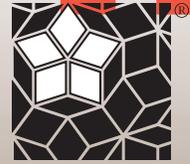


# Hands On!

A publication for mathematics and science educators

Spring 2003 Volume 26, Number 1



TERC

**in this issue...**

**Schools, Families, and Math • Eyes to the Future •  
Investigating Online Learning**

## Mars by Mouse

by Chris Randall

page 4

Mom, can  
we stay  
longer?

Can I drive  
the rover  
again?

What are  
they finding  
on Mars?

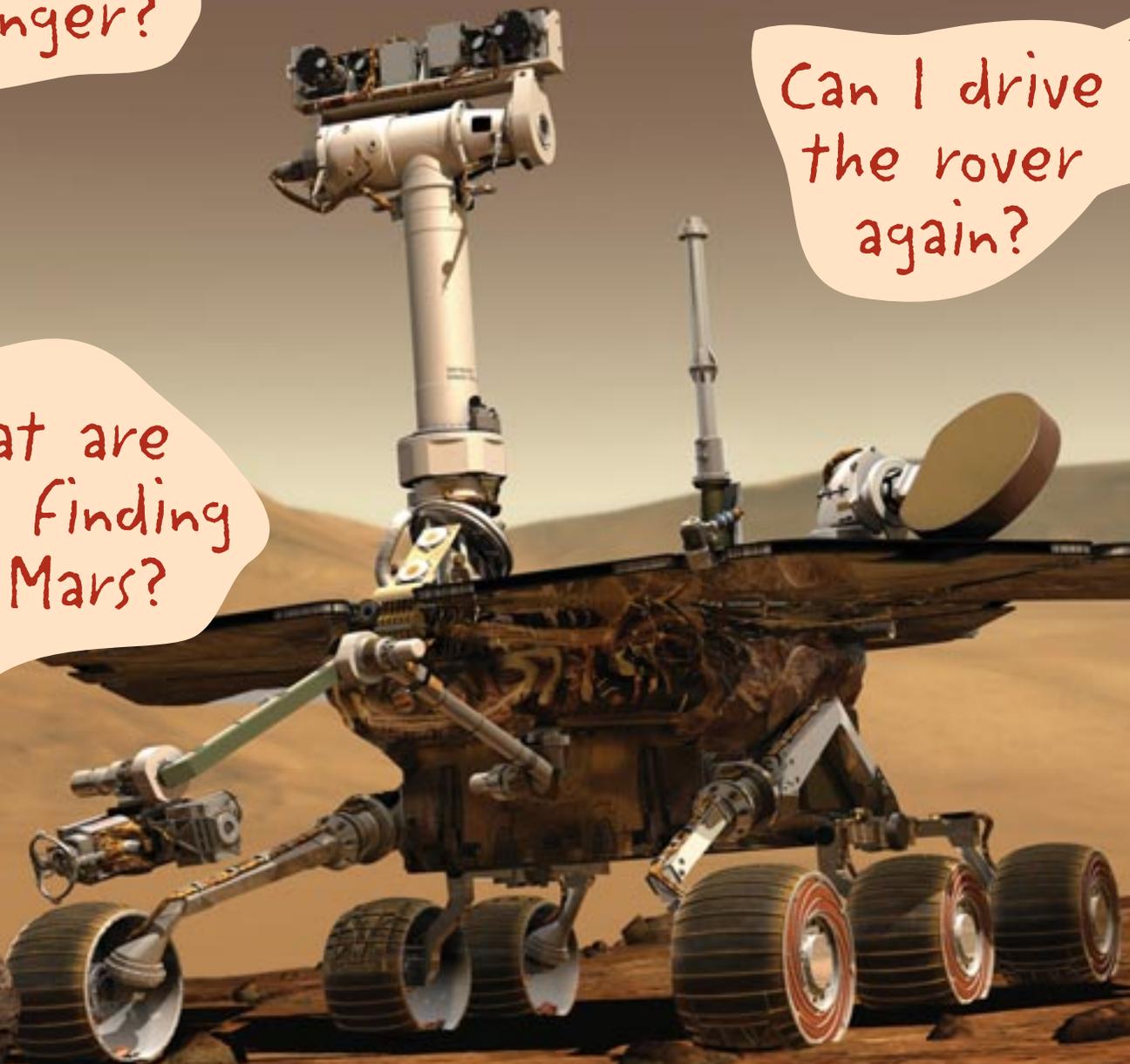


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**Forthcoming from  
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Photo: James Sparks

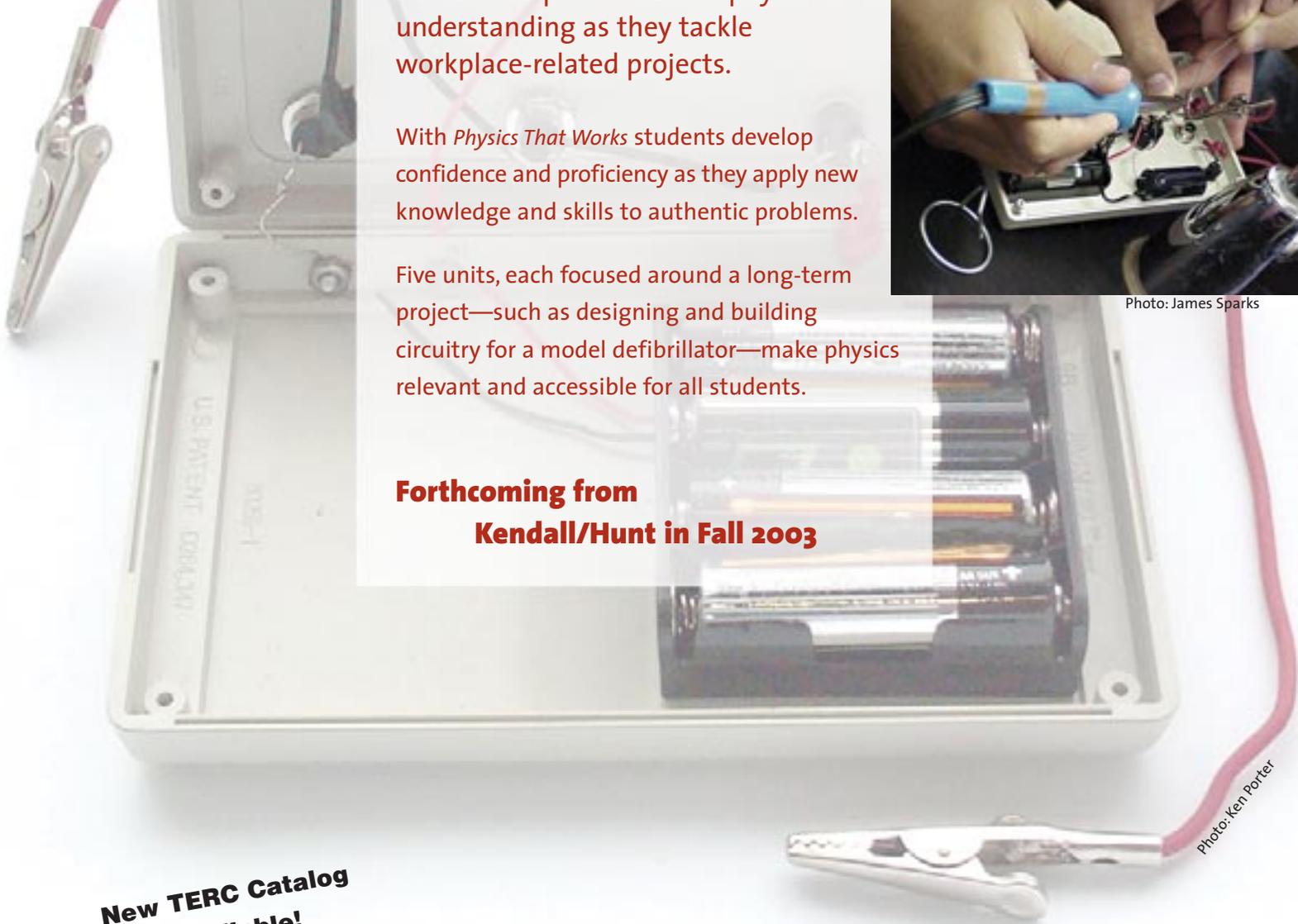


Photo: Ken Porter

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Now Available!**



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# Contents

Museums, afterschool programs, and the Web are just a few places that learning happens outside of school. These less formal environments can offer students significant mathematics and science content and the opportunity to explore and follow their own questions wherever they may lead.

This issue of *Hands On!* features some of the TERC programs that are happening outside the classroom. In our cover article, Chris Randall discusses a new web site that extends the reach of the traveling MarsQuest museum exhibit. *Line Becomes Motion* (page 16) is a snapshot of TERC's work designing museum exhibits to teach concepts central to calculus. The afterschool program *Eyes to the Future* (page 12) uses the Web to help build mentoring relationships between middle school girls and women working in scientific fields. The authors share some of the ways the program encourages girls to pursue science in high school and beyond. *Schools, Families, and Math* (page 8) is an excerpt from a guide aimed at helping teachers and administrators create a partnership with families to improve mathematics education. The excerpt focuses on the role of homework and what parents can do at home to further math learning.

Finally, we include a summary of a research study of *Try Science* (page 17), the first course in a master's program for science teachers delivered completely online. These are just a few examples of how TERC is exploring the potential of different environments to enhance students' math and science learning.

—Kenneth Mayer, Editor

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# Mars by Mouse

by Chris Randall

**Have you ever** left a museum exhibit wanting to return to learn or do more? *MarsQuest Online* is a response to that desire. This new web site enables visitors to extend their experience of *MarsQuest*, a traveling museum exhibit about Mars created by the Space Science Institute (SSI). The exhibit engages the public in NASA's unprecedented exploration effort that sends spacecraft to Mars every two years for the next decade. Museum visitors who are intrigued by the exhibit can log on to *MarsQuest Online* from home or school to continue their exploration of Mars and the adventure of searching for life on the Red Planet.

*MarsQuest Online* ([www.marsquestonline.org](http://www.marsquestonline.org)) is the result of a collaboration among SSI, NASA's Jet Propulsion Laboratory (JPL), and TERC. We, the design team, have created the site for people with a fledgling interest in Mars and space science. We have developed 34 highly visual, interactive

experiences that take up the most compelling questions and highlight the most interesting planetary features. *MarsQuest Online* draws visitors in by presenting the "best of Mars." One middle school student described the site as a stepping stone to NASA's vast amount of information, images, data, and resources, dubbing it "NASA for the rest of us." *MarsQuest Online* will debut in the spring of 2003, coinciding with NASA's launch of two missions to Mars in May and June.

## Mars at Your Fingertips

The web site has two main areas, the Tour and the Investigations. Activities in both areas unfold more like games than lessons. They have specific challenges, natural ending points, and clear measures of success. Most take five

The screenshot displays the MarsQuest Online interface. On the left, there are three panels for selecting landing site criteria. The top panel, titled "Where would you land a rover to search for life?", lists four criteria: solar power (yellow), safe landing speed (green), smooth ground (brown), and level ground (pink). The middle panel, titled "Display these layers to identify a water-rich site that might have signs of life," lists four criteria: channels (blue), ice (white), permafrost (red), and gullies (purple). The bottom panel, titled "Mark the landing site you have determined to be safe and that might have signs of life," features a red 'X' icon and a "check my landing site" button. On the right, a 3D globe of Mars is shown with a grid and a mouse cursor pointing to a location marked with a red 'X'. Below the globe are two circular buttons for rotating the view. The text "Click the buttons to rotate Mars right and left" is positioned at the bottom of the globe area.

Figure 1. In this in-depth challenge, visitors analyze data sets to select a safe landing site that may have signs of life, applying the concepts and skills developed in the Tour and Investigation areas. MarsQuest Online is a learning environment that piques curiosity, builds knowledge and skills, raises interesting questions, and models how to investigate them. Once inspired, informed, and prepared, visitors can begin to conduct their own inquiries.

# MarsQuest Online Site Map

## Homepage

### Tour Mars

- *Mars*
- *Floods*
- *Volcanoes*
- *Canyons*
- *Rovers*

### Search for Life Investigations

#### 5-Minute Investigations

##### Life Mysteries

- *What does life need?*
- *Would life be on or below the surface?*
- *Does Earth have organisms that could survive on Mars?*

##### Water Mysteries

- *Which landforms indicate water?*
- *Where do you find water on Mars?*

#### In-depth Investigation

- *Where would you land a rover to look for life?*

minutes or less and can be done in any order. Each activity has a specific learning goal, so even visitors who only spend a few minutes at the site can have a fulfilling experience and leave knowing a bit more about Mars. They learn by doing, absorbing important concepts about Mars without being taught directly or even realizing it.

The Tour is organized around the five *MarsQuest* exhibit themes—Mars, floods, volcanoes, canyons, and rovers. It introduces visitors to Mars and to how we use rovers to learn about the Red Planet. It also enables visitors to explore three of Mars' most impressive destinations—its 69,000-foot-tall volcano, its 3,000-mile-long canyon, and its 1,000-mile long channels gouged by the largest floods known to occur in the solar system.

Each tour uses the same set of five interactive experiences to showcase different facets of a destination. For example, visitors can fly through 3-D landscapes, using buttons to control their flight. Another interactive enables them to determine relative scale by superimposing outlines of familiar objects onto an image of a geographic feature. For instance, to understand the size of Mars' grand canyon, Valles Marineris, visitors can drag and drop outlines of a school bus, a football stadium, Washington D.C., Hawaii, Texas, or the United States on the image. Because Valles Marineris is 3,000 miles long, the first three objects are imperceptible; only Hawaii, Texas, and the United States show up, giving the visitor a relative sense of just how big the canyon is. Each Tour has two treasure hunts, one in which visitors locate the volcano, canyon,

and flood channels on an interactive Mars globe and the other in which they identify noteworthy landmarks within the feature. Finally, the How Did It Form? activity uses animations to show how planetary processes formed each feature.

The web site's other main part is the Investigations area. It offers six mysteries that examine questions central to the search for life on Mars. NASA's organizing principle in the search for life on Mars—follow the water—lies at the heart of these investigations. The activity What Does Life Need? helps visitors realize that life requires water. Since finding signs of water on Mars is far easier than finding signs of life, the search for life is really a search for water-rich areas. Other investigations teach visitors how to recognize water-related landforms and how to identify water-rich parts of Mars. Each investigation adds a crucial piece to the Investigation area's final puzzle, the in-depth challenge, Where Would You Land a Rover to Look for Life? (See Figure 1.)

This challenge is an open-ended exploration in which visitors apply the concepts and skills developed in the Tour and Investigation areas. It is built around the criteria NASA uses to choose landing sites—find a safe place to land that is scientifically interesting. To find a safe landing site, visitors use the interactive Mars globe to determine which areas are level, smooth, and have enough sunshine to power solar panels. To find scientifically interesting places, visitors use the interactive globe to zero in on water-rich areas, such as ice caps and regions with permafrost and channels. These areas may harbor life or hold signs of past life. Only a few sites are

both safe and interesting, and visitors recommend one of them as a landing site. The interactive then shows how closely the visitor's choice matches one of the 71 sites proposed by science teams in the recent landing site competition for the two upcoming rover missions to Mars. This in-depth challenge can take ten minutes to more than an hour, depending on the level of exploration and analysis.

## A "Slippery Slope" Design

At its core, *MarsQuest Online* is an edutainment site. It entices visitors with quick, fun activities and then builds on those experiences by presenting greater challenges. We term this a "slippery slope" design. The more activities visitors complete, the more likely they are to discover things that interest them, strengthening their personal connections to the site. As they gain knowledge and skills and their questions mount, visitors become more invested in the topic. This, in turn, increases the likelihood that they will delve deeper. One outcome we are testing is whether this slippery-slope design inspires visitors who began their explorations at the "tainment" end of the spectrum to keep going and finish at the "edu" end.

One way *MarsQuest Online* invites visitors to become more deeply involved is by recommending follow-on activities related to the one they have just completed. Each time a visitor finishes an interactive, an "Explore More" box appears, recommending related interactives on the site and pertinent NASA links. For example, someone who has just completed the treasure hunt for water-related features may want to try the site's treasure hunt for volcanic features. And, a natural follow-up to the 5-minute mystery about the connection between life and water is the site's interactive entitled, *Where Do You Find Water on Mars?* Having people investigate questions of personal interest is the ultimate realization of the slippery slope design.

## Learning Earth and Space Science

A goal of *MarsQuest Online* is to promote an understanding of Earth and space science. The site asks visitors to make Earth-Mars comparisons and apply concepts and techniques commonly used by planetary scientists—image interpretation and data visualization. For example, in the Tour's Find a Feature on Mars activity, visitors use the interactive Earth and Mars globes to look for similar features on both planets, such as the highest point, biggest ice cap, and deepest canyon (see Figure 2). Each time a visitor

locates the specified feature on either globe, a brief statement about how it formed appears in a text box, teaching visitors something about the process that produced it. Other interactives contrast Earth and Mars further by comparing their planetary orbits, surface conditions, and habitability.

The site's challenges enable visitors to put their understandings and skills into practice. By designing interactives around only a

few over-arching themes and revisiting them in a variety of ways, *MarsQuest Online* helps visitors develop a core set of skills and understandings that equip them to make effective use of NASA's treasure trove of Mars resources. This empowers people to articulate and investigate their own questions.

## What Will *MarsQuest Online* Help Us Learn?

The development of *MarsQuest Online* began with three questions: How can a web site meaningfully extend a museum exhibit? What helps make the Web a compelling environment for active learning? and How can we increase the Web's effectiveness in informal learning? To help answer these questions, our evaluators will compare the learning

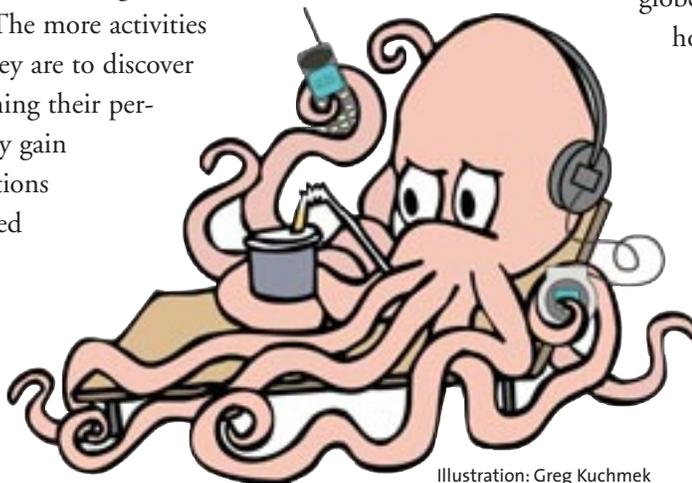


Illustration: Greg Kuchmek

*MarsQuest Online engages visitors by using unexpected elements. The investigation What Does Life Need? opens with a cartoon that shows an octopus lounging on a couch holding objects today's teenagers cannot do without. In several interactives, characters react in dramatic, unanticipated ways, such as transforming into ice cubes or dissolving into gooey puddles. The visual, aural, and cognitive surprises add a sense of playful fun to the site and help make the experiences engaging and memorable.*

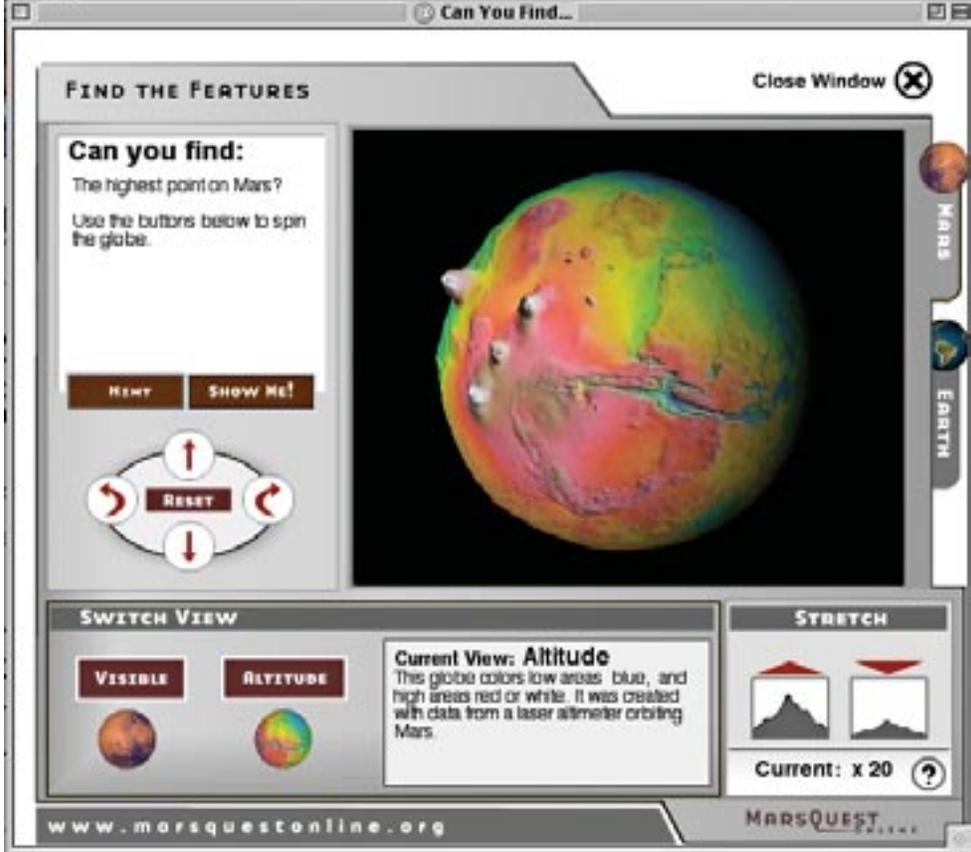


Figure 2. Visitors use the interactive Earth and Mars globes to look for similar features on both planets. Each activity has a learning goal, yet proceeds more like a game than a lesson. Even visitors spending only a few minutes can have a fulfilling experience and leave knowing a bit more about Mars.

experience of three groups of people to see how much they have learned about Mars and how interested they are in finding out more. The baseline group is *MarsQuest* exhibit visitors who have not visited the web site. The second group is exhibit visitors who have also visited the web site. The third group is people who have not visited the exhibit but have used the web site.

This last group is significant. Only a small percentage of visitors to *MarsQuest Online* will have seen the exhibit. Most will arrive via a search engine or through a link on another web site. As a result, *MarsQuest Online* needs to be understandable and useful to people who have never been or never will attend *MarsQuest*. While *MarsQuest Online*'s interactives can serve to deepen the interest sparked by the exhibit, they must be informative and self-contained enough to engage people who are contemplating Mars for the first time. Findings from the evaluation will be published, providing insights that will be useful to designers of educational web sites and museum exhibits.

## From Newcomer to Expert

*MarsQuest Online* is designed to reach as broad an audience as possible. The interactives are easy to use, run directly from web pages, download quickly, require minimal software installation, and work well over a 56K modem. The intention is to have something for everyone—newcomer to expert—and to inspire people to become more engaged in the adventure of exploring Mars than they were when they first visited the site. *MarsQuest Online* is a learning environment that piques curiosity, builds knowledge and skills, raises interesting questions, and models how to investigate them. Once inspired, informed, and prepared by *MarsQuest Online*, visitors can go on to conduct their own inquiries.

*Chris Randall is project director for MarsQuest Online and author of the four curriculum modules TERC produced for NASA's Mars Exploration Program. chris\_randall@terc.edu*

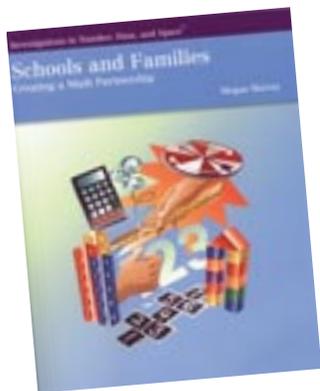
*MarsQuest Online is funded by the National Science Foundation #ESI0104589.*

### Related Materials

*Space Science Institute's MarsQuest exhibit, [spacescience.org/Outreach/TravSciExhibits/MarsQuest/1.html](http://spacescience.org/Outreach/TravSciExhibits/MarsQuest/1.html)*

*NASA's Mars Exploration Program, [mars.jpl.nasa.gov](http://mars.jpl.nasa.gov)*

*Mars Exploration Program curriculum modules by TERC, [mars.jpl.nasa.gov/education/modules/webpages/modulepage.htm](http://mars.jpl.nasa.gov/education/modules/webpages/modulepage.htm)*



# Schools, Families, and Math\*

By **Megan Murray**

## Schools and Families: Creating a Math Partnership

Available from Scott Foresman  
135 South Mount Zion Road  
P.O. Box 2500, Lebanon, IN 46057  
[www.scottforesman.com](http://www.scottforesman.com)

To order call 1-800-552-2259

ISBN 0-328-01881-3

## Math Activities for Families

There are many books that contain mathematical activities which parents and children can do together, often in the time they already spend together.

### Books

*Beyond Facts and Flashcards: Exploring Math with Your Kids* by Jan Mokros (Heinemann)

*Exploring Everyday Math: Ideas for Students, Teachers, and Parents* by Maya Apeiman and Julie King (Heinemann)

*Games for Math* by Peggy Kaye (Pantheon Books)

*The I Hate Mathematics! Book*, *The Book of Think*, *This Book Is About Time*, and *Math for Smarty Pants* by Marilyn Burns (Little, Brown). Available through Math Solutions Publications: [www.mathsolutions.com](http://www.mathsolutions.com)

*Math Games & Activities from Around the World* by Claudia Zaslavsky (Review Press)

### Web Sites

Helping Your Child Learn Math: [www.kidsource.com/kidsource/Content/learnmath\\_index.html](http://www.kidsource.com/kidsource/Content/learnmath_index.html)

Math Resources for Families:  
[www.lab.brown.edu/investigations/resources/math-resources.htm](http://www.lab.brown.edu/investigations/resources/math-resources.htm)

Through the Glass Wall (mathematical computer game reviews): [www.terc.edu/glasswall](http://www.terc.edu/glasswall)

*Many parents and teachers* of school-aged children have similar memories of their own elementary school experiences in mathematics. Desks were in rows, with the teacher at the front of the room. In a typical math lesson, the teacher presented a new procedure—such as long division or subtraction with regrouping—and then children practiced that procedure by doing a page of similar problems from a textbook. One perennial task was to memorize the multiplication tables. For this, some recall taking timed tests; others recall flashcards.

Today, many young students are in math classrooms that look and feel quite different from those that live in the memories of today's adults. Children sit at tables or desks grouped together. They may walk across the room to get manipulatives from a shelf, play a mathematical game on the floor in a corner of the room, or build a structure with blocks according to given constraints. They participate in energetic class discussions that require them to explain, justify, listen, evaluate, and reevaluate.

For parents, these differences often lead to questions about the teaching and learning of mathematics. Is this math? Why isn't my child getting flashcards and sheets of practice problems? Isn't this just a lot of fun and games? What was wrong with how I was taught? How will my child do on standardized tests? Schools must be prepared for these kinds of questions and concerns.

The book *Schools and Families: Creating a Math Partnership* grew out of the work of the *Investigations in Number, Data, and Space* Implementation Center and its efforts to help administrators and teachers respond to these questions. Filled with concrete ideas for communicating and collaborating with parents on the subject of school mathematics, the book draws on many strategies used by teachers from around the country. The hope is that readers will be inspired to find ways to involve parents and families in their children's math education—and keep them involved.

The book is organized into two sections. The first addresses barriers to creating effective partnerships and strategies for overcoming them, including hosting math events, communicating through homework, and helping parents see the math in their children's work. The second section offers the perspective of teachers, administrators, and parent leaders on establishing effective home-school partnerships. What follows is an excerpt from chapter 6 that discusses how homework can help parents see how their children are learning and doing mathematics in class.

\*Adapted from *Schools and Families: Creating a Math Partnership* by Megan Murray. Copyright 2002 by Scott Foresman. Reprinted with permission.

## Communicating Through Homework

Homework is an important means of communicating with families. Teachers can use it to share ideas about what math content is important, give families the chance to see their children working mathematically, and offer a glimpse of how the children are learning and doing mathematics in class. In *Investigations* there aren't homework sheets filled with rows and rows of addition or multiplication problems. Instead, there are sheets with one, two, or several problems, with plenty of room for children to show their solution process. Other homework consists of game directions and a score sheet or a request that children collect and record some data in a way that makes sense to them.

Parents who expect nightly sheets of computational drill may worry that this curriculum is less rigorous. In fact, what *Investigations* is aiming for—in homework assignments and in classwork—is a much deeper understanding of mathematics. Children may be solving fewer problems, but those few problems require more thought. It is often not immediately obvious how to solve the problems, and there are usually several possible methods. Often these assignments require several solution attempts, the refining of strategies, and a picture or diagram showing the problem and solution. When children must find ways to clearly explain a strategy, they must articulate—and therefore further clarify—key math ideas. One of the teacher's jobs is to help parents understand this purpose of homework, as well as what role parents play in the process.

### What Will Homework Look Like?

Because families often have preconceptions of what math homework should look like and how often to expect it, teachers need to let parents know—in newsletters, at Back-to-School Night, and on homework sheets—how homework is going to look and why. Families need to understand that math is about more than numbers and computation and that students will be exploring ideas in geometry, measurement, and data. At the same time they need to be clear about the importance of number and computation in the *Investigations* curriculum—that these areas will be investigated in great depth, for long periods of time, and that fluency with the facts is an important goal.

### First Grade Homework in *Investigations*

Dear Families,

Much of the math in first grade focuses on counting and comparing quantities and on developing strategies for solving addition and subtraction problems. To practice these skills, the children will go home to count, for example, all the windows or electrical outlets in their home and find a way to keep track of and record their findings. They will be playing counting games like "Compare" and "Collect 15¢." They will also solve number problems ( $12 + 13$ ), story problems, and recurring problems like "How Many of Each?" For example:

I have 7 items. Some are peas and some are carrots.  
How many of each could I have?

These examples (taken from one of the *Investigations* units) show some different ways students typically solve this problem. Some find just one solution; others find several. You might be interested to see how your child solves this problem!

—Ms. M.



Figure 1. Parent handout giving examples of first grade math homework.

For parents who express concern about "basic facts," teachers can highlight how the children will work on learning these number combinations. Across the grades, children are asked to think about which facts are hard for them and to develop strategies for remembering them. In second grade, that process might look like this: "8 + 9 is hard for me to remember. But 9 is almost 10, just 1 less, and I know 8 + 10 is 18. I added 1 too many, so take 1 away, and I have 17." In fourth grade, the process may sound like this: "I have a hard time remembering 8 times 7. But I know 7 times 7 is 49, and 8 times 7 is 1 more 7, and 49 + 7 is 56."

When first describing the homework in *Investigations*, teachers can give parents a sense of the range of assignments and materials that are likely to come home during the year. Showing typical homework assignments at their child's grade level can help make activities come to life. With these examples, teachers can explain the math involved and the strategies children will be developing as they work. To illustrate activities for newsletters or handouts, teachers can copy student work from previous years or use pictures from the *Investigations* units. (Figure 1 offers a first grade example.)

## How Do I Help My Child with This Kind of Math?

Being really clear from the beginning about homework expectations and responsibilities can prevent anxiety. Everyone needs to know that homework is the child's responsibility. Children will come home understanding the assignment and what's expected of them, and parents will receive information about the homework and how they can help. At the same time, teachers find it crucial to share with parents the strategies students are likely to be using.

Parents refer back to what they understand and how they learned math.... They think we're dumbing down the curriculum because we're not sending as many problems home and the practice is not there the way they remember it.... One of the answers for us has been sharing examples of how a problem might be solved so that when parents do see two or three problems come home, they have something by which to gauge children's work.—*B. Pierce, special education teacher and teacher leader (Arizona)*

In one district using *Investigations*, parents received the handout shown in Figure 2. It is designed to encourage parents to listen carefully to their children and ask questions of them, rather than simply telling them what to do, where they went wrong, or what the answer is. By helping in this way, parents mimic what teachers do in the classroom—try to follow children's strategies, to understand their logic, and to allow children to discover and correct their own errors. Parents will discover that as children explain their strategies aloud, they often find and fix their own mistakes.

## What about Flashcards? Workbooks?

Some parents will ask about using flashcards and workbook pages or about teaching the "standard" algorithms at home. Teachers handle these questions differently, thinking hard about what works best with their own beliefs, their classroom style, and the particular community in which they teach.

Some teachers try to point out the practice with basic facts and the four operations that is provided in the curriculum and to describe the kinds of activities that will be sent home to achieve the same goals. Parents who are worried about facts and operations are often unaware that there are other approaches; but they are often open to suggestions, so some

### Helpful Things to Say When Your Child Asks for Help with Math Homework...

In order to help your child become a strong and flexible problem solver, we assign a variety of math activities as homework.

Often your child will receive homework that is directly connected to the TERC math curriculum. You can recognize the TERC pages because they appear torn out of student books. On the back of these "Student Sheets" is a section called "To the Family." This section helps explain the concepts the worksheet is designed to reinforce. It also lists the necessary materials and a brief explanation of the activity. By reading this section, you can help your child successfully complete the work.

Games may also be assigned for homework. The TERC units use games as motivating ways to help children learn and master concepts. We play the games in school and expect you to play the games at home, too. Games are to be taken seriously! When your child asks you to play a math game, notice that your child has to remember and explain rules, create a strategy, and use math as well. Games challenge children's minds.

We also assign open-ended problems (multi-step word problems) or performance tasks ('measure this...', 'collect data about that...'). Many teachers call these "Problems of the Week." Often this problem of the week challenges your child to try to use all of her/his math knowledge to solve an unfamiliar problem. Sometimes children complain that "the teacher didn't teach me how to do this kind" and the children are correct, in a way. We cannot ever teach your child to do every kind of problem. Instead, we teach your child strategies to solve a wide variety of problems. When your child asks you for help, try not to jump in with an answer.

Instead, try helping your child get started by using these prompts:

1. Does this remind you of other problems?
2. What have you come up with so far?
3. Where do you think you should start?
4. What is the problem asking you to do?
5. Would drawing a picture or diagram help?
6. How can I help you (without giving you the solution)?

Figure 2. School-wide guidelines for parents on how to help with homework, used as a handout. From J. DiBrienza, K. Casey, and S. Nye, New York City. Reprinted with permission.

teachers keep on hand copies of *Investigations* games and activities for "extra work." The more specific the suggestions, the more empowered the parent will be to carry them out.

You asked about helping Allison with her multiplication facts, and I think it's great that you want to tackle this together at home. We've been doing some activities in class that focus on multiplication pairs and would be perfect for Allison to be working on at home: Arranging Chairs Puzzles, Multiplication Pairs, and Count and Compare. Two of these activities use array cards, which remind me of the flashcards you were asking about, except these cards are

more visual. On the array card for 4 times 5, the kids can see the total number of squares (20), the dimensions (4 rows of 5 or 5 rows of 4), and how it looks compared to other facts that equal 20 (it's half as long as 2 by 10, for example). As Allison uses these cards, she will be learning to visualize the facts and their relationships, with the goal of learning to use them fluently.

It is important to start where parents are—in their beliefs about mathematics, math education, and what their child needs. Some parents will feel that drill and practice with flashcards and worksheets, or learning the long division algorithm, are essential for their child's educational success. Teachers shouldn't expend effort telling parents what *not* to do, or dictating what they *must* do. Energy focused on helping parents understand homework, how they can help their child with it, and why it is important can establish and widen the common ground for schools and families.

### *How Do I Help My Child Learn and Enjoy Math?*

There's a lot families can do to create a math-friendly atmosphere at home. For starters, they can be encouraged to display a positive attitude toward mathematics—even if they find it difficult or unpleasant, or think they were never any good at it. There are several good books for parents who need help overcoming “math anxiety” (see *Dealing with Math Anxiety* on this page). Since some children think excelling in math is “uncool” or that only certain groups (boys, for example) are mathematically inclined, families can work at communicating the message that math is not only a practical necessity, it is something everyone can do and enjoy for its own sake.

A math educator, lecturer, and workshop leader says, “One of the most significant things parents can do is to help their children understand the normalcy and the value of struggle in mathematics.... Learning math ultimately comes down to one thing: the ability, and choice, to put one's brain around a problem—to stare past the confusion, and struggle forward rather than flee” (Sutton, 1998, p. 9). Parents are proud of children who work hard to master a particular piece of music or an athletic skill. But too often in mathematics, people see struggle as the sign of a lack of ability. This belief in innate mathematical ability is damaging to all children. Those who struggle assume they just don't get it and never will. Those who do not struggle believe their success is the result of ability, but then may lose their confidence the first time

## Dealing with Math Anxiety

### Books for Parents

*Math: Facing an American Phobia* by Marilyn Burns (Math Solutions Publications)

*Math Power: How to Help Your Child Love Math, Even if You Don't* by Patricia Clark Kenschaft (Addison-Wesley)

*Overcoming Math Anxiety* by Sheila Tobias (W. W. Norton & Company)

they hit a stumbling block. Parents can help their children expect, cope with, and work through the mathematical difficulties and frustrations they encounter.

Another answer for parents looking to help their child with math is to encourage them to find ways to explore math together as a family. Some parents find it helpful to think of reading with their child as a comparable example—what's the mathematical equivalent of reading aloud to your child every day? Mathematics can be fun if families find ways to include everyone in the family and don't focus exclusively on aspects that can cause anxiety, such as speed and memorization.

Implementing a well-balanced homework policy that takes into account the various needs and expectations of those involved can be difficult. It requires teachers to be thoughtful and purposeful in their assignments, to be respectful of children and their families, and to know well their mathematical goals for children. It is work that may seem easier if teachers remember “the power of homework to create shared mathematical experiences and meaningful mathematical conversations between parents and children” (Raphel, 2000).

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*As a member of the Investigations Implementation Center, Megan Murray works to support teachers, administrators, and parents in schools and districts using the Investigations curriculum. She is also an Investigations author. megan\_murray@terc.edu*

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# Eyes to the Future!®

By Shaileen Crawford Pokress,  
Joni Falk, and Brian Drayton

Twelve-year-old Valerie strides into the computer room after school on a clear fall day. She logs on to the Eyes to the Future web site and eagerly reads a message from Jane, a marine biologist. Jane has written back to Valerie and her teammates to answer their question about how things can live deep under the sea. Valerie is mystified to learn that some organisms live in very cold water and do not need light to survive. Eager to know more about Jane and her work, she quickly writes back. Referring to the scuba diving that Jane does on a regular basis, Valerie asks, "What do you do if you run into a shark down there? Is it scary?" As she sends the message, her friend Tricia logs on and reads a posting from Jenn, a high school girl on their team, who asked Jane how she chose her career and whether she ever thought she wanted to be something else. Valerie, Tricia, and Jenn are all connected to Jane through Eyes to the Future, a science mentoring program developed by TERC.\*



Figure 1. Eyes to the Future's home page includes three discussion areas and the web magazine.

Eyes to the Future clubs pair seventh and eighth grade girls with high school girls in their school district and women mentors working in science, math, and technology fields. The middle school girls meet weekly to do science activities and communicate with mentors and each other in a specially designed web environment. Girls also meet their mentors at school and at their mentors' workplaces. This unique combination of online and in-person mentoring allows strong relationships to develop over time. The personal connections which result provide opportunities for mentors and girls to discuss issues surrounding women in science, possible futures, and science content and exploration. The mentoring relationships the program supports also help the middle school girls see how their work at school relates to "real life."

The support that high school and adult mentors provide comes at a crucial time for these middle school students as they start to imagine their futures and begin to form opinions about their strengths and weaknesses. By specifically targeting girls, programs like Eyes to the Future can begin to close the gender gap in traditionally male-dominated fields such as science, engineering, and technology.

## Extending learning opportunities through cross-age mentoring

Teachers who are interested in providing informal science enrichment facilitate the Eyes to the Future clubs, which are organized into "teams" that typically have three girls, one adult mentor, and one high school mentor.

High school role models are an important part of the program because they can offer the perspective of girls who have "been there" recently. High school mentors are juniors or seniors who have been carefully selected for their academic

\*All names are pseudonyms.

proficiency, extracurricular engagement, and interest in mentoring. They offer valuable advice about staying involved with science and math in high school, including tips on studying, making course choices, coping with academic stress, finding supportive teachers, and joining math and science clubs. High school students help demystify short-term futures while the adult scientists address broadening long-term horizons.

Women mentors from science and technology backgrounds provide a fresh perspective on the relevance and “real life” applications of the science and math being taught in middle school classrooms. Many middle school girls know little about professions that require science and math skills. They rarely see their current classes in the context of possible careers and often lack female role models who can make science and math seem more relevant to their own futures. Eyes to the Future gives girls the opportunity to develop ongoing dialogues with female scientists.

Through this rich exchange, girls broaden their understanding of different fields of science.

### Online communities provide an environment for sharing and creativity

Many mentoring programs have focused on fostering relationships through some shared activity, usually in a one-on-one or small group setting. Eyes to the Future purposefully expands the traditional face-to-face mentoring model by offering an online component. The main hub of activity is the project’s web site (futures.terc.edu), on which each team has its own discussion area called “Team Talk.” The program

supports both cross-age and same-age communication with the different discussion boards (see Figure 2). Discussions are asynchronous so that the participants do not need to be online at the same time. While the girls and their mentors are the only ones who post to the discussion boards, program administrators and teachers can monitor the discussions for appropriateness.

The idea for a web-based mentoring environment evolved out of the understanding that most middle school girls find the Web a unique medium that, with mediation, becomes a safe space for exploration and communication. Girls find the site’s discussion posting interface appealing because they can customize their messages according to their mood by choosing an emoticon (smiley) and a color scheme for each message. The ease and fun of communicating allows the girls to develop in other areas that they may be more hesitant to embrace, like scientific knowledge and technology skills.

As students and mentors develop their relationships, topics of discussion range from “What was the scariest moment you’ve faced in your practice as a doctor?” to “I want to be a model someday.” A major advantage to



ine Speak Out!.

Team Talk
Middle School
Speak Out!
Talk w/ Teacher

**Middle School Girl:** “I want to tell you I admire all that you are in at the High.... In a sense I am a little scared to go into the High next year. Even though this school is pretty big, the first school I went to was only one floor and one room per grade.... I hope at the High that I can join lots of clubs and stuff to keep me busy like I am now.... BYE”

**High School Mentor:** “High school is actually not that intimidating.... It’s big, but very accessible. Room 100’s are on the first floor and 200’s on the second floor.... And the rooms are in numerical order.... There are lots of clubs in the high school. Science club is definitely one club you should consider. We also have a math club too! [Our] math team competes with 5–7 other schools every month. So far we’ve had 2 competitions and won both of them. You are our successors. Once we graduate, you’re gonna have to keep the team running (MAKE SURE YOU JOIN!).”

Team Talk
Middle School
Speak Out!
Talk w/ Teacher

**Middle School Girl:** “What does boat building have to do with physics?”

**Adult Mentor:** “What does boat building have to do with physics? When I first started working with boats, I learned about how they move through the water, what the wave profile (waterline) looks like on a boat as it moves at different speeds through the water. That’s where the physics comes in. Figuring out how fast something moves is a kind of physics problem that involves a distance and some specific amount of time; and then you can determine the speed or velocity of the object.”

**Middle School Girl:** “All that stuff about how building boats is related to physics sounds really cool... What made you want to become a physicist?”

Figure 2. Two exchanges from the Team Talk discussion board.

"You mentioned that one of your dreams is to be a model some day. You go, girl! While most of the models out there are very skinny, I've noticed that, more and more, other kinds of women are coming on the scene. I hope that this is a sign of the times, because it's not healthy for everyone to be that skinny. When I was your age, I worried a lot about my body and how it looked. Do you know when I became beautiful? When I decided my body was just fine as it is! I'm serious! So, keep your dream, and hold on tight to your self-respect.

You also mentioned that you were born in the Azores, and are Portuguese. So cool! I'm part Portuguese (just a little bit though), too. The Azores are amazing. They have hot springs there (did you ever visit them, or were you too little?) because the islands are located near the mid-Atlantic Ridge, which is where there are a bunch of undersea volcanoes. These undersea volcanoes are covered with life. The clams and shrimp that live there (different from the ones you'd like to eat) feed on the energy-rich chemicals spewing out of the volcanoes.

So, what do you remember (if anything, if you left when you were very little) about the Azores?? And who's your favorite model and why?"

—"Deep Sea"

Figure 3. Adult mentors use postings to build personal relationships and communicate science knowledge.

giving the girls the freedom to talk about all kinds of topics is that even messages that seem distant from science help build the relationship. They can open a door for the adult and high school mentors to offer sound advice on real issues that young girls face, such as body image, social relationships, and family life.

The posting in Figure 3 vividly captures how one mentor's response conveys science information along with sound personal advice—exactly the type of interaction the program seeks to foster.

As an environment, the Web provides not only a medium for exchange but also a medium for expression—and therefore reflection—which is vital to the metacognitive work that has to happen for girls to gain a greater understanding of their own scientific, academic, and intellectual development. An archive of messages and web page drafts also provides continuity, which is crucial for an afterschool program in which students and mentors engage more frequently online than face-to-face. Finally, the web environment connects the student to the community outside the walls of the school in



Figure 4. The Web Page Editor makes it easy for girls to create expressive web pages, without knowledge of HTML.

a more sustained and substantive way than can field trips or classroom visits from scientists—the web environment works to amplify the value of face-to-face encounters.

### **Speak Out! online magazine— a web site created by girls**

A uniquely engaging and important component of the program is an online magazine, created by the girls, called *Speak Out!* Using a proprietary web authoring tool developed by TERC for Eyes to the Future, girls can create their own web pages containing text, graphics, and hyperlinks (see Figure 4). Although the ability to create a web page using HTML is a useful skill, the web authoring tool is designed so that there are few technological hurdles for the girls to overcome in order to express themselves on issues related to science, careers, and gender. Girls can quickly approach making a web page, often their first, with a minimum of anxiety and frustration.

Girls take on the role of “investigative reporters” to create *Speak Out!* articles (see Figure 5). There are several different kinds of web articles that girls can write. Using information they have learned through communicating with an adult scientist, they may choose to construct an article about her career, her daily life, and possibly her goals and dreams. Other pages are often about life in middle school, girls' own career aspirations, and recent science field trips and experiments.

*Speak Out!* also offers a variety of resources about science that girls find interesting. Different sections of the site allow them to design and participate in online polls, to share or visit links to other science sites, and to ask questions of female scientists. This public forum allows for a different level of interaction between the girls and the scientists, and also among the girls themselves. Through the “Girls Want to Know” area on the site, students are able to submit questions about virtually any topic to all the women scientists. They often receive answers that offer different approaches to the same question or problem—an advantage of interacting with multiple scientists rather than just individual mentors. Through reading other girls’ pages and participating in polls, students gain a sense of community and shared purpose both within and across clubs.

By providing a fun venue for communicating ideas about science, *Speak Out!* opens a pathway into thinking about one’s own personal goals and dreams and whether a future in science fits with that vision. Additionally, this kind of creative environment encourages the development of literacy skills while improving technology comfort levels.

### Results on a human scale

Eyes to the Future enables adult women scientists and high school role models to have a positive impact on the lives of middle school girls at a transitional period in their lives. The program’s web environment supports the development of an intergenerational community of learners and allows each club and each team to take on its own character, as the members get to know each other through sustained conversations. In this way, community connections take shape between youth and scientists, even though face-to-face meetings are infrequent. The requirement to communicate in writing supports reflection and learning and allows the flow of conversation and activity to emerge from the interests and abilities of the group. Through hands-on science activities, meaningful mentoring relationships, and engagement in science journalism, participating middle school girls gain both confidence and interest in pursuing science in high school and beyond.

**Speak Out!** **Real Scientists**

Sort by School NS Stories NS Stories Real Scientists Talking Science Give Feedback

**Real Scientists**  
A Day in the Life of Katie

Katie Scott, also known as KT, is an adult mentor for Team B. She is definitely cool in the eyes of Team B and many other people. She works at Harvard University in Boston, Massachusetts and likes animals; especially water animals, brine and under water volcanoes. KT has been attacked by a Portuguese Man of War, jellyfish, sharks, crabs and nibbled at by small fish. Her favorite animal in the deep blue sea are Tubeworms, or as KT likes to call them, Lipstick worms. The tubeworms look like lipsticks that are three feet long. Under water volcanoes are unpredictable, lava squirting, cone-shaped mountains. They are pretty much the same as the ones you would find in Hawaii except when they erupt, it is like ripping a hole in the earth and lava pouring out....

KT usually spends most of her work days analyzing bacteria samples she collected while down in the deep ocean in a submarine called the ALVIN. She studies the bacteria samples to see how they interact with each other and their environment. The ALVIN is a type of submarine where the scientists (up to three people and a pilot) sit in a bubble-like space that is made out of titanium. Because it is made out of titanium, it can go under the ocean 10,000 feet (about 1 mile.) But a person couldn’t go out of the sub to collect the samples because the water pressure would squeeze the lungs of a human. So, they can collect the samples in two ways...

Figure 5. In *Speak Out!*, girls often write about adult scientists’ lives and careers.

*Shaileen Crawford Pokress is a senior research associate for the Eyes to the Future project. Joni Falk and Brian Drayton are principal investigators for Eyes to the Future and codirectors of TERC’s Center for School Reform.*

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*Material written by students from the Eyes to the Future project has been used in this article.*

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*For more information about the Eyes to the Future project, visit [www.terc.edu/etff](http://www.terc.edu/etff).*

# LINE

becomes

# Motion

**TERC is developing museum exhibits** for exploring motion through interactive devices that illustrate math concepts kinesthetically. Devices like The Shape Maker, The Shape Breaker, and The Story Line invite the visitor to play with motion—to go back and forth between a physical action and a graphical representation of movement.

One device used in the exhibits, The Story Line, invites visitors to unpack motion stories. For example: “Jon and Don are driving their boats from a dock down the river.

The exhibits are part of an ongoing research and development effort to look at how students understand the Mathematics of Change and in particular how people’s kinesthetic experiences with motion, flow, and shape contribute to their understanding of symbolic representations and the mathematical language of change.

This museum project is a partnership with the Science Museum of Minnesota. The museum will feature these devices



They come to a bridge with a no-wake zone. Jon slows down while Don speeds right through the area. Don is caught by the police and given a ticket while Jon cruises down the river. Can you retell the story using the objects on the Story Line’s two tracks or by using the computer to draw a distance (or velocity) vs. time graph that corresponds to the motion?”

As visitors move boats (or cars or mice) forward and back on the tracks according to the speeds suggested in the stories, they can, in real time, see corresponding graphs of the motion projected on a large screen. Visitors can also draw a graph and watch the objects enact the story. Line Becomes Motion (LBM) technology, developed by TERC, makes this reverse action possible.

and more in an exhibit entitled Handling Calculus, opening in November 2003. The opening coincides with the Association of Science-Technology Centers’ (ASTC) annual conference.

The Story Line, The Shape Maker, and The Shape Breaker will also be featured in the Math in Motion exhibit opening at the Charles River Museum of Industry (Waltham, Massachusetts) in September 2003.

*To learn more about these museum projects contact Tracey Wright, [tracey\\_wright@terc.edu](mailto:tracey_wright@terc.edu) or visit [www.terc.edu/mathofchange/CM/home.html](http://www.terc.edu/mathofchange/CM/home.html).*

*This work is funded by the Science Museum of Minnesota through a grant from the National Science Foundation #ESI0087912.*

# Investigating Online Learning



**T**ERC and Lesley University have been conducting research to investigate the learning experiences and outcomes of teachers engaged in a unique collaboration, a master's degree program in science education for elementary and middle school teachers conducted entirely online. This master's program is designed to develop teachers' understanding in science and improve their pedagogic skills relating to teaching and learning through inquiry. The research studied the experiences of teachers who took the introductory course *Try Science* online and of other teachers who took it "face-to-face" on campus.

Opportunities for online professional development are expanding with the constant advances in Internet and computer technology. The advantages of online courses include the convenience of studying at home and the flexible and rich learning experiences that can be provided through multimedia. This mode of delivery has the potential to become widespread and popular. But is it effective, particularly in providing the kinds of experiences that enable teachers to understand inquiry-based learning and teaching? How does it compare in effectiveness with conventional courses where participants meet face-to-face? The research reported here was initiated to address questions such as these and add to the understanding of effective professional development of teachers.

## Learning At Home

*Try Science* was designed from its inception with online delivery in mind. Participants conduct experiments at home and communicate electronically about their outcomes and the learning process with others in groups of five to seven teachers. Participants are expected to respond to the postings of members in their group each week.

The first 6 sessions of the 13-week course focus on learning science. During this time, participants conduct investigations relating to the properties of ice and water—floating, sinking, and dissolving. After a period of reflecting on their own learning, the teachers spend the next few weeks thinking

The research report *An Investigation of Try Science Studied Online and Face-to-Face* by Wynne Harlen and Craig Altobello is available from the TERC web site, [www.terc.edu/TryScienceReport/index.cfm](http://www.terc.edu/TryScienceReport/index.cfm). For print copies contact [will\\_cunningham@terc.edu](mailto:will_cunningham@terc.edu).

about children's learning and what is required to involve them in learning through inquiry. Finally, the teachers design and teach a hands-on activity in their classrooms, which they then report on and evaluate online with input from the instructor and other participants. Each section of the course, science and pedagogy, is led by a different facilitator.

The aims of *Try Science* present a particular challenge for online delivery, for they include developing teachers':

- understanding of inquiry through engaging in inquiry;
- understanding of strategies for supporting science inquiry in the classroom;
- ability to translate pedagogical knowledge into practice in the classroom.

Further, the pedagogical strategies of the course are chosen to emphasize and exemplify:

- teaching for understanding through inquiry;
- collaborative learning;
- reflection on teachers' own and others' ideas and experiences prior to and during the course;
- participation in sustained learning communities for teachers.

At first sight it would seem to be very difficult to achieve these aims using these pedagogical strategies through working online, particularly as inquiry in science for K–8 involves a

considerable element of “hands-on” experience. However, *Try Science* was designed from scratch to meet these challenges: it was not a conventional face-to-face course transferred to the computer.

## Designing the Study

Since it was never a campus-based course, *Try Science* also posed a unique challenge in designing the research. For the purpose of the study, a 13-week on-campus course, which covered the same material as the online course, was mounted at Lesley University. However, it was not possible for the courses to differ only in the mode of delivery. On-campus participants covered material in weekly three-hour sessions, while online participants spread out their work over the course of a week, and the curriculum presented was adjusted accordingly. Moreover, interaction among participants was asynchronous in *Try Science* online, and on-campus course sessions operated so that the major interaction was synchronous. The research has to be seen as a comparison of the processes and outcomes of two courses having the same essential content and objectives but differing in structure and detail, as required to suit the delivery mode of each.

The research questions were:

- What is the nature of the learning experience online and on campus?
- How do the processes and outcomes of online learning and on-campus learning compare?
- Are there learning outcomes that are more readily achieved though one form of study rather than the other?
- What features of online learning or on-campus courses might be incorporated into the other to optimize learning in both situations?

Data were drawn from the special on-campus course and from two separate semesters of the online course. Data sources included course work, pre- and post-questionnaires, interviews, in-class observation, and online posts. The data collected from or about participants related to: their course experience, change in their understanding of the science presented in the course, change in their understanding of inquiry in science, change in their view of inquiry in teaching, change in their confidence in teaching science, and change in classroom practice.

## What We Found

### The Experiences of Learning

Comparing the experience of the students in these courses was a central aspect of the study. The results gave evidence that participants in both courses were regularly using science inquiry skills during their science investigations. The main differences in the experiences of the online and on-campus participants were that the online participants were more involved in reflecting on their learning and on the process of inquiry. There was also greater frequency of application of certain aspects of pedagogy and of recognizing collaborative learning and valuing first-hand inquiry. Records kept by the participants showed that online students spent on average about two hours per week more on the course than the on-campus students.

### Thinking Like Scientists

At the beginning and end of the science content section of the course, participants were asked to apply their science understanding by conducting a thought experiment in which they predicted the outcome of a particular scientific experiment. Results of these pre- and post-tests showed that science understanding increased for participants of both courses, but the degree of increased understanding was greater for online participants. In answering questions about teachers' perceived learning, a large majority of participants in both courses recognized that the course had increased their understanding of the meaning of inquiry in science, although these improvements did not show up clearly on post-course questionnaires.

### Classroom Confidence

The major change from pre- and post-course questionnaire responses was found in relation to confidence in teaching science. This change was statistically significant for online participants but not for the on-campus participants. In terms of understanding what is important in inquiry-based teaching in the classroom, responses showed a few notable changes including a shift away from explaining ideas, demonstrating, and ensuring correct scientific answers, and towards giving students more opportunity to work things out for themselves and base their findings on evidence.

## Classroom Application

Lesson plans produced as the culmination of the second part of the *Try Science* course were analyzed as a measure of participants' application of ideas about teaching and learning through inquiry. Almost all students in both forms of the course included inquiry skills among their goals and involved students in hands-on activities, in generating data, and in making predictions. On the other hand, a majority of participants did not involve students in applying concepts they learned or investigating their own questions. It is likely that the single introductory module of the master's program does not provide experiences in sufficient depth to help teachers make more radical classroom changes. For example, the ability to take more risks in allowing students to regulate their own learning may develop for participants over the course of the full TERC/Lesley online program.

## Implications

Issues and implications for research arising from the study were explored at a one-day conference held at TERC in December 2002. The conference brought together 24 researchers, program developers, curriculum developers, education technology experts, and professional development providers. In relation to *Try Science* specifically, participants noted that the online environment may have some advantages over traditional classroom learning. Examples include fostering study and reflection throughout the process rather than concentrating these activities in class sessions, providing a written record of participants' ideas and activities, requiring all participants to give evidence of their presence and participation, giving enough time to conduct investigations, and communicating clear instructions and expectations. It's interesting to note that most of these features could easily be built into on-campus courses. For example, even with an on-campus course, investigations could be done at home instead of in class, leaving more time for discussion and reflection.

The on-campus course had some advantages also, including providing more directly shared experiences among students, using oral as well as written communication, and having more direct communication between instructor and participant. Again, online courses could and likely will include these features as appropriate technologies become more available.

In reviewing the research, conference participants identified many questions for further study.

- How should *Try Science* balance its combination of science and pedagogy teaching?

- Does the amount of time spent by participants relate to their learning outcomes?
- Are participants motivated by the course to continue learning and apply what they have learned?
- How does motivation and understanding build up across the whole master's program?
- How do power and status issues in the learning community play out in an online versus on-campus community?
- How could an online course be effectively scaled to impact a larger number of teachers?

Answering these questions would not only further clarify understanding of how online learning works, but would provide substantive improvements in the experiences of online learners. It would allow for optimal design of the curriculum, provide a better understanding of how online communication can be facilitated to deepen the learning experience, and ensure that the teachers' learning experiences are effectively translated into deeper science understanding for their students.

An Investigation of *Try Science* Studied Online and Face-to-Face was funded by the National Science Foundation #ESI9911770.

To learn more about the master's program and the experiences of the first group of candidates scheduled to graduate in 2003, see "The Reality of Virtual Learning" by Diane E. Ready (Hands On! Fall 2002) and "Watching Grass Grow: Biology Explorations Online" by Gillian Puttick (Hands On! Spring 2002), available at [www.terc.edulhandson](http://www.terc.edulhandson).

## Course Schedule

**Summer 2003** (Begins May 12)

Try Science (prerequisite)

Investigating Physics

Earth Science From a New Perspective

Engineering

**Fall 2003** (Begins September 8)

Try Science (prerequisite)

Biology Explorations

Ecology

Contact Lesley University, 29 Everett Street,  
Cambridge, Massachusetts 02140;

800-999-1959 x8938;

[science@mail.lesley.edu](mailto:science@mail.lesley.edu);

[www.lesley.edu/soe/science](http://www.lesley.edu/soe/science)

# Science for Today and Tomorrow

The Science for Today and Tomorrow (SfTT) project will render a three-year standards-based curriculum in life and physical science for students in grades 6 or 7 and in Earth science for grade 8. Using “Backward Design,” two prototype life science units are being developed for grades 6 or 7. One unit focuses on cells and human organs, and the second on heredity and human development. Each unit comprises about 8–10 weeks of class work. The project is also developing unit-specific online professional development materials for teachers, resources for administrators, and activities for families.

## Cells and Human Organs

This unit encourages students to build ideas of science content and process through hands-on and online investigation of cells, organs, and organ systems. Using the respiratory, circulatory, and digestive systems as examples, their studies focus on the integration of organ and organ system structure and function with cellular structure and function. In so doing, the student understands that individual cells are organized into organs and that, in a multicellular organism, the organs and organ systems support the survival and function of the entire organism and its individual cells.

## Heredity and Human Development

This unit encourages students to build ideas of science content and process through hands-on and online investigation of the question “What makes us the way we are?” Using the human as an example, their studies focus on the reliable transfer of information from one generation to the next and from cell to cell as the organism develops. In so doing, the student understands that, in the case of humans, there are thousands of genes. It is interaction among our individually unique collection of gene versions that establishes the characteristics contributing to our unique identity. The unit offers middle grade students opportunities to develop a qualitative understanding of genetics that will also serve as a basis for subsequent molecular-based studies in high school and beyond.

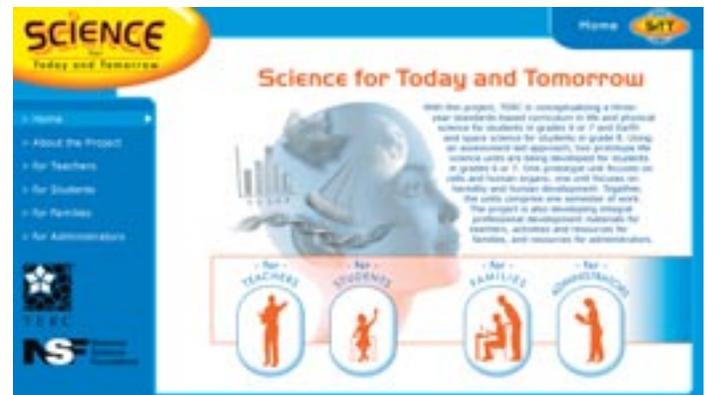
**Field Test Opportunity** Teachers are needed to field test these units during the 2003/2004 school year. To apply, visit [sftt.terc.edu/fieldtest](http://sftt.terc.edu/fieldtest) or contact [judy\\_vesel@terc.edu](mailto:judy_vesel@terc.edu).

## The Unit Web Sites

Each site connects to materials for:

- Students—Resources and activities for use, in class or outside of school.
- Teachers—Teacher’s Guide and duplicating masters of activity sheets, readings, and assessments as downloadable PDF documents; forms for ordering laboratory supplies and enrolling in the unit; list of questions and answers that provide concise information about the curriculum; resources for facilitating implementation and increasing content knowledge.
- Administrators—List of questions and answers with information about describing the curriculum to multiple audiences; tables showing alignment of a unit with national science and mathematics standards.
- Families—List of questions and answers about topics students study, skills they develop, and what families and extended families can do to support students’ out-of-school science learning; activities to do with students outside of the classroom are available as downloadable PDF documents.

*Science for Today and Tomorrow is funded in part by a grant from the National Science Foundation #ESI010179.*



# New Projects

## Center for Ocean Science Education Excellence

The New England Aquarium, Woods Hole Oceanographic Institution, and University of Massachusetts propose to create a New England Regional Center for Ocean Science Education Excellence. TERC will develop materials for the center that demonstrate hands-on use of scientific data and will advise on professional development and assessment strategies. Funded by the New England Aquarium through a grant from the National Science Foundation.

## GLOBE: Aerosol Monitoring Project

Through the Aerosol Monitoring Project, part of the GLOBE environmental program, students worldwide are measuring levels of particles in the air from their local study sites. Aerosols can enter the atmosphere from activities such as volcanic eruptions or burning fossil fuels. The project will support teachers by providing updated GLOBE materials, workshops, and conferences. The project will develop research partnerships among teachers, students, and scientists within the atmospheric science community, especially those using GLOBE schools to provide ground validation of space-based measurements. Funded by Drexel University through a grant from the National Science Foundation.

## Learning Mathematics and Science in Online Environments

The William and Flora Hewlett Foundation has awarded TERC a grant to plan the Center for Research on Learning Mathematics and Science Online. TERC is laying the groundwork for a center that will investigate how learning occurs in online settings. The planning grant is the result of over 12 months of preparation by TERC, which considered how such a center could most productively build on the organization's strong foundation of research in science and mathematics learning. The project is focusing on developing a center that is multi-institutional and multi-disciplinary and includes several other institutional and academic partners.

## Interactive Earth

TERC, in partnership with WorldLink, Inc. and with the cooperation of NASA Earth Observatory, is developing a DVD entitled "Interactive Earth 2.0." Using images from space, interactive maps, and custom animations, this multimedia tool will help students explore Earth's systems, its evolution, the rise of humanity as a significant force in the Earth system, and the long-term future of the Earth. TERC will develop a curriculum that engages students with issues relevant to their own lives and communities. Funded by the National Science Foundation.

## Lead Learners in Mathematics

The project is designed to build teacher leadership in elementary schools in Boston by providing teachers in each school with professional development that strengthens their mathematics teaching practice. Classroom support, professional development, and an apprenticeship program will help teachers assume leadership roles. Administrators and parents will also participate. Each school will ultimately create a Math Leadership Team prepared to transform mathematics teaching and learning in their school community. Funded by Boston Public Schools through a grant from the National Science Foundation.

## Predicting the Future: Science and Technology of Weather Forecasting

The Boston Museum of Science is building a permanent exhibit entitled "Predicting the Future: The Science and Technology of Weather Forecasting." TERC is advising in the development and implementation of the exhibit's weather portal, focusing on the use of satellite and radar data in forecasting. TERC is also developing a group learning activity for the museum's computer center and a web site featuring satellite and radar images. Funded by the Boston Museum of Science through a grant from the National Science Foundation.

## Learning Probe

Learning Probe is translating TERC's products *Tabletop* and *Tabletop Jr.* into Russian. These visual data tools introduce students to key concepts of data collection and analysis. The project will offer Russian K–12 students and teachers innovative learning tools to enhance their classroom experiences in math, science, and technology. This project is funded by the Moscow Institute for New Technologies in Education (INT). INT will also perform the implementation for these products.

## Math Momentum in Science Centers

This project, led by TERC and the Association of Science-Technology Centers in conjunction with a group of distinguished science centers, will expand and enrich the use of math in exhibits and programs at science centers nationwide. The project will provide significant professional development for science center staff through workshops, online courses, and materials focusing on data, measurement, and algebra. Funded by the National Science Foundation.

## Student/Scientist Partnership for Fossil Research

The Paleontological Research Institute (PRI) is conducting a research project in which students collaborate with scientists to analyze and date rock samples associated with fossils from the Devonian Era. The fossils enable scientists to investigate the rates of change and variation in several species. TERC is providing educational and design support to help PRI scale up the project. Funded by PRI through a grant from the National Science Foundation.

## Teachers for a New Era

TERC is collaborating with Bank Street College of Education's Teachers for a New Era project. Along with two action-oriented inquiry teams—teacher candidates and exemplary teachers—TERC will identify mathematical content knowledge, observe teachers and students in classrooms, and contribute to the inquiry process. The work will inform the preparation of teacher candidates. Funded by the Carnegie Corporation.

### VideoPaper Web Site/Tutorial

This project has developed VideoPaper Builder (VPB) 2.0, a cross-platform version of the original VPB 1.0 software developed at TERC. A teacher using VPB can create a single multimedia document consisting of video from the classroom, a slide show of related images, and interactive buttons connecting video with pages of text. The project has developed a web site to deliver the software, and a new User Guide and Tutorial. Available to download free of charge, June 2003, from [vpb.concord.org](http://vpb.concord.org). Funded by the Concord Consortium through a grant from the U.S. Department of Education.

### Have you ever used *Tabletop* or *Tabletop Jr.*?

TERC plans to revise and expand these popular visual data tools, and your comments are valuable to our design process. Data literacy is extremely important in the nation, and *Tabletop* is the only data tool on the market that reaches all grade levels K–12. Known for its power and simplicity, *Tabletop* has reached an estimated 85,000 classrooms nationwide. TERC staff will be in the Sunburst booth at NECC in June, so please stop by and fill out our brief Questionnaire. If you do not attend NECC, please look for the link to the electronic feedback form on the TERC web site, or contact [kathy\\_jean@terc.edu](mailto:kathy_jean@terc.edu).

**Investigations Workshops for Transforming Mathematics** offer support for teachers, math specialists, and administrators implementing the *Investigations in Number, Data, and Space* curriculum. Level 1 workshops engage educators in exploration of *Investigations* content and assessment while preparing them to use one unit. Level 2 workshops allow more experienced educators to focus on computation and number. Leadership Workshops assist educators supporting implementation in their schools and districts. Workshops are offered throughout the U.S. Visit [investigations-workshops.terc.edu](http://investigations-workshops.terc.edu), or phone 617-873-9785.

### VISOR

The VISOR (Visualizing Statistical Relationships) project is looking for middle and high school math teachers for a one-year biweekly seminar on data analysis and statistical reasoning. Participants will analyze data themselves and with their students, and reflect on the statistical reasoning happening in each context. The seminar will use two newly developed software tools for statistics education; participants need access to computer resources in their schools. Teachers are paid a \$2000 stipend. For more information, contact Camilla Campbell at [camilla\\_campbell@terc.edu](mailto:camilla_campbell@terc.edu).

### Earth Science by Design

Participate in Earth Science by Design, a professional development program for middle school teachers of Earth science. The program is seeking teachers from Massachusetts, Rhode Island, and New Hampshire to participate during the 2003–2004 school year, beginning with a ten-day institute this summer. Application deadline: June 1, 2003. Also needed: science supervisors and staff developers to work with the project. For more information and to apply online, go to [esbd.terc.edu](http://esbd.terc.edu).

### Lesley/TERC Try Science

Register for online graduate-level courses designed by TERC and Lesley University for K–8 educators who would like to strengthen their science background, learn more about inquiry-based science, and align their classrooms with the National Science Education Standards. Try Science is the prerequisite course for the online master's degree program in science education at Lesley University.

Summer session begins May 12, 2003.

Courses offered: Try Science, Engineering, Earth Science, Investigating Physics

Fall Semester begins September 8, 2003.

Courses offered: Try Science, Biology Explorations, Ecology

For information, contact Lesley University at [www.lesley.edu/soe/science](http://www.lesley.edu/soe/science), email [science@mail.lesley.edu](mailto:science@mail.lesley.edu), or call 800-999-1959 x8938.

### NASA Student Involvement Program

Find rewarding opportunities for research and exploration with the NASA Student Involvement Program's six K–12 competitions. NSIP's most popular competition, Design a Mission to Mars, is expanding to include not only Mars but also other solar system objects. NSIP's Science and Technology Journalism competition celebrates the 100th anniversary of the Wright brothers' historic flight. The NSIP web site offers classroom activities, resource guides, judging rubrics, and books, all free of charge. Visit [www.nsip.net](http://www.nsip.net), email [help@nsip.net](mailto:help@nsip.net), or call 800-848-8429 for information and materials.

### ISS EarthKAM

Middle school students can take photos of Earth from space! Through ISS EarthKAM, a NASA-sponsored education program, students control a camera mounted on the International Space Station and study the resulting images to enhance their learning of science, geography, mathematics, and technology. There are four or more missions each year, generally in November, January, April, and July. All images and educational materials are available on the Web. Register to join the program at [www.earthkam.ucsd.edu](http://www.earthkam.ucsd.edu).

### Online Science-athon

The Online Science-athon offers students opportunities to discover the science in their daily lives in ways that are engaging and fun, easy for teachers to incorporate into their teaching, and instructive. The Marble Roll, How Tall Am I?, and Catching Sunshine challenges are delivered via the Web and result in class data that are submitted to a central database. Visit [scithon.terc.edu](http://scithon.terc.edu) or email [judy\\_vesel@terc.edu](mailto:judy_vesel@terc.edu).

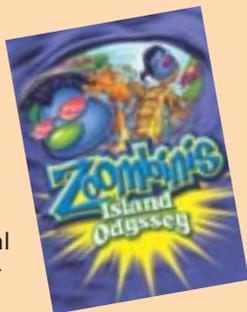
### Signing Science

Teachers of deaf or hard-of-hearing students in grades 3–8 are needed to field test signed versions of the web-based units What's the Weather? and Are We Getting the Oxygen We Need? Visit [signsci.terc.edu](http://signsci.terc.edu) or email [judy\\_vesel@terc.edu](mailto:judy_vesel@terc.edu).



## Zoombinis Island Odyssey Wins Bologna New Media Prize

The Zoombinis' newest adventure, *Zoombinis Island Odyssey*, has been honored with the prestigious 2003 Bologna New Media Prize. *Island Odyssey* was one of three winners recognized by an international panel of judges which considered over 500 entries from 12 countries.



In announcing the award, the panel said, "Original, funny characters combine with compelling logic puzzles to make this program both educational and addictive. The introduction of ecological concepts is effortless and witty, and the graphics are wonderful."

Published by The Learning Company/Riverdeep, the *Zoombinis* series has sold over 1.6 million copies worldwide and has been translated into five languages. Visit [www.learningco.com](http://www.learningco.com).

## TERC President Gives Keynote at Kuala Lumpur Museum Conference

TERC President Dennis Bartels spoke at the Asia Pacific Network of Science & Technology Centres (ASPAC) Conference 2003 in Kuala Lumpur, Malaysia. The conference was hosted by PETROSAINS, an interactive science discovery center. Bartels presented two speeches about the importance of informal science centers as bridges between scientists and the public, school and life, and content and technology.

## New Math Game

*USA by the Numbers*, a set of five math games developed for children ages 7 and up, will be published for release in Spring 2004. The games offer varying levels of difficulty and combine U.S. geography with math, data, logic, and strategy. Forthcoming from Educational Insights.



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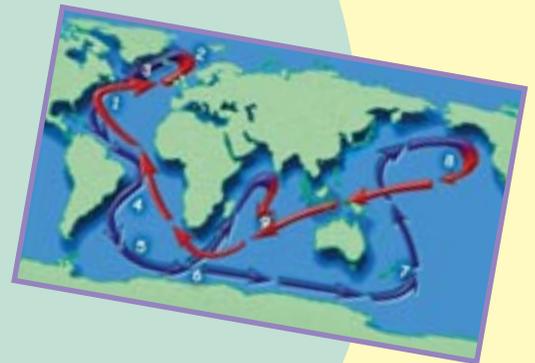
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