

# Hands On!

A publication for mathematics and science educators

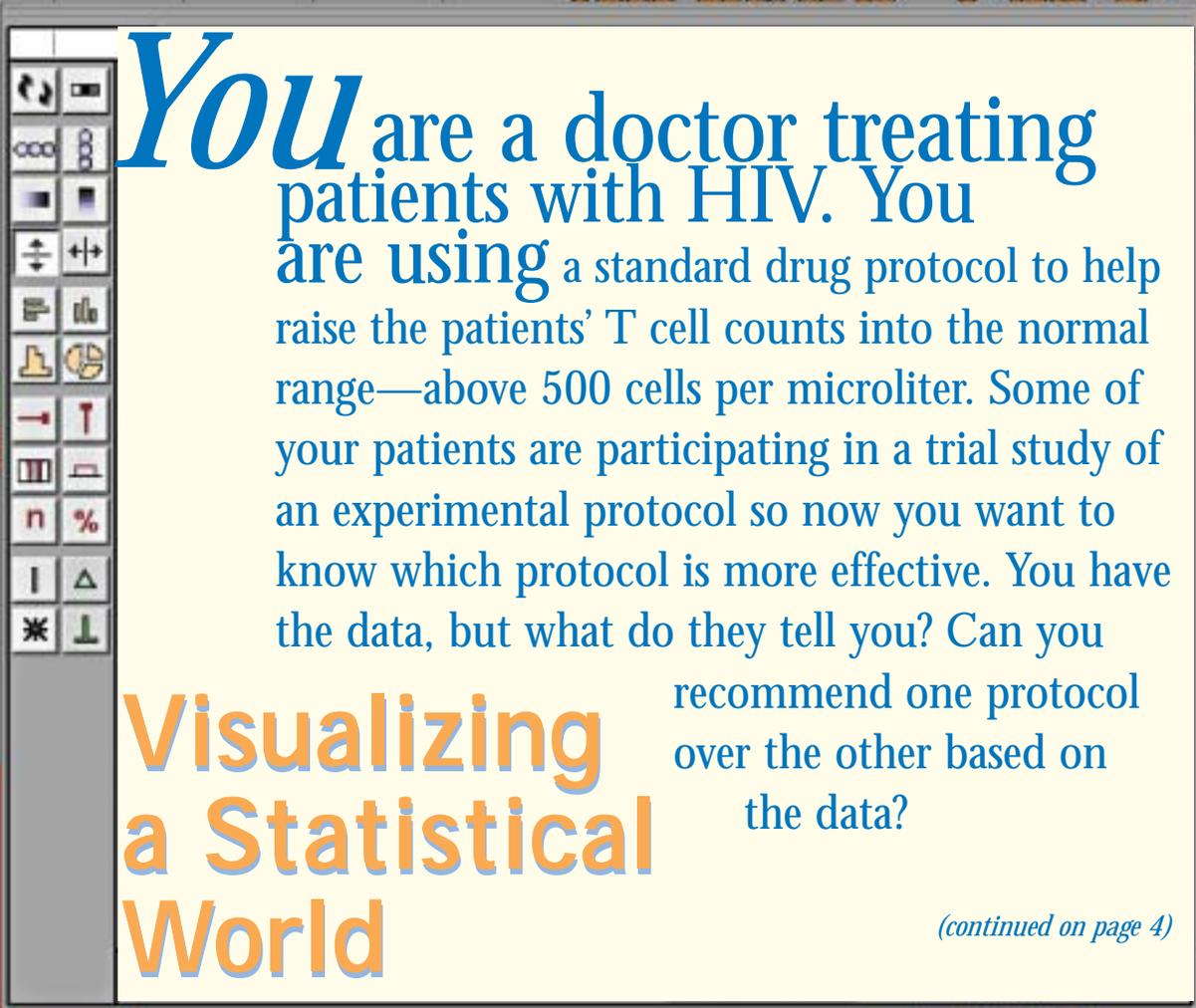
Fall 2002 Volume 25, Number 2



TERC

in this issue...

The Reality of Virtual Learning • VideoPapers •  
Standards-Based Mathematics Curricula: What Do Students Learn?



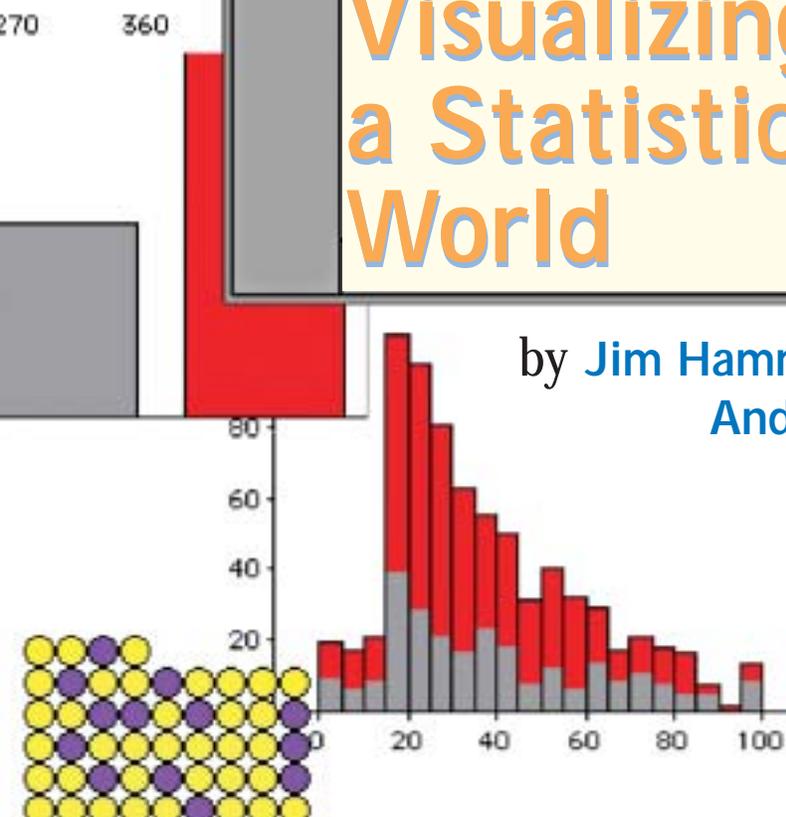
*You* are a doctor treating patients with HIV. You are using a standard drug protocol to help raise the patients' T cell counts into the normal range—above 500 cells per microliter. Some of your patients are participating in a trial study of an experimental protocol so now you want to know which protocol is more effective. You have the data, but what do they tell you? Can you

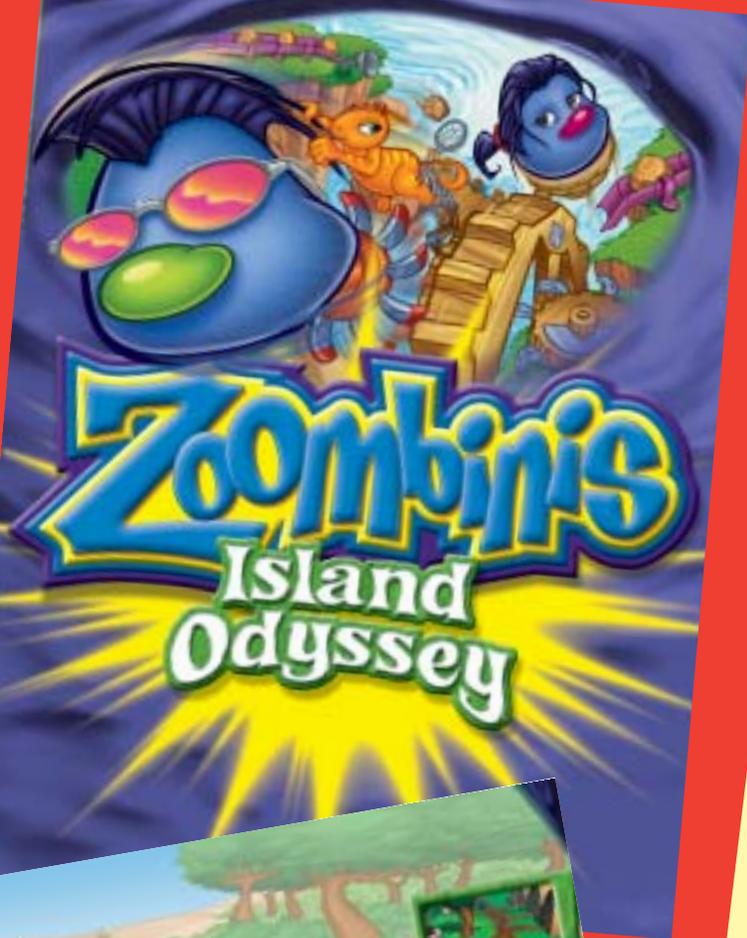
recommend one protocol over the other based on the data?

## Visualizing a Statistical World

*(continued on page 4)*

by Jim Hammerman and  
Andee Rubin



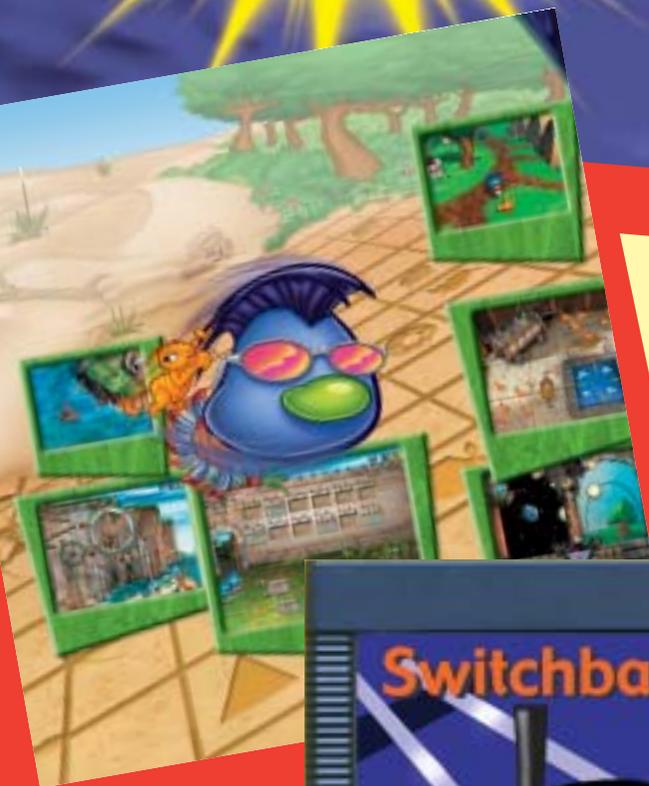


# FUN Software for Serious Learning

**T**ERCworks' newest software titles, **Zoombinis Island Odyssey™** and the handheld game **Switchback**, present puzzles that challenge children and adults to think, plan, and explore.

The newest generation of **Zoombinis** introduces children to important scientific reasoning skills in astronomy, mechanics, ecology and other life sciences. The addition of science reasoning skills complements the Zoombinis games' foundation of challenging math and logic puzzles—all presented in an adventure as entertaining as its award-winning predecessors. Featured in Children's Software Revue's All Star List. Available from Riverdeep/The Learning Company, 1-800-825-4420.

[www.zoombinis.com](http://www.zoombinis.com)



Match wits with **Switchback**, 30 puzzles that challenge your skills in spatial reasoning, planning, and logic. Maneuver a train through a maze of obstacles, and do it in the fewest possible moves. Then match wits with others by beaming them the Switchback puzzles you've created. Designed for adults as well as children, Switchback operates on Palm OS version 3.5 or higher.

[www.handango.com](http://www.handango.com)

# Contents

This issue of *Hands On!* focuses on some of the ways TERC is using technology to change how we teach and learn. In some cases technology has changed the environment for learning. In “The Reality of Virtual Learning” (page 8) students from an online master’s degree program reflect on how the online format has altered the way they study, interact, and learn from their classmates. Their observations may surprise you. Combining text and video to create a new type of research publication and serving it up through a web browser is affecting how researchers and practitioners evaluate and communicate about classroom practice. VideoPapers may, at first glance, appear to be a pop culture form of research, but it is allowing teachers to analyze their own practice and communicate their observations with other practitioners and researchers (page 12). Technology has been essential to our ability to efficiently store and sort information. The ViSoR project at TERC is studying how new computer tools that sort and display data can help people learn about data analysis and statistics (cover article). In each example, the traditional learning environment and instructional practices have been transformed, allowing more people to engage in rigorous math and science learning.

—Kenneth Mayer, Editor

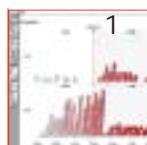
Executive Editor  
Peggy M. Kapisovsky

Editor  
Kenneth Mayer

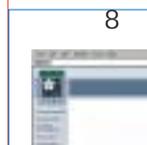
Assistant Editor  
David Shepard

Editorial Assistant  
Zoe Keller

Designer  
Jane Sherrill



1  
Visualizing a Statistical World  
*By Jim Hammerman and Andee Rubin*  
Computer tools that sort and display data help teachers learn data analysis and statistics



8  
The Reality of Virtual Learning  
*By Diane E. Ready*  
Master’s degree candidates talk about learning online



12  
VideoPapers  
*By Cara DiMattia*  
New software makes multimedia authorship easy



16  
Standards-Based Mathematics Curricula: What Do Students Learn?  
New book presents research on the impact of 12 mathematics curricula

20 Online Resources

21 New Projects

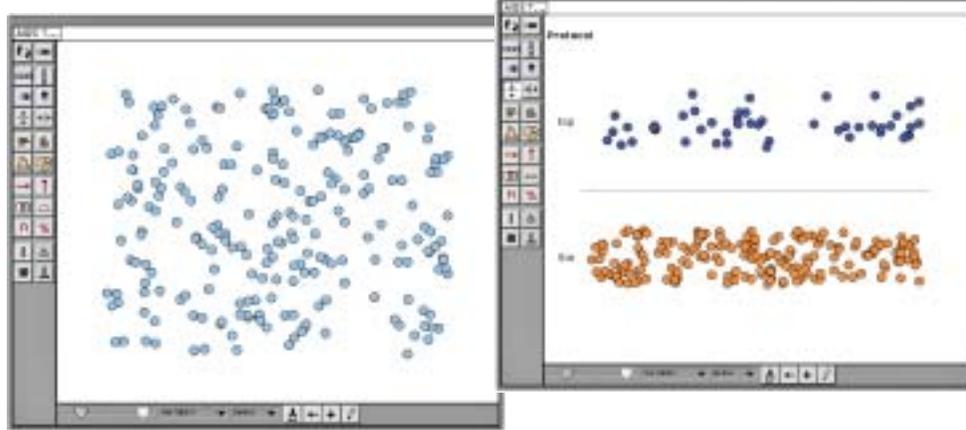
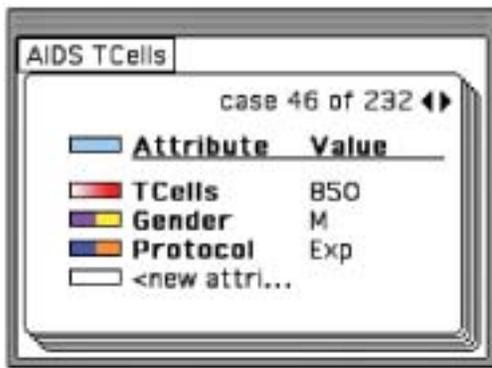
23 Get Involved

*Hands On!* is published semi-annually by TERC, a not-for-profit education research and development organization dedicated to improving mathematics, science, and technology teaching and learning. A contribution is requested to help defray costs of publication.

Copyright © 2002 by TERC. All rights reserved. No part of this publication may be reproduced without written permission. Contact Peggy Kapisovsky, TERC, 2067 Massachusetts Avenue, Cambridge, MA 02140, (617) 547-0430. [peggy\\_kapisovsky@terc.edu](mailto:peggy_kapisovsky@terc.edu). *Hands On!* is available at [www.terc.edu](http://www.terc.edu).

All opinions, findings, conclusions, and recommendations expressed herein are those of the authors and do not necessarily reflect the views of the funding agencies.

ISSN 0743-0221



Starting with a random display of data points, teachers use the software to highlight, sort, and order by different attributes. Each new display both answers and generates more questions for the teachers. They see new relationships among attributes as their understanding of the data and what they reveal develops.

With this scenario providing the context, 11 Boston-area public middle and high school teachers plunge into investigating a data set with the aid of two innovative software tools, Tinkerplots and Fathom Dynamic Statistics (see Software for Visualizing Data, page 7). The teachers are

As researchers, we have gained insights into how the teachers think and learn about statistics. We are seeing how the computer tools and the use of realistic and interesting data sets help the teachers stay engaged, allowing them to generate and answer increasingly sophisticated questions.

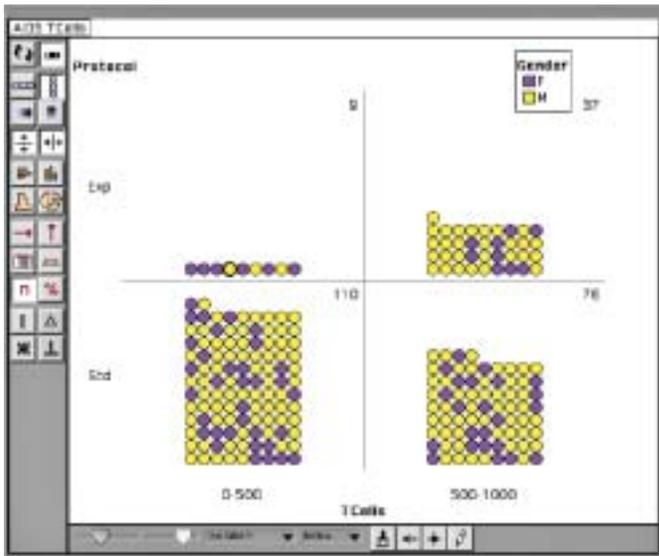


Figure A. Teachers organize the data by protocol, T Cell count, and gender.

### The T Cell Data

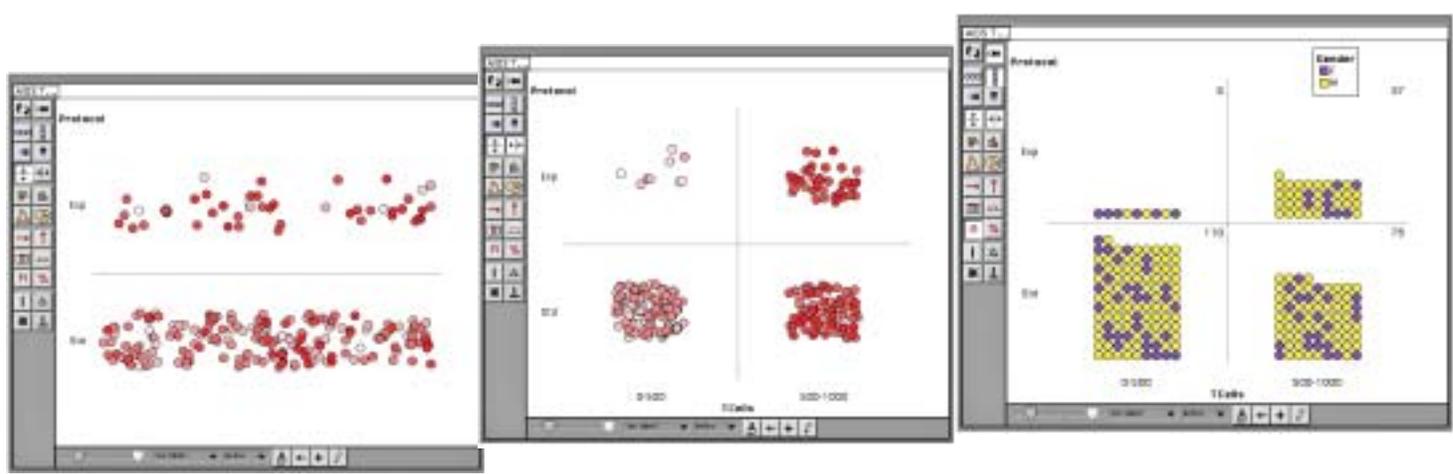
In the T cell example, teachers analyzed a data set of T cell counts for 231 patients with HIV who have been treated with either a standard or an experimental protocol. The data also include each patient's gender. The teachers started with a very general question: Did the experimental protocol work better than the standard one? Seeing the data displayed with Tinkerplots helped the teachers clarify their preliminary question and develop more specific ones.

### Organizing Data with Tinkerplots

Tinkerplots is a data analysis environment designed primarily for middle grades students. It allows users to create both simple and complex graphs by performing actions such as sorting data into categories or ordering the information according to the values of one variable. Combining these simple actions produces some graphs that are familiar and some that look very different from any of the standard graphs people learn about in school. Figure A shows how the teachers initially organized the data based on the protocols and T cell counts. First they split the data vertically, putting standard protocol patients below the line and experimental patients above. Then they split it horizontally organizing patients with below normal counts to the left and above normal counts to the right. This created a graph with four quadrants in which, for example, the lower left quadrant represents all the people in the standard protocol who had T cell counts

participants in the Visualizing Statistical Relationships (ViSoR) project at TERC which is studying how people learn about data analysis and statistics and how computer visualization tools can enhance that learning.

The teachers come to the project with varied experiences in statistics and technology. Some teach AP statistics or have done data analysis in industry. Others say they know very little about how statistics is “done” or would prefer to keep their hands off computers. Despite differences in background, all the participants have become fully engaged in the data exploration and are understanding the power and complexity of using statistics to make sense of data.



below normal. A function on the control panel allowed teachers to display the number of people in each quadrant. They chose to color the data based on gender, displaying female patients in purple and male patients in yellow.

This graph was a starting point. It gave teachers an initial sense of the relationships among the three variables. We have noticed that early in their explorations teachers often make graphs like the one in Figure A to try to get a complete picture of all the data and all the attributes. As one teacher commented, “I’m interested in low T cells. I’m interested in protocol. I’m interested in everything.”

Although the graph (Figure A) showed a lot of information, teachers couldn’t yet use it to answer their questions. They began to delve more deeply, examining the graph carefully. Some looked at how many people were in each quadrant and noticed the number of people above 500 cells was greater for the standard protocol than the experimental protocol. But the number of people below 500 was also greater for the standard protocol. In fact, more people were receiving the standard protocol than the experimental protocol. How could

they compare these results? “Is it legitimate to have different numbers in the groups we’re comparing?” they wondered. How should they proceed?

Continuing their exploration, some teachers considered deleting a few patients’ values to make the two groups equal in size. But which ones should they cut? Others took advantage of software features for determining percentages and means. The teachers created a continuous display of T cell counts along the horizontal axis (see Figure B). They introduced a reference line at 500 so that they could easily see which people were above and below that value and used the software to calculate the percentage of people in each protocol above and below 500. Some teachers used the “mean tool” to place a triangle ( $\Delta$ ) below the value of the mean for each protocol.

Teachers interpreted this graph in different ways. Some looked at the location of the largest cluster of data points for each protocol and concluded that the experimental protocol was better because its cluster (around 550–750) was higher than the cluster for the standard protocol (around 350–550). Others quantified this eye-ball view by noticing that 80% of the people in the experimental protocol were in the normal range, while only 40% of those in the standard protocol had normal T cell counts. A few noticed the difference in the mean values (471 for standard and 573 for experimental), but wondered whether that was important because they also saw from the graph that the spread of the data was much greater than the difference in the means.

From their experience in creating and interpreting the graphs, the teachers became convinced that the experimental protocol was generally better than the standard protocol. The best arguments that emerged from their discussions were based on looking at the data in terms of proportions or, more generally, paying attention to the shape of the data distribution. Some teachers commented that although they could plug the data into a formula for a more generally accepted statistical test—tests they vaguely remembered from prior

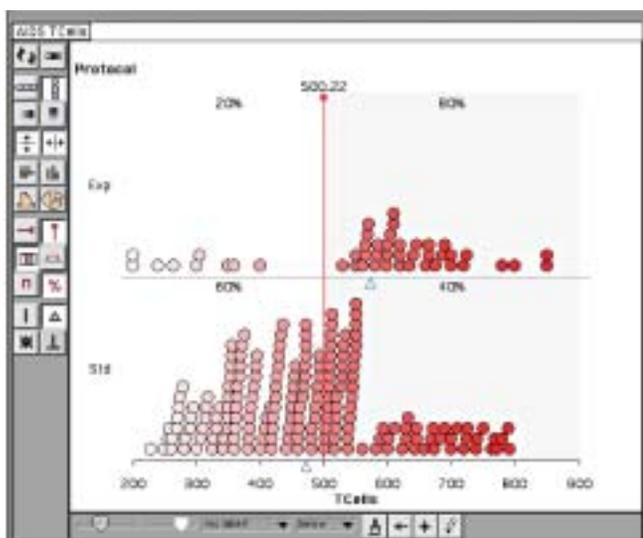


Figure B. Looking at the data a different way helps the teachers compare protocols.

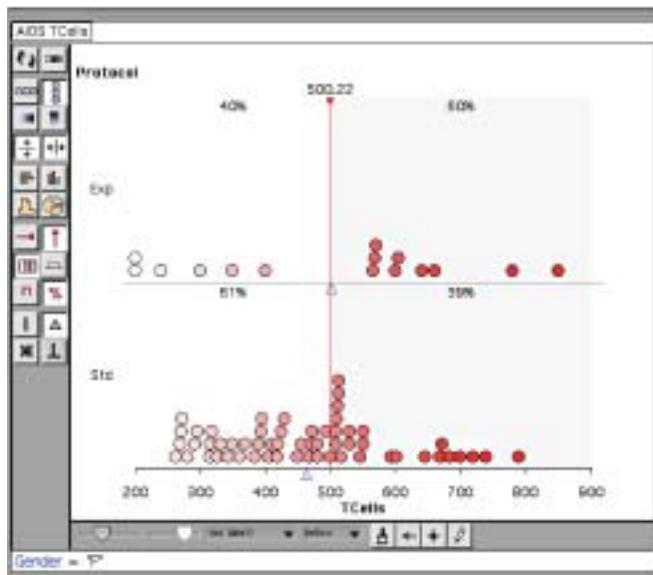


Figure C. Displaying the T cell counts for female patients, teachers see that females do slightly better with the experimental protocol.

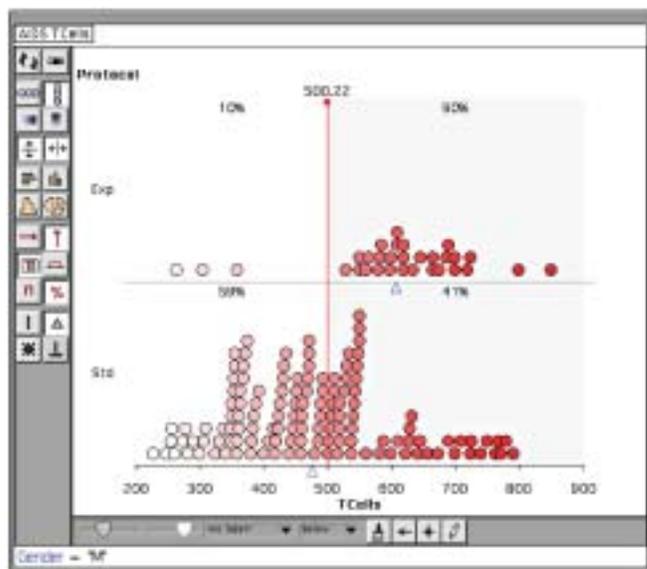


Figure D. The experimental protocol yields dramatically better results for male patients.

experimental data just below the 500 point, there are several people in the standard protocol who have counts of almost 500. Are these people well? Or does something important shift biologically when T cell counts rise above this marker?

Some teachers imagined stories about particular data points. “Who are these nine people who don’t improve with the experimental protocol?” they asked. “Is there something about their biology that makes them different?” These teachers were wondering whether there was another hidden variable that might lead to the conclusion that the people in the experimental protocol really came from two different groups. While the data collected for this study would be insufficient to test this hypothesis, it is the kind of

important question that arises when teachers can look at and make sense of the distribution of data.

### The Questioning Doesn’t End

The teachers were still not fully satisfied with their exploration of the data. Most were curious about whether the general conclusion that the experimental protocol was better than the standard protocol was equally true for men and for women. They developed a variety of ways of visualizing this, including using Tinkerplots’ filtering tool to create separate graphs for women and for men. Figure C shows that for women, the experimental protocol is slightly better than the standard protocol, with 60% of the experimental group above the 500 line and only 40% of the standard group in the normal range. However, for men (Figure D), the experimental protocol is dramatically better than the standard protocol, with 90% of those in the experimental group above the 500 line. Another way to look at this is that the standard protocol was equally good for men and for women, with roughly 40% of either group above the 500 line, but men did much better with the experimental protocol while women did only a little bit better.

It is striking that teachers were able to notice and describe a classic interaction effect—finding a difference in the effect of a main variable (protocol) as it relates to another variable (gender)—without using the common, complex numerical tests. By sorting and analyzing the data with Tinkerplots, they were able to see and identify this interaction.

coursework—the visually-based analysis made sense to them. They could see the differences in the groups, could attach numbers to those differences with the proportions tool, and could notice that the means differed. They could also see the variability in the groups, causing them to question how seriously they should take the difference in means.

In addition to seeing differences in proportions and central clusters, the teachers noticed specific data points and subgroups that sparked new questions. Some wondered how rigid the 500 T cells per milliliter number was as a divider between normal and non-normal counts. Could people with values nearly that high—495 say, or even 450—still be considered successfully treated? While there’s a clear gap in the

There is a danger in relying just on what the eye can see since graphs can obscure as well as highlight essential information. However, the features of the data that teachers were attending to—where the data were clustered, how much they overlapped, and how many data points there were to compare—are the very elements needed to construct more formal tests. Teachers were developing analytical strategies that could help them, and later their students, construct more robust understandings about data.

## Data Analysis as a Sense-Making Activity

Teachers became fully engaged in this exploration. It grabbed their imaginations. They cared about the results and thought the issue was important, which caused them to probe more deeply for answers. In fact, this is a common experience when people investigate data that matters to them. Because data analysis is often about making sense of something relevant, people are willing to invest time and energy to do so. And there are lots of places in our lives where making sense of data is essential, from interpreting election polls to understanding shifts in standardized test scores, from critiquing marketing claims to assessing environmental or medical risks. When data literacy is taught as a sense-making activity, as we are doing in ViSoR, then mathematics becomes an everyday way of thinking rather than something to be learned out of context and by rote.

While ViSoR is providing a professional development opportunity for teachers, it is also a research project about thinking and learning about data and statistics. The case described above illustrates some of what we are discovering. We find that people like to tell stories about individual data points or groups of data points. Sometimes this is useful, such as when the teachers developed a new hypothesis about a variable that might be missing in the experimental group. But sometimes stories can distract people from paying attention to trends that are true for the group as a whole. They try to explain every piece of data exactly rather than finding a general pattern that describes all the data at once and allows for variability in how well the general story fits for different points. This latter way of thinking is more “stochastic” and statistical, and we’re finding it is very difficult to develop.

## Software for Visualizing Data

The focus of ViSoR is the learning and teaching of data analysis and statistics. How software tools facilitate or hinder that learning is a fundamental research question for the project. To explore this, we are collaborating with the makers of two innovative software products—Cliff Konold of the Statistics Education Research Group (SERG) at the University of Massachusetts, Amherst, the developers of Tinkerplots; and Bill Finzer of KCP Technologies, the developers of Fathom Dynamic Statistics. Tinkerplots is a data analysis environment primarily for middle school classes which provides students with a wide range of tools to create traditional and non-traditional data representations. Fathom uses dynamically linked representations of data to provide a set of powerful tools for data analysis for secondary students and beyond, including the capacity to develop models and simulations for working with data and to test inferences. By working with the developers, we have been able to use specially modified versions of the software to better understand how software can contribute to people’s learning of important statistical ideas.

Visit [www.umass.edu/srri/serg/](http://www.umass.edu/srri/serg/) to learn more about Tinkerplots. Fathom is available from Key Curriculum Press, contact [www.keypress.com/catalog/products/software/Prod\\_Fathom.html](http://www.keypress.com/catalog/products/software/Prod_Fathom.html).

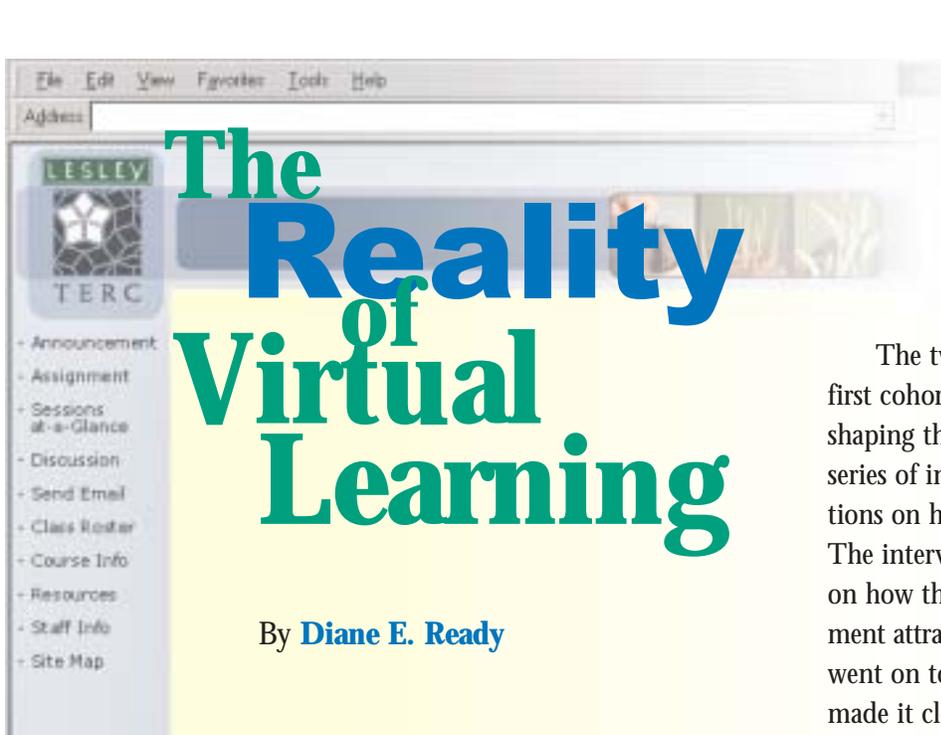
Another notoriously difficult statistical concept is the effect of sample size. In the investigation described above, teachers began to wonder how the size of a group affected the conclusions they could draw. In later sessions, we used the simulation and sampling features of Fathom (the other focal piece of software in ViSoR) to explore how teachers could develop more robust ideas about when and how sample size matters in data analysis.

As the ViSoR project continues into its second year, we will be expanding our research focus to include students’ thinking about data and teachers’ understanding of their students’ thinking. How will the students analyze the T cell data? How will the teachers’ own experience with data analysis help them to understand their students’ statistical thinking? Will students use Tinkerplots or Fathom in different and unexpected ways? These added layers of analysis are sure to complicate our research and—as we ourselves analyze our data—lead us to further questions.

*Jim Hammerman is a research associate for ViSoR. Andee Rubin is the principal investigator. [jim\\_hammerman@terc.edu](mailto:jim_hammerman@terc.edu); [andee\\_rubin@terc.edu](mailto:andee_rubin@terc.edu).*

*ViSoR is funded by the National Science Foundation REC-0106654.*

*The T cell data is adapted from a set constructed by Paul Cobb and colleagues, Vanderbilt University, 1999.*



# The Reality of Virtual Learning

By **Diane E. Ready**

When contemplating a return to school for a master's education, I briefly considered the possibility of online learning before choosing the traditional classroom route. Having earned a couple of degrees while the Internet was still reserved for the Department of Defense, I admit that the idea of online learning conjured up fears of getting lost in cyberspace and images of correspondence school ads on the back of matchbooks. I decided that the commute, the parking hassles, and the babysitter expenses would be tolerable in return for personal contact with professors and classmates and freedom from having an omnipresent course to attend 24 hours a day in my home. I should have talked to someone in the Lesley/TERC online master's degree program in science education first.

After recent discussions with participants in the master's degree program, I learned precisely how narrow and dated my view of online education was. The program, developed by TERC and Lesley University, exploits the creative potential of recent developments in distance learning to help teachers integrate inquiry-based science into their teaching and extend their science knowledge. The 33-credit-hour program aligns with National Science Education Standards and employs innovative, learner-centered teaching strategies. Through six courses, each focusing on a distinct area of scientific and pedagogical study, elementary and middle school science teachers learn science content by doing science. The classes teach pedagogy and assessment by modeling practical applications for inquiry-based teaching and by requiring students to try out and reflect on new teaching methods in their own classrooms.

The two-year degree program is new. Feedback from the first cohort of learners (scheduled to graduate in 2003) is shaping the curriculum for future degree candidates. In a series of interviews, program participants offered their reflections on how this innovative approach has worked for them. The interviews typically began with participants commenting on how the convenience and flexibility of the online environment attracted them to the program. The way that participants went on to discuss what they were learning in the course made it clear to me that while people sign on for the flexibility, they stay for the quality of the learning experience. The following is a sampling of observations and reflections from several degree candidates who have successfully completed their first year.

## When Your Daily Planner Says Impossible

For most of the participants interviewed, the flexibility to "attend class" when it fits into your schedule did more than make education convenient—for many it made a degree possible. One student interviewed explained that the program was the only option with a science focus open to someone who could only attend class at night or on weekends.

For Mary Sapp, who attends class from her home in Florida, the online option opened doors for her after she learned that there was no school within a reasonable driving distance that offered the master's program she required. The Internet is making it possible for students from anywhere with a modem connection to attend school—no babysitters, no residency requirements, no gas money, no parking stickers, no time in traffic.

The flexibility of setting their own class times each week is equally appealing to parents of young children who do not want to deal with adventures in babysitting, as well as parents of older kids who do not want to miss precious weekend time at their children's events. Program participant Grainne Phelps' crowded schedule is typical of that of the full-time teachers in the program. In addition to teaching science and math to sixth, seventh, and eighth graders each day, she goes home to three small children, one of whom is a toddler who has been in a full body cast. Grainne is not alone in saying,

## *People sign on for the flexibility and stay for the quality of the learning experience.*

“For me to get to a class was virtually impossible. The course is attracting people who are working. We need the convenience of doing it at home.”

Online master’s candidate David Michaud notes, “I’m especially pleased with the way the online format lets me continue with the rest of my life.” Some of his online classmates do coursework in the evenings, some work during the day at breaks or lunch, others reserve their weekends for long sessions.

### **You Can Do It Anytime, but You Still Have to Make Time to Do It**

Some participants shared my initial misconception that an online course would be easier than its classroom counterpart. The reality of the workload required by the hands-on approach used in the course quickly dispelled any hope they may have entertained of scrolling through lectures and filing occasional submissions to prove that they had read the material. “This is not a course for someone who is not a self-starter,” warns Grainne.

Karen Rose, one of the participants, speaks for many who were surprised at the amount of work required for the degree. “It’s more work than what I would do in a regular class. You have to be very organized—and I’m not. It’s not as easy as going to a class but the rewards are tenfold.” Interestingly, Karen echoes the sentiments of many who find the workload very challenging, and therefore more engaging. Several participants say they wish they could spend even more time on each course.

“It’s a lot of work but they send a letter on how long it’ll take you each week. You are given realistic expectations and have to plan accordingly,” Mary observes. “I set aside about seven hours each weekend to do the labs.”

### **Time to Think**

Participants speak of experiences in traditional classroom settings, in which teachers were experts who spoke a language that could at times be overwhelming, silencing learners who could not process the material as fast as it was dictated to them. Several of those interviewed observe that they do

not feel comfortable speaking in front of others, but feel more comfortable participating online because they have more time to prepare. Chris Willems appreciates the time for reflection: “I can think about something for 2 hours or 12 hours or 20 hours and then come back later after I’ve had a chance to digest it before responding. That’s something that just doesn’t happen in a teacher-directed classroom.”

### **Your Home Is Your Laboratory**

Students report setting up labs in basements, on porches, even in the bedroom. Grainne recounts some difficulty in “finding lab space where the kids won’t get to it,” but agrees with the majority of those interviewed who find the kits provided by the program to be self-contained and easy to set up at home.

The biology course, for example, requires growth of simple plants in small containers, while the physics lab involves exploring concepts such as acceleration and velocity using a liquid-filled container with a bobbing cork mounted on a small rolling cart. Since the materials are designed for easy setup, it makes them convenient for teachers to use in almost any classroom. “We get to keep the equipment, so I can do the experiments in class. Even when the lab doesn’t focus on the content I am teaching, I’ll use it as a change of pace when the kids need a break between units,” explains Grainne.

Karen teaches full time and is developing a new program for her school while working on her master’s. She says the constant presence of the lab does not result in a feeling that she must be working on it whenever she is home. “You go to it whenever you want,” she explains. “It’s not there every time I turn the computer on. I look at it as having the freedom to go to it 24 hours a day, but it’s only there when I want to go to it.”

## A Radically Social Experience

As adult learners, many of those interviewed had no particular concerns about how well or even whether they might interact with online classmates. One student said she predicted the course would involve independent study “with a little instant messaging.” Other students said they had some concerns about how to establish productive rapport with co-learners you would probably never meet. Before classes began, some students wondered how classmates at individual computer terminals, logging on at random and varied hours, would interact in small groups. Others worried about taking direction from words on a screen rather than from the mouth of a familiar professor who can read understanding or confusion from the look on a student’s face.

Though it may seem counterintuitive, participants in the program comment that the TERC/Lesley structure for online learning encourages more cooperative learning and dialogue than they ever experienced in the traditional classroom. Chris contends, “Without question, I have never had the kind of dialogue with my fellow students in a traditional classroom as I have had in this kind of classroom. This is a radically more social place. Even though we are in groups of five or six, there are students who jump across groups to correspond more.”

Student Michelle Roy finds the online environment very supportive. “Everybody cares what I have to say. Everyone is going to take the time to read what I said and—in a constructive manner—share points they agree or disagree on and ask me questions so that I’ll take it a step further. That’s never happened in any other courses...I find that with the online environment I connect more, I share more, I get more out of my peers than I ever would being in a classroom.”

Just as in a traditional class, online students fall into familiar roles—one may blaze a trail ahead, some may post close to the deadlines, some are unfailingly polite and tentative, others advance tough challenges to a classmate’s ideas. A key difference in the online environment, however, is that everyone contributes.

April Walton, who participates in the program from her home in Maryland, contrasts her experiences in the program with the lecture-oriented graduate classes she has had where,

*For me to get to a class was virtually impossible. The course is attracting people who are working. We need the convenience of doing it at home.*

“depending on how large the class was I could skip! But online you have to attend and participate, you have to post and respond and you have only a few days to do it. You can’t fall back on the professor or the text book in this class.”

## Online Doesn’t Have to Mean Out of Touch

Although the professor cannot assess understanding by noting bobbing heads or puzzled expressions, April notes that her online professors have responded to spotty postings as a symptom of student distress. “When I was having some trouble, the professor recognized my frustration and emailed me to ask how I was doing and let me know it was O.K. to be wrong and to put questions on the posting if I don’t have the answers.” April says that she has learned to use the same technique with her students, letting them know that getting wrong answers and generating questions are all part of scientific learning.

“It isn’t like a course where teachers only have certain office hours and aren’t going to help you in their off-time,” Karen observes. “This has been just the opposite. You get more than 100% support.”

According to Chris, “The professors’ presence is constant but they are not out front. You know they are there, but they don’t dominate or dictate. They present the material, offer intellectual teasers, and jump in occasionally, but the classes are student centered. That takes incredible skill. They are modeling the kind of teaching that the national and state standards say we are supposed to be doing.”

## Bringing Online Methods into the Classroom

Students were most enthusiastic about the way they could immediately apply the science content as well as the student-centered, inquiry-based teaching strategies. For April, a special education teacher who co-teaches science courses, using the inquiry approach has yielded remarkable benefits for her special education students. “I was teaching special ed students using an easily adaptable reading book. I didn’t even have a lab class to offer them labs. I lectured them, much the same way I was taught science. They didn’t really learn or understand it.”

“Before the class, I was a little like my students. I knew the text book definitions, but growing the grass, watching the radishes, and taking the plants through the drought to see what happens like we did in the biology course made me really understand it and be better able to explain it to my students. I let them do the same experiments I was doing at my house. They saw you don’t need a big lab or a lot of fancy stuff to be a scientist. At the end of the year, they could stand up in front of anyone and tell them about evolution, and adaptation, and photosynthesis. I felt very good about that.”

For Mary, the program has made it easier for her to teach when her students don’t get the “right” lab results. Like other program participants, she has learned to be more comfortable with teaching through questioning and not always having an answer or a text to fall back on. She recounts a recent lesson in which she knew water wouldn’t boil at the temperature cited by the text, but she did not warn her students so that they could discover and draw conclusions for themselves.

Grainne says she has learned how to “better use questions to spark and sustain group conversation.” Mary now incorporates PowerPoint graphing into her student’s assignments, “so they can achieve the greater accuracy I think I achieved by using it in my learning.” David uses what he has learned in his work designing educational museum exhibits: “Now I use interview techniques I learned to get to know what kids already know before designing an exhibit that can build on that knowledge.”

Chris enthusiastically sums up how the program teaches deep science content in an authentic, inquiry-based way that can work in an online or traditional classroom. “There’s a lot of theory floating around but the practice is lost. Here you are forced to be students, deal with things that make you uncomfortable. It puts you on the other side of the table—where your students are. It’s not ‘can you read this online article and regurgitate facts.’ It’s got everything to do with how you use your brain to look at the world around you. It’s read this, do this activity with this kit we send you, think about this, talk about this with your colleagues, post data, make PowerPoint slides, email each other, challenge each other. And really grapple with this information. That’s what our kids should be doing.”

*Diane E. Ready is a freelance educational writer based in Mansfield, Massachusetts.*

*Questions regarding the content of this article can be addressed to Sue Doubler, [sue\\_doubler@terc.edu](mailto:sue_doubler@terc.edu).*

*The Lesley/TERC Online Master’s in Science Education project is funded by the U.S. Department of Education #P116D990066 and the National Science Foundation #ESI9911770.*

*For more information about the Lesley/TERC online master’s degree program in science education see “Try Science Online” page 23.*

*It’s not ‘can you read this online article and regurgitate facts.’ It’s got everything to do with how you use your brain to look at the world around you.*

# VideoPapers

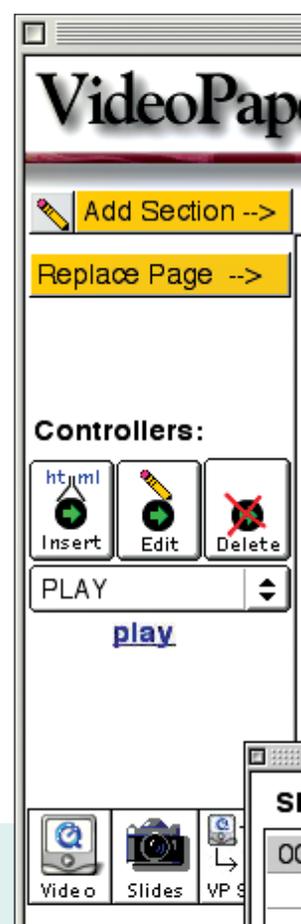
By Cara DiMattia

Ann Metz, an elementary school teacher, was reviewing a video of her class taped during a lesson on fractions. Ann is part of a teacher research group that uses videotape to document and evaluate classroom practices and student learning. As she reviewed the videotape, she was struck by the classroom discussion that emerged as students began reasoning through a problem together. Several students participated by demonstrating physically a “whole” and “pieces,” others explained their ideas verbally, while some drew on the chalkboard. Ann wanted to present the richness of the students’ thinking to the other members of her teacher research group but struggled to characterize in writing what she saw as a great example of the students applying and refining their understanding of fractions. She felt her description was inadequate; it didn’t seem to capture the dynamic nature of the conversation and the learning.

A colleague of Ann’s suggested that she might want to experiment with a new software program that would allow her to incorporate video segments into the written presentation of her observations. Ann was nervous about learning a new software program, but she decided to experiment—after all, she had learned to edit video with her iBook at home. After completing the software’s tutorial, Ann was able to import her classroom video, some still images she had taken of the students’ work, and the text of the paper she had started. In a few minutes, she was able to link the text to the video, capturing the dynamism she had been unable to describe with words alone. When she presented the VideoPaper to the other teachers in her research group, they were very interested; her presentation sparked a lengthy discussion about the class conversation and the learning that was taking place.

This scenario illustrates the potential educational applications of a new type of publication, the VideoPaper. While the scenario is hypothetical, the multimedia tool is not. Many teachers (as well as students and researchers) have downloaded and experimented with the beta version of the VideoPaper Builder, a software program developed by the Bridging Research & Practice project at TERC. VideoPaper Builder (see Figure A) is being used both in and out of the classroom. It was featured in a summer teacher seminar offered at the Curriculum

Resource Center at Tufts University (see page 14) and has been used to author VideoPaper research articles in forthcoming CD-ROM issues of the *Journal of Research in Mathematics Education* and *Educational Studies in Mathematics*. Researchers at TERC and the Concord Consortium are currently collaborating on a new version due out in 2003 that will be available through the Bridging Research & Practice web site, [brp.terc.edu](http://brp.terc.edu).

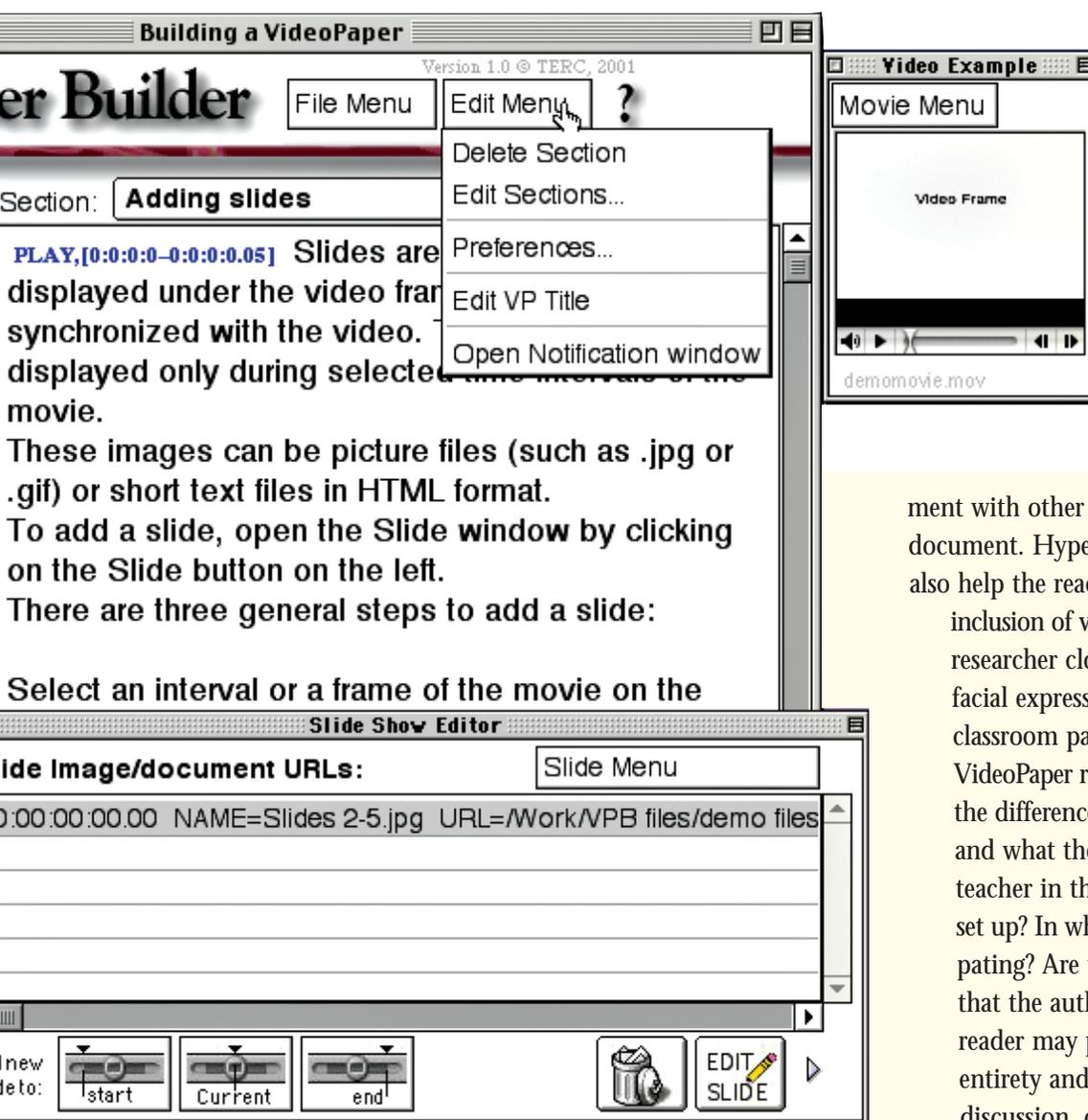


“ This presentation, where you can read things, and watch it, and then go back to it. ... I can definitely see a future in something like this”

—A high school math teacher

## What IS a VideoPaper?

To promote collaboration between researchers and practitioners, the Bridging Research & Practice project began developing a multimedia publication tool. They envisioned a tool that would allow more teachers to become part of the research community. They wanted to develop an easy-to-use software application that would allow teachers to capture data from



Section: **Adding slides**

**PLAY,[0:0:0-0:0:0.05]** Slides are displayed under the video frame synchronized with the video. Slides are displayed only during selected time intervals of the movie.

These images can be picture files (such as .jpg or .gif) or short text files in HTML format.

To add a slide, open the Slide window by clicking on the Slide button on the left.

There are three general steps to add a slide:

Select an interval or a frame of the movie on the

Slide Image/document URLs:

0:00:00:00:00 NAME=Slides 2-5.jpg URL=/Work/VPB files/demo files

new  
delete to:

start Current end

reader becomes a participant who can control what and how the text is read. The reader may select pages to view (in any order that seems interesting or relevant), watch and analyze pieces of video data, or experi-

ment with other interactive content inserted in the document. Hyperlinks to outside materials can also help the reader conduct further research. The inclusion of video, in particular, brings the researcher closer to the data, making gestures, facial expressions, and interactions among the classroom participants readily apparent.

VideoPaper readers may be especially struck by the differences between their own classrooms and what they see onscreen: where is the teacher in the classroom? How is the classroom set up? In what ways are the students participating? Are there elements the reader notices that the author did not write about? The reader may prefer to watch the video in its entirety and use it as a starting point for a discussion, or may choose to skip to parts of the video that are of particular interest.

## Pop Culture Research?

The combination of linked video, data, sound, and images creates powerful, immediate impressions. There is something especially engaging and accessible about the inclusion of video. But is the VideoPaper just an attempt to make research easy to digest for those not used to traditional, text and reference, research publications? Are VideoPapers a pop-culture, dumbed-down genre of research?

Well, no. Multimedia publication is a natural extension of the way we communicate and engage with information. Communicating with speech involves much more than words. It includes visual, aural, and physical cues, often without conscious intent. Our world is, by its very nature, multimodal.

*(continued on page 15)*

# VideoPapers by Teachers—One Example

During the summer of 2002, several Boston-area teachers learned to use the VideoPaper Builder software at a seminar offered by the Curriculum Resource Center at Tufts University ([ase.tufts.edu/crc/](http://ase.tufts.edu/crc/)). The teachers created VideoPapers based on their own classroom experiences and shared them among the group. The resulting VideoPapers ranged in content and style from a multimedia description of a reading course for learning-disabled students to a documentary on the ways one teacher used digital video cameras in a science classroom.

In each of the VideoPapers, classroom video added a dimension to the text that in traditional publications would be very difficult to capture. The Roller Coaster Lesson is one paper created for the seminar (see Figure B). The author describes it as “a look at one teacher’s attempt to combine teacher-driven discussion, student-student discussion, writing, and hands-on activities to create student engagement and real learning.”

Through video, still images, and text, the paper tells the story of how an eighth-grade science class examined the law of conservation of energy through group activities and class discussion. By including (captioned) classroom video instead of a transcript, the author is able to show not only the language used by the students, but also the full extent of their involvement throughout their exploration. Students who are rarely vocal show their engagement through actions and facial expressions—what could be read as a question-and-answer session becomes a classroom environment filled with laughter, camaraderie, and enthusiasm about the science topic.

Every participant in this summer program expressed interest in building more VideoPapers. Based on the success of the program, the Curriculum Resource Center is planning a 2003 summer VideoPaper seminar.

In another pilot program at Tufts University, 45 teacher education students built VideoPapers using video from their own classrooms. Their experience in using the software to help analyze classroom practice and student learning has led to the integration of VideoPapers into the teacher education program at Tufts University.

Figure B



(continued from page 13)

In recent years, multimodality has become legitimized as a theory and increasingly it is the subject of research in areas such as communication, semiotics, education, linguistics, and graphic design. For example, Multimodal Discourse Analysis is a linguistics theory which recognizes all discourse as being multimodal and strives to incorporate all 'contextual' elements of language, spoken or written, into discourse analysis (van Leeuwen, 2001). Despite this, traditional genres of publication have remained monomodal (literature, concerts), or strictly hierarchical in including a secondary mode, as with the use of images in newspapers. However, with the recent growth of digital culture and the increasing techno-literacy of the general public, authorship of true multimedia documents has become both a goal and a reality. Multimedia is a logical, valid, and now accessible means of communication and thus publication.

In 2001, the National Research Council published "The Power of Video Technology," a report recommending that the education research community pursue projects which make use of multimedia. To that end, the National Science Foundation has established several new programs geared specifically towards creating digital resources such as online libraries; NCTM has established a web site with multimedia mathematics explorations classroom video, and other online mathematics activities (Illuminations.nctm.org.). VideoPapers are a natural extension of this new interest in using digital technology to educate.

#### References

- Kress, G. & van Leeuwen, T. (2001). *Multimodal discourse: The modes and media of contemporary communication*. London: Arnold.
- National Research Council. (2001). *The power of video technology in international comparative research in education*. Washington, DC: National Academy Press.

*Cara DiMattia is a multimedia developer for the Bridging Research & Practice project. cara\_dimattia@terc.edu.*

*The Bridging Research & Practice project is funded by the National Science Foundation # REC-9805289. VideoPaper Builder 2 is being co-developed by TERC and the Concord Consortium's Seeing Math Telecommunications Project funded by the U.S. Department of Education #R286A0000006. For more information, contact seeingmath.concord.org.*

## How would you use VPB software?

The Bridging Research & Practice project conducted an online survey of the teachers who had downloaded the VideoPaper Builder software to find out how they were using the software. Here are some of their responses:

*I want to teach students to use it to do an assessment of their teamwork.*

*It may be very useful to assist deaf students in associating their visual language (American Sign Language) with their written language (English).*

*I would like to set up a way for teachers to share performance assessment activities .*

*I'm hoping to use it with teachers for a web-based school portfolio project.*

*I plan to use it to present information literacy and technology skills to grades 3-5.*

*I plan to use it with teachers to produce web-based lessons and with students to publish web-based multimedia papers.*

*I want to use it to deliver material to my psychology students. It may be suitable for the students to use to build research projects that go beyond just paper and pencil.*

## Accessible Multimedia Authorship ?

Yes, and not just for the tech-savvy or those with very expensive software. The Bridging Research & Practice project at TERC is taking advantage of the growing accessibility of web and video design tools to create a software application that makes it easy to author multimedia documents. With the VideoPaper Builder (VPB) software (beta version available for the Macintosh at [brp.terc.edu](http://brp.terc.edu)), users are able to create a multimedia document by importing text files and video and image files generated in iMovie (or other video and image editing software). VPB uses a point-and-click interface to generate HTML files as well as the more complex coding required to link imported files (video, audio, and text). It exports a cross-platform, stand-alone document that can be published on CD or on the Internet. A new version of VPB due out in winter 2003 will run on Windows and Macintosh platforms. Other additions include WYSIWYG, a Spanish-language interface, and video-to-text linking. See [brp.terc.edu](http://brp.terc.edu)

# Standards-Based Mathematics Curricula: *What Do Students Learn?*

**W**hat features characterize standards-based curricula? How well do such curricula work? A new book from Lawrence Erlbaum Associates poses these questions. The editors of *Standards-Based School Mathematics Curricula: What Are They? What Do Students Learn?* invited researchers who had investigated the implementation of 12 different standards-based mathematics curricula to describe the effects of these curricula on students' learning and achievement and to provide evidence for any claims they made. In particular, authors were asked to identify content on which performance of students using standards-based materials differed from that of students using more traditional materials. Authors were also asked to identify content on which performance of these two groups of students was virtually identical. Additionally, four scholars not involved with the development of any of the materials were invited to write critical commentaries on the work reported in the other chapters.

## Studies on the Impact of *Investigations*

In chapter 5, Jan Mokros of TERC, co-author of the *Investigations in Number, Data, and Space* curriculum, presents findings from three studies along with an overview of the curriculum's goals and approach. Mokros emphasizes that "a research priority for examining the impact of *Investigations* was to describe how students involved in this curriculum understand number operations" (p.114). To provide context for the design and focus of the research studies, she offers a discussion of the number operations content strand in the curriculum. (See *Investigations' Treatment of Number, Basic Facts, and Algorithms*, page 17.) The three studies she details posed word problems involving whole number operations and examined the accuracy and effectiveness of participants' methods of solving the problems. In her synthesis of the three studies Mokros writes:

In all of the studies, *Investigations* students performed better than their counterparts from other curricula with respect to word problems, more complex calculations embedded in word problems, and problems that involved explaining how an operation worked. For example,

*Investigations* students generated more sophisticated solutions when asked to write number sentences resulting in a given number. *Investigations* students were also more successful on word problems in which there were multiple solutions and the choice of operations was not obvious, such as specifying the ages of four people in a family whose ages total 101.... *Investigations* students were able to show deeper conceptual understanding when solving multiplication problems and to explain how the solution to one problem helped in solving a related problem.... Besides being more accurate with respect to solving complex problems, students in the *Investigations* groups showed qualitatively different ways of thinking about the operations than students in other groups.... Procedures of *Investigations* students displayed an understanding of the meaning of operation, of the structure of multiplication and division, and of place value. (p.127)

## Commenting on the Research

The book offers critical commentary from scholars not involved in the development of the curriculum. Ralph T. Putnam from Michigan State University reviews the four chapters that discuss the standards-based elementary curricula. He outlines the common set of assumptions and emphases about mathematics curriculum, learning, and teaching embodied by these curricula. He articulates the complexities of designing research and measuring outcomes and the limitations of the research presented in the chapters. The conclusion of his chapter summarizes the significance of the studies and underscores the need for developing appropriate forms of assessment.

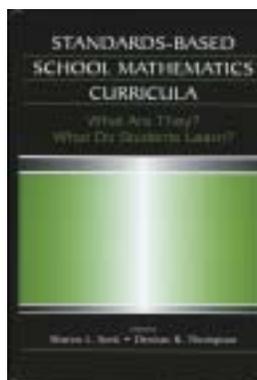
These chapters have provided us with an important look at the impact of several reform-oriented elementary mathematics curricula on the nature of students' experiences and learning....

*(continued on page 18)*

## Investigations' Treatment of Number, Basic Facts, and Algorithms

An excerpt from "Learning to Reason Numerically: The Impact of Investigations" by Jan Morkos in *Standards-Based Mathematics Curricula: What Are They? What Do Students Learn?*

edited by Sharon L. Senk and Denise R. Thompson (pp. 114–115). Reprinted with permission of Lawrence Erlbaum Associates.



Although other areas of mathematics are studied in depth in *Investigations* and are central to children's mathematical development, most educators (including ourselves) view number operations as a critical priority in the elementary grades. Furthermore, whole number operations are critical for work in geometry, statistics, and algebra. Thus, one of the research priorities for examining the impact of *Investigations* was to describe how students involved in this curriculum understand number operations. Before discussing achievement results related to number, a more detailed discussion of this content strand is provided.

When using *Investigations*, students are often expected to have two ways of solving a problem and to explain how their strategies work. For example, a fourth-grade student might explain that she computed  $4 \times 19$  by starting with  $4 \times 20 = 80$ , then subtracting 4 to get 76. A second way might be multiplying  $4 \times 10 = 40$ , then adding the product of  $4 \times 9$ , or 36. Both of these solutions rely on understanding the properties of multiplication, in this case the distributive property, as well as understanding number relationships....

As students progress in their work, greater fluency and efficiency with strategies is expected. They are not expected to invent new

strategies each time they do a problem; rather, they are encouraged to become more efficient at the strategies that make the greatest sense to them. Throughout their work, students develop new and better strategies by articulating their own ideas and by listening to others' strategies. In all cases, students are expected to meet standards of mathematical rigor by proving that their strategies work and that their solutions are accurate.

In the early grades, *Investigations* students develop their own strategies for solving addition and subtraction problems involving basic facts. The *Investigations* approach to basic facts is "strategies based," defined by Isaacs and Carroll (1999) as an approach that helps children "refine and extend their natural strategies for solving simple problems" (p. 509).<sup>\*</sup> They do this by building an understanding of the relationships between numbers and by examining different ways of composing and decomposing numbers. They often work with addition combinations that equal a given total. For example, a child who starts with  $6 + 6 = 12$  might use this known quantity to reason that  $7 + 5 = 12$ ,  $8 + 4 = 12$ , and so on. As children build these understandings, they practice addition combinations, through the use of number games, daily classroom routines, and other activities.

The *Investigations* approach to mastery of basic facts involves building an understanding of number relationships and practicing these in different contexts. However, the curriculum is not limited to numbers of certain sizes. For example, students at third grade are expected to generate all the multiplication combinations that yield the number 36, including combinations such as  $18 \times 2$  and  $2 \times 3 \times 6$ . In contrast, in a typical third grade, the only multiplication "facts" involving 36 are  $9 \times 4$  and  $6 \times 6$ .

---

<sup>\*</sup>"Strategies for Basic-Facts Instruction" by A.C. Isaacs and W.M. Carroll in *Teaching Children Mathematics*, 1999, 5(9), 508-515.

(continued from page 16)

Although the individual studies had measurement and methodological weaknesses, as a set they provide strong evidence for the fact that teaching mathematics with an emphasis on understanding can result in the learning of valued computational skills and at the same time foster mathematical understanding and reasoning. I close with two important implications of this evidence.

First, teachers who choose to emphasize mathematical understanding do not have to do so at the expense of procedural proficiency. Teaching mathematics for understanding can result in students gaining conceptual understanding *and* procedural competence.

Second, in the current political climate of promoting excellence in schools by increasing accountability through high-stakes tests, we must encourage the use of assessments that capture the broad range of mathematical knowledge, skills, and dispositions we want our children to learn. In these chapters, traditional standardized assessments typically failed to capture the problem solving, strategy use, mathematical reasoning, and number sense the new curricula were designed to foster. Without alternatives to traditional standardized tests, much of the important learning of students experiencing these new curricula would have gone undocumented. If we want our students to understand and use mathematics, then our high-stakes assessments must be broad and diverse enough to capture the conceptual understanding and reasoning we value. (pp. 177-178)

## ARC Study Examines Math Achievement Data

The ARC Center Tri-State Student Achievement Study was conducted in elementary schools in Massachusetts, Illinois, and Washington state and examined the performance of students using *Math Trailblazers*, *Investigations in Number, Data, and Space*, and *Everyday Mathematics* on state-mandated standardized tests administered in spring 2000. The study included more than 100,000 students—51,340 students studied one of the three standards-based curricula for at least two years and 49,535 students from non-using comparison schools matched by reading level, socioeconomic status and other variables.

Results show that students in the schools using the standards-based materials consistently scored higher than students in the matched comparison groups. All statistically significant differences favored the reform students; no statistically significant difference favored the comparison groups. The results hold across all racial and income subgroups. The results also hold across the different state-mandated tests, including the Iowa Test of Basic Skills, and across topics ranging from computation, measurement, and geometry to algebra, problem solving, and making connections.

For more information, visit the ARC Center's web site [www.comap.com/elementary/projects/arc](http://www.comap.com/elementary/projects/arc).

### ***Standards-Based Mathematics Curricula: What Are They? What Do Students Learn?***

edited by Sharon L. Senk and Denisse R. Thompson

ISBN 0-8058-4337-X  
Lawrence Erlbaum Associates  
10 Industrial Avenue  
Mahwah, NJ 07430-2262  
800 926-6579  
[orders@erlbaum.com](mailto:orders@erlbaum.com)  
[www.erlbaum.com](http://www.erlbaum.com)

# The Science of Everyday Objects

**Can** you build a catapult that can hit its target consistently, or design a model for a faster boat hull? The challenges presented in the *Science by Design* series (Construct-a-Glove, Construct-a-Boat, Construct-a-Greenhouse, and Construct-a-Catapult) let students grapple with concepts such as heat transfer, buoyancy, elasticity, and insulation, using easy-to-find, inexpensive materials. Developed for students in grades 9–12, *Science by Design* supplements students' science work, and has garnered praise for the way it encourages students to see the connection between everyday items and the four, project-based activities in the series.

Published by NSTA Press and developed by TERC, the four books in the *Science by Design* series are keyed to national standards and can be done individually or as a group.

The Construct-a-Boat unit presents students with a challenge in which they use readily available resources to create a hull that maximizes a boat's acceleration and top speed. As a team the students develop a working model and collect data about the model's performance. While redesigning their model, students document their progress and develop means to test the effectiveness of their redesign. In the Construct-a-Greenhouse unit, students develop an environment with enough adaptability to changing heat, light, humidity, and space conditions to support the growth of a giant vegetable. All four units provide ample opportunity to explore the linkage between inquiry and design, and will sharpen students' abilities to investigate, build, test, and evaluate a familiar product.



Available from  
NSTA Press at  
1-800-722-NSTA,  
[store.nsta.org](http://store.nsta.org).

Science by Design  
*reproduces the real-life  
complexity of design-and-build  
challenges and enables students to  
move towards design decisions  
informed by science, math,  
and technology.*

TERC offers several excellent

online resources for teachers wishing to include more inquiry-based activities in their classroom. As guides for explorations conducted offline, or as online resources, these materials are a wonderful way to enhance your students' math and science learning.

## **GLOBE**

GLOBE classes are part of an international program of students, scientists and researchers actively engaged in using science, math, and technology to improve their understanding of Earth's environment. GLOBE improves students' understanding of science because it involves them in performing real science—taking measurements, analyzing data, and participating in research in collaboration with scientists. Activities are supported through the GLOBE web site, which includes teacher's guides, "how-to" videos, a Help Desk, and clearly defined student investigations that can be published and shared with classes in over 12,000 schools in 100 countries. For more information about the GLOBE program of student/scientist partnerships in environmental science, visit [www.globe.gov](http://www.globe.gov).

## **Earth to Orbit Engineering Design Challenges**

The Earth to Orbit Engineering Design Challenges engage students in problems faced by NASA engineers in developing the next generation of aerospace vehicles. Each of the four challenges leads middle and high school students through the design, testing, and evaluation process and involves issues such as atmosphere re-entry, launch structure design, and satellite navigation.

The centennial of the Wright brothers' first flight is the context for the new Propeller Design Challenge. It uses hands-on scientific inquiry and observation to help students explore concepts such as propulsion, motion, energy transfer, and technological design. Visit [eto.nasa.gov](http://eto.nasa.gov).

## **Online Science-athon**

What is the Online Science-athon? The Science-athon offers students in grades 2–8 opportunities to discover the science in their daily lives. Presented as challenges, it asks students to investigate their world in ways that are engaging and fun, easy to do, and instructive.

The How Tall Am I?, Marble Roll, and Catching Sunshine challenges result in data sent to an online database, and include the exploration of questions using displays of the data. Information about the challenges is available at [scithon.terc.edu](http://scithon.terc.edu).

## **Internet Communications, IP Addressing and Remote Router Configuration**

This integrated math and technology enrichment module challenges ninth grade students to devise a set of Internet Protocol (IP) addresses and configure five Cisco routers via a web browser. The hands-on challenge aims to encourage interest in students who typically do not pursue studies in mathematics and technology. The module features shared Telnet sessions, an innovation in remote laboratory delivery developed by partner Network Development Group, Inc. For information about the complete module, contact Janet Fisher, [janet\\_fisher@terc.edu](mailto:janet_fisher@terc.edu). Selections from the module can be found at [www.netdevgroup.com/nets.htm](http://www.netdevgroup.com/nets.htm).

## FIELD TESTS

Master teachers are needed to test the standards-based life science unit Heredity and Human Development (grade 6 or 7). Teachers of deaf/hard of hearing students in grades 5–8 are also needed to test the web-based Adapting Kids Network for Deaf Students unit called "Are We Getting Enough Oxygen?" Tests begin March, 2003. Visit [SfTT.terc.edu](http://SfTT.terc.edu) and [SignSci.terc.edu](http://SignSci.terc.edu) or email [judy\\_vesel@terc.edu](mailto:judy_vesel@terc.edu).

## Study of Place

Study of Place is developing two web-based science units that give middle grades students access to technological tools and resources used by scientists, and provide opportunities for authentic inquiry about the interconnectedness of our world. These online materials bridge the school curriculum of Earth and physical science and social studies. Students use satellite images, GIS maps, and other visualizations to capture the inter-relationships among ice, oceans, and atmosphere. Each module is framed by an historical narrative that makes a connection between the physical environment and human activity. Assessments and scoring rubrics are embedded in each module, providing opportunities for tracking student learning. Antarctic Exploration is available now. Ocean Currents Exploration will be available January 2003. [www.studyofplace.com](http://www.studyofplace.com).

## Smithsonian NASM Volcanoes Cyber Center

In partnership with the National Air and Space Museum's Center for Earth and Planetary Studies (CEPS), TERC is developing three web-based activities and a poster around the subject of volcanism. "Cyber Center: Volcanoes" is part of an ongoing series relating to research currently being conducted by CEPS. It will consist of one middle school activity and two activities for high school students that will examine the shape of volcanoes, the setting of volcanoes, and volcanoes on other planets.

Activities vary in difficulty and can be used alone or in sequence. For information about the Volcanoes Cyber Center and other NASM educational services, visit [www.nasm.si.edu/nasm/edu/activity.html](http://www.nasm.si.edu/nasm/edu/activity.html).

# New Projects

## Using Data Project: Helping Mathematics and Science Reform Leaders to Use Data Effectively

The project aims to improve use of student learning and other data by mathematics and science education reform leaders by equipping them with the ability to use data to uncover achievement gaps, identify root causes, take effective action, and monitor results. Capitalizing on TERC's publication *Using Data/Getting Results* (Love, 2002), the project will develop the data literacy of mathematics and science education reform leaders and increase the effective use of multiple sources of student learning and other data in reform initiatives. The project will also create a national cadre of data facilitators and build a knowledge base about the conditions that support the use of data to improve teaching and learning in mathematics and science. Funded by the National Science Foundation.

## Earth Exploration Toolkit

The Earth Exploration Toolkit (EET) project is creating a collection of step-by-step chapters for educators at both the pre-college and college levels on how to use various Earth system tools and data sets developed and archived by and for scientists. EET chapters will help teachers and students use these resources to explore and investigate many issues in Earth system science. The EET will be promoted through teacher workshops and presentations at professional meetings, and housed online by the Science Education Resource Center at Carleton College. Funded by the National Science Foundation.

## MSP Network: A Technical Assistance Design Project

MSP Network is a technical assistance design project that will adapt, develop, and test models for the creation of an MSP network, a web-based, interactive, electronic community that will enrich the work of the Math Science Partnerships (MSPs) throughout the country. The network will encourage sharing of resources, problems, strategies, and solutions to issues; connect MSP projects with other resources at the National Science Foundation and the Department of Education; provide a mechanism for interaction between and within MSP projects; and provide MSP projects and the network as a whole with a public presence by publicizing the effort and disseminating results. Funded by the National Science Foundation.

## **NNECN: the Northern New England Co-Mentoring Network**

The NNECN project creates and supports a network of experienced teachers who mentor new math and science teachers in Maine, New Hampshire, and Vermont. Working with WestEd, TERC is conducting an external summative evaluation that will include a comparison study of the mentor/mentee pairs (up to 12 mentors in the sample) with a matched set of non-mentored new teachers. The summative evaluation will address issues of mentor practices, mentee responses (both affective and behavioral), and the degree to which mentee outcomes differ from those of non-mentored teachers. Funded by the National Science Foundation.

## **Preparing Tomorrow's Teachers in Mathematics and Science**

TERC, in partnership with Emmanuel College, is supporting Emmanuel faculty and students (preservice teachers) in understanding and applying inquiry-based mathematics and science methods in their course work and field work experiences. Through a reform-based mathematics and science methods course, students and faculty reflect on their own teaching and learning and apply this knowledge to pre-practicum teaching placements (also in reform-based classrooms). Participants will be able to explore inquiry-based technology and curricula while simultaneously using student work, field experiences, current research, and children's literature to develop a professional portfolio they can use to support their work as teachers. Funded by the Carolyn A. Lynch Institute at Emmanuel College.

## **GLOBE Learning Links for Professional Development**

GLOBE Learning Links for Professional Development is creating a new set of print and online professional development materials for GLOBE teachers. These materials will increase the number of teachers implementing GLOBE, an international program in which scientists and K-12 students collaborate to monitor the environment.

The project will maintain and enhance the 1,000-page GLOBE Teacher's Guide in print, on the Web, and on CD-ROM. It will also develop, field test, and publish two Teacher's Enhancement Guides for GLOBE teachers. Members of the Lawrence Hall of Science at the University of California, Berkeley, will collaborate with TERC scientists on the project. Funded by the National Science Foundation.

## **Lesley/TERC Online Master's in Science Education: Reopening the Science Door**

TERC and Lesley University are extending the faculty development efforts of an online master's in science education program for K-8 educators. The project will help to ensure the quality of course instruction, expand dissemination efforts, and help both new and seasoned scientists and science educators who teach online to understand:

- how to facilitate authentic and substantive science learning among K-8 educators; and
- how to support teachers as they integrate new ideas for science education into their own classroom teaching.

The project has three phases: participation in online seminars, mentoring of novices by seasoned facilitators, and participation in an online community. Funded by the National Science Foundation.

## **STEM-HELP**

The Center for the Enhancement of Science and Mathematics Education (CESAME) and the Eisenhower Regional Alliance at TERC are developing a customized technical assistance plan for higher-education faculty. STEM-HELP (Science, Technology, Engineering, Mathematics-Higher Education Liaison Project) is creating professional development modules and tools that will enable higher education faculty to plan teacher professional development based on curriculum implementation. High-quality STEM instructional materials will also be used in preservice teacher preparation programs. Funded by Northeastern University through a grant from the National Science Foundation.

## **NEWS** Coming in February, 2003

### **Preview Publication of Leveraging Learning Science Units!**

What Are Our Favorite Pets? (Grades 2-3)

What's the Weather? (Grades 3-5)

Is Our Rain Acid Rain? (Grades 3-5)

Are We Getting Enough Oxygen? (Grades 5-8)

Is Our Water at Risk? (Grades 5-8)

Each supplementary unit fits into your core science curriculum and includes a comprehensive Teacher's Guide; activity sheets; web-based and hands-on activities; and sharing, display, and analysis of student-generated data. Contact Judy Vesel, [judy\\_vesel@terc.edu](mailto:judy_vesel@terc.edu)

**Help align Leveraging Learning units with state frameworks. Interested master teachers should contact Judy Vesel, [judy\\_vesel@terc.edu](mailto:judy_vesel@terc.edu)**

# Get Involved

## Try Science Online

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.

Spring semester begins January 13, 2003

Courses offered: Try Science, Physics, Biology, and Ecology

Summer session begins May 12, 2003

Courses offered: Try Science, Biology, Earth Science, and Engineering

Try Science is the prerequisite for the online master's degree program in science education at Lesley University. For information, contact Lesley University at 617-349-8300; 800-999-1959 x8300 or x8938; or science@mail.lesley.edu.

## NASA Student Involvement Program

Rewarding opportunities for research, exploration, and discovery await you and your students: find out about the NASA Student Involvement Program's six K–12 competitions. The NSIP web site offers excellent classroom activities, resource guides, judging rubrics, and books. These standards-based resources are available online and free of charge to enrich your science classroom. Join the NASA team by entering one or more competitions: simply visit [www.nsip.net](http://www.nsip.net) to learn more and to download competition materials.

No web access? Email [help@nsip.net](mailto:help@nsip.net), or call 800-848-8429 for any materials you need. This year, NSIP celebrates the 100th anniversary of the Wright brothers' historic flight at Kitty Hawk, North Carolina, with a new competition theme. Visit [www.nsip.net/competitions/journalism/index.cfm](http://www.nsip.net/competitions/journalism/index.cfm).

## ISS EarthKAM

ISS EarthKAM, a NASA-sponsored education program, allows students to take photographs of Earth from space! Middle school students control a camera mounted on the International Space Station and study the resulting images to enhance their learning of science, geography, and mathematics. You and your students can participate. There will be several missions this year. All the images and educational materials are available on the Web. A simple online registration form allows you to join the program. Visit the ISS EarthKAM web site: [earthkam.ucsd.edu](http://earthkam.ucsd.edu).

For information about field tests, see pages 20 and 22.

cut here

### Sign up and join the more than 25,000 members who receive *Hands On!* magazine

F'02

**YES!** Send me  print only  electronic only  both versions  change of address

Name \_\_\_\_\_ Title \_\_\_\_\_ Organization \_\_\_\_\_

Street Address \_\_\_\_\_ City, State, Zip \_\_\_\_\_

Email Address \_\_\_\_\_

Occupation:  School Administrator  Business/Industry  Scientist  Math Coordinator  Science Coordinator  
 Technology Specialist  Researcher  Teacher  Government Agency  Other: \_\_\_\_\_

Level:  K–8  9–12  College/University

Areas of Interest:  Mathematics  Science  Earth and Space Science  Technology

**Support** Please send a contribution to help cover costs of publication. I am sending  \$35  \$25  \$20  other \_\_\_\_\_

#### Order other TERC Publications

##### Conference Reports

Blueprint for Change: Revolution in Earth and Space Science Education \_\_\_\_\_ # \_\_\_\_\_ Price \$5.00 Subtotal \_\_\_\_\_

Student and Scientist Partnerships \_\_\_\_\_ # \_\_\_\_\_ Price FREE Subtotal \_\_\_\_\_

##### Working Papers Research Series

Encouraging Inquiry in a Seventh-Grade Mathematics Class \_\_\_\_\_ # \_\_\_\_\_ Price \$5.00 Subtotal \_\_\_\_\_

Body Motion and Graphing \_\_\_\_\_ # \_\_\_\_\_ Price \$5.00 Subtotal \_\_\_\_\_

Science Talk in a Bilingual Classroom \_\_\_\_\_ # \_\_\_\_\_ Price \$5.00 Subtotal \_\_\_\_\_

Teachers' Perspectives on Children's Talk in Science \_\_\_\_\_ # \_\_\_\_\_ Price \$5.00 Subtotal \_\_\_\_\_

Children, Additive Change & Calculus \_\_\_\_\_ # \_\_\_\_\_ Price \$5.00 Subtotal \_\_\_\_\_

Equity in the Future Tense: Redefining Relationships Among \_\_\_\_\_ # \_\_\_\_\_ Price \$5.00 Subtotal \_\_\_\_\_

Teachers, Students, & Science in Linguistic Minority Classrooms \_\_\_\_\_ # \_\_\_\_\_ Price \$5.00 Subtotal \_\_\_\_\_

by TERC Product Catalog \_\_\_\_\_ # \_\_\_\_\_ Price FREE Subtotal \_\_\_\_\_

TERC Annual Report \_\_\_\_\_ # \_\_\_\_\_ Price FREE Subtotal \_\_\_\_\_

*Hands On!* Contribution \_\_\_\_\_ # \_\_\_\_\_ Price \_\_\_\_\_ Subtotal \_\_\_\_\_

**Total Enclosed** \_\_\_\_\_

Prices include shipping for U.S. orders. Prepayment required: Send check or money order in U.S. dollars, payable to TERC. TERC Communications, 2067 Massachusetts Avenue, Cambridge, MA 02140, USA

*Interested in more opportunities to engage  
in rigorous inquiry-based teaching and learning?*

TERC Communications is preparing a new edition of "by TERC." The "by TERC" catalog lists all currently available TERC-developed products, including a number of new science and math curricula, as well as new and recent publications, software, videos, and web-based tools for K-12 teachers, students, and staff developers.

To find out about all available products, visit [www.terc.edu](http://www.terc.edu), phone TERC at 617-547-0430, or contact [communications@terc.edu](mailto:communications@terc.edu) to request a copy of the new by TERC.



TERC

2067 Massachusetts Avenue  
Cambridge, MA 02140  
phone (617) 547-0430  
fax (617) 349-3535

[www.terc.edu](http://www.terc.edu)

Nonprofit Org.  
U.S. Postage

PAID

Permit No. 375  
Nashua, NH