STUDIES OF UREA IN SPACE

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Abstract

This is a good story. This is a story about space flight. This is a story about schools, a Native American High School and a University. This is a story about students and doing great research. This is a story about people working together to make some amazing things happen. Things like friendships, courage, commitment and knowledge. This is a story about a science teacher working on an Indian reservation with some of the brightest stars I know, the students and staff of Shoshone-Bannock High school on the Fort Hall, Indian Reservation located in southeastern Idaho. And last, but certainly not least, this is a great story about urine!

Introduction

The dropout rate of Native American students (30.4 percent) is the highest of all the United States ethnic groups (American Indian Report 2001).

As a member of this minority group and a science teacher working on the Shoshone-Bannock Indian Reservation, in Fort Hall, Idaho. I have seem first hand the lost potential of the students who dropout of school. I have been raised with the

knowledge that we all possess some gifts. I have seen the gifts of humor, art, science, math, history, and culture that Native American students posses. I have been taught that the gifts one receives should be used to help people. All students have gifts. All students are important. When a student quits or is a dropout he or she may not even know what gift they have given up. I have seen some students develop the "habit" of quitting. For example, they quit on school, family, tribe, and sometimes life itself. We all lose when this happens. We all lose the benefits of the great gift, the gift of life and the potential that life has to change the course of every life it touches, including mine. This is why I am concerned with the national dropout rate for Native Americans of 30.4 percent (American Indian Report, 2001).

Gilliland (1988) states in his book Teaching the Native American that there is "no single easy reason why Native American students dropout of school at higher rates than other ethnic groups" (p.2). I could not agree more. I believe there are many contributing factors, including history, school curricula, poverty, racism, community/Tribe, and the parent's attitudes. All have a role to play in why Native American students dropout of school (American Indian Report, 2001, Gilliland, 1988).

Guthridge (1986) states that a good way to show students why science is important is to teach it as a problem solving activity. Rubendall. Reyhner, and Gilliland (1988) explain that students need to know why science is important to their lives. I have found that many students see little or no relationship between their lives and what goes on in the classroom. A problem solving, hands-on approach to science, which emphasizes the skills of science and perhaps does not emphasize as great, the simple memorization of facts, may have a greater effect on the student's wiliness to learn science. If science is

shown to be important to the personal health and future of the tribe, and perhaps the world, then the science and supporting experiments and meaningful.

I wanted to use science as a tool to learn, but I also wanted to use science as a way of capturing students dreams and imagination. Could a science experiment be designed to help keep students in school and address Native American dropout rates of 30.4 percent? (American Indian Report, 2001).

STS-108 Endeavor

"Imagine being in spacecraft light years from Earth and surrounded by your own garbage but with nothing to eat. Your life would depend on your ability to recycle your waste and grow food, and that would depend on your ingenuity in using materials at hand in your spacecraft." (TechLink, 2001).

When I approached the students with the idea of flying urine in space, I got a lot of "Ugh! That's gross!" I smiled, as this is what I do, gross students out and make them think!

This experiment combined students from Shoshone-Bannock High School in Fort Hall, Idaho with Utah State University students in Logan, Utah, researchers from the J. R. Simplot Company of Pocatello, Idaho and researchers from the NASA Johnson Space Center in Houston, Texas and our own staff mentors. I hoped this team would expand agricultural knowledge and open up new frontiers of space survival knowledge. The students grew peas, potatoes, beans, squash, radishes, and other vegetables in a combination of Martin soil, space wastes, and zeolite, a common planetary substance. This experiment provided hands on learning, team work, short and long term goal setting

and valuable information about food production in closed systems that might ultimately affect the longevity of space missions (TechLinlk, 2001).

How does one get students interested in science and school? How does one get students interested in life long learning? Teachers need to show how science and scientific concepts are related to their lives. As Guthridge (1986) has stated, a good way to teach science is to teach it as a problem solving activity. Gilliland (1988) has shown that starting with the environment or other problems students are interested in, students can learn the scientific method of making a hypothesis, controlling experimental variables (controls), collecting and recording data, collecting evidence in a systemic way to test the hypothesis, and drawing conclusions from the evidence.

Procedure

Why fly urine? Well, for one reason it is fun to do! But another reason is that the Shoshone-Bannock tribe is interested in the reaction of zeolite with urine for its slow release of urea. This chemical reaction of zeolite with urine has a dual purpose for the students of Shoshone-Bannock High School. 1) The slow release of urea has the potential to prevent fertilizer runoff on tribal farmlands. This would greatly help the non-contamination of the tribe's ground water. 2) The Shoshone-Bannock students are interested in how life can be maintained in space.

Johnson Space Center commercial technology office and TechLink Center of Bozeman, Montana were contacted to see if groups from private industry and universities could be brought together for the following experiment. Students and researchers evaluated the rate of growth and yield of their food crops while varying the soil conditions by adding nutrients that would be found at a space station or a planetary

outpost. These nutrients would include human wastes and biomass from the spacecraft, and zeolite, which is abundant throughout the universe. Zeolite is a volcanic substance that soaks up and slowly releases the urea into the soil. The Shoshone-Bannock Indian reservation and other tribe have abundant supply of raw zeolite. NASA provides the simulated Martian soil for the team to use as the growing medium. The students produced the simulated human waste being utilized for the experiment by following a chemical recipe for making synthetic urine. Why use synthetic urine? 1) We can control more variables of our experiment if we make the urine up ourselves. 2) Students waned to give me so much of their urine; I felt I could not store it safely!

Experiment Benefits

Students learned to work together as a team. No one flies any mission all by himself or herself. Hundreds of people working together make a mission successful. Working together for a common goal is a valuable lesson to learn. Students also learn that science has application in their lives. The Shoshone-Bannock Tribes are very interested in the youth becoming active learners and learning about the environment. This experiment addressed both of these goals. Lastly, Ralph Oborn, Shoshone-Bannock High School mentor and researcher with Simplot Agronomy stated "We look at this project as a way to introduce students into the world of food production, if they can understand the complexities of the closed loop system in a spacecraft, they will be well prepared to work in almost any scientific discipline". Oborn further states, "Our Company is always looking at new and innovative ways to safely apply nutrients to crops. We'll be looking at soil chemistry, reaction rates, plant physiology, computer modeling, horticulture and many other aspects of modern agriculture" (TechLink, 2001).

NASA has mandated for the past decade transfer of technology from its research laboratories to private sector to help create job opportunities that will create job opportunities that will create the nation's productivity. This experiment addresses that mandate.

Results

The initial experiment results of STS-108 looked great. When we opened the canister at Kennedy Space Center that our experiment rode to space in, we could see that our experiment did run. This is always good news! Closer examination of our experiment indicated that we did indeed have a cleaner, clear (non-yellow) looking sample compared to our initial yellow artificial urine sample that was at the beginning of our experiment. We had succeeded in making "space water". Analysis concluded that we had .12 ppm of nitrate in our space water sample. It was concluded that we could use this water to grow our plants in space.

When we opened our canister we were looking for clean urine. We had observed that when our experiment ran we had lost about 20 millliters of our sample (it had leaked). I have speculated that the urine and zeolite provided a good medium for microorganism to grow. I obtained as sterile samples as I could of the organisms and took them to our local hospital and cultured them. I was very surprised to see that they grew. This was repeated at Idaho State University microbiology department. We had achieved growth of some microorganisms in a very hostile space environment. The organisms were later identified as Trichoderma and Aspergillus species. This has opened more doors for my students in that they now are working with hospital lab personnel and University microbiologists to help further identify and understand this "space hitchhiker".

This has me thinking of a new experiment to growing microorganisms and looking for antibodies that could be produced from a space flight. Again, I have more questions than answers.

Discussion

There is a great deal of evidence that schools with high Native Americans populations as a whole are not adequately adapting to the needs of the student and making instruction ineffective (Gilliland, 1988). Educational statistics indicate underachievement, absenteeism, over-aged students, and high drop out rates 30.4 percent for Native American students (American Indian Report, 2001).

STS-108 was our third successful space science experiment as a school, and Native American Nation. Why have our missions been successful? Students have been shown the importations of science in their lives and some students have developed a lasting interest not only in science but life as well. Student are taught to think for themselves and know they can do so very exciting research that not every high school students gets an opportunity to complete. I have attempted to demonstrate how a science experiment like flying urine in space has practical applications in the lives of the student as well as some interesting water recycling chemistry. I have tried to show how students can develop theory and then design an experiment to test that theory. Students are taught to observe and generalize from their data and observations. This makes my Native American student's life long learners. As a Native American science teacher I have taught the traditional Native Americans views, and foster natural curiosity, problem solving, information gathering, and meeting the very high standards that NASA requires

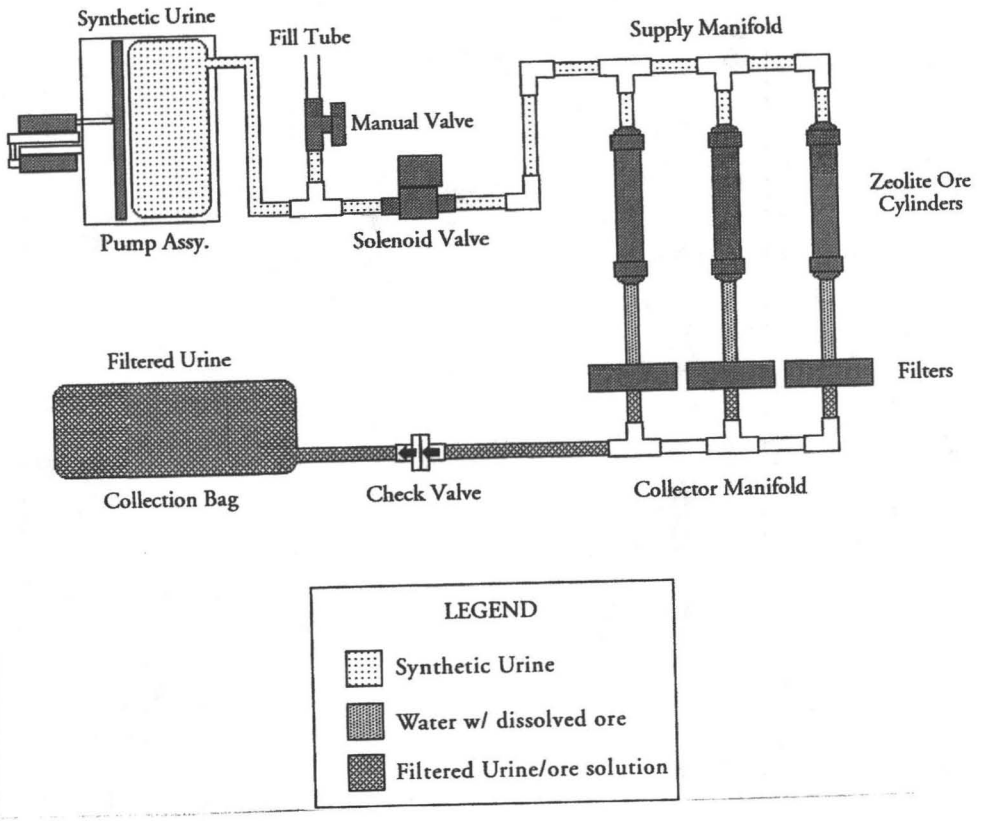
of all it's experiments to fly. This is what is successful to me to see: students working hard together as a team and finding success in life. Students learning about science and more importantly, Native American students learning about themselves. And lastly but most important, students having fun while learning about how to filter urine in space for "space water".

In summary, Shoshone-Bannock students learned about science and how to meet the strict requirements that NASA has to fly an experiment in space. Students also learned to set and reach long-term goals as a team. Students are exposed to great mentors in higher education and private industry. Lastly, when students see their experiment fly into space at Kennedy Space Center they are with other experimenters from around the world. They know they can compete with other people/scientists from around the world. This makes the Shoshone-Bannock Tribe and me extremely proud of our students. This is good to see.

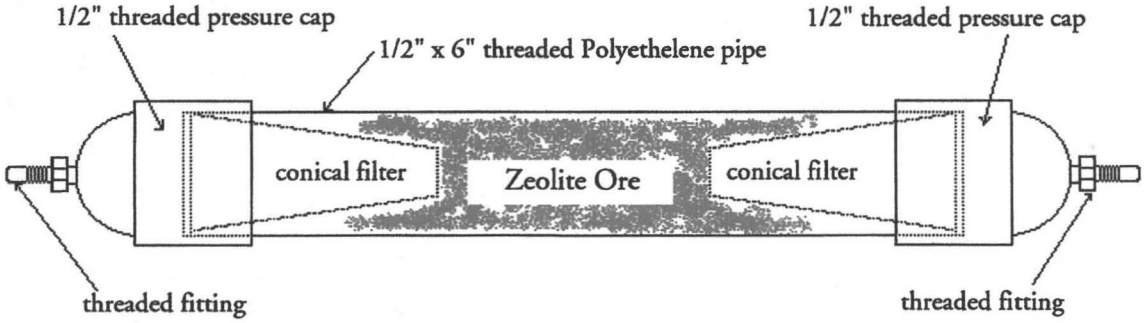
I like what John Dewey has said about education. "Only by being true to the full growth of all the individuals who make it up, can society by any chance be true to itself." All students have gifts. All students are important.

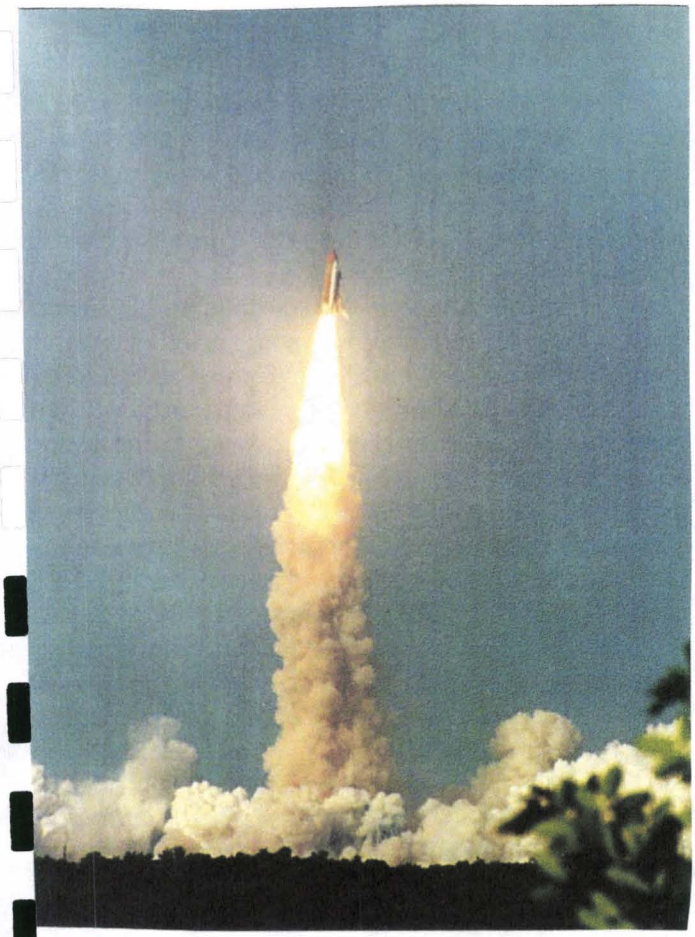
DIAGRAMS

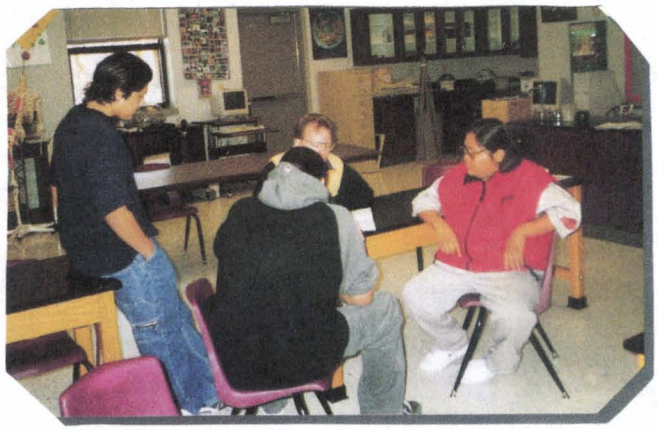
G 221 System Diagram

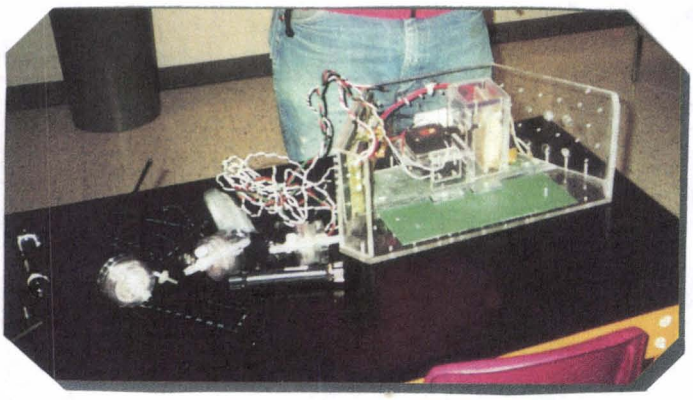


Zeolite Ore Cylinder Assembly










NASA
STS-108
ENDEAVOR
SHOSHONE
BANNOCK
HIGH SCHOOL

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