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Joan Berger
Internet Educational Consultant Roslyn Public Schools

Major Martin E.B. France Ph.D.
Command Lead for Space Support Plans Headquarters, Air Force Space Command

Elements of Space Flight Project: A Partnership for Space Education

Joan Berger
Internet Educational Consultant
Roslyn Public Schools
Roslyn NY 11577
k12robzj@hofstra.edu
jberger@dorsai.org
http://www.dorsai.org/~jberger

Major Martin E.B. France, PhD
Command Lead for Space Support Plans
Headquarters, Air Force Space Command
Peterson AFB CO 80914-4610
mfrance@spacecom.af.mil

ABSTRACT

A unique partnership for space education was formed to facilitate greater understanding of space technology and issues for K12 students world-wide. The Elements of Space Flight Project brought school children and teachers together with experts from government and industry, using the Internet, to create a one-of-a-kind learning experience. This four-week project involved thirty-one classes from all corners of the globe -- led by teachers who want to explore the universe with their students, and expand their horizons so they can take their place in the world of the future. 128 others were turned down due to a lack of funds and personnel to assist. Internet-monitored projects for the students included: construction of a space shuttle glider; rocket cars; and paper rockets. Students are tasked to conduct test flights, to analyze data and form conclusions concerning their work. They were also tasked to conduct research on a variety of space topics and answer challenge questions via e-mail. Each class was provided "e-mail Experts" from whom they could gather additional information or pose questions about their projects. Questions and results could also be posted to the general project membership for consideration and review. This model program, in its first year of existence, was made possible by the efforts of Ms Joan Berger of the Roslyn Public Schools, Roslyn, New York, the US Air Force Academy (USAFA), Air Force Space Command (AFSPC), NASA and the US Space Foundation (USSF). Results are presented from this first experience, as well as recommendations for changes to next year's program.

INTRODUCTION

There was an ancient, dying civilization that sent its inhabitants on a long journey to find a new world on which to live. Their spaceship was built to resemble their planet, encased in a sphere, so the people would feel they were still on their home world as they journeyed in space. The spaceship traveled for hundreds of centuries, seeking a new world, and the descendants of the original travelers eventually lost the knowledge that they were on a journey through space.

One day, a man ventured forth on top of one of the sphere's high mountains. Something inside him made him reach upward, and as he did, stunned, he cried out, "The world is hollow, and I have

touched the sky!" At that precise moment, he gained an awareness that there was more... he gained the knowledge that his world was not the tiny, isolated sphere that he once thought.

Teachers take their students on journeys every day -- journeys of the mind. I decided to take my students on a journey beyond our isolated sphere, a journey to "touch the sky," a journey to reach for the stars, a journey to participate in and coordinate a four week unit, including more than 30 schools from around the world. This journey would introduce them to the many facets of space and atmospheric flight, built around a virtual shuttle mission.

NASA and the US Space Foundation played a significant role in the ensuing creation of the "Space Flight Project." I attended week long sessions for two summers at the US Air Force Academy, Colorado Springs, in a course for educators entitled, "Getting Comfortable Teaching With Space," and a third session at Peterson Air Force Base in 1995 entitled, "Space Discovery." NASA, the USSF, USAFA and AFSPC provided the knowledge, the personnel, some financial assistance, and the materials to give me the background I needed to forge ahead.

My first step was to have the students acquire background knowledge that went beyond what current books could provide. I prevailed upon many of the instructors from the Air Force Academy and Air Force Space Command to respond to e-mail interviews from my students. My list of interviewees included many of the instructors and guest speakers from my courses in Colorado. My list of space resources grew to include Capt Doug Thayer, assistant professor of astronautics, USAFA; Major Marty France, PhD and former associate professor of astronautics, USAFA, currently assigned to Headquarters, Air Force Space Command; Capt Chito Parong, assistant professor of astronautics, USAFA; Dr Robin Murphy, astrophysicist and robotics expert, Colorado School of Mines; Dr Neal Brown, world's leading authority on the aurora borealis; William Buckingham, astronomer with Lowell Observatory; Capt William Cade, meteorologist and space weather expert, Air Force Space Command. The students also utilized specialists from industry to enhance their knowledge base. Dr David Kang, Mars Probe engineer from Draper Corp., and Dr Robert Panoff, computer simulation expert with the Shodor Foundation were among our interviewees. These specialists all remained as resources throughout the year, several having live-chats on-line with the class via the classroom Internet connection.

Besides using industry's technologists, I requested a donation of oak tag gliders from PITSCO, a corporation that sells science materials to educational institutions. PITSCO graciously sent me 100 gliders for use in our project. Now, combining the resources of industry, NASA, USAFA, AFSPC, and the USSF, with other scientific organizations and institutions, I proceeded to concentrate on designing the project.

Armed with a new knowledge base, I developed a unit of study on space flight, centering around a global Internet project. I put out a call for participation in several Internet educational forums, as well as in "Classroom Connect" magazine, an Internet publication for educators. The response was overwhelming. I received over 168 requests to participate from schools around the world, some even wanting to fax their interactions to me as they did not have e-mail access. As I could not manage that amount of correspondence and still do justice to my classroom teaching, I accepted only the first 30 schools that applied -- some schools having several classrooms participating. Another factor in limiting the number of participants was the cost involved with sending materials packets to each school. The principal of my school, Mr. Steven Kaplan, was very supportive in this effort and saw the potential for enriching the students, and agreed to provide funding for the mailings. I was determined to run a project that did not require a fee from any participant, as I feel

strongly that the Internet should be free for educational institutions and projects should be available to any and all. Cost should not be a factor in a teacher wanting his or her class to expand their horizons.

The call for participation was announced in August for a project that would begin 4 November and last four weeks. Within one week of the announcement, I had to begin turning away schools. The participants were a marvelous sampling of global interaction from Australia, South Africa, Japan, Canada, New Zealand, Kuwait, France, and the states of Oregon, Maine, Arizona, Texas, Mississippi, Massachusetts, Nebraska, Michigan, Kansas, New York, Florida, New Hampshire, Washington, California, Ohio, Virginia, Wisconsin, Missouri, Tennessee, Maryland, and North Carolina. The project eventually was extended to 6 weeks, due to teachers' requests for additional experimentation.

PROJECT OBJECTIVES AND DESIRED OUTCOMES

During the Space Flight Project, participating students:

- Construct a cardboard/paper model of the US Space Shuttle
- Conduct a series of test flights, recording distances flown, considering variables of height of release and weight
- Research the topics of flight, space shuttle, astro/aerodynamics, utilizing library and online resources
- Analyze data and submit finding via e-mail using form provided
- Perform experiments to demonstrate principles of aerodynamics and astrodynamics
- Have their research posted to the membership
- Have the opportunity to interact with other member classes via e-mail

The project had an ASK-THE-EXPERT section, where students were able to submit questions to experts from AFSPC and USAFA in the field of astro- and aerodynamics. A CHALLENGE QUESTION section was also included, where the experts presented "posers" to the students, requiring simple research to locate answers, and/or classroom brainstorming to analyze paths to take for our space future.

As desired outcomes from the project, the students:

- Learn, through experimentation, how to collect, record, and analyze data
- Increase their skills in using the world wide web as a resource
- Learn the value of available human resources
- Learn to seek out information from a variety of sources
- Learn the value of sharing data with other experimenters

PROJECT STRUCTURE AND ORGANIZATION:

The basic elements of the space flight project included the following:

- Construction of a space shuttle glider, followed by experimental test flights / recording and analyzing data, drawing conclusions, submitting conclusions via e-mail to moderator
- Construction of and experimenting with: space grasshoppers; ring wing glider; spiraling plane; rocket pinwheel; rocket car; paper rocket; and paper spinners

- Answering challenge questions via e-mail concerning how these will craft behave in a microgravity environment; experts responded to each observation and conclusion submit ted.
- Research elements of flight and related topics and submit research for posting to member ship.
- Ask The Expert: brainstorm questions for the experts; submit via e-mail to moderator; questions and responses posted to membership.
- Challenge Questions: experts pose weekly challenge questions for the membership to answer; students submit answers to the moderator; experts comment on all answers; all questions and answers are posted to the membership.
- Collaboration: e-mail other classes to collaborate on experiments or simply "reach out"; sharing other experiments with members via e-mail which are posted to group.
- Evaluation: e-mail a short evaluation, used to refine and debug project.

By September, each participating teacher was mailed a packet of materials, to assist them in planning their unit of study, two months hence. This packet included: two oak tag patterns for constructing the US Space Shuttle; a list of URL resources for the World-Wide Web (WWW); a list of suggested activities which are adaptable to any grade level; a suggested plan of study for their unit; a list of suggested publications (most from NASA), and a list of addresses of all the NASA Teacher Resources Centers they could contact for materials.

I then placed all the information on my classroom web site for all participants, as well as for classes that I could not officially include in the project, enabling them to follow along and utilize the resources. The list of participants was also placed there so there could be plenty of additional interaction among the schools.

For those needing background information for their instruction, I utilized the NASA publication, "Elementary School Aerospace Activities-A Resource for Teachers EP-147", and placed a consolidated version on my web page. This included background information on:

- Earth characteristics that affect flight
- Flight in the atmosphere
- Rockets
- Technological advances
- Unmanned Earth Satellites
- Unmanned exploration of the solar system
- Life support systems

A special page of approximately 44 space-oriented web links was established so that the students could research any of their topics directly from the Space Flight Project section of my web page. Capt Doug Thayer, of the US Air Force Academy, then created a plan for the 4 week unit, creating the unit as a "virtual" shuttle mission. I added sample experiments that could be performed under each heading and, along with Maj Marty France and Capt Chito Parong, we came up with our basic unit plan (see below), posting it to the web site.

Week 1 -- "Blast Off!" -- Students focus their discussion and experimentation on rockets and how they work.

Week 2 -- "Living and Working in Space" -- Students discuss and conduct experiments relevant to the space environment.

Week 3 -- "The Trip Back" / Students discuss heating and reentry with experiments on flight, (since this was the point in the mission where the Shuttle actually flies).

Week 4 --"The Future" -- Students discuss the future of the space flight and conduct experiments about future uses of space.

Each week, challenge questions appropriate to each topic were asked by the experts. Each class' responses were individually answered by our experts and posted to the membership. Maj France's questions for Week #4 centered more on thoughts and discussions about the future of our space program and the costs and benefits of space travel.

Capt Thayer then devised a list of possible topics for research to coordinate with the weekly project plan. Students could use the URL list on the web page to browse the web for the information on these topics:

Week 1 -- Rockets: shuttle, its parts and their function; Saturn V; Kennedy Space Center; Titan 4; history of Mercury, Gemini, and Apollo.

Week 2 -- In Space: shuttle crew; any astronaut; astronaut training; experiments done in space; benefits of free fall environment, spin-offs; any satellite.

Week 3 -- The Return: shuttle landing conditions vs. normal airplane; any airplane; airplane history such as the Wright brothers; X-1, X-15; Edwards AFB; shuttle reconditioning.

Week 4 --The Future: space station; DC-X/A; X-33; spaceplanes and reusable launch vehicles; mission to Mars; history of the Viking, Pioneer, and Voyager missions; different planets; colonizing the moon; stars.

The two shuttle glider experiments were the core around which the project centered. The students had to construct their gliders and fly them to determine the maximum time of flight, average time of flight, maximum distance flown, average distance flown, and average glider weight. They were also asked how they could modify the gliders to make them go farther, and what could they do to increase the time of flight. All data was submitted and placed on a spreadsheet by my classroom students for dissemination when complete and is included as an appendix to this paper.
During the six weeks of the project, I also e-mailed the following items of interest in the field of space exploration to the membership:

- A class form to utilize for a study of TOYS IN SPACE
- Information on the "Live From Mars" project sponsored by the Passport to Knowledge team
- Updates on Mars Pathfinder status and Mars Global Surveyor
- How to obtain free CD-ROM from the US Dept. of the Interior
- Dr Panoff made available new software for download which simulates a galaxy in motion where you can input data to create a variety of galaxies
- Announcements of other Internet projects involving space studies to participate in: Mea suring the Earth/moon distance during an eclipse; gray water Internet experiment on use of shuttle waste water; interactive Space Shuttle simulation
- Information on the Lunar Eclipse of Sep 26

- Shuttle Glider experiment forms
- Information on how to "fly your students" to Saturn on the Cassini mission
- New web sites
- Announcement of the Colorado Space Education Initiative Conference for Educators

RESULTS

Significant to note were the students' and teachers' comments regarding their data on their shuttle glider experiments. Many conclusions drawn conflicted with others. Here are but a few:

Peter Shardlow in Cape Town, South Africa: *Some people don't know the difference between mass and weight.:-) It doesn't help to add mass that can displace, i.e. pouring paper clips into the fuselage. A slight mass increase (1 paper clip) to the nose performed best. One plane flew better upside down. :-)*

Madame Magnol in Fumel, France: *We concluded that the glider went further when it was weighted. We put a paper clip towards the nose of the glider to do this... the glider flew further when they launched it from a standing position on a chair.*

Madame Henaff-Detrain, Fumel, France: *To make it go farther and stay up longer, we turned up the wing tips. The heavier the glider is and the better balanced it is, the further it flies.*

From Benton Roberts, Nashville, Tennessee: *We reduce the weight to make it go farther and if we threw it higher, with less weight, and bent the flaps, it stayed up longer. Tail weight makes it fall down.*

From the Glenn Family Homeschool, Tempe, Arizona: *Adding a paper clip to the nose made it go farther. Also launching with a slight upward curve seemed to make it go farther. We flew it from an 18 foot balcony in a church. That height helped.* (It should be noted that conditions were made uniform by requesting indoor experimenting and data from a "standing on floor" position.)

From Lucinda Surber, Hoover School, Palo Alto, California: *The testing was great fun. It took a lot longer than we expected to do the trials and evaluate the results. We learned to spot recording errors because they were so different than other results. Developing an efficient plan to help each other measure and record allowed some groups to move ahead to the next investigation. We learned a lot about averaging...we are now more skilled at using our calculators! Each group averaged their results and then we averaged for the whole class. The group averages were amazingly close to each other. We are really enjoying all the activities.*

Many of the comments mentioned the difficulty in acquiring the skill of throwing the glider.

EVALUATIONS AND FEEDBACK

One of the most rewarding aspects of the project was the evaluations and comments submitted by the teachers and students. A sample of some of the responses are shown below:

From Cathie Plaehn, Tiffany Creek Elementary, Boyceville, Wisconsin: *Today we did the space grasshoppers after talking about Newton's 3rd law...They couldn't stop at 5 cm. The smallest one that jumped was made from a square 1 cm square!!! We used gift wrapping paper. It was a good weight and very colorful. Everyone went home with families of grasshoppers. The squeals of*

discovery were wonderful and some came from 5th grade boys. It would have been worth video taping....The kids were fascinated and have become more aware of shuttle activity as a result of the project. Those of us who grew up with the Apollo missions have started to take space flight for granted...it is still amazing. I'm glad I was reminded so my students can be more aware.

Maj Marty France response to an "Ask the Expert" posed by students at LycÇe Marguerite Filhol, in Fumel, France, was written completely in French. This was the response from teacher Anthony Randell: *I would like to convey my own personal message of thanks to Major France who has given us an added reason to be proud of the efforts you and all those working with you have made. If you could pass on our congratulations for the message in French which will be well received by our participating elementary classes. I am very grateful for his noteworthy effort (since it is very commendable French - better than most of those I once taught in the UK!) and I am particularly pleased that in an environment such as Internet where English is the norm, he has given a good example that this Information Superhighway can be a communication tool for all languages.*

From Roberta Marshall, Luella Merrett Elementary School, Fort Worth, Texas: *Positive aspects....introducing students to e-mail, opening a 'world of communication', comparing data, a great way to stimulate interest in space and space travel. The students really enjoyed their answers from your 'experts'. In fact, they have bombarded me with questions this week as we're talking about rockets and the difference between using solid and liquid propellants... Stimulate interest and questions? It worked!*

From Lucinda Surber, Hoover School, Palo Alto, California: *Positive aspects...structured activities-the data collection sheets helped organize the investigations and we learned a lot about data collection and analysis; challenge questions were at the perfect level for kids to be challenged yet successful independently; your web site with links to space sites was very useful and informative; connection with the scientists-my kids were thrilled with a personal response; we really learned how to average.*

From Midge Yergen, West Valley Middle School, Yakima, Washington: *The activities generated a lot of individual creativity and questioning; the activities were hands-on, minds-on; the students loved hearing about the other schools; I plan to use these activities in future years to introduce our study of Space. They were really fun and the kids asked each day, 'What do we get to fly now?*

These were but a few of the comments submitted. Only one teacher was disappointed, as she did not have a working knowledge of the Internet and e-mail and couldn't get anything posted to the group. She expected me to instruct her on the use of the Internet, which is not an aspect of any on-line project, so she had difficulty.

Some suggestions for a future project were to extend the duration for more than 6 weeks as there was a lot more each teacher wanted to include. A home-schooling parent wanted a daily lesson plan to follow for the entire 6 weeks. Others wanted more background information on the experts and would have them explain their professions in order to perhaps build on their areas of experience. Most participants, however, were content with the project as presented.

RECOMMENDATIONS

In order to enrich this project for the future, I propose the following recommendations:

- Many schools that committed to the project and received their packet of materials, never followed through and dropped out. They took slots from schools that were begging to take part, and failed to notify me about non-participation. By committing to accepting more schools, the dropout rate would not be as significant and the impact lessened.

- If more schools are accepted, a financial commitment from my school district or outside sponsor would be required to defray the cost of mailings and preparation of materials.

- On the contingency that more schools are involved, I would request a high school student within the Roslyn Public School District to work on this project for his/her community service requirement that all seniors must complete. I would train him/her in handling the e-mail and collection of data, preparation of on-line materials, preparation of materials for mailing, and uploading data to the web site.

- I would like to see this project occur at a later date in the school year, to enable everyone to more easily work it into their curriculum year.

- The project could be extended to 6-8 weeks, giving teachers more time for experimenta tion and instruction.

- School introductions, which I posted to the membership, should be sent out early in the project, as opposed to near the end.

- Many student inquiries concerned topics of space/astronomy that were outside the specialty areas of my experts. I would recruit additional experts to further flesh-out the broad range of topics that are allied to space.

This project serviced approximately 700 students. However, since the project was available on the web site, hundreds more may have benefited. I sent out over 108 e-mailings during the course of the project and received an almost equal amount of inquiries and replies.

ACKNOWLEDGEMENTS

I have found that creating and moderating this project was a tremendous undertaking, but well worth the effort for the experience and knowledge gained by the students and teachers alike. I would like to thank the Roslyn Public School District and my principal, Mr. Steven Kaplan, for promoting my continuing education in this field and encouraging the use of the Internet in my classroom.

I would also like to express my sincere gratitude to NASA, the US Space Foundation, the US Air Force Academy, Peterson Air Force Base, Air Force Space Command, the Shodor Foundation, and PITSCO Corp. for their continuing role in the promotion of space education.

An exceptionally special thank you to Major Martin France, Capt Douglas Thayer, and Capt Chito Parong, without whose expert assistance, this project would not have "flown."

If more members of the scientific, industrial, and educational communities would support these types of educational journeys through financial aid, time, and the generosity of their expertise, the future of our space program and the resulting new discoveries will be in good hands.

The members of the Space Flight Project
have REACHED FOR THE STARS
and "TOUCHED THE SKY!"