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The New Face of Teacher Education
It has been five years since ASTC Dimensions last looked in-depth at teacher education programs in science centers and museums. Since then, the No Child Left Behind legislation has altered the formal education landscape in the United States, and formal-informal collaborations have changed elsewhere as well. We asked museum educators to tell us how their professional development programs for teachers have changed and how science centers are maintaining the commitment to inquiry-based education in the face of new expectations from public funders. This issue represents a sampling of their responses.

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Cover: As U.S. educators face a dual demand for improved student performance and “high quality” teacher certification status, science centers are stepping in with new professional development programs and partnerships. Photos, clockwise from lower left, the Inquiry Learning Partnership at the Fleet Inquiry Institute (photo by Colleen Pelak); the Huntington Botanical Gardens’ Grounding in Botany program (photo by Mike Kerkman); the Museum of Science, Boston’s Engineering is Elementary program (photo by Andrew Brilliant/brilliantpictures.com); and Chesapeake Bay Ecology, a graduate-level course offered by the Virginia Living Museum (photo courtesy VLM).
When Schools Meet Museums: Finding a Third Way

By Bronwyn Bevan

Let’s assume that you, the reader, already believe that informal science institutions (ISIs) can be powerful centers of science learning expertise, resources, and experience in their communities. You know that visitors to science museums, zoos, aquariums, and the like can see, touch, explore, and imagine aspects of the natural world that often remain invisible, unnoticed, or inaccessible in people’s everyday lives. You know that ISIs draw on their spatial, temporal, textural, and material qualities to build a visitor’s sense of the connectedness, historicity, relevance, and salience of science, in ways that many other learning settings cannot.

Visitors often say to ISI staff: Why wasn’t science taught like this in school? That makes us nod and smile, or maybe shrug and smile. We informal educators have often been drawn to work in informal settings precisely because of these unique qualities—because of distinctions between the way science is taught and experienced in schools and the way we believe it is experienced in the real world.

That’s fine. But there is something else we know: ISIs, as places, as pedagogies, and as resources, are not accessed equitably. For the most part, our audiences are white, middle class, and college educated—populations that already actively seek and secure the resources they need to further their own learning and to create more seamless developmental environments for their children.

Many ISIs undertake special efforts and programs to expand their reach to new audiences, especially to community groups that have been historically underrepresented in the sciences. But by almost any measure, these efforts seem to have little overall impact on the demographics of our institutions’ regular visiting audiences, much less on expanding participation in science fields and studies.

Natural and best partners

At the Center for Informal Learning and Schools (CILS), we believe that ISIs can contribute significantly to strengthening and diversifying participation in science. And we believe that schools are the natural, and perhaps the best, partners for any serious ISI efforts in this regard.

Schools are the key democratic institution in every community, working across all socioeconomic lines. While ISIs bring to the table ways of making science accessible, collaborative, tangible, and joyful, schools bring to the table ways of conceptualizing science as a coherent and systematic set of practices and ideas. Museums and schools need each other—and our colleagues in afterschool programs—to create the coherent learning environment essential for initiating and sustaining engagement with science.

CILS sees the key constituency of classroom teachers as the linchpin for such collaborations. Teachers have much to teach us about our communities, about our children, and about being accountable for teaching practices. At the same time, ISIs have much to offer teachers, notably (a) strategies and resources for engaging and sustaining student interest in science and (b) science-rich professional communities that can nourish and sustain teachers themselves. Working together, informal and formal educators can expand their repertoires of practice so that science learning, across multiple settings, becomes more engaging and coherent for more children.

It is past time to move beyond the either/or proposition that seems to dog the ISI discourse about working with schools, or about ISIs’ role in expanding participation in science. There is a “third way” to be found in thoughtful collaborations between informal science institutions and schools. So what do such collaborations look like?

Across institutional fields

Since 2002, CILS has been researching the nature of learning in informal settings, including ISI collaborations with schools. A 2005 CILS survey of the field, led by Doreen Finkelstein, found that 75 percent of U.S. ISIs provided programs for schools beyond the basic field trip. Extrapolating from that data, we found that ISIs provide programs to 62 percent of schools across the country. ISI programs include teacher development (59 percent), curriculum and kits for the classroom (42 percent), and student direct service programs (65 percent).

A 2006 study of ISI-based teacher professional development programs, led by CILS researcher Michelle Phillips and CILS doctoral student Saundra Weyer-Frerichs, found that


2. CILS, ISIs and Schools: A Landscape Study, 2005.

3. By contrast, another study that CILS is conducting with Harvard’s Program in Education, Afterschool & Resiliency (PEAR) and others found that ISIs partner with just 13 percent of after-school programs.
For almost 25 years, the Exploratorium Teacher Institute (TI) has provided ongoing teacher professional development to a community of more than 2,000 middle and high school science teachers. The primary focus of TI programs has been to strengthen content knowledge and pedagogy. But in 2004, science teachers came to us with a new and pressing problem: how to meet mandates of the federal government’s No Child Left Behind (NCLB) legislation that require them to demonstrate subject-matter competence.

According to NCLB, teachers must have formal college training in the subjects they teach, or they must show that they possess the requisite content knowledge for those subjects.

However, in California, because of teacher shortages throughout the state, science teachers are often forced to teach outside their fields. High school chemistry teachers, for example, may be assigned earth science classes, and biologists are sometimes expected to teach high school physics. The greatest challenge this poses is for middle school science teachers; the science curriculum for grades 6–8 is multidisciplinary, so these educators must have competence in several disciplines.

NCLB subject-matter competence can be demonstrated in two ways in our state: by completing a bachelor’s degree (or equivalent) in all science disciplines taught, or by passing the California Subject Examination for Teachers (CSET) in science, an exam that covers a broad range of science content areas in great depth.

Clearly, the most efficient way to meet the mandates is to pass the CSET. But many California science teachers, lacking support, had been “going it alone” and consequently not passing the test. At the request of the teachers’ community, TI designed a program that would strengthen science content and develop teaching practices at the same time.

For teachers preparing to take the CSET, the Exploratorium NCLB Teacher Support Program provides two options: an eight-week CSET Test Prep Seminar that meets once a week during the academic year, or an intensive CSET Test Prep Summer Workshop that meets daily for two weeks in the summer. In both, museum scientists and staff science educators facilitate hands-on, inquiry-rich activities designed to improve teacher content knowledge.

The program uses museum exhibits to teach especially challenging science content, helping to make abstract concepts more concrete. Sessions include time for teachers to answer sample CSET questions and then discuss their answers with peers and museum staff. Teachers also work in small tutorial groups led by museum scientists, focusing on content areas they have identified as particularly challenging. One recent group chose to meet with a biologist to study evolution; another chose to discuss force and motion with a physicist.

To date, 60 middle and high school science teachers have completed either a CSET seminar or a CSET summer course. Evaluations reveal that participants find the program “extremely valuable” in improving their own science knowledge, while simultaneously providing them with strategies for teaching content to students. Being able to discuss science content with museum scientists, staff science educators, and peers was identified as critical to the program’s success. The opportunity to explore exhibits and engage in classroom learning activities was also key.

But the real proof of the project lies in participants’ CSET scores. Of the approximately 20 teachers thus far who have taken the exam and received their scores, 18 are now qualified to teach under NCLB.

Linda Shore is director of the Exploratorium Teacher Institute, San Francisco, California; www.exploratorium.edu/ti.
undergo change themselves to effect change in the way that science is experienced in their communities.

Building on the research literature on partnerships, and using ISI-school partnership criteria emerging from the 2009 study, we are examining three robust ISI-district partnerships. Our preliminary findings indicate that these three have the following characteristics in common:

• shared long-term goals pertaining to transformation of science teaching and learning in their communities
• use of research-based approaches that draw on the affordances of both ISIs and schools, including experiential learning, distributed expertise, everyday science, and interplay between content and process
• strong and evolving personal relationships among ISI and school leaders
• clear, beneficial outcomes to each partner
• ongoing assessment related to the institutional goals of both partners.

We intend to apply this rubric to the ISI-school relationships reported in 2005 to test whether it can explain strong or weak collaborations across the field.

Supporting ISI educators

Establishing any partnership or collaboration (much less a transformative one) is not straightforward. Strong vision, leadership, and boundary-spanning skills are essential on the part of the ISI educators who take on this work. Yet there is today little to no professional training available to prepare informal educators for working with schools.

Although some call for the establishment of professional preparation programs for informal educators, I think this is a mistake. Our field values and benefits from a level of informality, serendipity, and eclecticism that formal

6. They are the Urban Advantage program at the American Museum of Natural History, the Youth Exploring Science (YES) program at the Saint Louis Science Center, and the Exploratorium Teacher Institute. (For more on TI, see page 4.)

Partners for a New Era: The Challenge of NCLB Funding

By Colleen Pelak

The task: Given two metal cans (each filled with 35°C Celsius water) and 15 minutes, maintain the temperature of the water in one can at 35°C while raising the temperature of the water in the other can to the highest possible degree.

The rules: You must record the temperature of the water in each can every 3 minutes for the length of the experiment. You may not remove the water from the cans, nor may you add anything that will change its chemical composition. Finally, you must detail the mechanisms of heat active throughout the investigation.

Faces with this challenge, what would you do? What materials would you use? What science concepts would you draw on? What language arts and math skills would you need to fulfill the requirements?

The description above is an actual task given to a group of elementary and middle school teachers during a workshop on heat at the Reuben H. Fleet Science Center in San Diego, California. The workshop is part of a new undertaking by the science center’s teacher professional development arm, the Fleet Inquiry Institute (FI).

Inquiry meets mandates

Conceived in 2001 and modeled, in part, after the Institute for Inquiry at the Exploratorium, FI strives to increase students’ understanding of science by expanding teachers’ knowledge of and comfort with inquiry-based instruction. Through intensive workshops and follow-up support, FI assists teachers with the implementation of inquiry in their classrooms.

During the institute’s first three years, FI staff worked with teachers from multiple school districts around San Diego County. Funding came from Improving Teacher Quality, a state grants program. The science center was the lead investigator, and district administrators had limited input.

As this cycle of funding came to a close, we sought new avenues of support. One prospect, the California Math and Science Partnership (CaMSP), looked intriguing. The Request for Applications promised “intensive work, a strong capital investor, and the potential for high returns.” Unfortunately, the not-so-small print revealed an obstacle that might thwart our plan: CaMSP is funded by NCLB Title II, Part B.

For many informal—and even formal—science educators, NCLB (No Child Left Behind) is a dirty word. Isn’t this the U.S. federal legislation that seems to place test scores before authentic learning? Was there any way an informal center for learning could accept NCLB funding? After careful consideration, the science center’s answer was “yes.”

There is no doubt that participating in an NCLB program has challenged FI and changed the way we do business. Yet on closer examination, we believe that the essence of our work has remained true to itself and has even strengthened through our partnership.

The challenges of NCLB...

There were, of course, a few obstacles to overcome—starting with the application process. As a museum, the Fleet could not apply for MSP funding by itself. These projects require the collaboration of a (Continued on next page)
(Continued from page 5) “high-need Local Education Agency” and an “Institute of Higher Education.” We canvassed the region to find formal education agencies willing to act as equal partners with a science center.

Two local school districts—Chula Vista Elementary and Lemon Grove—and the University of San Diego (USD) signed on; together, we applied for and won funding for a CaMSP professional development collaboration, the Inquiry Learning Partnership (ILP).

The next challenge in working with NCLB is that funded programs are subject to high levels of assessment and accountability. In ILP, we must measure not only the impact of our professional development on teachers but also its subsequent effect on students’ academic performance. To meet these expectations, we added an external evaluator to the team.

A third major impact of NCLB is summarized in the words “standards-based.” As a center for informal learning, FII had always been cognizant of teachers’ need to teach content standards, but remained flexible within this constraint. The new mandate has made us work harder and more creatively to meet teachers’ requirements while upholding the nature and mission of our institution.

...and the benefits

Ironically, some of the very things that challenge us most under NCLB have also proved to strengthen the work we do with teachers. The increased level of collaboration has brought FII recognition from the formal sector as an equal partner in learning and teaching. Teachers in ILP are eligible to receive credit and tuition reduction toward a graduate degree at USD, and 25 of 115 participants have pursued this option.

Each of the ILP partners brings a variety of experiences, knowledge, and perspectives to the program. We commonly share resources, including content specialists, pedagogy, data, and research. The insights available to all partners are immeasurable.

Before NCLB, FII never had a way to fully articulate and prove the impact of its work with teachers. Now as we gather evidence for the effectiveness of our work, our heightened awareness of our program’s strengths and weaknesses improves our ability to serve constituents. It also gives us the means to prove our capacity to future investors or participants.

The major objective of FII’s professional development program has always been to support teachers in their role as facilitators of learning. By modeling the use of inquiry with the very concepts teachers are responsible to teach, we help them gain the confidence to integrate this pedagogy into all areas of instruction. And by providing intensive in-classroom coaching, we can assure that teachers are not left alone to incorporate new methods into classroom curricula. Rather, they can collaborate with FII staff and their grade-level teams to implement—and document—the effect of inquiry-based instruction in the classroom.

Looking forward

In July 2006, our ILP project was re-funded by CaMSP to continue our work with the 2005–2006 cohort of teachers. This will allow us to measure the impact of long-term professional development on both teachers and students. Ultimately, we hope to extend the program to all educators in the two school districts.

An article like this can touch on only a few of the advantages and disadvantages of working within the NCLB system. If your institution is considering a similar venture, our advice to you is to do your research and be prepared for a few scrapes and bruises along the way. The rewards will be worth it.

A final note: If you were hoping to find a solution to the water-heating task here, you will be disappointed. This is inquiry after all—and your professional development activities will need to reflect the needs of your teachers. Our exercise is just one example of how an inquiry approach can be standards-based and cross-curricular (physics, language arts, and math) without losing sight of what we as centers of informal education do best—inspire interest in, and enthusiasm for, the process of science.

Colleen Pelak is Fleet Inquiry Institute project director at the Reuben H. Fleet Science Center, San Diego, California; www.rhfleet.org/site/education/ilp.html.

What the CILS data seem to show is that investing in staff who can build effective school partnerships helps to create the conditions in which our institutions can thrive. Such partnerships help us to meet our missions of expanding popular interest and participation in science, they correlate to institutional growth, and they can transform our institutions from relatively rarefied cultural icons to equitable and essential resources for our communities.

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Building Teacher Leaders:
The Da Vinci Fellows Program

By Dave Smith and Tara Broczkowski

There’s a hubbub in one of the classrooms of an urban school. Teams of fourth grade students cluster around a plastic box, animatedly devising plans to get its occupant, a single goldfish, to navigate a four-turn maze. The teacher asks questions and gives encouragement, helping the kids stay on task.

Few would notice that there’s also a visitor in the classroom. Sitting at a desk, trying to be as inconspicuous as possible, is one of the present authors (Smith). As teacher Mark McDermott and his students conduct their investigations, Smith observes and records.

What’s going on here? Where did that fish come from? The exciting lesson plan—and its trainable fish—are the original work of McDermott, a fourth grade teacher at Jefferson Elementary School and one of 67 Fellows currently enrolled in the Da Vinci Teacher Leader Institute (DVI), in Allentown, Pennsylvania.

Smith is director of professional development for the institute, which is based at the Da Vinci Discovery Center of Science and Technology. Later, he and McDermott will discuss his observations of the fish activity.

A plan is born

DVI was founded in 2004 with the aim of both improving teaching and creating a culture of reflection and study in schools across eastern Pennsylvania’s Lehigh Valley. The three-year program, which will graduate its first cohort of Fellows this year, arose out of conversations between local school districts and the science center about district needs for science education. A core group of regional districts—Allentown, Bangor Area, Bethlehem Area, Easton, and Nazareth, along with schools of the (Roman Catholic) Diocese of Allentown—developed the plan. It includes not only sustained professional development for K–6 teachers but also leadership training that prepares the Fellows to share what they’ve learned with colleagues at their schools. Other local partners include Cedar Crest College and Lehigh University.

The goal of DVI is threefold: to deepen Fellows’ understanding of core content in science, to enhance their use of inquiry, and to develop their ability to lead peer study groups in their own schools aimed at improving science teaching and increasing student achievement in science. Each of the three years focuses on a different content area—physical, life, or earth sciences.

The choice of school-based teacher study groups as a model for leadership and dissemination was influenced by research from the Merck Institute for Science Education (which also graciously assisted in DVI planning) and from the Inquiry Institute and the Center for Informal Learning in Schools (CILS) at San Francisco’s Exploratorium. To establish DVI, private and corporate donations to the science center were combined with a Title II, Part B Math & Science Partnership (MSP) grant to the Allentown School District from the Pennsylvania Department of Education.

In August 2004, 44 teachers, the first Da Vinci Fellows, gathered for an intensive workshop on the physical sciences. DVI was under way.

The leadership training process

Fellowships start in the summer, with a two-week content intensive taught by university science professors, exemplary elementary school teachers, and science center staff. During the school year, three days of additional workshops led by DVI staff help Fellows translate what they have learned into their own practice and support them as they develop study groups in their schools. But an even larger part of the program’s influence on teachers results from personal interactions of DVI staff with Fellows at their schools, either individually or in small groups.

One of the authors (Broczkowski) is an experienced science teacher and teacher educator who conducts most of the mentoring and observation of
Fellows for the project. She consults with the teachers before and after the observations, allowing them to discuss candidly the challenges they experience in teaching science. These discussions often lead to significant changes in the way teachers select content, choose from various inquiry-based strategies, and manage their time and equipment.

A common challenge faced by K-6 teachers is how to find time to teach science during a school day primarily occupied with the teaching of other subjects, such as math, reading, and writing. DVI staff have worked with Fellows to identify inquiry activities that integrate science across the curriculum, increasing their use of science learning centers, student writing journals, and projects that partner with district learning specialists.

Each Fellow commits to engage at least three teacher colleagues in improving science education at their school. Fellows convene and lead these peers in small study groups that identify a question for further research and implementation. DVI staff meet with these groups early in the school year and facilitate their formulation of goals, objectives, and plans.

In past years, many peer groups have chosen to study the implementation of science notebooks in the classroom. In one school, the implementation of science notebooks became a school-wide project under the leadership of a team of Fellows. The teachers shared their successes and challenges with their study groups as they grew in confidence with the new strategy.

In addition to mentoring, DVI staff may help teachers to assemble scientific equipment, design activities, plan field trips, and engage students in more authentic science experiences. They have even lent a hand as students chased insects in the playground, collected weather data with a handheld computer, or made fish prints using a paint-covered red snapper.

DVI Fellows and peer group members are entitled to bring their classes free to the Da Vinci Discovery Center to explore hands-on exhibits and engage in classroom inquiry lessons like “Forensic Adventure,” where students solve a “crime” with the help of chromatography and fingerprint analysis. Teachers may also schedule a Visiting Scientist outreach program for their school. Over time, all of these activities serve to reinforce relationships with teachers and to create relationships with students who understand that scientific work is fun and important.

**Evaluation and outcomes**

Data collection and evaluation are an essential part of the program. An external evaluator, Comfort Consults, LLC, regularly (Continued on page 10)
The 1996 National Science Education Standards (NSES), published by the National Research Council, state that inquiry-based teaching methods should be the primary way in which science is taught in the United States. But for science teachers, fostering the use of these methods has been a challenge.1

In 2002, COSI Columbus began a professional development program, Inquiry Learning for Schools (ILS), to help foster the skills that teachers need in order to do science by inquiry. This article reflects some lessons learned from participating teachers and staff during the first year of that program.

ILS was a collaborative effort between COSI, the Science & Mathematics Network, the Ohio State University–Newark, and 13 underfunded and underserved school districts in urban, suburban, and rural parts of the state. Support came from the U.S. Department of Education, Battelle, and the Ohio Department of Education. The yearlong program immersed teachers of grades 4–8 in inquiry-based science and provided them an opportunity to bring students to the science center on a field trip.

Start-up lessons

As defined by NSES, inquiry “is a set of interrelated processes by which scientists and students pose questions about the natural world and investigate phenomena.” But what does that look like in classrooms? It soon became apparent that each partner had a different answer to that question.

After much conversation, we came up with a definition everyone could support. Inquiry, we said, is a process in which (1) students investigate a question of their choosing, designing procedures, drawing conclusions, and communicating their results; (2) teachers are facilitators, posing questions that lead to deeper understanding; and (3) a flexible and risk-free environment promotes active, engaged learning.

Each school district assigned us one contact person, the “district liaison,” who would be the conduit for information between the ILS partners. The liaison would send out flyers and applications created by COSI to grade 4–8 teachers within that district, collect completed applications, and provide input on applicants.

An early lesson learned was that, in large districts, more than one liaison may be needed. For year two of ILS, we selected a small group of first-year participants to become “mentors.” (Larger districts had as many as six.)

Mentors’ duties included advising ILS on potential science topics and lessons and informing us of calendar conflicts, as well as communicating with teachers in the district.

Exploring content and skills

Like many teacher education programs, ILS began with an introductory, four-day summer experience. The plan was for participants to review familiar science content or learn new content via inquiry-based methodologies ILS had developed. The teachers told us right away that this one-size approach would not fit all. Different science topics are taught in grades 4–8, and high-stakes testing means that educators are strongly focused on their own curricula.

The solution was to break the teachers into small groups by grade level and assign them appropriate unit tasks based on Ohio’s science content standards for that grade. When we were building roller coasters, for example, fourth grade teachers wrote directions to explain how the coaster was created, while seventh grade teachers identified the greatest potential and kinetic energy and described the other energy transformations that occur.

In addition to inquiry, we featured activities that illustrate and identify science process skills, such as observation and inference. Because these skills are the foundation for science, it is critical for students to master them before conducting inquiry investigations. And because skills lessons have a range of applications, teachers can use them in the classroom right away.

Anecdotal data from educators led us to believe that their chief barriers to inquiry are time, supplies, and behav-

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ior issues. We couldn’t add hours to the day, but we could demonstrate how to prepare effectively for inquiry science lessons and how to manage supplies and students.

We set up an activity in which they were to use a variety of materials to build a device for capturing gas. Initially, we provided broken equipment, unlabeled substances, and little direction. After a few minutes of chaos, we stopped the lesson. Participants shared their frustrations and then generated a list of effective classroom management guidelines to use with students.

**Increasing confidence**

During the summer session, teachers got to know the museum well. ILS staff staged private shows for them and demonstrations with Q&A sessions. They visited exhibit areas with staff, exploring the exhibits as they might encourage students to do on field trips. Teachers told us they valued these opportunities highly.

During the school year, teachers returned to the museum three times. Inquiry methods were modeled and reinforced as they worked on specific science content. Last fall, for example, they explored Light and Shadow, an Exploratorium lesson, and experienced “open” (student-initiated) inquiry.

Science inquiry is exciting, but it involves taking risks. In the first year of ILS, we learned that teachers need to be comfortable with a group before they are willing to take those risks. Many ILS participants had taught for years and believed they must know all the answers; it was hard for them to admit they didn’t know everything. By working with the same group at COSI throughout the year, we increased their comfort level with inquiry-based teaching methods and reinforced what they had done in the summer.

**Documenting change**

Both before and after the ILS program, teachers were asked to rank, on a scale of 1 (Not at all) to 5 (Completely), their own preparedness for teaching science. Results showed that their confidence levels and attitudes about teaching science were positively influenced by the program. Rankings for “Teach science through inquiry,” for example, rose from 2.50 pre-ILS to 3.15 after, and for “Provide science instruction that meets district, state, or national standards,” from 2.79 to 3.10. Post-ILS teachers also indicated that they felt significantly more prepared to conduct activities that would lead to inquiry-based science teaching.

Teachers also rated how much their teaching had changed as a result of participating in ILS. All (100 percent) reported some change in their teaching, with 12 percent reporting that their teaching had “completely changed” and 49 percent reporting it had “changed a great deal.” Post-ILS teachers, significantly more than non-ILS peers, said they had made use of hands-on activities, calculators/computers, assignments that had students consider real-world science problems, and activities that had students design and conduct their own investigations.

Just as satisfying were the personal stories. One district science supervisor wrote us about a teacher who enrolled in ILS after learning that she would be required to teach all of the fourth grade science in her building: “When the students took the state proficiency test, her students’ scores improved by more than 40 percentage points.”

A fourth grade teacher whose 45 students included 10 special education students reported that 35 of them had tested “proficient” (including some of the IEP students) on the state science test and 11 were “advanced proficient.” But even better, this participant added, was that “at the beginning of the year my students indicated on a survey that they did not like science. At the end of the year, they responded with comments like ‘We need to do more science in school,’ or ‘We should do science all day in school.’ Hip-hip-hooray for inquiry!”

*Mary Ann Wojton is senior director of teacher programs at COSI Columbus, Columbus, Ohio.*

(Continued from page 8) observes DVI’s professional development staff, Fellows, study group peers, and nonparticipating teachers, using the University of Arizona’s Reform Teaching Observation Protocol (RTOP).

DVI administers conceptual tests to Fellows, peers, and nonparticipating teachers at the beginning and end of the summer intensive and the end of the school year. We collect multiple measures of student achievement from teachers, including common assignments and student notebook entries. These data show that DVI Fellows experience and maintain statistically significant content gains (19 percent gain in physical science, 11 percent in life science), and that peers in study groups also show a significant gain (11 percent gain in life science). RTOP data reveals that Fellows engage in roughly double the level of inquiry teaching behaviors that nonparticipating teachers employ (average score: 80 percent for Fellows, 39 percent for nonparticipating).

Fellows report that their confidence in conducting inquiry-based instruction and leading others in this type of instruction has increased. And preliminary comparison of notebooks from classrooms of Fellows and peers with notebooks of students of nonparticipating teachers suggests that Fellows and peers elicit higher levels of understanding and thinking from their students.

This external evaluation is valuable, not only to show funders that we have delivered what we promised but also, more importantly, to adjust the focus of DVI’s instruction and refine the messages and materials we bring to teachers. Ongoing presence and formative assessment followed by revision are the essential elements of the successes experienced by the Da Vinci Institute and the hard-working and dedicated Da Vinci Fellows.

David Smith is director of professional development and Tara Broczkowski is manager of the Da Vinci Teacher Leader Institute at the Da Vinci Discovery Center of Science and Technology, Allentown, Pennsylvania.
Imagining a teacher’s wish list for the ideal high school science lesson: inexpensive materials, engaging, standards-based, naturally suited to teaching with inquiry. At the Huntington Botanical Gardens, we show educators how using plants in the classroom can make those wishes come true.

As part of our mission to promote botanical science education, three years ago we created a professional development program for classroom biology teachers. Each year, 20 high school teachers from in and around Los Angeles are invited to participate in Grounding in Botany (GIB), a year-long program funded by the National Science Foundation and the Arthur Vining Davis Foundations in partnership with the California Institute of Technology and the University of California–Irvine.

The goals of the program are to enhance teachers’ knowledge of plant science and foster the use of plants as model systems in the classroom; to refine methods of teaching, using inquiry-based lab experiences; to support implementation of the California State Science Content Standards and make intercurricular connections, particularly among science, math, and technology; and to provide a connection between the classroom and current scientific research.

GIB meets these goals through a combination of lectures, laboratories, group activities, debates, demonstrations, problem solving, hands-on experiments, and the development of inquiry-based instructional materials.

**Off to a fast start**

The course begins with an intensive summer institute that follows the development of Wisconsin Fast Plants (WFP), an organism that completes its life cycle in five weeks. (We also work with Arabidopsis, a close relative of the WFP.) While their study plants germinate and grow, the teachers conduct labs and attend lectures based on that week’s stage of development. For example, when the seedlings develop leaves (second week), we study photosynthesis. When they develop flowers (third week), we study reproduction and genetics.

Not only do teachers experience labs that they can bring back directly to their classrooms; they also work with scientists from the academic and research community (University of California–Irvine, California Institute of Technology, Pasadena Community College, and Rancho Santa Ana Botanic Gardens) to understand current scientific research in the plant sciences.

Our teachers leave the institute armed with 32 inquiry-based, classroom-ready labs—on topics ranging from scientific logic, cell biology, and genetics to ecology and evolution—that they feel excited about and look forward to teaching. They have also devised, conducted, and reported on their own original scientific experiments, using WFP and other living fauna. And they have started to create lesson plans based on the course material; they will present these plans to their peers during the school year.

“This is the best workshop I have ever attended,” one teacher wrote about the experience. “Not only did I come away with current information on plant genetics, but also useful and interesting ways to teach it.”

**Follow-through and assessment**

The GIB summer institute is followed by five workshops spaced throughout the school year. Here teachers share with their colleagues the lesson plans they have developed, discuss implementation of course materials, and participate in new lectures, labs, demonstrations, and group activities that complement the summer material.

GIB’s commitment to participants extends beyond ensuring that they have the background, experience, and confidence they need to integrate the course materials into their classrooms. Each teacher also receives a $500 supply grant to spend on materials for the
Field Trips for Teachers

By Christine Lewis

The Virginia Living Museum, a not-for-profit natural science facility in Newport News, Virginia, that focuses on hands-on life, earth, environmental, and space sciences, has offered teacher education programming for decades. A particular highlight of these sessions is the opportunity we provide for classroom educators to engage actively with natural materials, both within the museum and at regional field sites.

With six classrooms and a professional teaching staff of 12, we have considerable capacity for offering professional development. However, during the school year, our instructors are fully engaged in teaching school outreach programs to more than 85,000 school students in grades K–12, as well as after-school programs. We therefore offer teacher education only in the summer.

Up to 10 different regional public school systems contract with the museum to provide professional development for their teachers. We offer workshops and courses aimed at teachers of grades K–2, 3–5, and middle/high school. We also schedule a number of open enrollment workshops, in which any teacher can register and receive the continuing education points required by Virginia school districts for recertification.

The museum’s extensive live animal exhibits, which feature primarily native animals of Virginia, and our entire collection of more than 400,000 non-living specimens, from fossils and Ice Age specimens to modern bird and mammal mounts, are available for use in these programs.

In addition to the diversity of our living collections, we are fortunate to be located within easy driving distance of ecosystems ranging from small ponds and lakes, to the James and York rivers and the Chesapeake Bay, to the Great Dismal Swamp and the Blue Ridge Mountains. The museum’s two 15-passenger activity vehicles and fleet of canoes make it possible to transport teachers to fossil and mineral deposits, wild caves, island preserves, wetland ecosystems, and more—many of the sites privately owned and not accessible to the general public.

A typical paleontology/geology program, to give just one example, would begin at the museum with an introduction to specimens and lab techniques; continue with a trip to a field site for observation and collection of materials and data; return to the museum for analysis and discussion; and end with modeling of and active participation in hands-on activities that teachers can take back to their classrooms, along with the samples they have gathered. Each participant leaves our program with two dozen or more classroom-ready activities, all linked to the Virginia science standards by grade level.

The formats of our workshops and courses have been modified in recent years to meet both state and federal science requirements, as well as the changing needs of teachers. All museum instructors are professional scientists with years of classroom experience; we occasionally bring in outside experts as well, from institutions like the College of William & Mary, Virginia Institute of Marine Science, and the Science Museum of Virginia.

Sessions range from day-long workshops in the museum’s classrooms and lab or at field sites to multiple-day programs to college-level courses. (For the latter, graduate credits in science are offered in association with Hampton University.) Workshops and courses, whether in the classroom or in the field, are correlated with state standards and are grade-level-targeted, inquiry-based, and hands-on.

Christine Lewis is director of education at the Virginia Living Museum, Newport News, Virginia. For more information on the museum’s teacher programs, visit www.thevlm.org/teacherscorner/teachertraining/index.php.

In the 2005–2006 school year, the scores of Pasadena students on the California Standards Test in biology rose by 10 percent.

With results like these, the Huntington Botanical Gardens considers Grounding in Botany, now entering its fourth year, a resounding success. In the future, we intend not only to continue to offer the course to teachers in Southern California, but also to expand the program to a national level, accepting educators from around the country.

Martha Krouac is botanical educator for special projects at the Huntington Library, Art Collections, and Botanical Gardens, San Marino, California; for details on Grounding in Botany, visit www.huntington.org/Education/gib.html.
Promoting Technology Literacy in Schools

A Museum of Science Initiative

By Cary Sneider

Elementary school teachers in Sudbury, Massachusetts, build a bridge out of recycled materials, an Engineering Is Elementary task. Photo by Andrew Brilliant, brilliantpictures.com

In September 2002, ASTC Dimensions addressed a growing concern among both informal and formal U.S. educators—the low level of technology literacy demonstrated by the public at large. Among the issue’s articles was one from the Museum of Science, Boston (MOS), in which we outlined our vision for a new kind of science-technology center, one where technology and engineering would be raised to the same level as science.

Little did we know how quickly our institution would be mobilized to achieve that goal. In January 2003, MOS welcomed as its president Ioannis Miaoulis, former dean of the Tufts University School of Engineering. Within a year, Miaoulis had established the National Center for Technological Literacy (NCTL), a museum department that would both oversee significant changes in exhibits and programs at MOS and seek to influence technology content in formal education.

At Tufts, Miaoulis had already worked with state officials to introduce engineering into Massachusetts’ elementary and secondary curricula; now he set for NCTL the ambitious goal of establishing engineering as a core subject for K–12 students nationwide by 2015. Three years later, we have made progress on both fronts. On the informal science education side, major renovations of several exhibit galleries are under way, and the museum is leading the NSF-supported Nanoscale Informal Science Education Network (NISE Net), working to create nanotechnology exhibits and programs in museums across the United States.

The focus of this article, however, is on the formal education side—in particular, the steps we are taking in teacher professional development to ensure that engineering really will, within the next decade, be part of the curriculum in every U.S. school.

Reaching all stakeholders

NCTL’s first step was to find out what was already out there. We launched an ongoing effort, the Technology and Engineering Curriculum (TEC) Review, to collect all instructional materials currently available for teaching technology and engineering at the elementary and secondary levels.

To date, the TEC Review has collected more than 650 instructional materials, 550 of which are in a searchable database at www.mos.org/TEC. Of those, the most promising 150 have been peer reviewed and mapped to national standards, as well as to technology/engineering standards in Massachusetts, New Hampshire, and Alabama. A search engine lets educators locate materials consistent with their own state standards and district curricula. Teachers can visit MOS’s Lyman Library to examine their top picks on the shelves, and the library also offers assistance in selecting materials for review.

Access to materials is important, but unless teachers are knowledgeable and excited about a new technology curriculum, as well as fully capable of teaching it, the program will have little impact. Each element of our NCTL project therefore includes a professional development component.

Grades K–5: Engineering is Elementary

The TEC Review told us that few instructional materials on technology and engineering existed for the elementary level. NCTL staff inaugurated a series of 20 units that integrate engineering and technology concepts and skills into elementary school science lessons. To date, 11 Engineering is Elementary (EiE) units have been completed.

Each unit starts with an illustrated story in which a child from a different country uses the engineering design process, aided by a mentor, to solve a problem. This sets the context for the activities students will do in class. All EiE units emphasize connections with language arts, social studies, and mathematics, so teachers won’t see this as
“something else they have to add.”

To support the curriculum, NCTL offers workshops for teachers and curriculum coordinators. We have established “hub sites”—California’s Tech Museum of Innovation, the Science Museum of Minnesota, and sites in two other states—where local staff can conduct EiE workshops for local teachers. As of March 2007, EiE (www.mos.org/eie) had reached 1,900 teachers and 27,000 students in 26 states.

Grades 6–8: Building Math
The TEC Review found some secondary curricula that linked science, math, and engineering, but none designed especially by and for math educators. For teachers of grades 6–8, we collaborated with the School of Engineering at Tufts to develop three Building Math “replacement units” aimed at improving students’ pre-algebra skills through engineering activities.

“Replacement units” are an established educational model that lets teachers try new methods one step at a time. Each Building Math unit poses an engineering design challenge in a realistic story context. Teacher’s guides, now in development, will be enriched by video segments, showing how the materials can be presented in ways that promote student reasoning and development of concepts in both mathematics and engineering. Educators at four schools in the greater Boston area are piloting these materials.

Grades 9–12: Engineering the Future
For high school classes, the TEC Review found five programs on engineering, but all tended to focus on narrow aspects of the field. NCTL developed a full-year engineering and technology course for students in their first or second year of high school.

Engineering the Future: Designing the World of the 21st Century (EtF) is equivalent to an introductory course in physics, biology, or chemistry. A central goal is to communicate how society is influenced by technology, and how the choices we make as workers, consumers, and citizens influence technology’s future development. Students learn to use the engineering design process in various contexts and develop math and science concepts to help solve open-ended design challenges.

Professional development for EtF is more extensive than for the previous programs. To date, we have held five three-day EtF Institutes for more than 150 pilot and field-test high school teachers. For those unable to attend, we offer an online EtF workshop with videos, readings, and downloadable activities. Teachers can take unit quizzes when convenient and interact with the course facilitator and other participants through a private online forum.

Surmounting obstacles
Naturally, there have been challenges in attempting to integrate a new area of study into existing school curricula. Early on, EtF field-test teachers reported frustration at the failure of school guidance counselors to understand what they were trying to do. Some were telling students that courses in engineering and technology are vocational, not “college track”; others assumed that a career in engineering was impossible for all but top math students.

NCTL responded by developing a one-day workshop designed to broaden guidance counselors’ understanding of engineering career opportunities and the educational background and personal characteristics typical of working engineers. Local engineering societies were invited to help us. More than 200 school guidance counselors and 100 engineers have taken part in the four workshops held since 2004.

For students interested in engineering careers, another challenge is gap between high school science and science at the college level. (Continued on page 16)

Teachers and Biotech: Drawing on Local Resources

The Boston area, with its combination of leading research universities, world-class medical institutions, and high-caliber workforce, is a magnet for the biotechnology industry. Support from local companies has allowed the Museum of Science to organize a range of professional development programs aimed at middle and high school teachers:

• Biotechnology Symposium brings teachers to the museum once a year to share ideas, classroom activities, and laboratory investigations and mix informally with scientists, biomedical engineers, and technicians.
• Dynamic Life Summer Institute, a two-week intensive, uses the museum’s exhibits, collections, laboratory, and staff to enliven the teaching of genetics, evolution, biological classification, photosynthesis, and diversity. Participants explore evidence, tools, and techniques associated with biotech breakthroughs.
• Measuring Vegetation Health, a collaboration with six other institutions, develops, refines, and distributes hands-on activities that investigate the health of the environment through remote-sensing and other sophisticated but affordable technologies.
• BioTeach, a long-range collaboration with the educational foundation MassBioEd, seeks to establish genetic engineering as a core topic in biology at each of the state’s 360 high schools. Participants receive a $10,000 grant for equipment and attend a multi-day summer institute.
• UMass Planet Genomics is the outreach component of a research project on the genetics and microbiology of the fast-growing plant Arabidopsis thaliana. A museum educator acts as facilitator.
• International Biotechnology Teacher Exchange is a cooperative exchange between the state of Massachusetts and the canton of Basel, Switzerland. Teams of five American and five Swiss high school teachers spend a week in each other’s countries, observing classes, touring R&D laboratories, and discussing how best to teach biotechnology.
• Life Science Teacher-in-Residence offers one teacher on sabbatical from a Massachusetts school the chance to work in the museum’s life science department for a year.

Support for these programs has come from Genzyme, the Novartis Institutes for Biomedical Research, MassBioEd, the Howard Hughes Medical Institute, the National Science Foundation, the U.S. Department of Labor, and the National Aeronautics and Space Administration.—Cary Sneider
Leveraging Training through Networks

By Eva Jonsson

Although technology has been a compulsory subject in the Swedish curriculum since 1994, teachers still have trouble with interpreting technological subjects. Many lack training in how to teach about technology.

For the past five years, Teknikens Hus has been one of several institutions charged by the National Agency for Education with offering professional development in their regions for teachers of technology. Thanks to government grants, we can provide this training free of charge. The science center has also developed, in collaboration with the Luleå University of Technology (LTU), technology education courses for preservice teachers. In both cases, participants receive points or credits toward national licensure or academic degrees.

Our technology training includes both theory and practical work. The theory covers school curricula and their interpretation, technology as a concept, gender and technology, history of technology, and the like. The practical work focuses on specific topics, such as materials, structural strength, mechanisms, electricity, and more.

This was not Teknikens Hus’s first effort to help teachers with the technology curriculum. In 1999, we organized a local teacher network in technology. Today we have networks in seven different municipalities around the county of Norrbotten. The county is very large—500 kilometers (310 miles) from south to north—so this is a useful way to maintain contact with working teachers and to supply them with professional development.

Each network has one or two contact teachers (currently 11 in all) who are responsible for all communication between the network and the science center. Professional development staff from Teknikens Hus meet with the contact teachers four times a year—twice at the museum and twice in each network’s hometown. In these meetings, we discuss teaching technology and exchange ideas and educational materials. If requested, museum staff will give special instruction in these meetings on subjects like construction, materials, robotics, and global warming. On occasion, we will use videoconferencing to meet with contact teachers.

The first teacher networks were launched with special funding raised by Teknikens Hus. Today, the local networks are implemented as part of the science center’s regular operations. School authorities pay for their own costs: travel, materials, and salary for the contact teacher. Teknikens Hus provides the teacher training at local network meetings held twice a year.

For these meetings, each network chooses in advance from a program of workshops and lectures. The contact teacher arranges a suitable location, often in a school. About 20 to 30 teachers and one or two Teknikens Hus staff usually attend the meeting—more if we are offering a popular class. The local networks also meet by themselves at least twice a year (many of them more often).

We also have a dedicated web site for network members only, where they can share ideas for teaching technology and store or download lessons, experiments, or other kinds of educational materials.

The external evaluation done by LTU in 2005 reveals that the project truly made a difference in teachers’ work. “Being a part of the network gave me a lot of courage and will to develop as a teacher,” commented one participant. “Just having to organize the meetings, having contacts with the Head of Education in the local community and with the politicians—this is the best thing I have ever done, and I am happy I took the chance!” Said another, “I don’t know about any other project that reached this many teachers at the local level. More often there are just a few teachers who get involved and get all the input. This is for everyone who wants to participate.”

It is gratifying to note that our work has become a model for building teachers’ networks nationwide in other subject areas as well. Everyone involved is pleased: teachers, because they get professional development in a flexible and effective way; school authorities, because their educators become more qualified professionally at a reasonable cost; and Teknikens Hus, because we play a vital role in the region when it comes to teacher education.

Eva Jonsson is director of education at Teknikens Hus, Luleå, Sweden; www.teknikenshus.org.
Learning Before 4: Science for Early Childhood Educators

By Cindy Detuelo

With all of the focus that “No Child Left Behind” has put on student achievement in U.S. elementary schools, it is easy to conclude that everything related to students’ academic achievement should be built on grade-level standards. Unfortunately, research shows that the most critical learning time for children happens long before they enter the doors of an elementary school.

Studies by brain researchers like Leslie Hart and Eric Jensen have found that the years between birth and age 4 are the most important for cognitive development. As a former public educator who retired after 28 years to enter the informal learning world, I know that teaching children from birth can have far-reaching impacts. I also know that it does “take a village” to raise them to competent adults—and that science centers and children’s museums can play an active role.

That is why EdVenture, in Columbia, South Carolina, has designed a program to help those who work with very young children become more effective in inspiring the academic growth of our state’s youngest learners. Armed with sources like Kathleen Cotton and Nancy Faires Conklin’s Research on Early Childhood Education (NREL, 2001), which identifies the many positive and significant relationships between preschool participation and academic, social, and attitudinal growth, our education department has developed a series of Saturday “mini-conferences” for early childhood educators.

Held six times a year around the state, the four-hour sessions cover topics ranging from brain development and stages of childhood development to instructional approaches that range from early science and math skills to techniques for strengthening and supporting parenting skills. All of the topics are based on South Carolina’s early learning standards. The cost is low, and participants receive required license-renewal credits from the state.

This, of course, is more than one medium-sized museum could do. Fortunately, we have collaborative partners. Instructors from the state’s departments of Health and Environmental Control and Education, from South Carolina chapters of Prevent Child Abuse, as well as local universities and the United Way, have graciously served as presenters in areas that surpass EdVenture’s expertise. Our staff’s contribution has been to model the teaching of early science and math skills to young children and to present research-based instructional methods that work to maximize the brain’s potential.

After only two years, it’s clear that the mini-conference program has sparked a new curriculum approach for early childhood educators in our state. In a recent set of evaluations, one teacher said, “Everything I learned today can be incorporated into my classroom.” Another commented, “I learned that applying the ‘brain research’ ideas to my classroom will benefit my students— as well as me, as I become a lifelong learner.”

The program has definitely raised EdVenture’s profile within the state’s formal educational system, but it also is benefiting our informal science programs by helping the museum to build future audiences. We notice that mini-conference participants often bring their young charges to the museum after completing their training. It is obvious that programming for early childhood educators is a sound investment for all.

Cindy Detuelo is director of education at EdVenture, Columbia, South Carolina.

(Continued from page 14) To smooth the transition, we created Power Up!, a series of summer institutes in which high school and college instructors can explore energy technologies as a common ground for understanding.

Finally, although Massachusetts now has strong technology and engineering standards, it can be difficult to make headway unless school administrators and community leaders understand why that is important. To that end, NCTL established the Gateway to Engineering and Technology Education, a network of school-district leadership teams focused on implementing the state standards.

Teams from 10 highly innovative school districts were invited to attend an inaugural Gateway event. Sessions were liberally spiced with hands-on engineering design activities, exploration of resources, and opportunities to network with peers. But the main focus was—and will remain—on each team’s report of what they are doing, discussion of what works and what doesn’t, and time for planning new initiatives.

To date, 54 district leadership teams have joined the Gateway community.

Living with standards

Standards and statewide assessments are here to stay. Although we may expect some change in federal legislation in coming years, the standards movement has support from both Democrats and Republicans in Congress. And unless there is a change in the U.S. Constitution, the power of setting standards will continue to reside in the states.

Given that situation, the work of convincing states to strengthen and clarify their engineering standards, with a focus on the engineering design process as an equal partner to scientific inquiry, can be an important role for ASTC-member museums.

Cary Sneider is vice president for educator programs at the Museum of Science, Boston, Massachusetts. Other science centers are welcome to join in NCTL efforts; contact Larry Bell (lbell@mos.org), associate director of informal education, or Yvonne Spicer (yspicer@mos.org), associate director for K–12 education.
Looking Beyond NCLB: Alternative Audiences for Teacher Education

By Pete Yancone

In the post—No Child Left Behind landscape, U.S. science centers are struggling to find out what local educators want and need from professional development. Compare this to a decade ago, when individual teachers or principals considered staff development provided by museums a valuable equivalent—indeed a refreshing alternative—to what the school system itself might provide. In today’s U.S. public schools, the NCLB focus on fulfilling the objectives of specified curricula, combined with increased oversight by school administration, has powerfully influenced the choices of teachers and administrators alike.

In Maryland, we now have a first-ever, voluntary statewide curriculum, statewide assessments, and a new set of criteria outlining what constitutes “high quality” staff development. Unless the methods or content conveyed in a teacher workshop at the Maryland Science Center are directly linked to those appearing in the statewide assessments, our potential to attract classroom teachers is significantly reduced. And if we cannot provide follow-up to monitor participants in their classrooms, if a presenter lacks credentials, or if the contact hours for the workshop are insufficient, the “high quality” imprimatur will not be available. Our efforts are further complicated by the fact that we serve distinct teacher audiences—each with interests that may be shared, but that also frequently overlap or conflict.

All of this has altered the way the science center approaches teacher education. We now emphasize content updates. We provide access to research scientists who share the latest work out of their corporate, academic, or government labs. Museum staff assists with translating this new knowledge and any resources provided into classroom activities for use with students.

While it may take a while to work things out with the public schools, the good news is that K–12 teachers are not the only audience for whom museum professional development may be appropriate. Here are some other candidates.

Private and parochial school teachers are unconstrained by NCLB. Still focused on individual student achievement in a broad context, they are willing to make a personal commitment to participate in training provided by the museum. Though their schools are supportive, most of these teachers do not expect to be reimbursed for the cost of professional development. They have more flexibility to introduce concepts and content into a unit without concern about violating the curriculum.

Preservice teachers—those still in training at the undergraduate or graduate level—are, in my experience, very open to informal education perspectives. Because their time and capacity to pay for workshops is limited, the Maryland Science Center’s best efforts here have resulted from collaborations with higher education institutions that provide teacher training and are willing to incorporate our teacher programs into their course work.

I also see new opportunities with two groups that have a pervasive unmet need for teacher education: preschool teachers and childcare providers. There has already been some consciousness raising around the fact that it is both possible and desirable to provide science- and math-based activities to preschoolers. And increasingly, these educators will need to seek professional development as part of their recertification process.

Another audience we might cultivate more is homeschool teachers. Unrivaled in the level of concern they display for student achievement, these parent educators seek access to any resource that will support their instructional agenda. Their calendars, scope, and sequence are adaptable, allowing them to respond quickly to museum opportunities. The impact of NCLB on this group is undetectable. As long as fees are modest and comparable to other museum programs, they are willing to pay for the experience. The largest hurdle to overcome with this group lies in devising a program that is teacher-focused, not student-focused. It may help to identify those parents who serve as the science resource teacher for a larger community of homeschoolers.

What do I see as the overall outlook for museum teacher education? NCLB is not going away; its iterations will influence the U.S. education landscape for some time to come. Collaborations with institutions of higher education—particularly those awarding degrees in education and courses leading to certification—will be critical if science centers are to retain a significant role in working with the public schools.

But if funds and staff are limited for this kind of partnership, there are alternatives. At the Maryland Science Center, I would prefer to move our teacher programs to arenas where they will stand out and have the best potential to develop affinities for the museum among participants. If this means working more with preschool and preservice teachers and less with actual classroom educators, I am prepared to make that call.

Peter Yancone is director of education at the Maryland Science Center, Baltimore, Maryland.
Supporting Xciters: A PENCIL Program

By Sheena Laursen

Funded by the European Commission and coordinated by Ecsite, PENCIL (the Permanent EuropeaN resource Centre for Informal Learning) is a project aimed at developing and testing innovative methods for science teaching. ASTC-member participants include Heureka, the Finnish Science Centre; Technopolis, the Flemish Science Centre; Experimentarium (Denmark); Ciencia Viva (Portugal), the Bloomfield Science Museum (Israel), and Città della Scienza (Italy). The following article is from Experimentarium.

Xciters (www.xciters.dk), a program for students aged 13 and 14, was developed by the Experimentarium, Copenhagen, as part of the 2004–2007 PENCIL initiative. The project was inspired by the model of “learning by teaching,” or “peer-to-peer” teaching, often used in Danish schools when students are faced with complex, emotional topics.

After seeing an introductory show from Experimentarium staff, seventh grade students at Copenhagen-area schools are encouraged to apply for Xciters. Two or three pupils from each class, accompanied by their teacher, then attend a science and communications course at the science center. Once certified as “fully qualified” Xciters, the young science communicators will return to school and lead their classmates in a combination of experiments and dialogue. Those classmates in turn will go on to tutor younger pupils.

The role of the teacher

A program that turns students into science communicators naturally calls for a new approach to teacher education. In Xciters, the teachers, at their own request, attend the classes in which pupils are introduced to new scientific content. But they also participate in professional development of their own. These sessions work on several levels: They provide deeper insight and knowledge in the scientific areas pupils are covering. They allow teachers to share with each other and with us practical strategies (ranging from coordinating with other teachers to fitting Xciters into the curriculum to acquiring the necessary lab equipment) for making the program happen in their schools. And, finally, they introduce new skills, through workshops on how to supervise inquiry activities, use narrative to teach science, and employ various communication “tools.”

From the beginning, Xciters teachers assume more of an observational role than a didactic one. As students prepare for their presentations, teachers may help out with logistics; during class, they function as a safety net if an Xciter needs help.

As part of the program evaluation, two focus groups were conducted with Xciters teachers in February 2006, and the same teachers were interviewed in May 2006. The collective opinion of the group was that pupils gain a great deal, both practically and personally, from taking part in Xciters. They believe that the program fulfills its primary objective, which is to increase students’ interest in scientific subjects. Most teachers felt confident in their own ability to handle experiments and subject discussions, but some expressed a wish for more training in tutoring.

Bente Kold-Christensen, a teacher whose eighth grade students are all certified Xciters, expressed a satisfaction felt by many of the educators: “One of my colleagues recently saw my pupils... [He] commented that if he hadn’t seen their concentration with his own eyes, he wouldn’t have believed it! That’s when it becomes a pleasure being a teacher.”

Sheena Laursen is manager of the Xciters program at Experimentarium, Copenhagen, Denmark. The program recently received an additional five years of funding from the Ejgmont Foundation.
‘Children’s Champion’ to Speak at ASTC 2007

Harlem Children’s Zone president Geoffrey Canada will address the conference on Saturday, October 13. Photo courtesy HCZ

ASTC and the hosting California Science Center are pleased to announce that Geoffrey Canada will be the Saturday keynote speaker at this year’s ASTC Annual Conference, to be held October 13–16 in Los Angeles.

Named one of “America’s Best Leaders” in 2005 by U.S. News and World Report, Canada is president and CEO of Harlem Children’s Zone (HCZ) in New York City and the author of Fist Stick Knife Gun: A Personal History of Violence in America. He currently oversees an interlocking network that delivers social services, education, and community-building programs to children and families in a 60-block area of Central Harlem.

Prominent among HCZ’s initiatives are the Beacon School, Harlem Peacekeepers Program, and Community Pride Initiative. Canada, a third-degree Black Belt, also founded the Chang Moo Kwan Martial Arts School, where community youth learn the principles of Tae Kwon Do along with anti-violence and conflict-resolution techniques.

Honors Canada has received include the McGraw Prize for Education, the Robin Hood Foundation’s Heroes of the Year Award, Child magazine’s “Children’s Champion” award, and the inaugural $250,000 Heinz


22–23 ASTC RAP Session.* “Creating Quality Connections between Museums and Schools.” Hosted by Creative Discovery Museum, Chattanooga, Tennessee. Details: Lynn Mulligan, 423/648-6068, lpm@cdmfun.org


8 World Ocean Day. Sponsored by the World Ocean Network and The Ocean Project. Details: www.worldoceannetwork.org

JULY


SEPTEMBER


24–29 21st Annual Theatre in Museums Workshop. Children’s Museum of Indianapolis, Indiana. Part I provides basic information; Part II focuses on script development. Enrollment deadline is August 17. Details: Patricia Daily, patriciad@childrensmuseum.org

OCTOBER


* For information on ASTC RAPs, visit www.astc.org/profdev/. For updated events listings, click on ‘Calendar’ at www.astc.org.
Award for his “passionate concern for children and his selfless determination to make their lives safer and more successful.” In January 2006, New York mayor Michael Bloomberg chose Canada to co-chair a task force charged with reducing poverty in the city. He is also the East Coast regional coordinator for the Black Community Crusade for Children, a nationwide effort coordinated by Marian Wright Edelman and the Children’s Defense Fund.

A Trio of Tours

Recognizing that ASTC 2007 attendees may have their own plans for side trips, ASTC has scheduled just three group tours this year. All offer unusual access to restricted sites. Participants can sign up for preconference visits to NASA’s Jet Propulsion Laboratory (JPL) in Pasadena and the Getty Conservation Institute (GCI) in West Los Angeles, or a postconference day trip hosted by the Catalina Island Conservancy on Santa Catalina Island.

Staff at JPL (www.jpl.nasa.gov), the NASA facility at the California Institute of Technology, remind us that space exploration, with its long-range planning and talented team members, is an inspirational topic for museum programming. Their “Explore Space!” tour, on Friday, October 12, will follow the lifecycle of a scientific mission from concept to assembly, test, and operations.

Participants will have the chance to visit key facilities, see replicas of historic spacecraft, and meet senior staff. In the morning, scientists and engineers from various NASA missions will field questions in JPL’s historic von Karman Auditorium. After a box lunch, a panel will discuss education and outreach opportunities related to robotic space exploration. The final panel of the day will highlight the experiences of NASA’s science center partners, including lessons learned and best practices in bringing space exploration to museum audiences.

The Getty Conservation Institute (www.getty.edu/conservation) is part of the spectacular 110-acre, hilltop campus that also houses the J. Paul Getty Museum, the Getty Research Institute, the Getty Leadership Institute, and the J. Paul Getty Trust. Participants in “Getty Conservation Institute: A Behind-the-Scenes Visit,” also on Friday, October 12, will learn how GCI scientists use theoretical and applied disciplines of science and engineering to develop and promote appropriate solutions to the conservation problems of collections, artworks, architecture, archaeological sites, and monuments.

Current GCI research includes work aimed at improving collection environments in hot and humid regions, at better understanding the character of paint materials used by today’s artists, at developing safer ways to illuminate light-sensitive artworks, and at identify-
ing the many photographic processes developed and used since the beginning of that art. Participants will enjoy free time to visit the art museum, stroll in the extensive public gardens, have lunch in one of the Getty Center restaurants, and savor the magnificent views from the site.

Southern California’s eight Channel Islands are home to a rich biodiversity. On Wednesday, October 17, the full-day “Catalina’s Wild Interior: A Custom Eco-Tour” will take participants to Santa Catalina Island, where nearly 90 percent of the 75-square-mile land mass, created when tectonic plates collided, is now under the protection of the nonprofit Catalina Island Conservancy (www.catalinaconservancy.org).

After a one-hour ferry ride, the tour begins with a visit to the Catalina Island Museum. Housed in the island’s historic Avalon Casino, the museum documents Catalina’s many roles, as home to the native Gabriélino/Tongva tribes, safe haven for pirates, cattle ranch, military base, Hollywood film location, and even spring training site for baseball’s Chicago Cubs (whose owners, the Wrigley family, controlled the island from 1919 to 1975).

Conservancy staff will then host a motorcoach tour of the inner island and share details on how the group is protecting and restoring Catalina’s unique plant and wildlife communities. The schedule includes stops at the Airport in the Sky and Avalon Canyon nature centers, and a visit with native wildlife ambassadors Tachi, a Catalina Island fox, and Pimu, a bald eagle. Rounding out the day will be a visit to a restored hacienda and stables that figured in Catalina’s ranching history and a stop at the beautiful Little Harbors beach.

For the latest information on ASTC 2007, visit www.astc.org/conference.

Wild Music on Tour

The Wild Music traveling exhibition, a collaboration among ASTC, the Science Museum of Minnesota, and the University of North Carolina at Greensboro, opened in St. Paul in March. (For a detailed description, see Spotlights, page 22.)

In June, the 4,000- to 4,500-square-foot exhibition, made possible by major funding from the National Science Foundation, will begin a six-year tour. First stop is at the North Carolina Museum of Natural Sciences, in Raleigh.

For availability, visit www.astc.org/exhibitions, or contact Wendy Hancock, ASTC Exhibition Services manager, at 202/783-7200 x 117, whancock@astc.org.

ExhibitFiles in Beta

Open in late April, ASTC’s newest web site, www.ExhibitFiles.org, was designed in collaboration with exhibit prototypers, designers, and developers from across the field. The site combines social networking features with an easy-to-use system for sharing images and records of exhibitions and exhibition reviews. Registered users can post material, comment, and receive notification when someone comments on their exhibitions.

ExhibitFiles was developed with support from the National Science Foundation. Kathleen McLean of Independent Exhinitions served as advisor to the project, and design and software development are by an Ideum team led by Jim Spadaccini.

Join up now, add your exhibitions and reviews, and sign up for weekly updates. We’ll be publishing more news over the coming months as development of the site continues. Contact: Wendy Pollock, Director of Research, Publications, and Exhibitions, wpollock@astc.org.

Correction

The 2007 Visitor Studies Association conference will be held in July, not June, as previously reported. See the Calendar, page 19, for details. We regret the error.
A visitor to Wild Music uses the parabolic microphone in Forest’s Edge to track animal sounds. Photo by Wendy Hancock

**SOUNDS OF NATURE**—Why are we born musical? What prompts creatures like birds, whales, and humans to sing? On March 3, Wild Music: Sounds & Songs of Life, a new traveling exhibition that explores the biological origins of music, premiered at the Science Museum of Minnesota (SMM), St. Paul. Opening-day visitors were treated to a Javanese gamelan performance and a lecture by whale researcher Roger Payne, complementing the exhibition theme.

Produced by SMM in partnership with ASTC and the University of North Carolina at Greensboro School of Music, the 4,500-square-foot exhibition features three immersive environments, each based on current scientific research:

- Forest’s Edge allows visitors to hunt for sounds of forest creatures using a parabolic microphone, compare thrush songs, and explore music inspired by birdsong.
- In City Square, visitors can record their musical memories and engage in an experiment to learn what scientists have already discovered: that all of us are born with the capacity to identify rhythm and pitch.
- Ocean Deep’s highlights the songs of whales and their similarity to human song in phrasing, rhythm, and thematic variation. A hydrophone, used in the study of whales, can be lowered into a tank of water to amplify other sounds of the sea, such as a throbbing ship’s engine.

Additional components of Wild Music include the Jamming Room, a soundproof studio where visitors can lay down a beat, add animal sounds and songs, and finish with their own voices or instrumental playing; the Bioacoustics Laboratory, offering a touchable spectrum analyzer and working models of a human larynx and bird syrinx; and a short film on the power of sound and music across species to help us bond, work together, and even grieve.

The exhibition soundscape, blending human and animal sounds, was composed by Philip Blackburn. Accessibility is incorporated in tactile experiences and Braille and acoustical labels. Signage is in both English and Spanish. Major funding for Wild Music was provided by the National Science Foundation, with additional support from Harman International, Inc. and NEC Foundation of America. The exhibition closes at SMM in June to begin its ASTC-managed tour.

**Details:** Wendy Hancock, manager, ASTC Exhibition Services, whancock@astc.org; web site: www.wildmusic.org

**MICROBES ON THE MOVE**—Can the spread of communicable disease be stopped? In Infectious Disease: Evolving Challenges to Human Health, a new exhibition at the Marian Koshland Science Museum of the National Academy of Sciences, Washington, D.C., visitors can investigate how diseases like HIV, malaria, and tuberculosis move through populations. More importantly, they can learn about measures to slow or even halt that progress.

Museum staff and volunteer scientists turned cutting-edge studies into interactive displays and computer simulations for the 1,500-square-foot exhibition, which opened in March. It begins with a computer animation that shows how bacteria multiply, mutate, and react to antibiotic treatment. To see where microbes live, visitors can slide a computer screen over photos of people from different nations, identifying “hot spots” on a doctor’s wrist, a businesswoman’s suit, or a farm girl’s chicken. Descriptions of each parasite, fungus, bacterium, or virus and its effects appear on-screen.

Nearby, kiosks show disease distribution on a global scale. A world map, updated weekly, tracks recent outbreaks, and visitors can map the prevalence of HIV, tuberculosis, malaria, and cholera against related local factors like sanitation conditions and availability of safe drinking water.

The second half of the exhibition focuses on public health measures that fight disease. The message? Success depends on both preventive measures and development of new drugs. Using a computer model, visitors can test which practices will best reduce malaria infection in a Tanzanian village: anti-malarial drugs, indoor spraying for mosquitos, bed nets, or a combina-

**Interactive displays in Infectious Disease reveal the harmful—and helpful—roles that microbes play in human health. Photo courtesy Marian Koshland Science Museum**

**Details:** Deborah Danuser, media associate, ddanuser@nas.edu
INLAND OCEAN—Children in landlocked upstate New York can gain new perspectives on the seas through a program launched last fall at the Sciencenter in Ithaca. Thanks to funding from a local foundation, dozens of second grade classes in the region will enjoy free visits to Connect to the Ocean, a new permanent exhibition. Regular visitors will also enjoy the 1,200-square-foot exhibition, which is intended to show, through live animal exhibits and hands-on activities, that ocean conservation is relevant to everyone, not just coastal residents.

Connect to the Ocean is centered around three animal exhibits representing different marine habitats. The largest, a 350-gallon tidepool touch tank, allows visitors to handle live marine invertebrates, including sea stars, sea urchins, hermit crabs, and snails. Two smaller tanks display animals produced in captivity through aquaculture. The first, home to a live coral reef, features species typically found in “back reef” areas where waves and currents are strong; the second houses species from protected lagoon areas found along tropical coastlines. Visitors learn firsthand how managed production of aquatic plants and animals offers a viable alternative to current harvest practices.

Other hands-on exhibits complete the exhibition. In All Drains Lead to the Ocean, visitors see how everyone is connected to the ocean through local waterways. Visitors can dump plastic-bead “contaminants” into a model of an Ithaca storm basin to see the effects of polluting the watershed. What Happens When? shows the impact of natural and manmade events on coral reef health.

Funding for Connect to the Ocean came from the Brooks Family Foundation and the Tompkins County Strategic Tourism Planning Board. The Triad Foundation is sponsoring the free field trips over the next three years. Others involved in the project include the California Academy of Sciences, Reef Encounters, Monterey Bay Aquarium, and Shoals Marine Laboratory.

Details: Lara Kimber, associate director, lkimber@sciencenter.org

AMPHIBIAN ALERT—Do frogs carry warnings of global warming?

ECHO Lake Aquarium and Science Center, Burlington, Vermont, invites visitors to investigate this question in FrogWorld, a new 400-square-foot permanent exhibition that opened February 25.

One-third of amphibian species worldwide are threatened with extinction, and 122 are already lost—victims of habitat loss caused by pollution, deforestation, and climate change. Says ECHO executive director Phelan Fretz, “Sometimes it takes something small to remind us of something big. Frogs are the canary in the coal mine.”

The exhibition features 14 frog species from six continents. Visitors can compare a Vietnamese mossy frog, a steamroller-flat Suriname toad, a steamroller-flat Suriname toad from South America, and Madagascar’s tomato frog with local species like the American bullfrog and gray treefrog. A rotating, 7-foot metal “frog globe” pinpoints the animals’ origins and also highlights significant lakes (including Lake Champlain) of LakeNet, an international organization that seeks to improve water quality and wildlife habitat worldwide.

In other activities, visitors can learn about frog songs, try to identify different calls, or “morph” into frogs themselves, merging their faces with pictures of local frogs to create e-cards to send to friends. Panels provide “frog friendly” tips, such as using outdoor lights that turn on as needed and limiting use of chemical fertilizers.

FrogWorld is the first of a planned series exhibitions that will encourage ECHO visitors to think globally. The $200,000 exhibition was made possible by a grant from the U.S. Environmental Protection Agency–New England and private donations.

Details: Julie Silverman, jsilverman@echovermont.org

Grants & Awards

The National Academy for Curriculum Leadership, part of the Washington State LASER project headed by Battelle and the Pacific Science Center, Seattle, Washington, has received $750,000 from Battelle to help school districts improve curriculum and instruction and strengthen professional development in high schools over the next three years. A portion of the gift will support a LASER science materials resource center.

Prairie Ridge, the field station of the North Carolina Museum of Natural Sciences, Raleigh, has received $69,760 from the State Energy Office of the North Carolina Department of Administration to support development of sun- and wind-powered projects aimed at eliminating the use of fossil-fuel-generated energy at the site. The 38-acre site, located in West Raleigh, already showcases an array of sustainable design strategies and conservation features.

Richard and Peggy Notebaert, whose generous donation to the Chicago Academy of Science eight years ago helped launch the city’s Peggy Notebaert Nature Museum, have given the museum an additional $1 million. The gift will be used to enrich exhibits and education programs, enhance the visitor experience, and provide for the future of collections and the institution. Numbering 250,000 specimens in all, the collections serve as a benchmark for the natural history of the American Midwest.

The Naples Botanical Garden, Naples, Florida, was recently awarded a grant of $112,500 by the Collier County government and the Collier County Tourist Development Council. The funds are being used to promote the garden and to support the temporary exhibition Dinosaurs in the Garden, which opened in February.
Paul Tatter, founding executive director of Explora, Albuquerque, New Mexico, stepped back from that position in March. Tatter, who served previously as director of the Science Center at the Children’s Museum of Denver and of the Science Center of Eastern Connecticut, continues at Explora as associate director for special projects and planning. The museum’s new executive director is its former associate director, Patrick Lopez.

The Kansas Cosmosphere and Space Center, Hutchinson, Kansas, has announced the appointment of Christopher Orwoll as president and CEO. Orwoll is the former commanding officer, Naval Reserve Officer Training Corps, and professor of naval science at the University of Kansas. He replaces Jeff Ollenburger, who left the museum in December 2006.

Taking over as director of development at the Long Island Children’s Museum, Garden City, New York, is Donald R. Vogel. Previously director of advancement for the College of Engineering and Applied Sciences at Stony Brook University, Vogel has also worked for the New York Botanical Garden and Liberty Science Center.

Victoria Scalise is the new executive director at the Palouse Discovery Science Center, Pullman, Washington. Most recently event coordinator for the state of Idaho’s Lewis and Clark Bicentennial, Scalise has a long background in business management and development, project planning, and marketing.

Al Najjar, president and CEO of the Sci-Port Discovery Center, Shreveport, Louisiana, resigned effective March 31 to become director of the new Children’s Museum of Tampa. In Florida, he will supervise development of the museum’s new facility, due to open in late 2009. As of August 1, his successor at Sci-Port will be Ann Fumarolo, president for the past 11 years at Science Central, Fort Wayne, Indiana.

Alexandra Barnett, executive director and CEO of Chabot Space & Science Center, Oakland, California, resigned her position November 30, 2006. Barnett, who has married and moved to Los Gatos, California, will continue to serve the science center as advisor and consultant. Jerry Fidler, former CEO of Alameda-based Wind River Systems, will serve as interim until a replacement can be found.

The Hagley Museum and Library, Wilmington, Delaware, announces the appointment of Geoffrey Halfpenny as director. Previously director of the Delaware Museum of Natural History, Halfpenny will assume his duties on or before June 1. He replaces George L. Vogt, who left in November 2006 to become executive director of the Oregon Historical Society.

The new president and CEO of Adventure Science Center, Nashville, Tennessee, is Susan B. Duvenhage, a former associate director and head of exhibits and public programs at the Florida Museum of Natural History, Gainesville. Duvenhage succeeds Ralph Schulz, who left the science center last October to become president and CEO of the Nashville Area Chamber of Commerce.