computer Corporation loaned twelve $139 HOBO data collectors for the period of one year.

The program has grown from the inclusion of one classroom the first two years to three classrooms and district talented and gifted (TAG) students at the present time. It has also grown from including one school to two presently. Parents have become involved through a parent informational night in November. Many at that time offered expertise and materials in areas such as insulation.

The snapshot of the student population engaged is as follows. In 2005, 32 students were involved: 16 boys and 16 girls. 2006 added 28 students: 16 girls and 12 boys. 2007 involves 86 classroom students plus an undetermined number of Klamath County-wide TAG students. 48% percent of students in the original school qualify for free or reduced lunches. The school

demographics: Asian 1%, Black 1%, Hispanic 9%, Multi 5%, Native American 5%, and Caucasian 78%.

Parent interest and involvement has also increased each year. The second year, students and parents were invited to participate in a pre-flight experience known as "Breakfast with a Scientist." A LaunchOIT faculty advisor led a group-building experience in which students partnered with their parents. The teams constructed Lego "satellite landers" to carry payloads of light bulbs which were weighed in and "launched" from a ladder. The winner was the lightest payload with a light bulb that worked after the launch and landing.

In addition, students took a field trip to the OIT campus in the fall of 2006 to be introduced to the project. They had lunch on campus and participated in an interactive presentation on the BalloonSat activity. They were encouraged to use their science knowledge in a simple balloon lift versus payload weight demonstration activity. The trip was expanded to include tours of OIT's alternative energy labs.

"To the Edge of Space" Program Collaboration Benefits

The greatest benefit of the To the Edge of Space collaboration is the involvement of elementary students in authentic science inquiry in which their data is valued by a scientific entity: OIT. A side benefit is exposing the students to a college campus, its instructors and students.

The project provides a rich learning environment in which there are more questions than answers. The students see the need for and seek background knowledge in data collection, atmospheric studies, inquiry, and analysis. That knowledge is gained through both in-class lessons by the teacher and former students, in fieldwork, and with the help of parents. High school students assisted with this phase of learning in 2005.

(a)

(b)

Figure 3. (a) A rich learning environment: elementary, high school, and college students collaborating with elementary school teachers and college professors (b) Real science

The project is without boundaries as college students and faculty further work with these elementary students during the launch and recovery phase of the project. The elementary students feel and are treated as equal partners during the launch and recovery. Faculty and students are careful to explain each step to the younger students and the necessity for it. In the final phase, the elementary data is analyzed and valued.

Teachers benefit with the professional development provided through OIT's Journey to the Edge of Space class. They are exposed to topics ranging from properties of the atmosphere to data collection techniques to ozone layers to analyzing National Weather Service data on the computer. The project provides an authentic avenue for teachers to design lessons for the students that address state standards in science, mathematics, social science, reading, writing, and technology. The addition of two more classrooms this year has allowed the three teachers to form a professional learning community for collaborating about lesson designs.

The university partner benefits at several levels. The college students have the opportunity to share the results of their learning through the undergraduate research activities they are involved in. By performing their launch services role, there is some amount of service learning that occurs as they attempt to take their college BalloonSat experiences and adapt them to a public as well as elementary school audience. They have opportunities to interact with high-level university administration and occasionally the news media.

The university as a whole benefits by the OSGC tie which brings in resources. This real-science-and-space in the elementary school classroom reality has attracted the attention of the public, which is especially significant since Oregon does not have a particularly strong aerospace industry presence. It strengthens the university's engineering technology and engineering programs by allowing students to work in genuine multidisciplinary settings.

Next Steps, Challenges, and Sustainability

Continuity is the key to sustainability of the balloon program. OSGC strongly supports the K-12 outreach programs developed as a result of the balloon programs originating at OSGC higher education institutions. The To Edge of Space collaboration is no exception. This continued support provides the potential for the funding of new or expanded initiatives within the local program.

A significant next step that is being taken is the development of a formal curriculum that will help elementary school teachers integrate the BalloonSat activity into their classrooms. This effort is being led by the original collaborator at Ferguson School. Dissemination is currently progressing through program expansion at one new school and one new classroom at Ferguson School. It is envisioned that through OSGC support, this new curriculum could be disseminated statewide. The challenge (and benefit) in bringing this kind of program to the elementary classroom is the requirement for a university partner with a strong BalloonSat program as well as a deliberate outreach component. Such a curriculum, however, will lead more schools into meeting their standards with exciting, hands-on, and real science-based activities.

OSGC continues to sponsor affiliate members to attend the Starting Student Space Hardware Workshop in Boulder, Colorado, which provides fundamental program knowledge to ensure success of the program in Oregon. In addition, OSGC provides the annual affiliate meeting as a venue to discuss successes of the balloon program as experienced by each participating affiliate institution. The time is also used to discuss possible statewide collaborations among the balloon teams and other OSGC entities including informal educators, middle school and high school STEM programs, and other local NASA sponsored programs such as the NASA Explorer School Program. OSGC can maintain a strong statewide LaunchOregon BalloonSat program only if local programs like LaunchOIT is strengthened.

In 2005, in an effort to provide continuity, a statewide name, LaunchOregon, was given to the Oregon high-altitude balloon program. Each affiliate program adopts the name to fit its respective institution resulting in a more uniform program identity. Currently, OSGC balloon teams include LaunchGFU, LaunchOIT, LaunchOSU, LaunchPSU, LaunchSOU, and LaunchWOU. These other BalloonSat programs are the potential partners for To the Edge of Space collaborations within the state of Oregon. Other efforts to ensure sustainability across Oregon include offering a workshop similar to the Starting Student Space Hardware Workshop locally, presented by existing LaunchOregon balloon teams. LaunchOIT has taken the lead on presenting and hosting the workshop in the past. These efforts will continue to fuel the success of the To the Edge of Space collaboration.

Acknowledgements

Special thanks go to Tim Brower, Jamie Zipay and the LaunchOIT student team. It is they who put the "launch" in LaunchOIT. Also, a debt of gratitude is owed to Jack F. Higgenbotham whose enthusiasm, support, and sponsorship enables LaunchOIT to soar.

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