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## Informal Mathematics and Science Education

School isn't the only place to learn about math and science. Informal learning experiences provide students with some understanding of the subjects, and lots of questions. Learn about the resources available to teachers and families from national parks, zoos, and aquariums.

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### Welcome to the electronic version of the *ENC Focus* issue on the topic Informal Mathematics and Science Education.

This page provides access to the full text of all articles in the print version of the magazine. Some articles have been enhanced for this electronic version.

This electronic version has other benefits. Live links are provided for all web sites mentioned. [Focus on the Collection](#) links to complete catalog records of resources selected from ENC's vast collection.

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## Focus On Informal Mathematics and Science Education

*Informal learning environments such as science centers, museums, and zoos can provide students with unique and engaging learning opportunities. Combining formal experiences in school with informal experiences is critical to improving students' mathematic and scientific literacy.*

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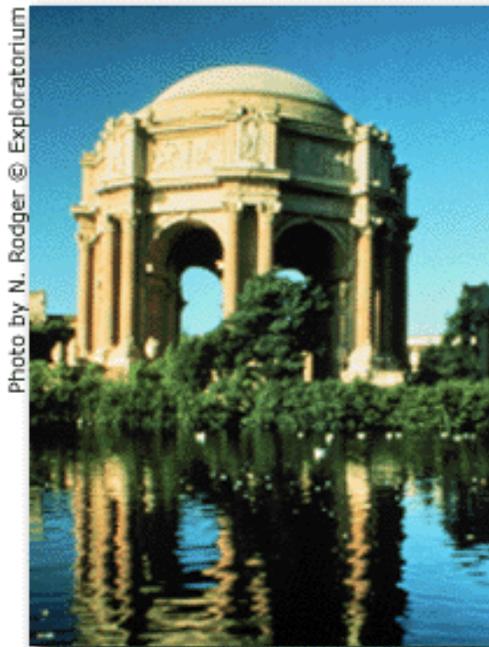
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## Introduction to this Issue

by Kimberly S. Roempler, ENC Content Support

It's ironic that today, the day I'm writing this introduction, my daughter is visiting the Center for Science and Industry (COSI) in Columbus, Ohio, with her Brownie troop. More than 400 girls, ages 6 to 8, will descend on the place and spend the day getting involved in both structured and nonstructured activities. My daughter will experience the power of electricity, watch a 60-foot, 200-pound pendulum knock down pins, lift a 1,000-pound car using a lever, and discover just how hard her heart works. Will the experience be like herding cats for the troop leaders? Probably. What will my daughter get out of her visit? Lots of stories and plenty of questions, I'm sure. Her explanations of what she saw will probably not be exactly scientific. So, why is it still important for her to experience COSI and other informal education sites such as zoos and aquariums?



*The Exploratorium Science Center in San Francisco, California*

Children are naturally curious and have a sense of wonder. They are

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constantly asking questions, using their senses to find out more about the world around them. Informal science learning environments such as science centers, museums, and zoos can provide students with unique, engaging, and captivating science experiences and opportunities. Combining formal experiences (schools), informal experiences (zoos, science centers, aquariums, etc.), and nonformal science experiences (4-H programs, Girl and Boy Scouts, etc.) is critical to improving their scientific literacy (Carlson and Maxa, 1997)<sup>1</sup>

## Informal Education Experts

In this issue of Focus, we highlight resources and identify people from different informal and nonformal educational settings. To illustrate the importance of informal education and the impact it can have on children's growth and learning, we interviewed a number of experts, including Jack Hanna from the Columbus Zoo and David Letterman fame; Richard Taylor, a Texas teacher who started bringing his physics classes to Six Flags before it was "the thing" to do; and Ellen Petrick-Underwood, Environmental Education Specialist for Yellowstone National Park. Each of the interviewees were asked questions such as: Why should I, as a teacher or parent, take advantage of the informal educational programs in my area? How can I get my students focused on learning while they are there? What are the long-term benefits of bringing students there? These questions and more are answered in the articles found at the beginning of each section.

Throughout the interviews, many of the same themes kept cropping up, such as the idea that in an informal setting there is nothing "virtual" or "fake" and that the learning is from the tactile and the immediate. Ellen Petrick-Underwood says informal locations such as national parks have the distinct advantage of being able to teach the real thing in the right place. To Richard Taylor, it is incredible to see what happens when he takes his students into the real world and shows them that what they have been doing all year in the classroom really does apply to things they do every day. He knows that the students will go to Six Flags for the rest of their lives, and every time they do from now on, they will think about physics. Jack Hanna says that live experience is the key. For instance, hearing the low rumbling of an elephant or feeling a snake's smooth skin really make a lasting impression on students who come to the zoo.

A second common theme is to make sure that what happens in an informal setting reflects what is going on in the classroom. Valerie Chase from the National Aquarium in Baltimore recommends choosing a field experience to be either a motivator at the beginning of a project, a site from which to collect data or information in the process of a project, or a summative experience at the end of a unit that reinforces what you have been teaching. She says that informal education is even more effective when it supports what goes on in the classroom.

Modeling the behavior of scientists is another theme that runs through many of the interviews, and many programs ask participants to model the types of investigation that scientists do. Dr. Rob Semper, Executive Associate Director of the Exploratorium science center in San Francisco, believes that opportunities of surprise are key educational events at a museum and that parents should be good role models of inquiry. Similarly, Carolyn Kennedy, Director of Special Projects with Girl Scouts of the U.S.A, describes how the National Science Partnership for Science Museums (NSP) encourages participants to work through the processes of science. People are active participants in their own learning and therefore the goal is to give people experience with asking their own questions and driving their own investigations. Many of the interviewees also describe extensive teacher professional development programs. Programs such as teacher sleepovers, week-long teacher workshops, and orientations are available

for teachers. In addition, many museums, zoos, and national parks have volunteers and staff that are willing to make classroom visits.

## Real and Virtual Resources

In addition to these articles, this issue of *Focus* highlights resources, both real and virtual, that were developed by each of the different kinds of informal science centers featured in this issue. We specifically chose resources that could be used in classrooms anywhere in the country, even though the topic might be the Everglades or Yellowstone. We have highlighted materials from other national parks such as Acadia National Park in Bar Harbor, Maine, and Fossil Butte National Monument in Kemmerer, Wyoming.

In each of the six sections, we chose Internet sites that provide not only wonderful activities and resources for classroom teachers and parents, but also virtual field trips that can be taken by individual students, families, or entire classrooms. Don't think you will ever make it to Big Bend National Park in West Texas? Visit their Web site to read about the natural history of Big Bend, review the rock cycle, and view images that demonstrate the effects of faulting, folding, and jointing. The site also features a virtual hike along the Lost Mine Trail, located in the Chisos Basin of the park. The hike includes examples of erosion, native plants, and biological weathering as well as additional rock structures. This is just one of many virtual field trips available on the Web. For more information on electronic field trips, check out [commtechlab.msu.edu/sites/letsnet/NoFrames/BigIdeas/index.html](http://commtechlab.msu.edu/sites/letsnet/NoFrames/BigIdeas/index.html).

We hope you find the resources and information in this issue helpful. The opportunities to enhance and support learning through informal means are enormous and should not be overlooked by any educator- and that includes parents and teachers. For example, can you picture 20 children, tape measures and stopwatches in hand, racing fish that are swimming in a 110-foot long 335,000-gallon aquarium? Or students collecting data from differently shaped fish over multiple trials, figuring out their speed and then determining the relationship between shape and speed? It's definitely better than reading about it in a book.

By the way, my daughter brought home a tadpole from COSI- she named it Spot. He's alive and well and getting bigger all the time. Talk about enormous learning potential!

## Web Sites

### Informal Science Education: An NSTA Position Statement

[www.nsta.org/handbook/informaleducation.htm](http://www.nsta.org/handbook/informaleducation.htm)

The National Science Teachers' Association (NSTA) supports the development of sustained links between informal institutions and schools as a means of meeting the goals articulated by the *National Science Education Standards* (1995). The position statement presented on their Web site defines informal education as programs and experiences developed outside the classroom by institutions that include museums, zoos, and botanical gardens, as well as parks, nature centers, and environmental education centers. Other informal education sources are community-based, such as youth organizations and community outreach services. The position statement lists the contributions of informal science education in terms of enhancing science studies, addressing different learning styles, increasing community and parental involvement, and promoting life-long learning. NSTA advocates that local corporations and institutions support informal

science education in their communities. [ENC-011940](#)

## Science Standards for Nonformal Education

[www.cyfernet.org/scistandards.html](http://www.cyfernet.org/scistandards.html)

The *Science Standards for Nonformal Education* were developed by the Minnesota Extension Service at the University of Minnesota. The standards are designed to help educators and volunteer leaders understand the importance of nurturing the skills necessary for a scientifically literate society. They are compatible with other national science standards efforts, such as *Benchmarks for Science Literacy* and the *National Science Education Standards*, and include sections on scientific inquiry content standards, science and technology, and teaching and learning in nonformal settings. The purpose of these standards is to encourage understanding of science and technology, address standards from a nonformal perspective, and ensure that nonformal standards are compatible with other science standards. The standards recognize that youth with diverse backgrounds, learning styles, and interest levels acquire understanding in varying ways that are appropriate and fun for them. A checklist is provided to evaluate good learning experiences and examples show how good learning and teaching methods can be applied to science. [ENC-011346](#)

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<sup>1</sup> Carlson, Stephan & Maxa, Sue. (1997). *Science Standards for Nonformal Education*. St. Paul, MN: Minnesota Extension Service, University of Minnesota.

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## Annotated Bibliography

Barlow, D. (1997). Education to make a life. *The Education Digest*, 63(1), 43-46.

This article describes a week-long trip Barlow took with students and parents to Crow Canyon Archaeological Center in Colorado. He comments on participants' educational experiences and reflects that although most of them won't use what they learned, their lives will be richer because of the time spent in Crow Canyon.

Clemens-Walatka, B. (1998). Amusement park inquiry. *The Science Teacher*, 65(1), 21-23.

The author describes the experience of taking her students on a field trip to an amusement park at the end of the school year.

Confar, P. L. (1995). Field trips worth the effort. *Learning*, 23(6), 34.

This article discusses well-designed, relevant field trips and how they can relate classroom topics to students' lives.

Cullinan, K. (1995). Recharge yourself at a science center! *Science and Children*, 33(3), 41-42.

Cullinan describes how teachers can adapt a science center's educational programs and hands-on activities for their classrooms.

Farmer, A. J. (1995). Field trips and follow-up activities: Fourth graders in a public garden. *The Journal of Environmental Education*, 27(1), 33-35.

In this study, the relationship between learning, field trips, and follow-up activities is examined.

Kongshem, L. (1995). The discoverers: Science museums. *Executive Educator*, 17(11), 17-21.

This article focuses on the Exploratorium in San Francisco, California, a museum that demonstrates

how educators can encourage student involvement in science.

Lanier-Morris, D. (1995). Slumber party science: Why my class slept over at the science center and how yours can, too. *Instructor*, 104(6), 50-51.

This article describes a camp-in night at the Maryland Science Center.

Leary, R. (1996). Field trip tips. *Science and Children*, 34(1), 26-29.

This article focuses on the importance of student preparation for field trips.

McCreeedy, D., Borun, M., Mosatche, H.S., & Wagner, K.F. (1996). A collaboration for education. *Science and Children*, 34(2), 38-41.

This article discusses museum and community partnerships that encourage family involvement in science.

Power, B. (1997). How to turn field trips into writing adventures. *Instructor*, 106(7), 42-43.

This article provides eight management tips to turn field trips into writing adventures.

Ramey-Gassert, L. (1997). Learning science beyond the classroom. *The Elementary School Journal*, 97(4), 433-50.

The focus in this article is on the importance of informal science learning experiences in a variety of out-of-school science environments for children and for inservice and preservice teachers.

Sussman, B. (1995). Late night at the museum. *Science Scope*, 18(6), 60-62.

Part of a special issue on science in nontraditional settings, this article describes a field trip that involved staying up all night at the Chicago Field Museum of Natural History.

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## Learning the Natural Way: Interviews with Chip Littlefield and Ellen Petrick-Underwood

by *Julia L. Harris*  
*ENC Publishing Group*

*As a child, I went on many camping trips with my family, and I remember well the times we spent looking for arrowheads, carving figures out of soapstone, building shelters from fallen branches . . . We saw an occasional fox, several deer and squirrels, and one thrilling time in Yosemite, we even saw a bear. The adventures I had meandering in the woods gave me a lifelong appreciation for nature and an interest in conservation-and a healthy respect for poison oak.*

*Because of my own background, I know what a valuable resource we possess in our National Parks, and how significant their influence can be in a young person's educational and personal development. I spoke with two people who work for the National Park system-Chip Littlefield, a long-time park ranger at Saguaro National Park in Arizona, and Ellen Petrick-Underwood, Environmental Education Specialist at Yellowstone in Wyoming-and they agree that time spent in nature can have an impact that lasts long after the visit itself has faded from memory.*

### Chip Littlefield: Cultivating Stewards of Nature

For 15 years, Chip Littlefield has been working to build an awareness of nature and a sense of responsibility in the children and adults he works with at Saguaro National Park. The zeal he brings to his work can perhaps be traced to his own upbringing near Maine's Acadia National Park, one of the most heavily visited parks in the country. "I didn't have any idea of the significance and beauty of this National Park and what it meant," he says. "So I think it's important to reach kids early on and give them a vested interest in preserving our wilderness areas. They need to realize that they are the stewards; I'm just the custodian."

Littlefield works with a cadre of volunteers, made up of former teachers, principals, and school superintendents, to make sure that a visit to the park is more than just a fun field trip for the children. Park staff regularly make pre-visit presentations to classrooms to prepare students for what they will see and do on their trip. During these presentations, children are told what they will need to wear and bring with them, what kinds of

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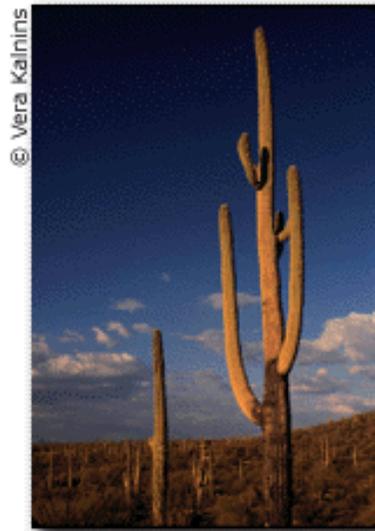
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behavior are expected of them while in the park, and what kinds of things they'll be learning. The purpose of the pre-visit, Littlefield says, is to give students a kind of road map that explains expectations and outlines parameters, thereby reducing the level of uncertainty students feel.

## Extending the Classroom

A key component of a successful experience at a park or wilderness area is to make sure the educational programs are curriculum based and support what is happening in the classroom. Saguaro provides environmental education resources for educators that include a teacher's guide, sent out in advance of the visit to the park, and additional activities that can be completed in the classroom once the visit is over. Coupled with a hands-on, interactive excursion in the park, these materials provide a comprehensive approach to the environment, which Littlefield sees as crucial. "The program might be fun and enjoyable, and the kids get to be outside, but if it doesn't support what they are learning in the classroom, then you're missing the mark," he explains.



*A desert landscape peopled with Saguaro cacti.*

While at the park, students work in small groups and progress through four "stations"-storage, food, shelter, and communication-where they learn about the interrelationships among desert plants and animals. At the storage station, children learn about how the Indians stored things and experiment with making pottery from clay. The communication station is another favorite with participants, because they are encouraged to examine and draw the petroglyphs that were etched into the rocks by Indians more than a thousand years ago. "It's a good hands-on program and we try to involve the children as much as we can," Littlefield says. "We stress that there are no wrong answers-if something comes up that is not quite accurate, we just work it into a more correct context."

In addition to its environmental education programs, the park offers a Junior Ranger program geared primarily for grades 5-12-although Littlefield says the range of participants can be quite diverse: "I've seen 4-year-olds go through with their parents writing the answers for them, and once we had a 60-year-old person do it." The program is informal enough so that people can simply go into the visitor center, sign out a backpack full of materials, and walk through the program on their own. Saguaro also offers a one-day summer camp and a more comprehensive version of the Junior Ranger program, called Cactus Rangers.

## Teaching the Teachers

Children aren't the only ones who can benefit from the resources at Saguaro. Twice per year, Littlefield and his colleagues offer workshops that are designed to stimulate teacher interest and enthusiasm about nature. Participants are taken through the same program as the children, getting a chance to make their own clay pots and petroglyphs, even going on night walks through the desert. "We try to keep it fun," Littlefield says. "We know that teachers are moms and dads, they are busy with things to do after school, so we try to keep them moving instead of making them sit through a lecture and get a credit for it." The hands-on approach works with teachers as well as it does with children, and the workshops have helped get teachers excited about the learning possibilities at the park.

Littlefield cannot stress enough the importance of an interactive experience with nature. "I think there needs to be a more holistic approach to education-it doesn't just happen in the schools, and it's not just about abc's," he insists. "It happens in the home and in field events and opportunities to get outside the classroom, whether you go to state parks, county parks, national parks, even your local park. The resources are all around us; we just need to get out and slow down a little bit and smell, touch, feel. That's what it's all about."

## Ellen Petrick-Underwood: Staying Power

Littlefield's sentiment is shared by Ellen Petrick-Underwood, Environmental Education Specialist at Yellowstone National Park. "In parks we have the distinct advantage of being able to teach the real thing in the right place," she says. "There is nothing virtual or false, and we're not teaching primarily from books but from the tactile and the immediate. That tends to stay with people."

Petrick-Underwood has been at Yellowstone for four years now; before coming on full time, she spent nine summers living and working in the park. Her longstanding relationship with the park has helped deepen her appreciation for the work that goes on there. And Yellowstone is unique, not just because it is the world's first National Park. Set aside for posterity by an Act of Congress in 1872, its 2.2 million acres contain half of the world's known geothermal features, including more than 300 geysers. The world's tallest geyser, Steamboat, can be found here; when active, its eruptions can reach heights of more than 380 feet. Yellowstone also protects several federally listed endangered species, such as the gray wolf, the whooping crane, and the peregrine falcon. Wolves were reintroduced into the wild at Yellowstone in 1995, and have proven to be a big draw for the more than 3 million annual visitors. Yellowstone is also responsible for rescuing from extinction the last remnant of the once-vast bison herds of the Great Plains.

The park has an impressive pedigree, and Petrick-Underwood is committed to providing quality education programs that showcase the resources it has to offer. One of these programs is "Expedition Yellowstone," which has been in existence since 1985 and is targeted for students in grades four through six. The program is curriculum-based and can be done in either a classroom setting or in conjunction with an extended stay in the park. Based at the Lamar Buffalo Ranch, the historic site where the bison were brought back at the turn of the century, the program is taught by a seasonal staff of park rangers with extensive and varied experience in environmental education. The goal of "Expedition Yellowstone" is to teach the natural and cultural history of the park, investigate current issues affecting the Yellowstone ecosystem, and promote preservation in both school and home communities. "It's a field-

based program," says Petrick-Underwood. "We focus on park geology, plants, animals, and human history. A lot of learning occurs through hiking."

As at Saguaro National Park, Yellowstone also runs a popular Junior Ranger program, which serves more than 11,000 students each year. Offered during the summer months, the program encourages students to participate with their parents to earn the Junior Ranger badge. "The goal is to provide families with a broader understanding of park resources, as well as their own responsibility toward them," Petrick-Underwood explains.

For local students, the park hosts a summer day camp program called "Exploring Yellowstone," which introduces school-age kids to skills that will enable them to more fully appreciate and responsibly enjoy Yellowstone. With a focus on outdoor activities, the program offers classes such as fly fishing and drawing from nature. Another program for surrounding schools is "Earth Day Yellowstone Educational Fair," where students spend a day learning about Yellowstone and the importance of preservation through a variety of fun and educational activities. In addition, lectures, field trips, and school programs both in the park and community are offered on a request basis, and the environmental education office responds to many informational requests from students and teachers each year on a wide variety of topics.

## Hands-on Yellowstone

The opportunity to visit the park and experience its resources firsthand simply cannot be duplicated through any other means, says Petrick-Underwood. "There are some excellent CD-ROMs, books, videos, and teaching kits available, but a visit to the park is an invaluable experience," she stresses. "The students are not reading about the geological process—they're going out and hiking it, seeing petrified trees, geysers, hot springs, wild rivers and lakes. . . They are living it as they are learning about it."

As students encounter these phenomena, they have the opportunity to explore the geology more fully and ask questions such as why there are geysers in Yellowstone and not elsewhere, and how they work. To help students process some of what they are learning, Yellowstone staff ask them to keep journals in which they can record their observations and answer some guided questions about the specific environments they have experienced. Another way to extend students' learning experience is to encourage them to talk about it with their parents; Petrick-Underwood recommends that children take their family back to Yellowstone and lead them through the same program. The child then becomes the expert for the family and gets the opportunity to demonstrate what he or she has learned.

For Petrick-Underwood, the most rewarding aspect of her work is the opportunity to provide park visitors with an educational, fun, and memorable experience that will stay with them long after their visit. "Our parks are national treasures and should be a part of every American's sense of identity," she says. "For students who go through these programs, it really is a once-in-a-lifetime experience. . . the possibilities really are endless, and the experiences are priceless."

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