



Science has a bad reputation among most kids. It usually means memorizing formulas and dissecting frogs and conducting messy experiments for no clearly understood goal. So why is science class at Peterson Middle School one of the absolute favorites of sixth graders?

Because two clever and persistent teachers have discovered how to make their subject not only accessible but cool—the ultimate measure of kids' respect. Vonnie Miller and Brenda Goldstein scraped together more than \$70,000 in grants and donated labor and materials to build a simulated space center in their Sunnyvale, California, classrooms.

Miller got the idea in the spring of 1992 while visiting the NASA exhibit at Disney's EPCOT Center in Orlando, Florida. It's always a big draw for kids. She started to wonder what it would take to reproduce that exhibit on a smaller scale and have her students learn science from things astronauts may do as they travel through space.

"We were just puppies when we started," Miller says. "We didn't know anything and learned as we went along."

Miller and Goldstein visited NASA and Lockheed, where the prototype for Space Station Freedom is located. With some help from the scientists there, the teachers brought their vision back to Sunnyvale. With a \$13,000 grant from Hewlett Packard, Miller and Goldstein set out to purchase equipment and materials. Miller's husband, who is a general contractor, and a carpenter hired by the school began to construct the framework for the two modules in July 1992.

By March 1993 two 12-foot-long, steel-skinned, simulated space capsules were ready for the students. They are located in the "space media center," a carpeted, sky-blue room that is between Miller's and Goldstein's classrooms. Students move freely among the three rooms.

Even though these space capsules won't ever be launched, Miller wanted them to look and feel like the real thing. Their exteriors are rounded, as that's the design that fits best in a launch vehicle. The inner dimensions are squared, though, so that work stations could be placed on four sides. All pieces are screwed together rather than nailed, which makes the capsules sturdier and portable.

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# SCIENCE

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# MADE

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# FUN

*This Class is Practically  
Out in Space*

by Otmar Silberstein and Lawrence Brooke

Knowing that image is everything among kids, the teachers used a few special effects, too. Acrylic mirrors in the capsules create an illusion of more space. Seamless walls—achieved with Bond-o compound—are covered with a textured white wallpaper. Cupboards and other furniture and equipment are ultra modern. Floors are glistening white.

Once ensconced in their high-tech home, what would the astronauts need while in orbit? First their health would have to be assured, so one of the capsules is equipped to monitor vital signs during exercise or task performance.

The other is dedicated to growing vegetables hydroponically, as would have to be done to provide sustenance for the crew.

With help from NASA and Lockheed scientists and the Hydroponic Society of America, the teachers set up two 4' x 3' hydroponic units, each of which has four troughs. Nutrient-rich water flows over the roots of lettuce and tomato plants, and an aeration system supplies the needed oxygen.

### Curriculum tie-ins

What Miller and Goldstein now have is a futuristic lab in which the principles of science and technology can be learned hands-on by about 350 kids each year.

In the yearlong program, Miller and Goldstein each teach one semester that is centered around space technology and invention. Miller teaches technology, geology, meteorology and pre-engineering. Goldstein focuses on chemistry, biology and ecology.

Each student participates in mixing solutions for the hydroponic systems. Nutrients are carefully measured and mixed with fresh water according to the needs of the particular crop. The students are aware that different kinds of plants benefit from different nutrient mixes and that they can improve growth rates and yields by altering the mix for stages in the plant's life cycle.

Students increase their communication skills during recordkeeping of pH and TDS (total dissolved solids) fluctuations, plus frequency of nutrient changes. Tomatoes are hand-pollinated using a fine paint brush. Flowers and fruit are counted and documented. Tests of the flavor of vine-ripe vs. prematurely picked and stored fruit are compared.

The convenience of hydroponics as a



A "space station" based on the NASA model launches students into the world of science at Peterson Middle School in Sunnyvale, California.

teaching tool is in its great flexibility. Hydroponic planters work well inside the classroom, offering much more dramatic growth rates than soil gardening. Effects of light, temperature, nutrient composition, water quality and comparisons of different kinds of plants can be demonstrated and used in studies of plant physiology, plant anatomy, chemistry, physics, engineering and computer applications. Projects of increasing complexity can be designed to suit all levels of education from elementary through the university level.

Another appealing aspect is that students can see, feel and taste the results of projects. Peterson's cafeteria serves the hydroponically grown lettuce and tomatoes. In this school there's no problem getting the students to eat their vegetables because they are so proud of their harvest.

Miller says the whole school science program has been beefed up because of the space project. Eighth graders compete to become teaching assistants in the hydroponic program. High schools actually are beginning to complain that Peterson graduates are too interested in science and are swelling biology and chemistry enrollments to the bursting point.

The project has gained enormous support in the community as well as within the school system. An open house last spring attracted more than 300 visitors—parents, educators and many of the sponsors and contributors to the project. Plans are under way to double the size of the aerospace program.

## Community spirit

If you want to build your own space lab for integrated science courses, Miller has one piece of advice: "You can't wait for someone to hand it to you."

Miller says she and Goldstein got no special funding from the state or local school district for the space media center. The Hewlett Packard grant was the only money the teachers ever saw in a lump sum, and most of that went toward equipment. For the remaining \$50,000 or so, they relied on old-fashioned, door-to-door selling.

Miller put together a brochure that outlined plans for the space media center using video-stills from the Space Station Freedom model. She listed the needed materials, which were decided on as the capsules were being built, and canvassed the local business community.

Each time a lumber yard donated

## Hydroponics as a Teaching Tool

Hydroponic techniques are increasingly popular among science teachers in the U.S. In 1992 three of eight National FFA Organization science project finalists had hydroponic projects. Robin Baseman, the grand prize winner used hydroponics to study the effect of cadmium pollution on plant life. Another finalist combined hydroponics and aquaculture, growing plants and fish simultaneously. The third studied the production of biomass in space.

A high school student in Pearland, Texas, has won first prize in his school's and region's science fairs with his hydroponic projects. There are many others whose experiments or projects give them great opportunities to learn from their successes and failures.

During the last few years the Hydroponic Society of America has been working with educators to familiarize them with the opportunities and concepts that can be explored using hydroponics as an educational tool. A curriculum outline is available, as is information on experiments, guest speakers and suppliers for hydroponic equipment. Most vendors who are society members are willing to offer advice and contribute materials to help teachers and students get started. The Society also offers a special student membership, which includes the bi-monthly newsletter, "The Soiless Grower."



Growing vegetables hydroponically gives Peterson students a taste of science.

For more information, contact the Hydroponic Society of America Education Committee, 2819 Crow Canyon Rd., Suite 218, San Ramon, Ca 94583, phone 510 743 9605.

wood or a building center contributed materials, the companies' names were added to the brochure. That made it easier to appeal to other business owners, who were eager to be part of the project. In the end more than 75 sponsors donated everything from steel and plastic to paint and wallpaper.

"I told them we were targeting at-risk kids and sold it as a total community project," Miller says. "No one turned me down."

Sponsors' names also hang on silver stars inside the lab. Students and parents also can buy stars. The community buy-in scheme has resulted in a veritable galaxy suspended from the classroom ceilings.

Such dedication and ingenuity are part of what has earned both Miller and Goldstein a "Golden Bell," which is California's top award for teachers.

"We're renegades more than anything

else," says Miller. "There are two ways you can teach science—with stuff and without stuff. And the expensive stuff is much more fun."

## About the Author



Otmar Silberstein is chairman of the Education Committee of the Hydroponic Society of America, a non-profit organization promoting the exchange of information, education and scientific research in hydroponics. Lawrence Broke is a founding member of The Hydroponic Society of America and owner of General Hydroponics Co. in Corte Madera, California.

Students can learn a lot of science through the study and application of hydroponics, the technology for growing plants without soil. Biology, horticulture, chemistry, physics, mathematics, engineering, climatology, and computer science may all be incorporated into classroom experiments, science fair projects, school science projects, etc. Students also learn an appreciation for resource recycling, plant/environment interaction, and process control. To provide educators with general information and techniques the Hydroponic Society of America (HSA) sells a wide variety of books about hydroponics and Controlled Environment Agriculture (CEA), a curriculum guide for junior and senior high school and community college courses, and Proceedings of our annual conferences. Educators are welcomed as members and are invited to attend the HSA annual conference, which offers member interaction, displays, presentations, workshops, and tours of nearby facilities. Recent conferences have been held in Tucson, Vancouver, Chicago, Orlando, and Portland. All members receive the HSA's bimonthly newsletter *The Soilless Grower*.

Student requests to the HSA for information on hydroponics have never been higher. Their interest has apparently been stimulated by their visit to The Land of EPCOT in Disney World, by public accounts of NASA's work on hydroponically-based life support systems for Antarctica and for future extraterrestrial missions and settlements, and by media coverage of commercial ventures. The HSA answers such requests with answers to specific questions, bibliographies, referrals to local members of the society, etc. HSA also offers a half-price student membership, and a small book of hydroponic experiments at a nominal cost.

Student efforts in hydroponics have been outstanding. Three of the eight student finalists chosen to exhibit at the 1992 National FFA Convention dealt with hydroponics and one of these three was the grand prize winner. At the Peterson Middle School in Sunnyvale, CA, students recently built a mock-up of a space station and incorporated beautifully designed, electrically lighted, hydroponic systems. The students are making observations and collecting data on lettuce, tomatoes, and other vegetables. When harvested, the fresh produce is served in the school cafeteria. The project is supported locally, by national companies as well as some members of the HSA. Congratulations to the students and their dedicated teachers. The HSA newsletter devotes a page in each issue to students who have such accomplishments.

Many people look to growing plants as a hobby. Some prefer simple systems, while others prefer a more technically oriented approach. All enjoy the clean, weed-free, high production capability that hydroponics offers. Hobbyists, like the students, are experimenters and learners. They attend seminars and conferences, purchase books and systems, and become inventors and entrepreneurs. They also become members of the HSA, and are often its best teachers and representatives.

Hydroponic crop production offers career and business opportunities. It is becoming an agricultural success in numerous countries in Europe, South America, the Middle East, the Far East, and the Southern Pacific, particularly where land and resources are limited, or the climate is adverse for field agriculture. Hydroponically produced crops also help meet the international demand for uniform high quality and consistent supply in high value flowers and vegetables, some of which are now imported from The Netherlands, Spain, Israel, Columbia, and other countries. The membership of the HSA includes a significant number of scientists, commercial growers, and companies who are attempting to enhance American competitiveness in controlled environment agriculture through education. Today's students and hobbyists are tomorrow's professionals.

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