Hands On!

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A magazine for mathematics and science educators

TERC

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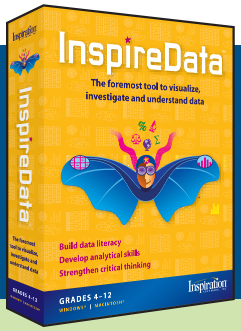
BY GEORGE HEIN

Science Education for a Thriving Democracy

"In order to save our democracy we've got to educate the people who vote."
—JERROLD ZACHARIAS[1]

"Science Education for a Thriving Democracy" is an appropriate rallying cry for any vision for education in the United States. Our nation prides itself on championing democracy, and public education has been the most powerful tool available for forging our democratic society and sustaining it for more than 200 years. Early republican writings emphasize the importance of free, public education for the fledgling democracy. Jefferson considered his work in establishing free education his most important contribution to building the United States.[2] (CONTINUED ON PAGE 4)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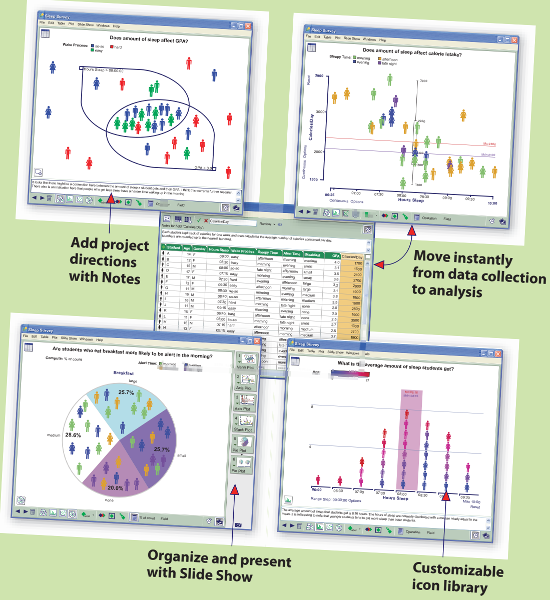
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TAKING THE TIME TO REFLECT and mark a milestone is rare in today's fast-paced society but it is so important to take a look back if you want to move forward.

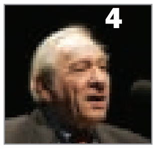
On a sun-filled fall day in 2005, TERC took the time and celebrated a milestone—forty years of introducing students to the exciting and rewarding worlds of math and science learning. The daylong symposium, Science Education for a Thriving Democracy, brought together educators and community and industry leaders to discuss the state of science education today. Participants reflected on past achievements and offered visions for the future of science education.

Our cover article by George Hein is based on his Symposium presentation. He reflects on his forty years working for educational improvement and passionately argues for the role of science education in society and the importance of developing the scientific talent of all citizens.

His words set the tone for the day's discussion, and also provide the perfect context for the TERC work we highlight in this issue of *Hands On!*. The articles report on some of the research and programs happening at TERC that seek to engage and inspire students, helping them to develop the skills they need to ask questions, solve problems, and expand their opportunities.

Kenneth Mayer,
Executive Editor

features



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Science Education for a Thriving Democracy

BY GEORGE HEIN

George Hein addresses participants at a symposium celebrating TERC's 40th anniversary

Madison's famous letter to W. R. Berry applauded the Kentucky legislature for its "liberal appropriations" for a general system of education and argued

> *A popular Government, without popular information, or the means of acquiring it, is but a Prologue to a Farce or a Tragedy… it is better for the poorer classes to have the aid of the richer by a general tax on property, than that every parent should provide at his own expence [sic] for the education of his children, it is certain that every Class is interested in establishments which give to the human mind its highest improvements, and to every Country its truest and most durable celebrity.*
>
> *Learned Institutions ought to be favorite objects with every free people. They throw that light over the public mind which is the best security against crafty and dangerous encroachments on the public liberty."*[3]

This faith in the power of public education for all and massive support for a truly inclusive public education system have repeatedly stirred the nation and brought dramatic opportunities for previously underserved sectors of the population. The Morrill Act of 1862 creating "land grant" colleges was such a bold move. It has provided affordable higher education to millions of citizens. Another was the GI Bill of Rights (Servicemen's Readjustment Act of 1944) that opened up college educations for returning GIs who might otherwise never have had such opportunities.

It seems particularly important today to reaffirm the connections between our commitment to education and allegiance to democracy since this essential feature of our American social contract is increasingly ignored. The primary argument for supporting public education and science education has been reduced to an economic one: that it is necessary for us to produce more scientists and engineers to maintain our competitive advantage in the global economy.[4]

Our modern efforts to renew and revitalize science education began after World War II with similar calls to protect our global dominance, specifically to counter Soviet advances that threatened our economy and our way of life. But the scientists and educators who provided us with modern science education in public schools subscribed to the bolder and broader original U.S. vision for the role of education in a society: they viewed education, especially in science, as essential to sustaining our democratic society. A similar rallying call is necessary today. We can learn from the giants of the 1950s and 60s—on whose shoulders we inevitably stand—as we reach for better education for all.

We Didn't Talk About "Failing" Schools

In reflecting on my own experiences as a young scientist who left the laboratory to devote himself to science curriculum development, as well as looking at historic documents, I've been struck by two major themes. One is the way public views on education and political rhetoric have changed during the last 40 years. The other is that there is a mythology about science education in the 1960s that doesn't match what occurred. These two themes are related; we reinterpret history through the prism of current understandings.

First, there's a matter of language: we didn't talk much about "reform" and about "failing" schools. That view of

"In order to get people to be decent in this world, they have to have some kind of intellectual training that involves knowing [about] Observation, Evidence, the Basis for Belief." — JERROLD ZACHARIAS

education is much more recent. The goal was to improve education because it was "inadequate," not because it was "failing." The American Association for the Advancement of Science (AAAS) organized a series of conferences for scientists and educators in 1960-61 that helped generate support for new elementary science projects. The final report summarizing the conference begins

> *There is an urgent need for major improvement in the science instruction offered in elementary and junior high schools. In the hope of finding ways to effect this improvement, three conferences of teachers and scientists, all sponsored by AAAS but conducted independently, recently considered the following aspects of science instruction: present practices and materials; recent efforts to create new courses for senior high schools and recent experiments in teaching young children.*[5]

I remember the excitement of joining the staff at the Elementary Science Study at the Education Development Center (EDC) in an era seeking improvement rather than blame. I was part of a national effort to make science education richer and more interesting for children, bring about change in public schools, and, therefore, improve social conditions for everyone in the United States.

Jerrold Zacharias was the most significant scientist who initiated the effort to improve K-12 science education in the United States starting in the 1950s. We need only look at what he had to say to recognize that his motivation encompassed more than a commitment to keep the United States economically and militarily strong. Zacharias had successfully guided the Radiation Lab at the Massachusetts Institute of Technology (MIT) during World War II, earning the respect of both scientists and government policy advisors.[6] After the war, Zacharias remained in Boston, took up teaching and research at MIT and started consulting for the growing technology industry. He had a full life including experimenting with novel teaching methods, government consulting, running a lab, and participating in profitable technological enterprises. But in 1955, he decided to switch his major attention to science education improvement.[7]

Zacharias' new interest coincided with the emergence of the National Science Foundation (NSF), founded in 1950, as a first and major federal government agency to support science research and science education. It was part of the NSF mandate to stimulate and improve science education at every level. Through his strong government ties and the support of MIT's administration, he was able to launch an MIT spinoff that later became EDC. The United States was concerned with the production of new scientists and the increase in scientific productivity in this country, but Zacharias saw the problem on a much grander scale.

"We have stunted an entire generation of students because people believed it was important to simply enumerate objects, rather than understand what the object was in the first place."
— Neil deGrasse Tyson,
Keynote Address, TERC Symposium

> *The reason I was willing to do it [PSSC, a high school physics course] was not because I wanted more physics or more physicists or more science; it was because I believed then, and I believe now, that in order to get people to be decent in this world, they have to have some kind of intellectual training that involves knowing [about] Observation, Evidence, the Basis for Belief.*[8]

> *It was largely a matter of social conscience, I believe, that motivated us [scientists] to school work. As scientists, we seek evidence before we try to create order, or orderliness, and we do not expect, nor even hope for, complete proof… We live in a world of necessarily partial proof, built on evidence, which, although plentiful, is always limited in scope, amount and style. Nevertheless, uncompleted as our theories may be, they all enjoy, in a sense, the benefits of due process of law. Dogmatism cannot enter, and unsupported demagoguery has a tough time with us. A Hitler or a McCarthy could not survive in a society which demands evidence which can be subjected to examination, to reexamination, to doubt, to question, to cross-examination. It may be this lesson that gives us a missionary zeal.*[9]

Free public education for a fledgling democracy.

Zacharias' first venture into K-12 education was the creation of the high school physics course, PSSC. That course, like all the other secondary school science curricula developed elsewhere at that time—CHEM Study, CBA and BSCS—was developed as a general secondary school science curriculum, not for advanced students or what today would be an AP course.

A few years after the wave of secondary school curricula (and attendant workshops for teachers) were begun, the growing community of scientists and educators engaged in these projects realized that improvement was also needed at the elementary and junior high school level. A major effort to provide science education for all students was launched. Again, social goals predominated in the thinking and motivation of those who were involved in the second phase. The report from the AAAS conferences mentioned earlier was clear that more and better science education was necessary for all students in public schools and that the purpose was not to produce more scientists, but to educate children to become better citizens.

As part of general education, science should constitute a regularly scheduled part of the curriculum in all grades. The purpose is to equip all persons for life in a scientific and technological society. If all of the more than 35 million pupils in elementary and junior high schools can be given good experiences in science all will have a good start towards scientific literacy.

More than anything else the purpose of science in general education is to develop a more complete view of life in a scientifically oriented world culture.[10]

Individual projects were also explicit in stating that they were developing curriculum and teacher workshops for a general audience of all students, not only for the preparation of future scientists.

My own experience working in curriculum development in the 1960s was without doubt that we were attempting to introduce programs that would serve all children, not any special group, and that the main purpose of introducing inquiry science into classrooms was not only to provide a grounding in science, but to provide experience with the processes of science that could be applied to all subjects. We saw science education, essentially missing from the elementary school, as the easiest way to revolutionize elementary school practices. All other subjects—reading, arithmetic, social studies—had well-established methodologies and any effort to change them needed to compete with existing texts, teaching methods and curricula. The beauty of science was that it hadn't been taught and was now seen as important. Therefore it could be used to shake up the schools and have all teaching focus more on thinking skills than on rote learning of decontextualized material. Supporting our efforts to develop materials for all schools, considerable development work was carried out in schools that served the poorest students and those in working class communities.

There is another myth about the earlier curriculum projects, namely that they "failed." It's difficult to know what might be the evidence for this belief, since we could hardly expect to find 40-year-old curricula still in use. Today's elementary and secondary science education is profoundly influenced by the work carried out 40 years ago. The general conception that science should be taught through inquiry, and, more important, how this could be carried out in the classroom—the hallmark of all the programs and methods currently encouraged by both the NSF and

"We were attempting… not only to provide a grounding in science, but to provide experience with the processes of science that could be applied to all subjects."

all the relevant professional associations—was essentially invented and implemented on a national scale by the science education improvement efforts of 40 years ago. The materials used today in elementary science, and the profusion of kit-based programs, are a direct consequence of the earlier work. Another domain where the science materials of the 1960s are actively used is in science museums and science centers, a growing informal educational community that did not exist 40 years ago.

Quality Takes Time and Money

I cannot overemphasize the difference in rhetoric about schools in the 1960s compared to today. Federal assistance to schools was minimal before passage of the National Defense Education Act of 1958, during Eisenhower's administration.[11]

In 1965, the year of TERC's founding, the groundbreaking Elementary and Secondary Education Act was passed under President Johnson as part of his broader program of the War on Poverty. Johnson went to Texas and signed the bill with his former grade school teacher at his side. The language is mainly positive, with the emphasis on funding programs (this includes Head Start, Title I and other compensatory programs), reaching underserved children and helping to redress past inequities. In contrast, NCLB is focused more on regulatory provisions and includes mandatory testing, expanded options for parents, and an emphasis on particular teaching methods, especially for reading. The general public discourse about schools—that they are failing and need to be "reformed," that is, fixed by applying business methods, including "bottom-line" accountability (whatever that business term may mean when referring to schools) simply didn't exist 40 years ago.

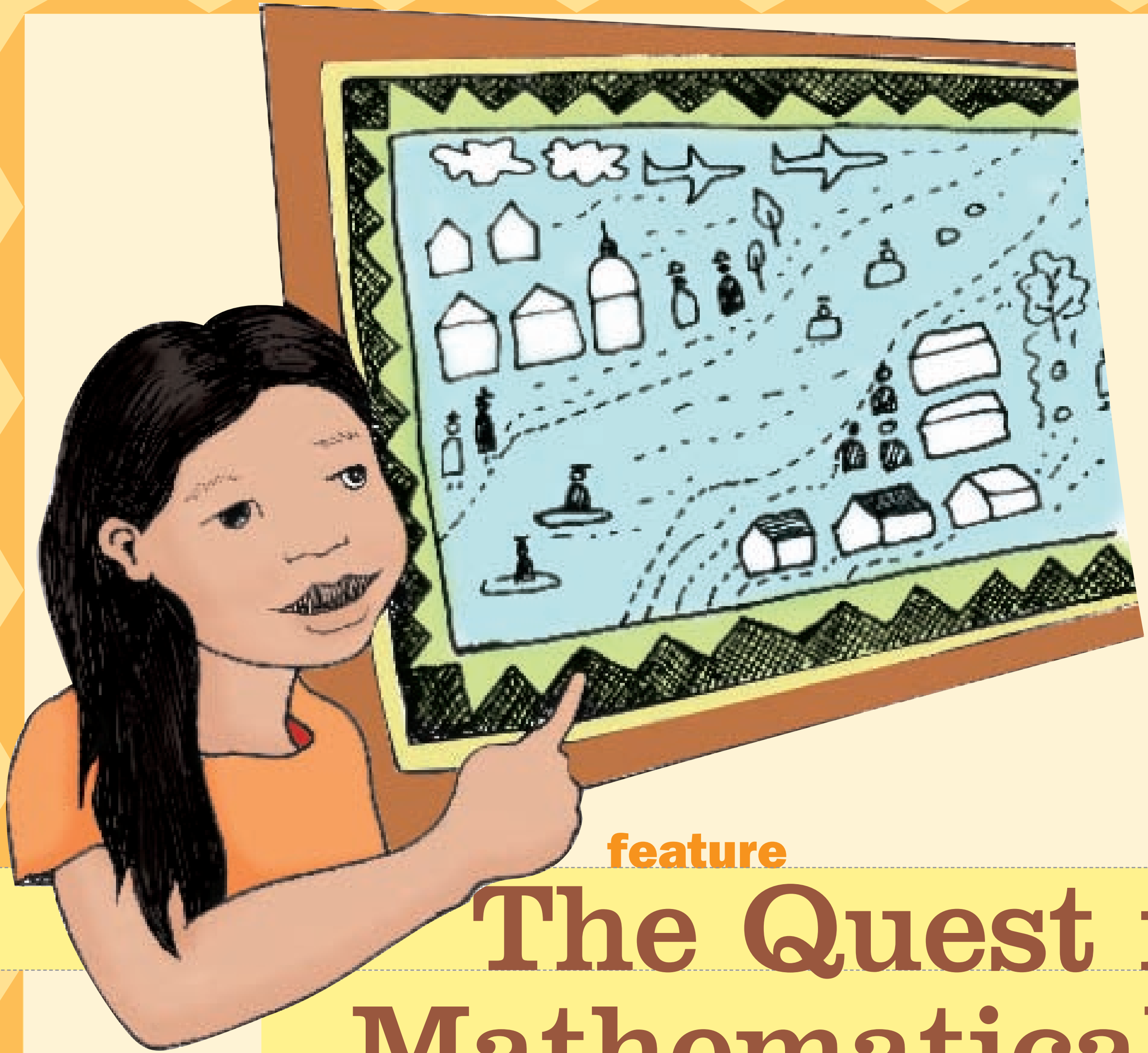
Most significant for curriculum development and professional development is what these changes in policy and public attitude mean for working in classrooms and with teachers. The pressure on teachers today to follow detailed lesson plans and conform to specific curricular goals is enormous. Any request that they experiment with new materials is asking them to take a tremendous risk. That certainly wasn't the case when we were working in schools in the 1960s. I remember a two-month period during which my colleague Joe Griffith and I went to an elementary school in Watertown, Massachusetts, twice a week. We explored a unit on prehistoric tools that included starting fires by various primitive means. The children were only occasionally successful in coaxing actual flames from the bow drills or flints and white cedar shavings we supplied, but we certainly generated a huge amount of smoke! I can't imagine being allowed to do this today. But you don't get good curriculum without the freedom to take risks and try activities that don't work out. The vital pedagogic truism that you have to make mistakes to learn is very difficult to implement today.

Not only did the earlier science improvement efforts benefit from a more confident climate, they were supported more generously. The typical new curriculum went through several trial phases of increasing complexity: a first trial in a class was followed by an alpha version in multiple classrooms, then a beta version distributed nationally, and only then was a gamma version published commercially and sent to classrooms with the expectation that it, too, might be revised after some use. More recent projects usually leave out one or more of these development phases.

We had time, and we also had money. "Quality costs," Zach used to say. The NSF was willing to pay for quality and, I believe, they got it. For an example of what was spent on projects, PSSC received $1.8M in start-up costs before the October 1957 launch of sputnik. That's equivalent to 12.8M in today's dollars. The expenses were high because the course audaciously proposed extensive use of film,

continued on page 19

(far left) Symposium panelists Darren Wells, winner of a Presidential science teaching award, George Hein, and Cary Sneider, Director of Programming for the Museum of Science, discuss the current state of science education; (left) Megan Bang, a research fellow at TERC, presenting her research on science learning among American Indian students; (right) Mish Michaels, CBS4 meteorologist, discussing the TERC/Museum of Science WeatherWise exhibit



feature

The Quest for Mathematical Equity

by Jan Mokros and Ricardo Nemirovsky

The following is an excerpt from the forthcoming book, "Math Momentum in Science Centers," available in early 2007. The book is designed to help museum staff make the math in their exhibits and programming more explicit and accessible. This resource is the result of a collaborative effort among 13 science centers across the United States.

A group of major business leaders recently concluded, "Together, we must ensure that U.S. students and workers have the grounding in math and science that they need to succeed and that mathematicians, scientists, and engineers do not become an endangered species in the United States."[1] This report stresses the need for a special effort in recruiting and retaining currently unrepresented groups in mathematical and scientific occupations.

Looked at from an individual's perspective, there are many benefits to being fluent in math. People who take more mathematics courses earn substantially more money than people who do not and have more career opportunities. Mathematically skilled people are also better able to estimate costs when they shop, determine how much an item on sale should cost, interpret medical findings, understand how to do their taxes, interpret political polls, and make consumer decisions.

Not everyone in the United States has equal access to math, and students who drop out are disproportionately people from low-income, African-American, and Latino groups.[2] Until recently, women were also less likely to pursue math, though by 2000, 47% of all math majors were women, and women and men were achieving comparable grades in college math courses.[3] It's important to dispel the myth that any demographic group has less innate mathematical talent than another. The most that can be concluded from an immense amount of research is that some groups of people perform better on some tests of some mathematical skills under some conditions.

Equity Through Relevance

Science centers could be key players in addressing inequities with respect to math achievement, and they possess a critical tool to address equity—the ability to engage visitors in relevant math that is seen in a variety of intriguing contexts. This tool is one that formal educators are trying to use more often and more effectively. In one of her President's Messages to the National Council of Teachers of Mathematics, Cathy Seeley states, "Student engagement is perhaps our most important tool in our battle for equity."[4] She goes on to talk about the importance of providing tasks that a broad range of students will find relevant.

Here, we illustrate in detail how one school program (built upon an exhibit at the Science Museum of Minnesota depicting a Hmong house) pulls children into math by engaging them with cultural artifacts that are a significant part of their lives. The Hmong are an ethnic group whose homeland is Southeast Asia. Minnesota is home to a large Hmong population. The accompanying program developed by the museum for fifth grade children included math activities for field trips, as well as classroom activities for before and after these trips. One important goal of the program was to reach urban elementary students who needed additional academic support.

Staff from the museum observed children and teachers as they engaged in the math activities. In one of the observations, we follow Elizabeth, who is from a Hmong immigrant family. She is working on an activity that involves reading about tessellations, which is explained as "a pattern of closed shapes that completely covers a surface" and shows samples of tessellations from clothes used in different cultures. The activity consists of looking for tessellation patterns in the museum's Collections gallery, drawing one of them on the student sheet, and discriminating its geometrical components.

After gathering all the materials and reading the student sheet, Elizabeth starts walking toward an exhibit, which recreates elements of a traditional Hmong house. Inside, the teacher and a classmate of Elizabeth's examine a tessellation pattern of triangles that forms the border for a story quilt. They call Elizabeth, but she has stopped in front of a traditional Hmong altar. Elizabeth calls the others to join her. While Elizabeth calls them, she bounces slightly on the bench. The teacher asks Elizabeth, "So, do you see some tessellations here?" Elizabeth responds, "Yeah, right here," pointing at a strip of paper cut into a pattern. Elizabeth stays on the bench, drawing the pattern on the student sheet.

Shortly thereafter, another student walks up and asks Elizabeth about the altar. Elizabeth responds, "It's a Hmong thing that Hmong people… they, uh… do this; they light that (pointing to something in the altar), and then they, uh, say a little prayer (bouncing on the bench in accordance with Hmong ritual) so the ghosts don't come back to them and haunt them forever."

Illustrations: Maureen Burdock

The teacher sits down next to Elizabeth.

Teacher: So, have you been to a shaman's house, where you…?

Elizabeth: That's my grandpa.

Teacher: He's a shaman? (Elizabeth nods.) Awesome.

Elizabeth: Um, my grandma's a shaman too. Um… like if you… like, say, they're not… people are not supposed to [do something], and they say a little prayer (slight bounce), and they say that… like, help them (bouncing). Like, they light that (points to object in altar). They…um, they put all this right here (gestures horizontally on the altar, over the upper shelf).

Teacher: So it looks a lot like this (points at the altar).

Elizabeth: They go (she bounces)… they create, so souls… so ghosts… don't haunt them.

Teacher: So people will come to them.

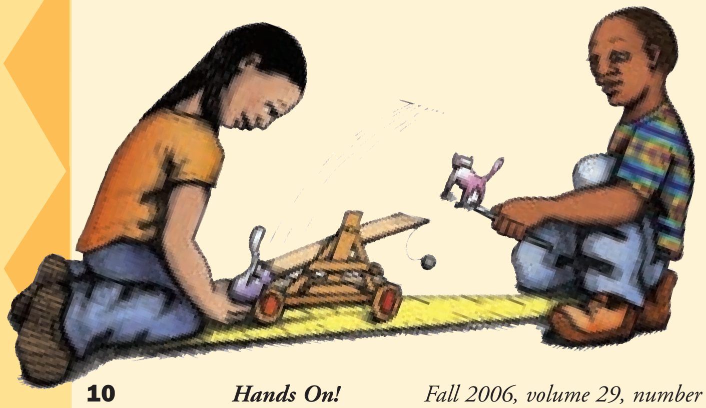
Elizabeth: So ghosts don't haunt them forever. Like if they did something.

Then a Hmong boy, Robert, walks over and puts his clipboard on the floor. Elizabeth gets up and the boy sits down on her place.

Robert: So, they put something over the head, and they do this (he bounces like Elizabeth did, only higher).

Robert gets up and Elizabeth sits down again. She starts bouncing while the teacher and the boy are talking. Elizabeth says, "My grandpa does that," and she starts drawing on her clipboard.

What does this episode tell us? Within the Hmong house, Elizabeth and Robert became authoritative sources for the meaning of the altar; they were visitors who could animate the altar to explain it to the teacher and other children ("It's a Hmong thing," said Elizabeth). This interaction suggests a challenge that goes to the core of equity: designing math programs and exhibits so that visitors from nonmainstream worldviews can participate as experts and contributors.



Gutstein[5] talks about the importance of blending classical mathematical knowledge with community interests. In the Hmong house, Elizabeth and Robert are beginning to learn classical mathematical knowledge—in this case, geometry—within the context of deep interest and knowledge about their community. Equity is not only a matter of making programs and exhibits accessible to all, but also involves enabling minority visitors to share their own cultural traditions, and to enter mathematics.

Another important message in this episode involves the question "How does one make a highly engaging exhibit mathematical?" A good starting point is by carefully examining an exhibit to find the mathematical opportunities. In the Hmong house, the mathematics of tessellation hidden in the story-quilt patterns was made explicit through the use of student materials and worksheets. This suggests beginning with existing exhibits that have strong cultural components, and then identifying places where mathematics might be lurking in these exhibits. As seen in this episode, integrating more math need not be an expensive proposition and doesn't have to involve building more exhibit components.

Finally, this episode raises questions about what makes an exhibit not only engaging, but also interactive. In the science center world, it is common to refer to an exhibit as interactive if it has buttons or other mechanical-electronic means to respond to the user's actions. The Hmong House has no such devices. And yet, for Elizabeth and Robert, the exhibit was a call to action. They bounced on the bench to recreate a ritual; they gestured to and talked about the objects positioned on the shelf; and they acted the presence of their ancestors striving to alleviate those who had done something unjustifiable.

Interactiveness—the genuine mutual animation of visitor and exhibit—is not a matter of buttons, but of a resonance between the exhibit and the visitor. An exhibit is not interactive *per se* but *for someone*. Elizabeth transitioned back and forth between tessellations on the paper strip and bouncing to imitate the work of a shaman.

Capitalizing on Visitor Expertise

Connected to the issue of engaging visitors is the issue of capitalizing on their expertise. All visitors, no matter how young or old, or how poorly or well they have done in school math, have mathematical expertise. Whether they are able to use this expertise in science centers depends on how exhibits and programs are designed. For example, visitors may have deep knowledge about the mathematics of measurement as used in gardening, remodeling, or cooking. By building on visitors' expertise, they gain access to math in ways that are non-threatening. For example, the Math in the Garden program at Lawrence Hall of Science takes visitors of all ages directly into the garden and engages them in familiar planting and monitoring tasks that have a mathematical bent. Young children are given ten popsicle sticks and choose ten plants to examine. Each plant that is not "eaten" in any way gets a blue stick, while plants that have been nibbled upon get a red stick. Because young children are working on establishing what two numbers can be combined to total ten, this task is an excellent way of melding gardening with developmentally appropriate mathematical reasoning.

Visitors bring all kinds of math-related knowledge with them on their visits to science centers. Finding and mobilizing cultural "funds of knowledge" with respect to mathematics is a critical task of science centers.[6] The first step is to investigate community knowledge, focusing on the strengths that people bring to an educational situation. Moll offers a list of questions for educators as a self-assessment to guide this process, adapted here to address the mathematics in science centers (See Figure 1).

Science centers know how important it is to build upon visitors' strengths and interests, and not to prejudge what visitors can do. Making use of what visitors bring to the situation, as Moll suggests, means truly getting to know visitors' backgrounds and skills, through formal visitor studies, talking informally, or even interviews in the home. As TERC President George Hein points out, "It is a good rule of thumb to assume that you know less about your visitors than you think you do."[7]

Beginning the work of designing mathematical experiences by examining visitors' expertise represents a major shift in perspectives. As Martin and Toon point out, "… a kind of Copernican revolution has taken place in the type of enculturation museums do. The locus of meaning-making has shifted from being centered on the museum's body of knowledge to the museum's understanding of its visitor."[8] Understanding visitors' cultural backgrounds is a critical foundation for incorporating high-quality math experiences into science centers.

Illustrations: Maureen Burdock

FIGURE 1

Building on Visitors' Funds of Knowledge

1. How well does our center link visitors' math experiences to families and communities?
2. Do we provide ongoing parent education and training so parents can help their children with math?
3. Have all our staff had training to help them use visitors' families, languages, and cultures as a foundation for learning?
4. How do staff tap into visitors' funds of knowledge?
5. In what ways do we affirm visitors' home languages, while linking them to Standard English?
6. Do our staff members know how to use visitors' informal languages as a tool for developing math literacy?
7. How well does our center tailor its exhibits and programs to the particular needs, interests, and learning styles of individual visitors?
8. In what ways do we encourage and teach to the many intelligences and learning styles of visitors?
9. How does our center encourage visitors to articulate their dreams and aspirations and link them to math learning?

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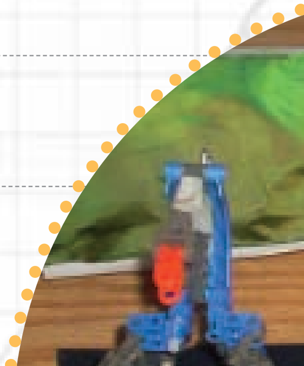
Astrobiology After School

by Hernando Romero

Middle school students are looking to the heavens to learn more about their own planet. The NASA-sponsored Astrobiology After School project at TERC guides Boston students on an exploration of life in the universe.



As part of the biology component of the program, students collect water from a local pond. Later they draw pictures of the bacteria they see through a microscope.

The afterschool program harnesses student enthusiasm through building and launching model rockets.

The program is based on the TERC Astrobiology curriculum, an interdisciplinary life sciences course (see page 23). By investigating factors that make a planet habitable to life, such as temperature, water, atmosphere, and nutrients, kids also learn about the biological systems of planet Earth. The possibility of life on other planets captures their imaginations while they learn the core concepts of Earth and space science. The informal program meets just once a week, but students are captivated, and spend additional afterschool time conducting research and sharing their findings.

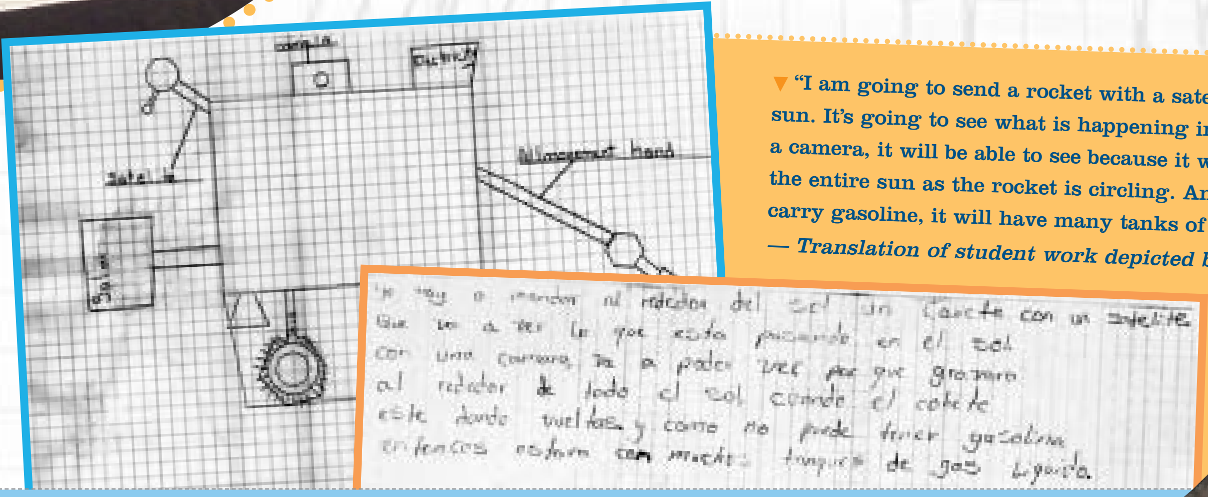
The culminating project is a mission to the planet of their choice. Students at one middle school had a chance to impress their families with all they had accomplished during the 10-week program. Many students chose Mars because of its favorable distance from the sun. Another

Students designed and constructed models of planet exploration vehicles. This robot for exploring Mars was given extending arms.

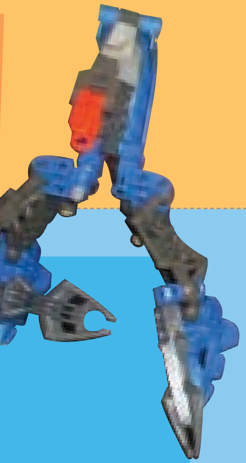
Summer program participants are given access to the Dexter School's state of the art astronomical observatory.

▼ **"I am going to send a rocket with a satellite around the sun. It's going to see what is happening inside the sun. With a camera, it will be able to see because it will record around the entire sun as the rocket is circling. And since it can't carry gasoline, it will have many tanks of liquid gas."**

— *Translation of student work depicted below*



Yo voy a mandar al rededor del sol un cohete con un satelite
que va a ver lo que esta pasando en el sol
con una camara, va a poder ver por que grabara
al rededor de todo el sol cuando el cohete
este dando vueltas y como no puede tener gasolina
entonces estara con muchos tanques de gas liquido.



group chose Pluto, which created the opportunity for extended math explorations. They explained to the class that, factoring in the average speed of a rocket and the vast distance from Earth, it would take several decades to reach Pluto. The kids amazed themselves with the calculations they performed in determining the challenges of operating a rocket for more than 50 years, and what it would take to receive data from their explorer. For many students, this was their first exposure to the scientific process and may spark their interest in future science careers.

This project was funded by NASA. It builds on the Astrobiology high school curriculum project funded by the National Science Foundation through Grant No. ESI-9730728.

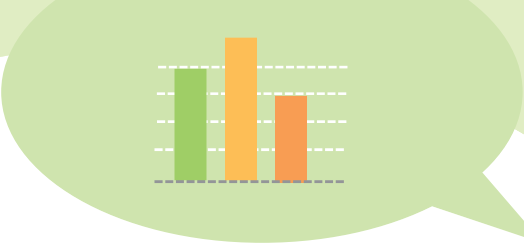
FOR MORE INFORMATION

about the Astrobiology After School program, contact Hernando Romero, Implementation Director, hernando_romero@terc.edu.

PROJECT PARTNERS

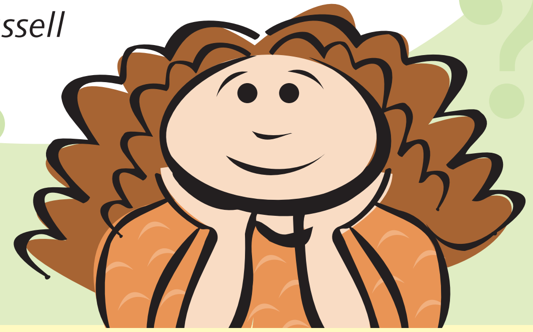
- **Mass Audubon's Boston Nature Center Education Program**
- **Citizen Schools at Mildred Avenue Middle School (Mattapan, MA)**

The Astrobiology After School Educators Guide will be available free of charge in December 2006 from NASA and TERC.



What's in a Question?

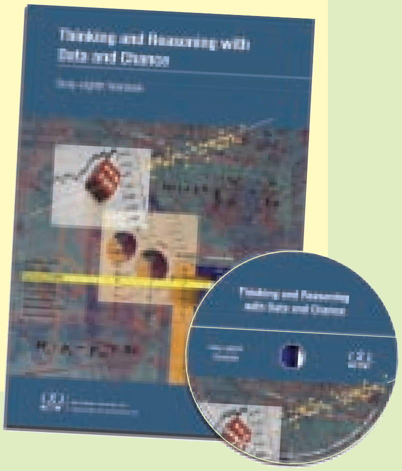
By Susan Jo Russell



The National Council of Teachers of Mathematics' 68th Yearbook, Thinking and Reasoning with Data and Chance, includes the chapter *What Does It Mean That "5 Has a Lot"? From the World to Data and Back* by Susan Jo Russell. The excerpt below discusses how students learn about developing and refining a question for data collection. The rest of the article addresses how students make sense of their data once they are collected: how do they relate graphs, numbers, and statistics back to their original question? The Yearbook and CD with a related video episode, can be purchased at www.nctm.org.

What do you think of when you think about data in the elementary grades? You might think about tables and graphs, or about statistical terms such as range, outlier, and median. You might picture students conducting surveys, keeping track of plant growth, or considering questions such as, "How do the bedtimes of third graders compare to the bedtimes of students in other grades?"

All these elements are present in students' work with data. Collecting, describing, representing, and summarizing data are key activities. To understand what data are and how to use them, students must themselves be engaged in developing questions about their world and creating data to shed light on those questions. The phrase *creating data* may be an unfamiliar one. However, this phrase points to an underlying understanding that students are developing in the elementary years: *Data are not the same as events in the real world, but they can help us understand phenomena in the real world...*


Thinking and Reasoning with Data and Chance
Thinking and Reasoning with Data and Chance

Even in the elementary grades, students can start thinking about what it is they want to know and how to ask a question or develop an experiment or take measurements that will best lead to that information. Data collection is not an exact science. There is not one correct question or experiment that we can know in advance will necessarily get better results. By devising a data collection method, trying it out, and revising it, statisticians as well as elementary school students develop better methods—methods that are more likely to result in useful information. Many students in elementary school collect data through surveys of their classmates. In this context, students can learn a great deal about formulating questions. For example, in a second-grade class, students had several experiences working on data questions suggested by the teacher (Russell, Schifter, and Bastable 2002, 30-34). After these experiences, their teacher asked them to come up with their own questions. She wrote:

> *I anticipated that the initial brainstorming and discussion of interesting questions to investigate would be brief. I expected that the students would be eager to begin and would later discover the issues and ambiguity around their questions as they conducted their survey. In this case, I truly underestimated how far the class had come in their thinking about data. From the very start of our brainstorming session, the students were full of questions and quickly focused on the clarity of each survey question. Many seemed to have the end in mind and were concerned with different interpretations people could give to the same question. [P. 31]*

One student suggested the question, *How many houses are on your street?* Here is part of the conversation that ensued:

Susannah: Zachary [the student who had suggested the question] and I live on the same street and it's really short. But what if you live on a really long street? How could you count all the houses?

Zachary: Well, I guess it could be your block. How many houses are on your block?

Helena: What about houses being built? I have a house being built on my block.

Will: And how about condominiums and apartments? Not everyone lives in a house. Thomas and I live in the same building, and we have like a gazillion apartments in the building. It takes up the whole block!

These second graders are focused on defining their questions in a way that will be clear to those they survey and will provide information they can interpret accurately. Later in the conversation, students consider the connection between their data collection methods and their results:

Susannah: Everyone has to understand your question. If they don't understand your question, everyone will be answering just any old way.

Thomas: I wouldn't trust your data very much then!

Teacher: Why not?

Thomas: Well, people wouldn't be thinking very hard about their answers.

Keith: If I came along and I asked the same question, then I might get different answers than Susannah because people might not really understand what we were asking. If we ask the same question and we ask the same people at the same time, then our answers should be the same.

Already these students are developing a notion of "good data"—data that are collected in such a way that they reasonably represent the events they are investigating.

For children in the elementary grades, the idea of specifying a meaningful question can be challenging. However, there is a danger that a focus on creating a clear question can overshadow the focus on collecting meaningful data that are of interest. For example, in this same classroom, Natasha and Keith tried to define a survey question about the number of states students had visited. As they tried out their question, they discovered that they did not have a clear idea of what they wanted to find out—or rather that the two of them had very different ideas about their purpose. Natasha tried to explain her ideas to Keith about what should count as a "visit" to a state. As the teacher explained (Russell, Schifter, and Bastable 2002, p. 33),

> *Natasha . . . felt that a visit only counted if you were going to that state for a specific purpose, not simply passing through to reach another destination. Thus, airports could not count. If you stayed with a friend out of state, it counted only if you really, really wanted to see them and you stayed with them for more than a day: The list went on, and the stipulations became more detailed and confusing. Keith was bewildered by her many qualifying factors and stated that he wanted to make it much simpler. Natasha finally declared, 'I know exactly what I mean. I just can't say it in a simple way!'*

Natasha has some sense of the kind of information she wants. In her mind a "visit" is something substantial—enough time spent, perhaps, to actually get to know a place, to have some image of what it is like—not just changing planes in an airport but spending time in the place itself. Hers is a sophisticated notion, and her second grader's ability to express her ideas precisely may not be up to the depth of her idea. But Natasha is on to something here. She is wrestling with an important issue in the design of data investigations—the formulation of a data investigation design that will have a good chance of resulting in the information she is after.

Consider another scenario. In a grade 5 classroom, students are also working on this issue as they develop questions for a survey (Russell, Schifter, and Bastable 2002, pp. 27-30). As they formulate their questions in small groups, the teacher helps them clarify what they want to find out. One group is interested in how many times students in their class have moved. They first formulate their question as, *How many times did you move in the last 10 years?* Here is part of the conversation that follows:

Luke: Some of the kids in fifth grade are not 10 yet.

Michelle: You're right! Let's ask how many times did you move in your life.

Silvia: I like this question better.

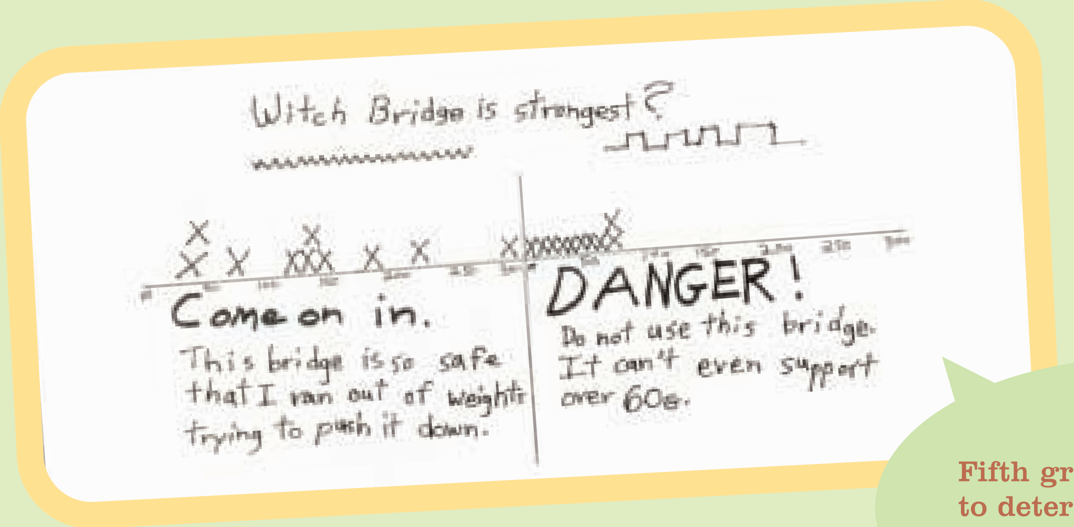
Teacher: What do you mean by "moving"?

Luke: Going from one place to another.

Silvia: From state to state.

Teacher: What about from one side of town to another—is that "moving"? . . .

Michelle: Yeah! Even from the same neighborhood, like Ron did this year. . . . My brother just went to college, I am in his room now with his TV. Wait! Is this "moving"?



Fifth graders collect data to determine which of two paper bridges is stronger.

Natasha and Keith tried to define a survey question about the number of states students had visited. As they tried out their question, they discovered that they did not have a clear idea of what they wanted to find out—or rather that the two of them had very different ideas about their purpose.

After some discussion, the group decided to ask, *How many times have you moved from house to house with all your belongings?* Later, the teacher asked the students to write in their math journals about what they had learned about developing questions for their surveys. Luke wrote, in part: "Because if the question wasn't clear, then the person might not have a clue what you are talking about or the person might say a different answer to the question than the answer you want." Luke's phrase, "the answer you want," is a reference back to the purpose of the study—the need to collect data that are relevant to what you want to know.

Natasha's and Luke's experiences show that the work that students do in developing their questions is not just about being "clear." A survey question might be limited so that it is clear and unambiguous, yet not result in data of much interest. As Natasha and Keith ran out of time or, perhaps, energy, they settled on a simpler question: *How many states have you ever set foot in?* However, Natasha was dissatisfied: the question would not result in the information she wanted. They were carrying out the assigned task but not creating the data that were of interest to Natasha; in Konold and Higgins's (2003) terms, the question had been "trivialized" and, therefore, the enterprise of data investigation itself had lost meaning for Natasha.

Teachers can help students with this balance between the clarity and manageability of a data collection method and the need for gathering data that are useful and relevant. They can do the following:

- Make sure students try out their data collection methods and refine them according to what they find out.
- Ask questions to help them clarify their questions.
- Help students to keep in mind their original questions and interests and to consider whether their data collection questions and methods are resulting in data that yield information about those original questions.

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The Earth Science by Design Program

Earth Science by Design brings *Understanding by Design* to Earth Science.

Developed by TERC and the American Geological Institute with funding from the National Science Foundation, ESBD is a year-long program of professional development for middle or high school teachers based on the Understanding by Design approach pioneered by Grant Wiggins and Jay McTighe. ESBD has been field-tested by staff developers in eight sites nationwide.

ESBD helps teachers:

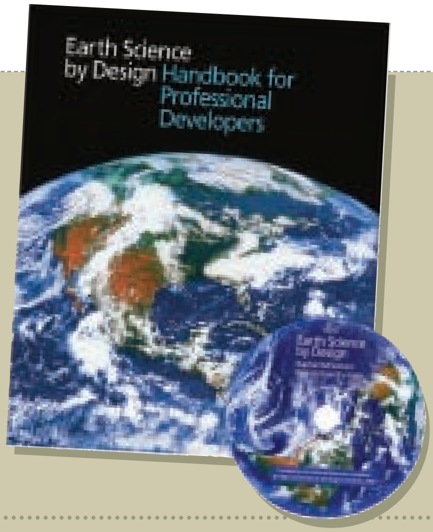
- Teach for deep and enduring understanding of the "big ideas" in Earth science
- Use "backward design" to create curriculum units and lessons that are engaging, rigorous, and aligned with national, state, and local standards
- Design effective classroom assessments and rubrics
- Incorporate powerful web-based Earth science visualizations and satellite imagery into an Earth system science approach

A Complete Professional Development Package for staff developers, including:

- The ESBD Handbook—everything you need to offer the program, including detailed workshop lesson plans
- The ESBD Web Site—where you can advertise your program, register your teachers, and where teachers can develop curriculum units online
- Online resources for Earth science teaching and learning
- PowerPoint presentations for workshops
- DVD video of teacher reflections

Workshops for teachers and leaders:

- TERC offers leadership workshops to support staff developers in the implementation of ESBD


Earth Science by Design Handbook for Professional Developers
Earth Science by Design

FIND OUT why teachers said:

"I will never teach the same way again."

"ESBD helped me become the teacher I thought I was."

"I have had a major paradigm shift...
I have been teaching for 25 years, and this is the most logical design I've seen."

For more information on workshops or to order your ESBD package contact:

Harold McWilliams
Principal Investigator and Project Director
harold_mcwilliams@terc.edu
617.873.9673

Design: Carol Maglitta one[visual]mind

which was relatively expensive. It also produced spectacular pedagogic material. An unforgettable example is *Frames of Reference*, which begins with one physicist upside down and the other right side up. The two argue about who is in each position. CHEM Study, a straightforward high school chemistry course, received $2.8M from NSF in the 1960s, (equivalent to $16.2M today) and ESS received $7.6M ($44M today).

Another difference in approach during that period was the concept that it was essential to produce multiple curricula and multiple approaches to pedagogy so that districts, schools and teachers would have choices. The NSF emphasized that it did not want to dictate either what should be taught or how it should be taught. Instead, it purposely supported a range of materials and methods.

Perhaps the greatest difference between then and now is that the materials were produced and used in school before the introduction of “standards” and the now ubiquitous high-stakes tests at many grade levels. The nation has moved from benchmarks, guidelines and frameworks published by professional organizations and sometimes states, to detailed written documents, couched in language that accommodates multiple-choice test questions. The documents become long lists of facts to learn or nebulous platitudes about science, and make both inquiry-based curriculum development and professional development difficult.

A Vision for Education

Starting 50 years ago the United States launched a major national effort to improve science education, to expand its scope among the school population, and to increase the quality of instruction, through both funding new curricula and supporting professional development for teachers. The high point of this effort was probably 40 years ago, when a dozen secondary school projects from astronomy to geography were available; middle school was rich in new programs ranging from social studies to earth science; and there were 8-10 elementary programs under development. Most of the individual programs no longer exist; they are out of date or simply weren’t strong enough to survive in the competitive world of textbook adoption.

What has survived and totally changed the landscape of science teaching is that, at least to some extent, science is taught at all levels. Even if science education is not universal or always taught as we wish it would be, at least there are districts that have demonstrated through years of experience that inquiry science, using materials and engaging children in meaningful activities that lead to richer and stronger understanding of science, is possible on a large scale in U.S. classrooms.

We need to incorporate these successes into our vision and consistently emphasize that while more science education can be good for the economy, it has a larger role to play in educating all children to learn to question, challenge and base decisions on evidence. We know that active science education can be part of school. It can be implemented and assessed on a national scale to lead to a more scientifically literate society and most important, can strengthen our democracy.

George Hein is president of TERC, george_hein@terc.edu.

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2. See Lee, G. C. (1961) *Crusade Against Ignorance: Thomas Jefferson on Education*, New York: Teachers College Press. 160-167.

3. Kurland, P. B., and R. Lerner (eds.) (1986) *The Founders’ Constitution*, chapter 18, document 35, Chicago: University of Chicago Press.

4. See, *Rising Above the Storm: Energizing and Employing America for a Brighter Economic Future* (2006), released by the NAS Committee on Prospering in the Global Economy of the 21st Century.

5. AAAS, (1961) Science teaching in elementary and junior high schools, *Science*, 133, No. 3469, (June 23, 1961) 2019-2022+2024.

6. Arthur Nelson was one of the illustrious staff that worked on the roof of Building 6 developing radar, one of the Lab’s major achievements.

7. For a detailed and very readable biography of this extraordinary man, see Goldstein, J. S. 1992. *A Different Sort of Time*, Cambridge, MA: MIT Press.

8. Quoted in Goldstein, p. 164-165. Goldstein points out that “Observation, Evidence, the Basis for Belief” were Zacharias’ mantra, “He always capitalized them, they were as fundamental to him as breathing.”

9. J. Zacharias, Research scholars and curriculum development, *ESI Quarterly Report*, Summer Fall 1965, p. 101-104, from an address to the Modern Language Association, NY, 12/29/64.

10. AAAS (1961) op. cit.

11. Eisenhower’s response to concerns about Sputnik was not to ask for massive military build up but to increase federal support for education including a five-fold increase in the NSF budget for educational activities. See Goldstein, pp. 170-171.

New Projects

Children and Science Tests

This project is studying children's performance on high stakes science tests by characterizing how the interpretive demands of test items interact with the diverse sense-making resources that children draw on in responding to them. It will shed light on test-taking itself as a situated practice and contribute to the development of a fuller science of assessment that serves the goal of equity. The project focuses on the science portion of the Grade 5 Massachusetts Comprehensive Assessment System (MCAS) and is a collaboration with schools in Boston and Cambridge, MA. *Funded by the National Science Foundation.*

Lesson Study for Successful Science Teaching

TERC is studying the extent to which special and general educators engaged in lesson study increase their knowledge of science content and learning disabilities, and apply new knowledge to improve teaching practice in inclusive science classrooms. TERC is examining correlations among teacher knowledge, classroom practice and student participation/achievement prior to and following the intervention. *Funded by the National Science Foundation.*

Lifelike Virtual Tutors to Support Authentic Learning, Phase II

This project is extending development of the 3D animated explanatory avatar to include delivery from a Mac platform, refinement of the Virtual Marble Roll, and its integration into the Catching Sunshine challenge. TERC is using the Authoring Tool developed by Vcom 3D to write and integrate avatar scripts into the challenge. *Funded by the National Science Foundation.*

Math in Zoos and Aquariums

TERC and the Phoenix Zoo are pioneering the infusion of mathematics into educational programs involving animals by providing professional development for staff. Visitors are seeing powerful applications of data and measurement as they study animal behavior. Workshops are already scheduled at over 15 zoos nationwide, with the aim of reaching 100 institutions. *Funded by the Institute of Museum and Library Services.*

Meeting the Challenges of Accountability in Mathematics and Science

TERC is creating a monograph to share vital lessons learned through the Using Data project. The paper will be disseminated to educators with responsibility for mathematics and science improvement. The monograph shows how schools involved with the Using Data project solve the very problem virtually every low-performing school is now facing—how to use data effectively to continuously improve student learning results. *Funded by the National Science Foundation.*

TERC
Mathematics & Science Education

Check out the new TERC website at www.terc.edu for more information about these projects

Model Chance

TERC is creating middle school curriculum materials to accompany probability modeling software, "Model Chance," currently under development. The project draws on the research and personnel of several current and recently completed projects that have been researching how students reason and learn about probability through a modeling approach. This project expands the possibilities for both what and how students learn probability and random-based processes by making computer modeling a central rather than peripheral part of instruction in probability. *Funded by the National Science Foundation though the University of Massachusetts, Amherst.*

Researching Science in the Wireless High School

TERC is conducting a study of science teaching in high schools that are pioneers in the implementation of ubiquitous computing environments. The study is examining the values added to science teaching and learning by new technology environments, the role of school culture in shaping these innovations, and the challenges that schools and teachers face when integrating new electronic tools. The study is designed to rapidly provide schools with usable knowledge regarding technology implementation, integration with content, and classroom infusion. *Funded by the National Science Foundation.*

Signing Science Dictionary Project

TERC, in collaboration with Vcom3D, is creating and evaluating a second volume of a 3-D interactive sign language dictionary to support understanding of standards-based science content among elementary and middle-grade students who are hearing impaired and whose first language is sign. The project is building on the interface, vocabulary, and findings from development of Volume 1 of the dictionary to create a robust Volume 2 containing approximately 1500 words that will be delivered via CD-ROM and run with and without an Internet connection. To access the prototype dictionary, visit the Signing Science website at signsci.terc.edu. *Funded by the NEC Foundation of America, National Science Foundation, and US Department of Education.*

Teachers Investigating Adult Numeracy (Project TIAN)

The Adult Numeracy project at TERC is building on recent work by developing and testing an approach to in-service professional development with math teachers whose students are in adult education programs. The project goals are to increase and deepen the content knowledge and instructional skills of mathematics teachers who work with adults in adult basic education, pre-GED and GED classes, and to support teachers' alignment of their practice to state standards. *Funded by the National Science Foundation through the University of Tennessee.*

Windows on Earth

This project is conducting research and creating a museum exhibit. The centerpiece is the "Earth Window"—a dynamic, interactive display of Earth as seen from the International Space Station. The images are computer-generated from a database, creating photo-realistic views displayed on a high-definition screen. TERC is working with several museums to integrate the Earth Window into existing Earth science exhibits. TERC is also creating a web site for large-scale access to this Earth exploration experience. *Funded by the National Science Foundation.*

EARTH EXPLORATION TOOLBOOK

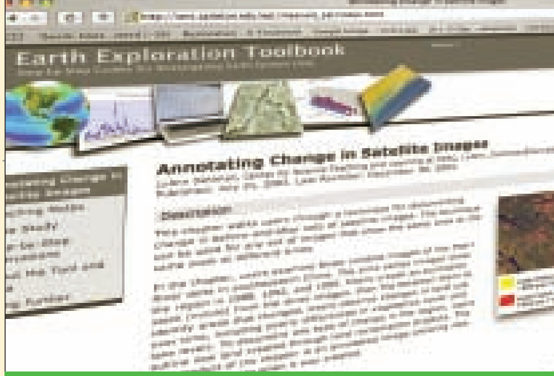
The following projects relate to the Earth Exploration Toolbook (EET, http://serc.carleton.edu/eet), an online resource for teachers and students. It is a collection of computer-based learning activities discoverable in the National Science Digital Library (NSDL) and the Digital Library for Earth System Education (DLESE). Each activity or chapter in the EET provides step-by-step instructions for accessing specific data and analyzing it with a software analysis tool to explore issues or concepts in science, technology, and mathematics. EET chapters use a variety of technology tools, including geographic information systems (GIS), image processing programs, spreadsheet applications, and others.

Earth Exploration Toolbook Workshops

The use of Earth science data by students is facilitated through Earth Exploration Toolbook (EET) Data Analysis Workshops, a four-hour two-part professional development telecon-online workshop series for teachers. In the first workshop teachers are walked through an EET chapter and in a follow-up workshop these teachers share how they used these materials with their students. These workshops are conducted via a teleconference and on the internet simultaneously, and each pair focuses on a different EET chapter which features a specific dataset and analysis tool. *Funded by the National Science Foundation.*

Enhancing Use of Data in Education

TERC is expanding the work of the DLESE Data Services project through an annual workshop that brings together members of scientific and educational communities to develop educational modules using Earth science data and data analysis tools. Participants form teams, each with a data provider, tool specialist, scientist, curriculum developer, and educator. The work of these teams leads to the development of an Earth Exploration Toolbook chapter. *Funded by the National Science Foundation.*


Earth Exploration Toolbook
Annotating Change in Satellite Images

Find resources from the Earth Exploration Toolbook at serc.carleton.edu/eet

Tools for Data Analysis in the Middle School Classroom

The DataTools project helps middle school science teachers and students use Earth system science data, and the IT tools needed to analyze and draw conclusions from the data. The program includes a two-week summer workshop and year-long support through online discussions, teleconferences, and two one-day meetings. The project will result in customized data-rich activities linked with the EET chapters. *Funded by the National Science Foundation.*

Workshop on Data Access for Education

TERC led a workshop to refine the recommendations of the task forces of the Data Access Working Group (DAWG) on the following topics: 1. Envisioning an Intellectual Commons/Development Area in an educational digital library with respect to data resources, 2. Defining review criteria for datasets/datasites for acceptance into an educational digital library, 3. Defining educational metadata for datasets/datasites that will be cataloged in an educational digital library. *Funded by the National Science Foundation.*

new projects continued

EVALUATION

The following projects are headed by members of TERC's Evaluation Group. The group builds on its members' collective research strengths in mathematics, science, engineering, and technology to provide evaluations and consultation for organizations with existing grants and programs, and to collaborate with proposal writing teams to design evaluations.

Equity Achievement Analysis

TERC is analyzing data about student achievement and class, gender and race/ethnicity for the Berkshire Hills Regional School District. *Funded by the Berkshire Hills Regional School District.*

Evaluation of the National Biotechnology Teacher-Leader Program

TERC designed and implemented a summative evaluation for the 2005 Teacher-Leader program and is continuing to evaluate the program in 2006 on participants' classroom practice and outreach training of other educators. Participants include secondary school teachers, and two and four year college faculty. TERC is collecting data about changes in teacher knowledge of biotechnology concepts and lab techniques as well as biotechnology curricular integration and its impact on student exposure and learning of biotechnology. *Funded by the National Biotechnology Institute.*

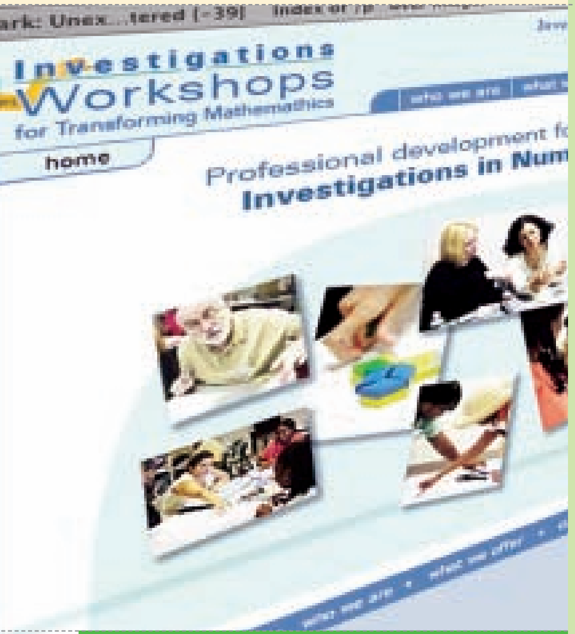
Evaluation of the BioTeach Program

TERC is designing and implementing a multi-year evaluation study for the BioTeach Program. Formative evaluation will focus on the effectiveness of professional development workshops and the extent to which schools, teachers, and counselors are implementing their BioTeach grants (e.g., incorporating materials and lab activities). Summative evaluation is focused on changes in teacher efficacy and knowledge of biotechnology, school support for biotechnology teaching, and attitudes of teachers and students toward biotechnology. Students' levels of participation in biotechnology schoolwork, internships, and college enrollment are being followed. *Funded by the US Department of Labor through the Massachusetts Biotechnology Education Foundation.*

Fantasy Sports Games As Cultures for Informal Learning

TERC is evaluating the Fantasy Sports project at Pennsylvania State University. The project is studying the decision-making strategies used by fantasy sports players, with focus on informal mathematical practices. The evaluation will be used to inform the design of a fantasy sports system that provides explicit support for decision-making with mathematical evidence. The goal is to enhance everyday mathematical practices of African American and Latino adolescent players by augmenting existing activities with tools for reflection and data analysis. *Funded by the National Science Foundation through Pennsylvania State University.*

Get Involved



Find detailed descriptions of Investigations Workshops at investigations-workshops.terc.edu

← Investigations Workshops for Transforming Mathematics

We offer the following professional development workshops, each supporting the implementation of the K-5 *Investigations in Number, Data and Space* math curriculum: Investigations in the Classroom, Building Computational Fluency, Exploring Geometry, and Leadership Workshop. For detailed information and workshop availability, see investigations-workshops.terc.edu. Contact: Peter Swanson, peter_swanson@terc.edu.

Lifelike Virtual Tutors to Support Authentic Learning

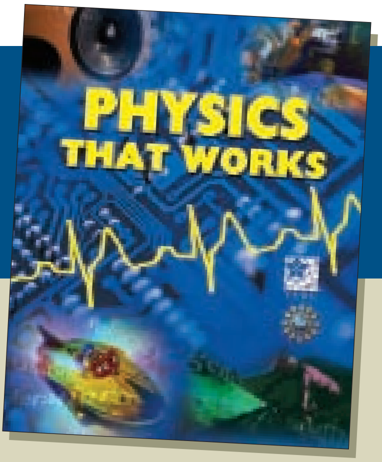
Teachers of students in grades 4-8 are needed to pilot test a web-delivered Virtual Reality simulation that incorporates lifelike virtual tutors capable of communicating in written or spoken English or sign language into the Marble Roll—an Online Scienceathon challenge. For more information, contact judy_vesel@terc.edu.

Signing Science

Teachers of deaf or hard-of-hearing elementary and middle-grades students are needed to pilot test an interactive 3D sign language dictionary. The dictionary is designed to provide students whose first language is sign access to science material delivered on the web, via electronic media, and in hard copy. Additionally, it is designed to offer teachers and parents a library of recognized signs for discussing scientific ideas with students. For more information, contact judy_vesel@terc.edu.

PHYSICS THAT WORKS

A full-year high school curriculum



Bring physics to life with Physics That Works, a full-year high school curriculum that introduces students to physics as they tackle workplace-related projects—designing, building, and testing everyday objects.

STUDENTS WILL:

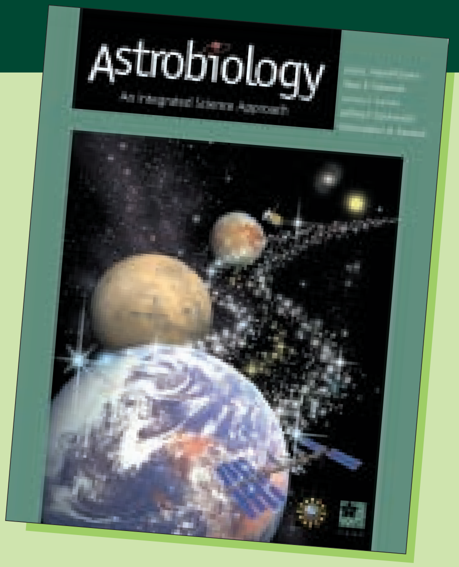
- Design and construct a motion toy, and analyze consumer expectations in preparation for release to the marketplace.
- Design and conduct performance tests for all-terrain vehicle tire treads.
- Construct an electrical circuit similar to the one that controls a portable defibrillator, the device that restores an erratically beating heart to normal rhythm.
- Improve the function of a generator-powered bike light.
- Build and operate a transmitter and receiver to "broadcast" a series of notes from an instrument, which students also construct.

Published by Kendall/Hunt.

Find more information at www.kendallhunt.com

ASTROBIOLOGY:

An Integrated Science Approach



TERC introduces a full-year, integrated science curriculum coinciding with NASA's recent missions to find life beyond our planet. The inquiry-based course combines biology, chemistry, Earth and space science, and physics and leads students to explore intriguing questions around the origin, search for, and future of life in the universe. Features include:

- 600-page full-color Student Guide
- Deep collection of teacher resources and technological tools
- Teacher's Guide designed for instructors unfamiliar with teaching integrated science courses
- Web site with resources and links used within the curriculum

Published by It's About Time.

For information see www.its-about-time.com/htmls/astro/astro.html

Using Data

Is Getting Results

How can schools use test data constructively to guide school improvement? For help, many districts are making large investments in hardware and software that simplify the process of disaggregating test scores by categories, but these programs still cannot identify the reasons for low student achievement. **To make good use of data, districts must invest in people. School staff need skills in analyzing data to improve student learning.**

With the Using Data Program developed at TERC, districts are investing in people and seeing results. The program helps teachers and administrators work collaboratively to investigate problems, look for solutions, take action, and monitor change. Educators take collective responsibility for student learning and embrace and test out solutions together through rigorous use of data and reflective dialogue.

The Using Data Program is being implemented in large districts across the country, including Canton City, Ohio, Johnson County, Tennessee, Las Vegas, Nevada, and San Diego, California, and through service districts in Arizona, Kansas, Missouri, Oregon, South Dakota, and West Virginia.

(above) Teachers identify the learning problem from the data they have collected; (right) Diana Nunnaley, Using Data Program Director, leads a group of data facilitators

Districts implementing the program are demonstrating greater engagement in data-driven decision-making and measurable improvements in student outcomes. For example,

CANTON CITY, OHIO has seen marked improvement in their mathematics achievement scores. During a three year period the students scoring proficient or above on the Ohio Graduation Test increased by 22%.

During a similar period, JOHNSON COUNTY, TENNESSEE saw improvement in mathematics and science for grades 3-6. In mathematics, the number of students with disabilities scoring proficient or advanced increased by 38%.

If you would like to learn more about the Using Data Program contact Diana Nunnaley at TERC, diana_nunnaley@terc.edu.

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