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FAIRCHILD TROPICAL BOTANIC GARDEN

Students at BioTECH @ Richmond Heights High School, a conservation biology magnet school in Miami, Florida, conduct botanical research in this state-of-the-art lab.

To motivate students to learn science, some schools are expanding the range of their courses. While at Mission Heights Preparatory High School in Casa Grande, Arizona, biology teacher Robert Gay created a paleontology program after he told his students about his training and work in paleontology, and they "felt my passion for it and were really intrigued by it," he relates. The program, which began with one course in 2014, grew to four courses, including a two-week summer field course.

"Paleontology is a good way to engage kids in science. Kids like fossils and dinosaurs, and they want to know what is true and what isn't: [They ask,] 'Is *Jurassic Park* real?'," he maintains, adding, "you can talk about physics, biology, and chemistry through a lens they're already interested in."

Paleontology is "a practical science" because "it's the only way to know about the past…To make decisions about the future, you have to look at the past," he observes. His students were exposed to paleoclimate data, which can help them understand climate change. "Students will understand the impacts of policy decisions," he contends.

He also taught students how microscopic fossils help locate oil and how scars on dinosaur fossils can answer questions such as "Were their digestive systems able to process what they ate? Could a T-Rex eat you?" Students learned that many paleontologists teach at medical schools because physicians have to understand "how bones have changed," he notes.

In his Paleontology 1 course, students learned "the history of paleontology and the history of life on Earth," Gay explains. In Paleontology 2, they studied the techniques of paleontology, such as determining the ages of fossils. "In both courses, students [got] to apply their skills in the field," he points out.

Students in Advanced Paleontology "do research projects that will result in publications. I want them to work on projects that can be published in a peer-reviewed journal," Gay asserts. He has had three students write about topics including "the first appearance of a species and the abundance of species in an area."

He continues, "I've seen students who have issues with reading and writing get emotionally invested in these papers. They want to understand the scientific vocabulary and produce a good and professional paper. Their literacy skills are on the rise."

The application process to attend the summer field school was very competitive. "We take five to six students to south Utah for two weeks. It's a really intensive camp," he notes. Students had to pass the other three courses and submit a letter of interest and letters of recommendation. "It's preferred that they have taken Earth science and biology as well," he adds.

"We've collected more than 300 specimens," he reports. "My students made amazing finds this summer," such as a dinosaur tooth from the Triassic period.

Safety, Transportation

One challenge Gay faced with the field portion of these courses was "most of the students have never even been

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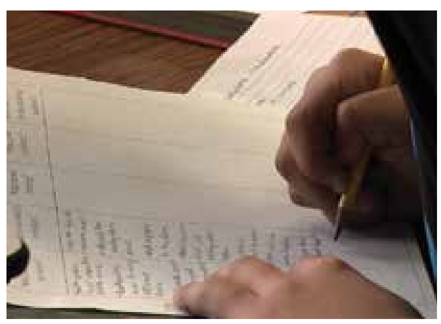

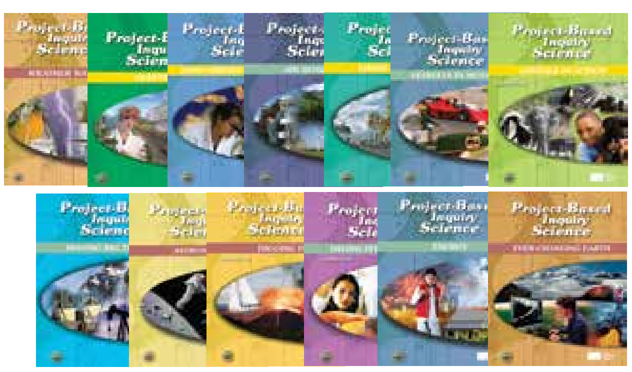

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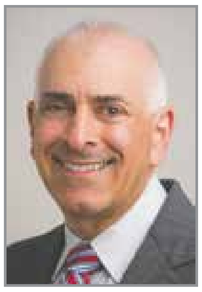
COMMENTARY: **Matt Bobrowsky**

Science Projects Are More Authentic With No 'Hypothesis'

By Matt Bobrowsky



Matt Bobrowsky

How do you define the term *hypothesis*? Apparently some teachers still incorrectly teach that a "hypothesis" is a prediction of the outcome of an experiment. They may call it a "guess," or even an "educated guess," but either way, it's a prediction of the expected result. Many teachers use the term that way in online discussions and on lab worksheets. Whenever I judge science fairs, I frequently see a student's poster stating something like, "Hypothesis: I think that…[possible experimental result]." Unfortunately, various sources, including some textbooks and popular websites, perpetuate this misconception.

The truth is, scientists rarely guess at an answer. For example, let's say I want to know how large a red blood cell is. It won't help to first guess at its size. That won't help me discover the answer, and it doesn't help me learn anything. All I need to do is make the measurement, and then I'll know. Please consider not requiring a "hypothesis" in students' science fair projects or in labs. Stating a research question or an engineering challenge is perfectly good. Incidentally, the Intel International Science and Engineering Fair does not require a hypothesis; a good research question is sufficient.

For most physical scientists, a hypothesis is not an "if...then…" statement or a prediction. It is a *tentative explanation* for some observed phenomenon. A good hypothesis will have two properties: (1) It will explain the observations, and (2) it will make predictions—that can be tested. If it's not testable, it's not a *scientific* hypothesis.

To clarify, I'm not discussing the "hypothesis" referred to in statistical analyses, as in the "null hypothesis." (This would not be needed unless the investigation includes a statistical analysis that requires such a hypothesis.) Rather, I'm referring to the hypotheses used by most physical scientists, as defined earlier. Some teachers have students write an "if-then-because" statement. In this case, the hypothesis follows "because." That's where the possible explanation is stated.

Here's an example of a hypothesis: Suppose you observe that the Moon goes through phases, and you hypothesize—incorrectly—that this is due to Earth's shadow on the Moon. (As a hypothesis, this is a possible explanation, not a prediction about any particular experiment.) A prediction from this hypothesis is that part of the Moon should appear dark only when the Moon is in the Earth's shadow. So then you observe the Moon for a month and discover that part of the Moon appears dark even when the alignment of the Sun, Earth, and Moon does not place the Moon in the Earth's shadow. You then must reject the hypothesis.

There are several reasons why we should not ask students to make guesses or predictions of the outcome of an experiment. (Please don't call these predictions *hypotheses!*) My top three are

1. Making a prediction introduces bias, as the experimenter—consciously or unconsciously—acts to increase the likelihood that the experiment will have the predicted outcome.
2. Students incorrectly think it's important that their prediction be correct, which may lead them back to Reason 1. In fact, the rejection of incorrect hypotheses—based on testing predictions—is one of the main ways that science advances. (Frankly, my favorite science fair projects are often ones in which the outcome differs from what was expected. When that happens, real learning occurs, and students experience that delightful "Aha!" moment.)
3. Scientists usually don't make predictions in this way, so why do we ask students to do it? After all, aren't we trying to teach them how science is actually practiced?

Want to teach about real hypotheses? Give the students a gadget (with complexity somewhat above their current level), and ask them to develop a possible explanation for how it works. That possible explanation is a hypothesis. However, especially at the lower grades, you don't need to use the word *hypothesis*; just ask them to say or write what they think is happening. To be scientifically useful, the proposed explanation should include what evidence would support it and what evidence would refute it. Then ask how they might test their proposed explanation. This gets them thinking in ways that are much more creative than following an arbitrary checklist of science project "requirements." Instead they experience science the way scientists do, as fascinating explorations and discoveries. It is this latter, more engaging way of learning that forms the basis of Phenomenon-Based Learning. ●

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camping before. They ask, 'How will I go to the bathroom? How will I groom myself?'" He answers all of their questions and covers field safety in the Paleontology 1 course. In addition, "we have briefings at the beginning of each field session on dehydration and [the need for] sunscreen use…Students are trained not to panic if trapped by a flash flood," for example, he reports.

Gay and adult volunteers were certified in first aid and CPR; every vehicle had a first-aid kit. Adults kept students in visual range and carried cell phones.

Back in the lab, students wore safety goggles and ear protection when using the air scribe, which Gay describes as "a mini jackhammer that removes rock from fossils." To protect against dust, "we have a fan and open-air ventilation," he notes. "Our chemical use is very limited [because] we don't have a fume hood, so students work with vinegar in a separate room."

Gay's other major challenge—and expense—was transportation to field sites because school buses were too large. "We had a pickup truck donated, but we need[ed] a new vehicle. When we go to Utah, it's 600 miles one way, and we [would] have to rent SUVs and minivans." Though Gay obtained grant funding for his courses, students had to pay for transportation expenses. He would offer financial aid to students who couldn't afford the fees.

The paleontology program was "a lot of work, but very much worth it," Gay concludes. Since most of Mission Heights' students come from low-income families for whom travel is a luxury, "they get to see sights and do things they normally couldn't do. Their parents really like that," he observes. "My students are doing well and getting noticed by colleges. [The program gave] them the chance to do something that improves their future—even if they don't go into science."

Next Generation Botanists

In Florida, the Fairchild Tropical Botanic Garden of Coral Gables worked with Zoo Miami and Miami-Dade County Public Schools to establish BioTECH @ Richmond Heights High School, a conservation biology magnet school that offers the first botanical field research program in the nation, along with a zoology program. "There's a growing need for people with a background in botany [because] the botany community worldwide is aging out," says Amy Padolf, Fairchild's director of education. "It's harder to find botany instructors because in Miami schools, not enough students are interested in botany. [The botany program was established because] if kids get the interest early, they'll want to study it."

"We've brought in kids who were initially attracted to the zoo, but many of them decide to go into botany because they've developed an appreciation for plants," observes Daniel Mateo, BioTECH's assistant principal. "With plants, so many genetic modifications are possible…Plants aren't boring."

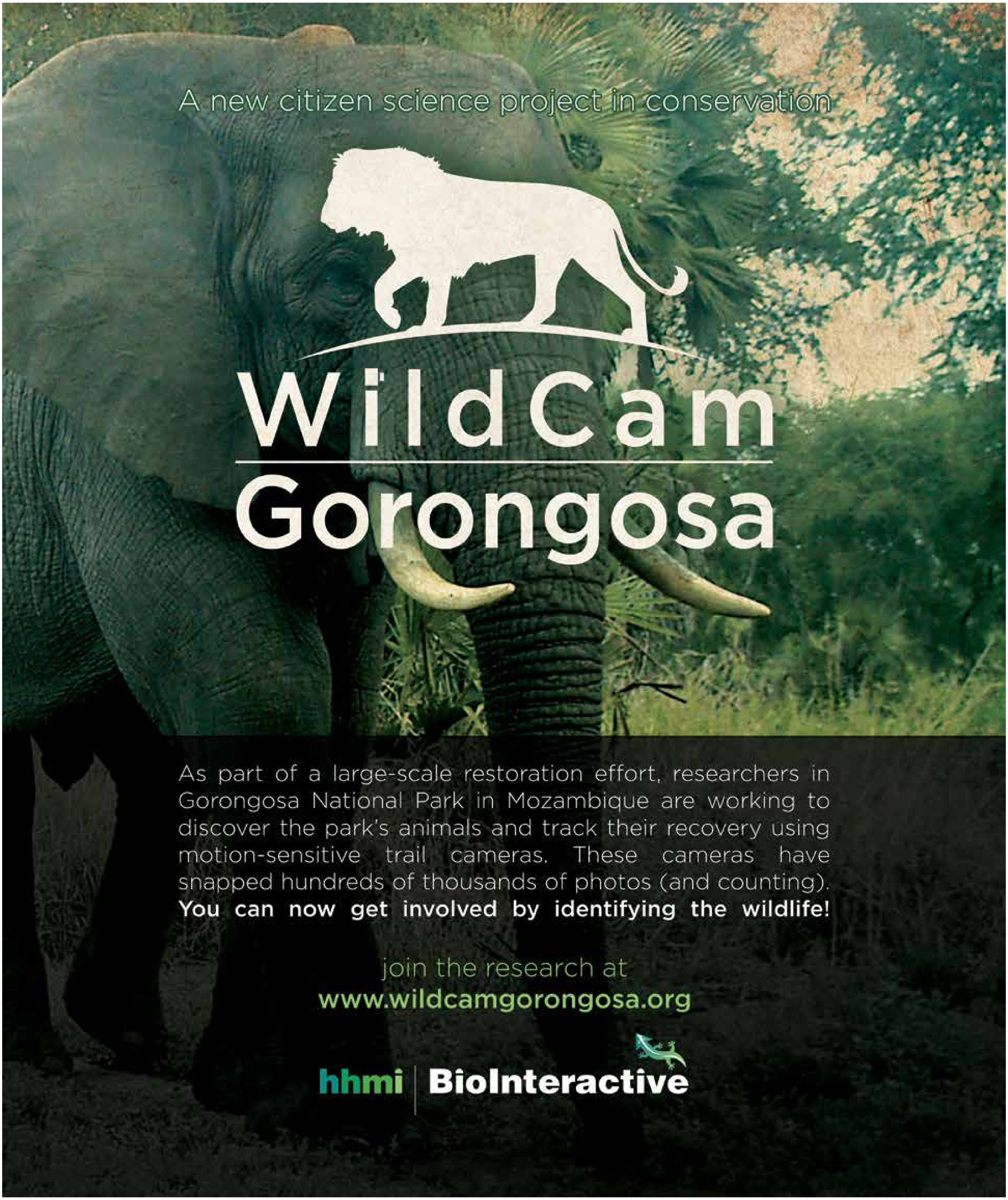
BioTECH's students "learn about the interconnectedness of all living things, [including] how the animals, like the mega fauna at the zoo, need plants to survive," says Padolf. "[Students learn that] the seawater level in Miami is rising, and we need mangrove trees to stop that."

With a student body that is 76% "of Latino descent" and 22% "African American/Caribbean," BioTECH represents "the new face of science education" and aims to produce "the next generation of botanists," she asserts.

BioTECH students engage in "actual, practical, authentic research projects" in the school's state-of-the-art labs and greenhouse and work with scientists in the field at Fairchild and the zoo, says Mateo. "There is project-based learning in every course, and conservation biology is incorporated into every subject…We have 14-year-olds manipulating variables and doing what researchers do."

When BioTECH opened in 2014, students began micropropagating native orchids as part of the Million Orchid Project, which Fairchild created with the goal of reintroducing 1 million endangered orchids to Miami's public spaces. "Our students are propagating from seed, which is difficult to do," Mateo points out. Students presented their findings and growing methods to visitors at the International Orchid Festival in March 2015.

As juniors and seniors, students will take the college-level Introduction to Botany course and focus their research on a particular topic, according to Padolf. Fairchild "will work with them to get their research published in peer-reviewed journals," she notes. ●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Making Data Collection Meaningful to Students

Gathering data while exploring the outdoors makes the process more meaningful to students. And when students collect data with adults, they are exposed to role models and science careers. Teachers around the country are taking advantage of opportunities to combine these elements in projects.

Students in Portage, Indiana, are benefiting from a local initiative called Building Bridges for Environmental Stewardship: Schools, University, and Community Collectively Embracing the Health of a Local Watershed. Headed by Julie Peller, associate professor of chemistry, and Laurie Eberhardt, associate professor of biology at Valparaiso University (VU) in Valparaiso, Indiana, and funded by an Environmental Protection Agency Environmental Education Grant, Building Bridges aims "to connect the university to the Portage community to cultivate awareness of a local watershed and to create a curriculum for monitoring local streams," explains Eberhardt. "We also want to provide kids with role models to show them college might be possible for them," she notes.

Peller contacted Carrie Sanidas, eighth-grade science teacher at Willowcreek Middle School in Portage, to enlist teacher and student participation in the two-year project. "The water quality of the tributaries that flow into Lake Michigan is often poor. We want our students to take some ownership of [this]," says Sanidas. "Our local watershed enters Lake Michigan right at the Portage Lakefront (the local beach)…We depend on Lake Michigan for drinking water and activities. [This project] ties in our community with our classrooms," she observes.

Middle school students were targeted "because the curriculum fits well [with the project], and middle school is a good place for a shift in community behavior. Middle school students will tell their families about [what they learn], and it will spread throughout the community," Eberhardt contends.

Sanidas and five other Willowcreek science teachers of honors seventh and eighth graders are participating. "We were looking for new and authentic ways to provide differentiation for honors students," she relates. The project also offers "cross-curricular opportunities to integrate what students learn in the field across the curriculum."

Valparaiso University student Elly Walsh-Rock (center) assists Willowcreek Middle School students with water-quality monitoring as part of the Building Bridges for Environmental Stewardship initiative in Portage, Indiana.

The teachers' professional development featured presentations from community partners like Save the Dunes, a nonprofit dedicated to preserving Indiana's dunes, and Hoosier Riverwatch, a program that trains volunteers to monitor stream water quality. The Save the Dunes presenter "updated teachers about the status of the watershed," while the representative from Hoosier Riverwatch informed teachers about how they could connect with state efforts, Eberhardt relates. The teachers also practiced data collection at several field sites.

The project launched in September with a beach cleanup by VU students in Eberhardt's Science of the Indiana Dunes course and Willowcreek students. "The [Willowcreek] students were shocked at the number of cigarette butts they found," Sanidas reports. They recorded what they gathered.

"[We] had the college students compile all the data on the garbage collected. [They then wrote] reports about what was found in the form of letters to the middle school classes, [which were] shared with the middle school teachers," says Eberhardt. This showed the younger students "that what they did was collect useful data on what's happening around Lake Michigan," while for the VU students, "it was a nice exercise in how to collect and analyze data from a big data set and how to create comparison graphs, stuff we hope students will learn in a basic non-major science class," she concludes.

In October, the water-quality monitoring began. Having the VU and Willowcreek students work together "has proved a bit challenging because the middle schools require background checks of all adults [who] work with kids directly, so we can't just take any volunteer. But we had enlisted 6–10 secondary education majors who have had the appropriate checks...[They] go out with classes of middle schoolers and help guide groups of students through the data collection protocols," Eberhardt explains.

The education students are learning "what it takes to do a successful field trip with students," she notes. In addition, "we have trained college students going out separately and collecting data on various chemical parameters in the area watershed streams, and these data will be put on a shared website to be available for the middle school students to use in classroom exercises."

Sanidas says the education students will work with the Willowcreek students in December to analyze the data. "It's important for our kids to see what college students do [so they can decide] if they want to pursue science or engineering careers," she maintains.

Gathering Data With Researchers

Last spring, as part of a unit on sustainability, 30 sixth graders at Middle Township Middle School in Cape May Court House, New Jersey, gathered data on the wetlands near their school with staff from the Lomax Consulting Group, an environmental services company. Owner Pete Lomax "mapped it all out for us…He did a lot of preparation for that day," says science teacher Susan Blood. "He cut the trail to eliminate poison ivy, identified areas for the kids to study, [and used his company's resources] to produce maps of the area and a book of different types of soil for students to use."

In addition, Lomax and two of his employees worked with three groups of 10 students to explore the soil, vegetation, and hydrology. They brought an auger that students used to determine the level of moisture in the soil—an indication of whether the area is a wetland. "The students were able to take six soil samples with the auger," Blood relates.

While her main goals were to ensure students understood the importance of wetlands and to expose them to environmental careers, Blood says she also sought "to show students that when doing research in the field, nothing is black and white, and it's okay to be unsure. It's okay to see wetland plants in an upland area." She advised students to "use your judgment. If 70% of the plants you're seeing are wetland plants, then this is [most likely] a wetland area."

The students recorded their data and observations on a form that Blood and two other teachers created based on a more complex form used by Lomax Consulting Group staff. Though Pete Lomax determined that the data they collected during the hour-long field study wasn't extensive enough for further analysis, Blood says students "were able to conclude that Area A was an upland and Area B was a wetland. They used data in an informal way, and it was good for them to see the 'grey area' in research." She adds that it was important for students to hear from Lomax that "he makes decisions based on data every day." ●

Scouting Branches Into STEM

In 2014, the Boy Scouts of America (BSA) launched STEM Scouts (*https://stemscouts.org*), a pilot program in Knoxville, Tennessee.

"The idea for STEM Scouts originated from a former chief scout executive who wanted a way to [expand] scouting's positive impact on youth development. He thought part of the answer was STEM [science, technology, engineering, and mathematics]," recounts April McMillan, PhD, who, with Trent Nichols, MD, PhD, serves as the national directors of STEM programs for BSA. "He came to us and asked, 'Can you guys start a new scout program based on STEM, based on learning and being exposed to STEM disciplines?' We spent about a year developing the program, researching how kids learn, what inspires them. Trent and I came from science careers, so we thought about what makes us scientists: We are inherently curious. We wanted to make sure everything we do inspires curiosity."

"It's all hands-on activity, lots and lots of fun. We believe if we get them excited, they'll do better at school even if we teach them just a few facts," says Nichols. "The curriculum was originally written by scientists and engineers, then professional educators took those projects, made [modules]."

Each module, which lasts between four and six weeks, is designed to be "youth-led and adult-guided," according to McMillan. Modules cover robotics, physics, biology, and more. Groups of Scouts, called Labs, meet weekly during the school year to work on the challenges presented in each module. Labs are open to boys and girls in grades 3–12. "When this was developed, we did keep [the *Next Generation Science Standards* and the *Common Core Standards*] in mind…[T]his is about inspiring kids to learn. Really what we want is to have kids use their critical-thinking skills," she adds.

Many of the modules are cross-disciplinary, but most include at least some math. "Trent and I believe math is the language of science. We try to incorporate math in every activity," McMillan asserts.


GREAT SMOKY MOUNTAIN COUNCIL

A week-long summer day camp provided STEM Scouts with opportunities to participate in longer learning modules. Here, Scouts experiment with bubble wands and bubble solutions of their own design.

"The Labs are very similar to traditional Scout groups," explains Heather Shepard, the STEM executive for the Connecticut Rivers Council, where she has been working to launch new STEM Scout Labs. "Each Lab consists of 12–15 youth, and they are divided into three age groups. Each child is given a leadership role [within a group of three to four]…[W]e try to mimic what an actual lab would look like… During each module, STEM Scouts step into a different role so that they have the opportunity to be responsible for something else." The roles include principal investigator, associate investigator, and technician. The adult leaders are called lab managers and associate managers.

The pilot program succeeded in introducing more children to scouting, with 85% of STEM Scouts being new to scouting, according to McMillan, who adds, "The breakdown by gender was 54% male and 46% female."

As with many youth-serving organizations, the majority of the children were elementary-aged. However, STEM Scouts will be offering an additional incentive for older Scouts: an opportunity to be published in a peer-reviewed journal. In addition to working with their Labs, STEM Scouts in high school will be able to submit an article on either an independent research or engineering project to the *Scientific Journal of the BSA*, which is expected to launch by February 2016. McMillan says faculty at the University of West Virginia will serve as primary reviewers.

"This gives high schoolers quite a leg up [when applying to colleges]," she states. "They will have to have done a science or engineering project, and write it up in the proper format."

"In order to be a leader, not everyone has to have a STEM background. Anyone who is enthusiastic, willing to learn, with a great attitude, enjoys working with kids, and wants to have fun can be a leader," says Sarah Barnett, STEM executive for the BSA's Great Smoky Mountains Council. "You don't want leaders to have all the answers; you want [the Lab] to figure things out together."

Barnett was charged with recruiting Scouts, leaders, and chartering organizations for the pilot program, which launched in Fall 2014. McMillan says the response was "overwhelming." The original recruitment goal was 300 children by May 2015. They suspended registration in December 2014, with 376 children and 75 adults registered in the pilot program.

"Almost every school was giddy to get in," says Barnett. Although recruiting adult volunteers could be challenging, "we have found we've gotten what we needed," she notes. "What we have found is in some areas, it is a little easier to get the leadership component [compared to] the traditional side [of scouting]. There have been a few teachers interested in being a Lab manager or associate Lab manager." She reports that registrations at renewing schools have typically exceeded last year's numbers.

BSA has not assessed what STEM Scouts have learned, but Barnett has heard anecdotally from parents that their children's in-school performance has improved. "I've heard from several parents," she says. "One in particular said last year, her child tested very well above average in science, likely because of hands-on science [experience in STEM Scouts]. One parent said her child said he was disappointed [when the school year ended] because there was no STEM Scouts in the summer."

STEM Scouts' success in Knoxville has led to a national expansion of the program this fall. Labs are being established in Connecticut, Texas, Illinois, Colorado, Indiana, Missouri, Arizona, New Jersey, and Wisconsin. McMillan and Nichols are working with Robert Tai, EdD, at the University of Virginia to conduct assessments of what Scouts have learned to evaluate the educational effectiveness of the program.

Summer STEM

To foster STEM interest through the summer, Barnett says the local council offered a summer STEMology Camp. The week-long day camp incorporated a variety of STEM challenges for children, such as making giant bubbles by crafting their own bubble wands and preparing their own bubble solution, magnetic slime, and oobleck.

"We wanted to keep them interested in STEM [since most Labs didn't meet during summer]," she recalls. "We wanted to give them an opportunity to do something with STEM, wanted to make sure we're still fostering their excitement about STEM. Some things we might want to do in a Lab, but wouldn't have time. It was a good way for Scouts to meet others outside their Lab. They could meet new people, experience new things, but still have a common interest." ●

Teaching the Art and Science of Glass

Glass is ubiquitous, serving countless functions and taking endless forms. It has been used for thousands of years to create works of art and fulfill practical applications. Educators even use it to inspire critical thinking and scientific curiosity among their students.

In Jamestown, North Dakota, Bonnie Tressler decided to incorporate the arts into the science, technology, engineering, and mathematics (STEM) the town's fifth graders had been learning. As the artist-in-residence, she worked with nine teachers in six schools.

"For the last three to four years, I've been on the STEAM [science, technology, engineering, arts, and mathematics] team at the North Dakota Council on the Arts," Tressler explains. "I decided I wanted to include what I had been learning" at professional development events. She worked with the teachers, who had to apply for incentive grants to fund a special project that centered on glassblowing and the art of American glass sculptor and entrepreneur Dale Chihuly.

"I wanted to connect the science of making glass" to recycling and reuse campaigns, she continues. Since working with glass presented significant safety challenges, the students cut and painted plastic bottles to create artwork while discussing recycling and reusing items, as well as how glass was made. She acknowledges that connecting the plastic bottles they were using to glass was "a weakness of the project," but "kids got the idea" that glass is made from a mixture and learned about states of matter. "The teachers also explained how glass starts as silica," she adds.

In addition to the challenge of coordinating the project with so many teachers, Tressler says not all of the teachers were convinced that "you can teach science" through the arts. However, the project was successful, she says.

"I think I proved in the end by getting it in the classroom, getting kids [working with] bottles, their curiosity was piqued," Tressler says. "I'm not sure if kids would have asked the same quality of questions…that in turn made teachers see that a lot of lessons can come from questions [raised by students]. I think a lot of them plan lessons [without] any [input] from students. [This project] led to lessons based on student questions."

"They talked about how molecules in liquids, gasses, and solids move differently. They were really excited about it. It was something new to them, something fresh," recalls Anita Frey, fifth-grade teacher at William Gussner Elementary School. "We were talking about math: how much glass weighs, how hot [the temperature has to be to melt it]. In language arts, [students had to demonstrate] listening skills, telling us back, 'What did you learn? What did you find really neat?'"

The project culminated in a field trip to the Jamestown Arts Center, where some of the plastic bottles they had been working with were repurposed into a sculpture and Fargo glassblower Jon Offutt demonstrated glassblowing.

"He showed them how he works with glass. They got really excited when he asked me to dip [a rod] into melted glass. He grabbed glass [on the end of the rod] and asked [students] how far they thought it could stretch. They guessed several feet, then longer. He got all the way to the arts center before the glass broke. Kids were amazed to know that's what fiber optics are made out of," Frey says.

Working With Glass at MIT

The MIT Glass Lab, housed in the Department of Materials Science and Engineering, introduces the art and science of glassmaking to middle school and MIT students alike.

"The Glass Lab gives demos for materials science classes, sometimes other classes if they want a concept illustrated," explains Program Director Peter Houk. "There is a huge amount you can learn about from the physics of glass, the chemistry of glass."

Michael Cima, the David H. Koch Professor of Engineering and faculty director of the Lemelson-MIT Program in the Department of Materials Science and Engineering, says MIT faculty have been incorporating Glass Lab demonstrations into their curricula throughout his 30 years at the institute. The demonstrations can illustrate a number of principles, including heat transfer, fluid mechanics, viscosity, and strain energy. One of Cima's favorites, the Prince Rupert Drop, illustrates strain energy in a "very dramatic way that's hard for them to forget," he says.

"Basically, you take molten glass and drop it into water. The drop stores an immense amount of strain energy," Cima explains. He invites students to take turns hitting the glass drop with a hammer. The strain energy within the glass prevents it from shattering. However, a small thread of glass formed at the end of the drop when the molten glass fell off the rod. "The drop turns to dust when you break that little thread. It goes off with a bang!" he exclaims.

"The Glass Lab is open to students all over the institute. There are lots of activities that bring in students in physics, engineering," Cima continues. "It's very popular…we've doubled the size of the lab in the past year, and we're nowhere near meeting demand… These are activities that are real, not theoretical. There has always been an element of learning at MIT that is associated with learning by doing. It's tapped into the interest of students."

While many MIT students visit the Glass Lab for demonstrations or to create instruments for the institute's Glass Band, middle school students from Cambridge, Massachusetts, can work with molten glass during the summer Science and Engineering Program for Middle School Students. MIT's Center for Materials Science and Engineering (CMSE) has run the National Science Foundation (NSF)–funded program since 1992. (The center is funded as an NSF Materials Research Science and Engineering Center.)

The summer program is "designed to expose kids in inner-city schools… to careers in engineering," says Houk. "It's more hands-on than academic. We have really limited time with them, so it's really important for them to have direct experience with glass.

"These are pretty young kids. We're not overtly saying, 'Look, you can have a career in science and engineering.' We're trying to make them curious, get them excited about the material. If we can do that, they'll start asking the questions," he adds.

"It's a week-long program," says Susan Rosevear, CMSE education officer. "The objective of the program is to introduce students to materials science and engineering, to convince them that science and engineering [are] fun. There is no classroom teaching, per se. Essentially the glassblower focuses on teaching them to use tools, where the glass came from, temperature…As they're doing, they're learning about states of matter, although we're not using this terminology...We talk about thermal properties, why cool air on the outside pressing on hot glass makes it crack. In that way, [students are] learning about those things, but it's not typical [classroom instruction]. "

Rosevear says they have heard from teachers that the students are more willing to take academic risks and are more excited. In addition, the teachers are able to refer to the experience when discussing content during the school year.

"When I set up the program, I tried to cover a number of different materials. Glass, metal casting, polymers, circuit building," remarks Rosevear. "But glass and metal are very fundamental." ●

Quotable

There is no greater education than one that is self-driven.

—Neil deGrasse Tyson, U.S. astrophysicist and science communicator

Storytelling and Neuroscience

By Carolyn Hayes, NSTA President 2015–16

I have a degree in biology and taught biology at the high school level, but I didn't truly appreciate neuroscience until after I retired from public school teaching. While participating in a teacher leadership academy, I met Pat Wolfe, EdD, and found myself having many "Aha!" moments about my teaching. Who would have thought that telling stories to my students and having them role-play scenarios would enhance their learning? I knew that my students were having fun, but I never realized the impact I was having on their learning.

After that first encounter, I attended more of Wolfe's workshops and sought out books and articles about neuroscience and how to apply it to my teaching. The publications *How People Learn* and *How Students Learn Science in the Classroom* also helped me to reflect on why particular strategies were more effective than others. One interesting strategy was the use of stories found in real-world scenarios and literature—particularly those related to scientists' struggles and successes.

Teachers today are realizing the value of literature in the teaching of science and that stories offer a way to connect with all students regardless of their background. NSTA publications such as *Picture Perfect Science Lessons* and *Start With a Story* provide teachers with examples of how to use stories to engage their students and teach science. Elementary science teachers are developing curricula that incorporate reading into their science classes instead of teaching subjects within silos. College professors are using case studies to help students develop critical-thinking skills. Stories such as that of Henrietta Lacks and the impact her cancer cells have had on science are challenging students to question ideas and analyze findings. Stories that reveal discrepant events place students in the role of problem solver or urge them to determine why one method works better than another.

Why are stories so effective in a science classroom? Storytelling is an important part of the cognitive process. Using the principles of neuroscience, teachers are tapping into the power of storytelling to guide their teaching of science and to promote student learning.

Students come to our classrooms seeking ways to link new science content to their past experiences. They are trying to connect what they already know to what is being taught. Telling a story or presenting a real case study causes their brains to search their existing neural networks to find that connection. This results in students asking questions about the story and wanting to know more. These questions lead to experiential opportunities such as a laboratory exploration helping students understand the content and connecting it to their neural network.

Now ask yourself, "What was my favorite lesson in science class?" Undoubtedly, you were excited, had fun, and felt safe. Emotion is a primary catalyst in the learning process. Because the amygdala, the center of emotion, is so close to the hippocampus, where memories are created, you will have a better memory of these experiences over other ones in which the learning was not very challenging.

Storytelling is an example of a positive emotional experience. After hearing a story, students will want to know "what's next?" or "how does it work?" This results in more experiential activities and a better learning environment.

Stories are important to our students. They not only "hook" their attention, but they also challenge their thinking. Stories promote curiosity and elicit prior knowledge.

Use stories in an instructional sequence such as the 5E Learning Cycle. Telling a story will get the attention of the student's brain and provide a means to *engage* the student. The questions students generate will allow their brains to interact with the science content through *exploration*. That exploration creates opportunities for students to *explain* the meaning of what they have learned. Students reinforce the content they have learned by *extending* their knowledge to a new scenario provided by the teacher. Finally, the teacher and students *evaluate* each student's ability to demonstrate his or her learning of the content.

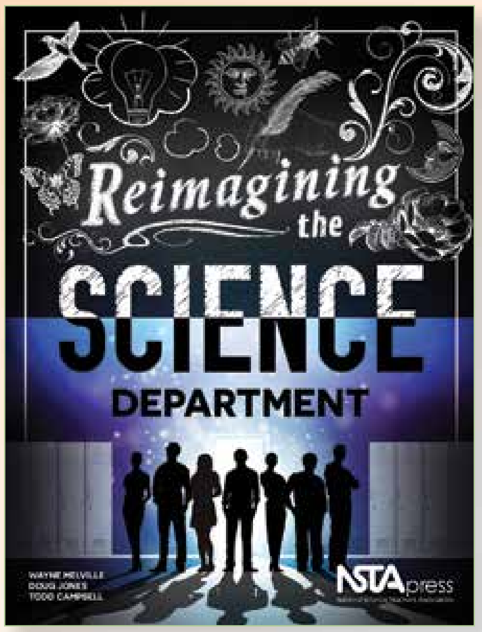
So tell your stories! Use them to inspire your students, to challenge their thinking, and to have fun. Make sure you also share your stories with other teachers. I hope that when I see you at one of the NSTA conferences, you will tell me your stories and I will tell you mine. My favorite is *As the Cell Turns*. ●

Quotable

Nature doesn't put the world into silos of science, technology, engineering, and math. We do that.

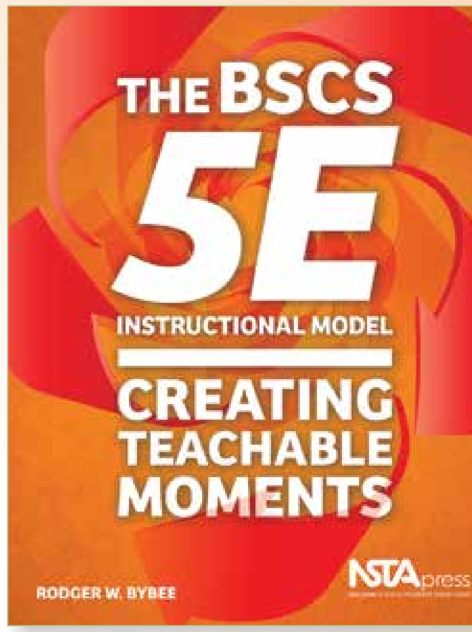
—Ainissa Ramirez, U.S. scientist and educator

LEAF THROUGH THESE NEW BOOKS



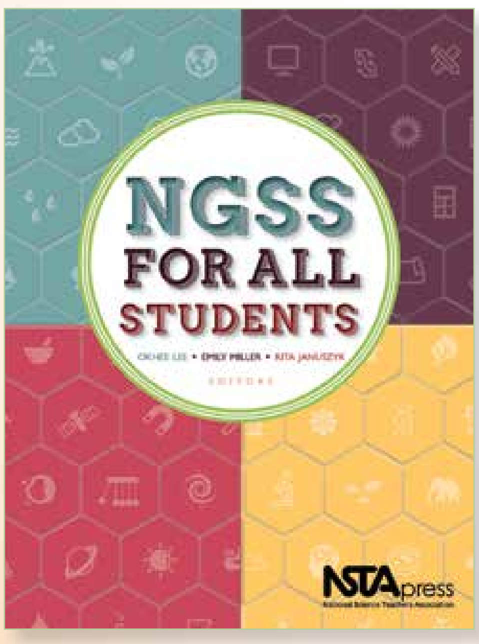
Grades K–12

Book: Member Price: $23.96 | Nonmember Price: $29.95
E-book: Member Price: $19.47 | Nonmember Price: $22.46
Book/E-book Set: Member Price: $31.15 | Nonmember Price: $38.94



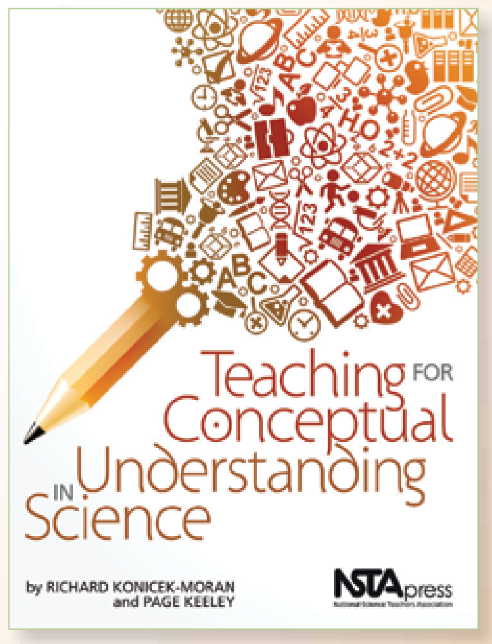
Grades K–12

Book: Member Price: $25.56 | Nonmember Price: $31.95
E-book: Member Price: $20.77 | Nonmember Price: $23.96
Book/E-book Set: Member Price: $33.23 | Nonmember Price: $41.54



Grades K–12

Book: Member Price: $27.96 | Nonmember Price: $34.95
E-book: Member Price: $22.72 | Nonmember Price: $26.21
Book/E-book Set: Member Price: $36.35 | Nonmember Price: $45.44



Grades K–12

Book: Member Price: $27.16 | Nonmember Price: $33.95
E-book: Member Price: $22.07 | Nonmember Price: $25.46
Book/E-book Set: Member Price: $35.31 | Nonmember Price: $44.14

To place an order or download a free chapter, visit
www.nsta.org/store

NSTA National Science Teachers Association

PULL-OUT SECTION

SCIENCE TEACHERS' GRAB BAG

Inside this Convenient Pull-Out Section you will find:

Freebies for Science Teachers

Resources for Atmospheric Sciences. The University Corporation for Atmospheric Research (UCAR) Center for Science Education provides K–12 educational resources and teacher professional development in the field of atmospheric sciences. Educators can access multimedia web content, videos, games, interactives/simulations, and lesson plans on weather, climate, and other atmospheric phenomena. The materials can be used in the classroom or as a "refresher" for teachers who want to deepen their understanding of atmospheric science.

Popular topics include clouds and the layers of the atmosphere as well as units on severe weather, climate change, and pollution impacts. Don't miss the virtual "Teaching Boxes," which present curated materials on a single topic (e.g., air quality, climate and water, El Niño, greenhouse effect, nature of science, and others) in an accessible format. Visit *http://bit.ly/1JvhpDC*.

Energy and Agriculture. Show students how energy education and agricultural literacy connect through curriculum units from the American Farm Bureau Foundation for Agriculture. Available in middle level and high school versions, each unit provides five comprehensive lesson plans that support the *Next Generation Science Standards* (*NGSS*), along with resources for further learning. The high school curriculum, which includes hands-on activities and a lab investigation, explores topics such as energy flow and transmission, where commodities come from, renewable energy comparison and analysis, biodiesel, and issues surrounding farming with renewable energy. The middle level curriculum addresses energy forms, energy input and food production, energy distribution, and energy careers. Access the materials at *http://bit.ly/1KFc7GF.*

KONFLIKTY.PL

Aviation 101. This online course features nine video lessons on aviation fundamentals, such as aircraft systems, aerodynamics, flight instruments, radio communication, aeromedical effects, and aviation weather. Teachers and high school students can watch the videos to explore aviation concepts in the classroom or learn about careers in the field. Students (and others) who complete the course receive a certificate of accomplishment. Refer to *www.Aviation101.org*.

Think Earth. Teach students in grades K–3 about the environment and how to protect it with these lessons from Think Earth Environmental Education Foundation. Core concepts include learning about the benefits of trees and the importance of conserving natural resources (kindergarten); using resources wisely (grade one); finding ways to minimize pollution (grade two); and understanding how waste from the production, distribution, consumption, and disposal of products contributes to pollution (grade three). Family Activity Sheets reinforce the lesson content and help students continue Think Earth behaviors at home. Additional units for grades 4–9 are in the works. Visit the website *http://thinkearth.org/curriculum*.

The GeoMentors Program. As part of the national Connect ED Initiative, Esri—a Geographic Information System (GIS) software company—is offering its digital mapping and data analysis program, ArGIS Online, to K–12 educators in the United States. The software can be incorporated into any subject or grade level to support curriculum standards and enhance students' experience with technology. The program also provides a GeoMentor (see *www.geomentors.net*)—an educator or other professional skilled in using the ArGIS program—to help teachers use the software effectively in their classrooms. GeoMentors can suggest ideas for incorporating the software into the curriculum and provide access to instructional resources that use the software within existing science curricula.

For example, Earth Science GeoInquiries are short activities that use advanced digital mapping technologies to extend map-based concepts presented in leading middle level Earth science textbooks, including topographic maps, remote sensing, landforms, earthquakes, volcanoes, and other topics. (Refer to the website *http://arcg.is/1gsadCg*.)

See Freebies, pg G2

Freebies, from pg G1

Inside Science Lesson Plans. Spark excitement in the physics classroom with attention-grabbing videos and accompanying standards-based lesson plans from Inside Science, the American Institute of Physics' news and information service. In the video *Ping Pong Balls Break the Sound Barrier* (*http://bit.ly/1hj6Qgr*), students observe how an hourglass-shaped nozzle on an air cannon can accelerate a ping-pong ball to supersonic speeds, propelling it through wood and soda cans and even denting steel. In the video *Bubbles, Bottles, and Breakage* (*http://bit.ly/1GqRfCb*), students observe how a rubber hammer striking the mouth of a glass bottle filled with water can cause the bottom of the bottle to shatter or fail. Accompanying lesson plans, adaptable for grades 7 to 12, provide ideas for using the videos in multiple ways, such as for bell ringers, exploration activities, and reading and writing activities that build scientific literacy.

Build a Model Seaplane. In this engineering design activity, teams of upper-elementary students build a model glider based on a Navy-Curtiss NC-4 Flying Boat—the first aircraft to fly across the Atlantic Ocean. Students then test the gliders to see which one flies the farthest, learning about engineering design and trial and error (and success and failure) along the way. The activity includes student instructions, suggestions for modifications to balance the plane, and a photograph of an actual Navy-Curtiss NC-4 Flying Boat to label. Click on Elementary School Projects at *http://1.usa.gov/1OPrYcB*.

Speaking of Chemistry. A production of the American Chemical Society's *Chemical and Engineering News*, this program features short (two- to four-minute) videos on weird and otherwise interesting chemistry issues. Topics include biodegradable wipes (*Are Flushable Wipes Really Flushable?*), a flower's scent (*Stop and Smell the Volatile Organic Compounds*), pesticides and strawberries (*Are Strawberries Going Away?*), and itching (*Why You Itch—And Why You Shouldn't Scratch*). Middle and high school teachers can use the series to spark science conversation in their classrooms. Subscribe to the series at *http://bit.ly/CENOnline* or follow it on Twitter @CENMag.

PATSY LYNCH

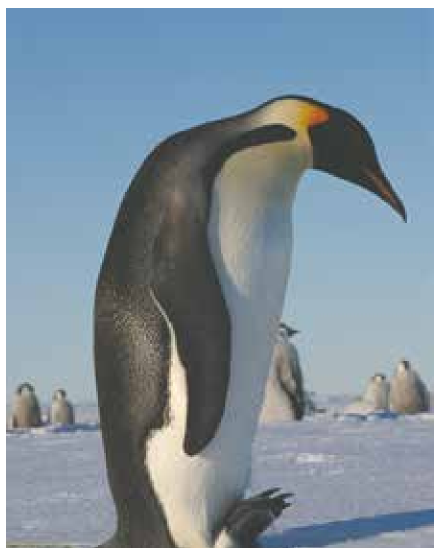
Next.cc for Integrating Art and Science. Growing evidence suggests that arts integration can enhance science, technology, engineering, and math (STEM) skills and spark creativity. How? Read the blog post at the design learning website Next.cc (*www.next.cc/blog*), which discusses how the *NGSS'* crosscutting concepts promote innovative thinking through science and art integration. The goal is to help educators see how the new science standards promote informal and cross-disciplinary learning.

Dynamic Periodic Table. As high school students learn more about the impact of various elements (heavy metals, gases, acids, etc.), you can use this virtual interactive periodic table to teach them more about the elemental players. Learn more and watch a demo at *www.ptable.com/about.html*.

izzit.org. In search of educational videos and other resources that promote critical thinking and respectful debate among students? At *www.izzit.org*, registered teachers can access DVD-centered teaching units with teachers guides containing worksheets, lesson ideas, discussion questions, and more. The site also offers articles about current events that include discussion questions, vocabulary words, and educational videos. Among the science resources is the video *Power to the Planet* (grades 4–12), which explores the pros and cons of our eight main energy sources: coal, oil, natural gas, nuclear, hydro, biomass, wind, and solar.

3D Printing in the Classroom. Educational technology guru Kathy Schrock has a web page of resources on 3D printing. The page contains publications, lesson plans, videos, and tutorials about 3D printers and how they can be used in K–12 classrooms. Highlights from the page's many resources include the infographics The History of 3D Printing and How 3D Printing Works, and two Pinterest boards with images of 3D printing developments and successes around the globe. Visit *http://bit.ly/1OnT8Yb*.

Ohiorc.org. You don't have to live in Ohio to benefit from the Ohio Resource Center's wide range of materials for preK–12 science education, organized by topic. The categories address everything from current news on the latest science discoveries to resources for new teacher survival and science safety in the lab. Science Bookshelf (grades K–5) presents noteworthy children's trade books, and Science Mini-Collections (grades preK–12) features online resources focusing on specific topics. See *http://bit.ly/1JV8hZe*.



HANNES GROBE/AWI

Save the Penguins STEM Teaching Kit. In this kit, middle level students are challenged to design and build a shelter for an ice cube—shaped like a penguin—that reduces heat transfer and keeps the ice from melting. As students work through the kit's five lessons, they explore concepts related to heat and energy and learn the basics of engineering design. They also develop an understanding of who engineers are: people who design solutions to problems. Visit *http://bit.ly/1PefpHe*.

Growing Gardeners: Lessons for PreK and K. Help young students discover the joys of gardening with these 16 lessons from George Watts Montessori Magnet school in Durham, North Carolina. The lessons are presented in a traditional Montessori format and can be used to extend students' science, language, and math learning. Titles include Sensorial Experiences in the Garden; Importance of the Sun, Water, and Soil; The Way Things Grow; and Measuring in the Garden. Refer to *http://bit.ly/1WHdVY0*.

AP Lessons in Calculus, Physics. At edX (*www.edx.org*)—an online source for higher education instructional content—teachers can access course modules aligned with the curricula taught in AP Physics and Calculus. The self-paced modules use video segments and interactive activities to develop digital skills and prepare students for their AP exams. The modules were created as part of Davidson Next, an initiative striving to offer supplemental, blended-learning opportunities for AP students, with an emphasis on students who lack access to AP teachers or who are traditionally underserved in college classes.

Epic! for Educators. This growing library offers thousands of picture books, chapter books, early readers, nonfiction books, and graphic novels (including science titles) that elementary teachers can use to complement the curriculum. Registered teachers can receive unlimited access to the books and customized recommendations for their students' age levels and interests. They also can create up to 30 student profiles and track students' reading progress. Epic! is available for iPads, iPhones, and Android devices and can be used with any web browser. Learn more at *http://bit.ly/1DQbFIQ*. ●

News Bits

- **In 2016, Alabama students will be required to learn about evolution and climate change for the first time, thanks to recent changes to the state's science education standards.**

Unanimously approved by the board of education, the new guidelines will require students to use evidence to support evolutionary theory and to analyze humans' impact on the planet. In addition, the standards mandate a shift away from teaching methods encouraging "regurgitation" to those that develop "higher-order thinking," says Steve Ricks, who led the initiative to update the standards. "No longer can a teacher take a textbook and have students just read it and answer questions," Ricks adds.

State officials hope the new guidelines will improve students' scientific literacy. Only 21% of 10th graders in Alabama meet or exceed national science testing standards, and the state ranked 37th out of 50 for ACT science scores last year.

Though the new standards require the teaching of evolution, they don't mandate removal of stickers in Alabama textbooks that label it a "controversial theory." A committee will review the stickers' compliance with the new regulations in November. Read more at *http://huff.to/1KVHQEv* and *http://to.pbs.org/1hfNoRR.*

- **Middle school students in high school classes? That's the trend in some New York and New Jersey school districts.**

Students at New Jersey's Valleyview Middle School, for example, can now take select high school science, math, and language classes. About 20% of Valleyview students have enrolled in these courses, which help them fulfill the prerequisites needed to take more advanced classes in high school. Students don't receive high school credits for these courses, but the courses help them avoid doubling up or taking summer classes if they want to be eligible for more advanced courses later on.

In New York's Baldwinsville Central School District, enrollment in Regents prep classes for science and math became mandatory this fall for sixth and seventh graders. And next year, those seventh graders will take Regents algebra and Earth science classes. Students will earn high school credits for the courses.

"By making a decision at the end of sixth grade and putting these kids on two tracks, students who weren't on that accelerated track never had the chance to catch up," says Superintendent David Hamilton. The new program allows all students to enter high school with four credits and thus be able to enroll in more advanced classes later on, he explains.

Some parents have expressed concerns about the program. "If given the option, I would not have my daughter go into the accelerated program," says Kim Sullivan-Dec. "She takes a little bit more time, and I don't think they're building in the time."

Hamilton says the district will revisit the supports in place if many students are struggling. Read about the New Jersey courses at this website: *http://dailyre.co/1OcuxWa;* the New York ones at *http://bit.ly/1QPgALv.*

- **In a recent iPlant Collaborative poll, 95% of biologists nationwide report working with large datasets, but nearly two-thirds have little to no experience in bioinformatics, and only a third say their institutions have adequate computational resources. The National Science Foundation–funded "RNA-Seq for the Next Generation" project seeks to bridge this gap by giving undergraduate biology faculty tools to better understand and teach big data and bioinformatics.**

"The average bench biologist cannot analyze this data [independently]," says Jason Williams of iPlant Collaborative, which has partnered with the DNA Learning Center on the three-year project. They "either ask a collaborator to analyze the data for them or hire somebody to try and analyze it." He says the project's "primary purpose is to get this into the classroom so that students will be doing the same experiments and working with the same datasets as any biologist in a lab at an institution."

Participating faculty receive the high-performance computing resources they need to generate and analyze their own genome-scale datasets and answer related research questions. "We trained biologists so that they would feel comfortable bringing their own RNA-seq experiments into the classroom…We want researchers to combine their own interests with their teaching and use [these resources] as a tool to not only analyze data for themselves, but to work with students as well," Williams maintains. Learn more at *http://bit.ly/1Lo4OcU.*

- **Middle schoolers in Georgia and New York conceived and designed school products as part of the Designed by Students initiative. Sponsored by Staples and the nonprofit Tools at Schools, the project pairs students with professional designers who help them turn their ideas into products.**

For several weeks, students at Middle School 88 in Brooklyn and Ron Clark Academy in Atlanta worked as designers do. Teachers scaffolded their thinking by having them create idea boards on what inspires them, the problems they face as students, and their "big ideas" for solving them. Design experts visited the schools to help them.

"We used that time together to ask questions, to allow students to really talk through their ideas," says Renat Aruh, cofounder of Tools at Schools and a product designer based in New York. "We were there to offer support and help them figure it out—not to give answers."

The result was a portable, foldable desk that students can use to do homework nearly anywhere. Students turned their prototype over to Staples, which created the final product and made it available on the store's shelves this fall. Read more about it at *http://bit.ly/1WBrHvq,* and learn how your school can get involved at *www.tools-at-schools.com.* ●

What's New

FROM U.S. GOVERNMENT SOURCES

U.S. Fish and Wildlife Service (FWS)

Conservation Connect LIVE! Broadcasts

Connect your students with conservation professionals during the Fish and Wildlife Service's new broadcast series. Free Conservation Connect web-based videos aim to link youth ages 10–14 with the great outdoors and conservation careers. Students can view a FWS Conservation Connect episode at *http://1.usa.gov/1jOymnW* and chat with featured professionals, asking them questions about wildlife, careers, and new technology the FWS uses to study our natural world.

Broadcasts take place at 2 p.m. Eastern Time (ET) on the third Wednesday of the month, November 2015 through May 2016. Educator resources and featured videos are available at the website *http://1.usa.gov/1L0jGLs*.

National Institutes of Standards and Technology (NIST)

'Do It Yourself' Watt Balance

Watch NIST's 10-minute "mock infomercial"—targeted for high school and college physics students—to see the process of building a LEGO® watt balance. Watt balances are ultra-precise weighing instruments that are playing a key role in the current international effort to redefine the kilogram. Watt balances work by making an indirect comparison between mechanical power and electrical power: They measure the downward pull of a gravitational force on a mass by counteracting it with an upward electromagnetic force; their design makes watt balances capable of ultra-precise mass measurements.

The LEGO version of the instrument employs the same basic principles as a full-sized watt balance. Teachers can build a "DIY" watt balance in the classroom using LEGO bricks and basic electronics and provide students with a firsthand connection to the scientific community's ongoing effort to redefine the world's basic unit of mass. Access the video and an accompanying paper from the *American Journal of Physics* (*AJP*), which offers detailed instructions and a list of parts, at *http://1.usa.gov/1PVTOSs*.

U.S. Forest Service

Natural Inquirer Scientist Card Series

Introduce middle level students to natural resource science careers with the Natural Inquirer Scientist Card Series. Produced by the Cradle of Forestry in America Interpretive Association and the U.S. Forest Service, the cards highlight Forest Service scientists from around the country, including ecologists, social scientists, wildlife biologists, astacologists, entomologists, engineers, and foresters. Each card has a photograph of the scientist in the field as well as a description of the type of science he or she conducts, the research questions he or she answers, the equipment used in the scientist's research, and favorite scientific discoveries he or she has made. The cards are available in various sets: A full set (100 cards) or Women in Science, Classroom, and Wildlife Series (30 cards each).

In addition, teachers can access a standards-based lesson to incorporate the use of the cards in the classroom. In the lesson, students select a card and present information about their scientist to their classmates; they then use the card as a template to create a scientist card about themselves. Visit *http://bit.ly/1RudJsn*.

National Park Service

Every Kid in a Park Program

The White House's Every Kid in a Park program invites fourth-grade students in the United States—and their families—to visit U.S. national parks for free. The program aims to inspire students to become environmental stewards who want to preserve and protect national parks and other public lands. At the web page *www.everykidinapark.gov*, students and teachers complete an activity introducing federal lands and the importance of preserving them for public use. In the activity, students research a national park of their choice and create an informational brochure about it. Afterward, teachers print free entry passes (valid through August 31, 2016) to more than 2,000 federal recreation areas, including national parks.

In addition to the classroom activity, students can complete an online "adventure diary" to learn more about federal lands, and parents can access trip planning tools, safety and packing tips, and other information to make the most of their visit to the national park.

National Institutes of Health (NIH)

National Drug and Alcohol Facts Week (NDAFW)

Get set for NDAFW, January 25–31, 2016! This annual, week-long observance—created jointly by NIH's National Institute on Drug Abuse (NIDA) and the National Institute of Alcohol Abuse and Alcoholism (NIAA)—brings together teens and scientific experts at community-based events around the country for discussion about substance abuse and addiction and how to prevent them. Schools, community groups, and other organizations host events, providing a safe place for teens to get questions answered about drug and alcohol use without judgment. Middle and high school educators and others interested in hosting an event can access planning toolkits and other resources at *http://1.usa.gov/11oGjXQ*.

Noteworthy resources include the booklet *Drugs: Shatter the Myths* (*http://1.usa.gov/1P9YIfT*) and the 2016 National Drug and Alcohol IQ Challenge, an online multiple-choice quiz that tests teens' and adults' knowledge about drugs and alcohol. NIDA's *Choose Your Path* videos present everyday scenarios to help students learn how to prevent prescription drug abuse (*http://1.usa.gov/1LYMSEG*). Scholastic's clickable poster, "Drugs + Your Body: It Isn't Pretty" highlights the effects drugs have on the teen body (*http://bit.ly/1Q8qvf1*). Teachers can also register to participate in the NDAFW Chat Day, January 26, 2016, from 8 a.m. to 6 p.m. ET. Scientists will answer students' questions on drug- and alcohol-related topics in real time.

National Oceanic and Atmospheric Administration (NOAA)

Digital Atlas Activities

NOAA Ocean Explorer missions are full of surprises because they often occur in places no one has ever visited. To help share the excitement of ocean exploration, NOAA's National Coastal Data Development Center (NCDDC) provides a map-based atlas that links to information about past expeditions of NOAA's Ocean Explorer program. The digital atlas can be used to orient students to expedition locations and provide practice in interpreting and analyzing data and associated discoveries from specific expeditions.

Teachers can access a series of activities using the digital atlas at the website *http://1.usa.gov/1YXMWK5*. The first activity, How to Use the Ocean Explorer Digital Atlas, adaptable for grades 5–12, teaches students how the tool is used to determine where specific expeditions were taking place and information about discoveries. It also teaches students methods to work with the data collected from the ship. Follow-up activities build students' skills using the digital atlas, allowing them to use the tool to study a New England seamount (*http://1.usa.gov/1FOoapj*) and an area where cold seeps were found (see *http://1.usa.gov/1PVlR42*). ●

In Your Pocket

Editor's Note

*Visit **www.nsta.org/calendar** to learn about more grants, awards, fellowships, and competitions.*

November 20–30

National Wetlands Awards

The Environmental Law Institute's awards go to individuals who have made significant contributions to wetlands protection and restoration. Awardees receive national recognition and travel to an awards ceremony on Capitol Hill. Nominations can be submitted in one of six categories:

- conservation and restoration;
- education and outreach;
- landowner stewardship;
- science research;
- state, tribal, and local program development; and
- wetland community leadership.

Current and retired federal employees and projects in accordance with the Clean Air Act are not eligible for these awards, and self-nominations are prohibited. Nominate a friend or colleague online by **November 20** at *http://elinwa.org/nominations.*

AAD Shade Structure Program Grants

The American Academy of Dermatology (AAD) awards these $8,000 grants to public schools and nonprofits serving children ages 18 and younger that want to purchase permanent shade structures for outdoor areas that aren't protected from the sun. Recipients also get a permanent sign that explains the importance of sun protection to display near the structure.

Applicants must be recommended by AAD dermatologists, and applications must demonstrate a commitment to sun safety and be considering a shade that meets AAD requirements. Apply by **November 25;** visit *http://bit.ly/1iMkI3K.*

Wyland National Water Is Life Mural and Art Challenge

This challenge asks students in grades K–4, 5–8, and 9–12 to submit classroom murals that portray the impact of climate change on our coasts. The winning class in each category will receive a $250 Michaels' gift certificate for art supplies and a signed piece of Wyland artwork. At least five students in each class must also submit entries to the individual art contest on the "Our Coasts and Climates" theme.

Submit both class and individual entries by **November 25;** see the website *http://bit.ly/1j9njF4.*

SeaWorld Environmental Excellence Awards

These awards recognize students, teachers, researchers, and other individuals working at the grassroots level to protect and preserve the environment. The organization funds work in four major areas: conservation education, species research, habitat protection, and animal rescue and rehabilitation. Apply by **November 30;** consult the website *http://bit.ly/1FvfiQe* for details.

Reading Is the Way Up Literacy Grants Program

City National Bank awards grants to support literacy and financially-based literacy projects at public and private elementary, middle, and high schools in California, Nevada, New York, Tennessee, and Georgia. Grants will provide up to $500 for the recipients to create, augment, or expand literacy projects that are judged to be creative and engaging and that may help improve student achievement. Awards can also be used for books, videos, CDs, DVDs, computer software or hardware, or in other ways as long as the recipient shows that the project for which funds are sought will support literacy and financial literacy.

Applicants from the same school may apply individually or as part of a team. Each team may receive up to $1,500. Any full-time teacher, librarian, or administrator at schools in the five states where City National has offices is eligible to apply.

The deadline is **November 30.** Apply online at *http://bit.ly/1Mf6m3B.*

December 1–4

AAPT's Barbara Lotze Scholarships for Future Teachers

The American Association of Physics Teachers (AAPT) provides grants of $2,000 and one-year AAPT student memberships for aspiring physics teachers. Undergraduate students enrolled in physics teacher preparation programs at accredited two- or four-year universities, or high school seniors admitted to such programs, are eligible. Applicants should show academic promise and be U.S. citizens. Apply online by **December 1** at *http://bit.ly/1N2jAq3.*

Maley/FTEE Technology and Engineering Teacher Scholarship

The Foundation for Technology and Engineering Educators (FTEE) provides these $1,000 scholarships to help teachers improve outcomes in their classrooms. Technology and engineering teachers at any grade level who are beginning or continuing graduate study and are International Technology and Engineering Educators Association (ITEEA) members may apply. Applications are due by **December 1;** see *http://bit.ly/TXsDxJ.*

Greer/FTEE Grant for Technology, Engineering Educators

The FTEE also provides $1,000 grants to help teachers and supervisors in technology and engineering education in grades 6–12 attend the ITEEA Annual Conference. Applicants must be ITEEA members, have already registered to attend the conference, and not have attended more than three previous conferences. Apply by **December 1;** refer to *http://bit.ly/OxTttX.*

ITEEA's Teacher Excellence Award

ITEEA presents this award to technology and engineering teachers who have made significant contributions to the field and to their students' success. Winners at the state or local level receive a plaque, a one-year ITEEA membership, and a discounted rate for and recognition at the ITEEA Annual Conference.

ITEEA members who incorporate technology and engineering in their curriculum and have been teaching for at least three years are eligible. Nominate yourself or a colleague by **December 1;** see *http://bit.ly/1KSz9Ll.*

Partners in Science Program

This MJ Murdock Charitable Trust program helps high school science teachers work with a mentor to conduct cutting-edge research over the course of two summers. The goal is to bring the knowledge gained from these research experiences back to the classroom to promote hands-on learning. About 25 grants are awarded each year to teachers in the Pacific Northwest. Participants must arrange their own partnerships, though some guidance is provided.

Apply by **December 1.** Consult *http://bit.ly/VfZmvR.*

Space Foundation Teacher Liaisons

The foundation invites educators who teach about space to apply for this program. Teacher Liaisons receive training and cutting-edge resources to further integrate space in their classrooms and serve as links between the foundation and their respective schools and districts. Liaisons also work with other space organizations, such as NASA. Once selected, Liaisons remain active in the program as long as they continue to meet its requirements.

Public and private school and homeschool teachers; school administrators; and informal educators in preK–20 settings are eligible. Apply by **December 4;** see *http://bit.ly/ V3cPbO.*

December 13–31

Kennedy Center/Stephen Sondheim Inspirational Teacher Awards

The Kennedy Center in Washington, D.C., seeks nominations for these awards, which honor teachers who have made a significant difference in their students' lives. Awardees will receive $10,000 and be showcased along with the people they inspired on the organization's website.

Only former or current students can nominate a teacher for this award. Nominees must be legal residents of the United States and have taught at a K–12 school, college, or university. Teachers in all subjects and grade levels are eligible.

Nominate your favorite teacher by **December 13.** Learn more at the website *http://bit.ly/18BIrcj.*

Teaching Tolerance Award

This award, sponsored by the Southern Poverty Law Center, honors five teachers who are doing transformative anti-bias work in their classrooms. K–12 teachers working toward prejudice reduction, improving intergroup relations, and equitable school environments are eligible.

Winners receive $2,500 and travel to Montgomery, Alabama, for an awards ceremony, where they will share their methods with attendees. Apply by midnight Central Time on **December 15.** For more information, visit the website *http://bit.ly/1KMHBxR.*

NAGT Outstanding Teaching Assistant Awards

This National Association of Geoscience Teachers (NAGT) award honors 30 outstanding teaching assistants (TAs) in geoscience education. Winners receive a one-year NAGT membership, which includes a subscription to the *Journal of Geoscience Education* and the *In The Trenches* quarterly magazine.

Both graduate and undergraduate TAs are eligible and must be nominated by the department chair or faculty member coordinating TAs. Submit nominations by **December 15** at *http://bit.ly/10WLGZO.*

Paul DeHart Hurd Award

The National Middle Level Science Teachers Association (NMLSTA), an NSTA Affiliate, offers this $1,000 award to an outstanding middle school science teacher who has demonstrated leadership in sharing his or her skills and ideas with others. In addition to the cash prize, the winner will also receive a complimentary one-year membership to NMLSTA and a plaque. The award will be presented at the NSTA national convention at the NMLSTA Share-a-Thon during the following calendar year.

Applicants must be NMLSTA members and full-time middle school science teachers with at least three years of teaching experience. Entries must be postmarked by **December 15.** For more details, visit *http://bit.ly/1N8Q6qB.*

United States-Japan Foundation Educational Grants

The foundation promotes stronger ties between Americans and Japanese and provides grants for projects that support mutual understanding, create effective communication channels, and address common concerns. Of particular interest are precollege teachers who wish to study topics related to the United States–Japan relationship. Interested teachers should submit letters of inquiry by **December 15.** Refer to *http://bit.ly/1rmg9je.*

Scholastic Art & Writing Awards

Since 1923, these awards have recognized talented youth and provided creative teens with millions of dollars in scholarships. Students in grades 7–12 can apply in 29 categories. Winners also have their work published and displayed in a national exhibition in New York City. Teachers of winning students are eligible to receive up to $1,000 in awards.

Students must submit entries by **December 16.** For more details, visit *www.artandwriting.org.*

Katie's Krops Grants for Youth Gardens

This program provides grants to help youth ages 9–16 start a vegetable garden in their community and donate their harvest to people in need. All types of gardens are eligible, whether they are container gardens in a city or vegetable gardens in a neighborhood or school. Grantees decide what kind of garden to grow and where to donate their harvest.

Winners receive a gift card to a garden center in their area, support from Katie's Krops, and a digital camera to document their work, but must commit to maintaining the garden for at least one growing season. Grants to attend Katie's Krops Camp and scholarships are also available.

Postmark applications by **December 31;** learn more at *http://bit.ly/13T3zxS.*

January 1–4, 2016

ACS Dorothy and Moses Passer Education Fund

The American Chemical Society (ACS) provides this grant to support continuing education activities for teachers at two- and four-year colleges and universities with no advanced degree programs in the chemical sciences. Grants support activities that directly relate to the recipient's teaching and take him or her off campus.

Applicants must be full-time faculty members at their college or university and members of the ACS Division of Chemical Education. Apply by **January 1, 2016;** consult *http://bit.ly/XFpNZT.*

Ocean Exploration Trust's Science Communication Fellowship

The fellowship immerses formal and informal educators in the Nautilus Corps of Exploration and empowers them to bring ocean exploration—specifically in the fields of science, technology, engineering, and mathematics (STEM)—to a global audience via the Nautilus Live website. Fellows share accounts of ocean science, expedition operations, and daily life with audiences through live audio commentary and question-and-answer sessions from aboard the ship.

Through participation in live interactions with student groups and public audiences, fellows also engage people of all ages in real-time exploration. Science Communication Fellows then bring their expedition experience back to their own classrooms, organizations, and communities in the form of engaging lesson plans and activities centered around their time at sea aboard *Nautilus* and other vessels. Apply by **January 4** at *http://bit.ly/1OmNghY.*

Apply Year-Round

Green Education Program Grants

The Alternative Fuel Foundation provides grants of $250 to $500 to forward-thinking schools with projects that use alternative fuels and promote sustainability. Those that also encourage parent involvement and build community spirit are preferred. Nonprofit public and private K–12 schools and their associated parent groups are eligible. Applications are welcome year-round; learn more at *http://bit.ly/1N2fkXv.*

The Safeway Foundation's Grants

These grants fund nonprofit organizations dedicated to Safeway's four priority missions: education, hunger relief, health and human services, and assistance to persons with disabilities. Applications are accepted year-round from organizations located near Safeway stores; refer to the website at *http://local.safeway.com* to determine whether your community qualifies.

The next application review period will be in January 2016. For more information, consult the website at *http://bit.ly/1LiLQmi.* ●

Summer Programs

Editor's Note

Visit www.nsta.org/calendar to learn about other summer professional development opportunities.

Developing Academic Literacy and Language in the Content Areas. In this Center for Applied Linguistics (CAL) institute, participants learn research-based strategies and gain hands-on tools for helping English-language learners develop the skills they need to be successful when faced with rigorous academic content. Participants will design activities that bridge students' own literacy skills with classroom literacy tasks, such as argumentation and close reading. Sample unit plans from science, social studies, and English language arts will be presented.

This institute is specifically designed for content area and English as a Second Language (ESL) teachers or other school specialists at the middle and high school level. Collaborative teaching teams and teacher leaders are especially encouraged to apply. The institute takes place July 14–15, 2016, in Washington, D.C.; early bird registration ends on **April 11.** Learn more at *http://bit.ly/1MH79Nn.*

The University of Cambridge's International Science Summer Programme. Located in the United Kingdom, the university is known for the quality of its scientific education and research. Its Science Summer Programme draws on the expertise of the university's senior academics to offer courses for undergraduate and graduate students in the sciences, as well as teachers and other professionals. One-, two-, three-, and four-week options are possible during two summer terms: Term I, July 3–16; Term II, July 17–30. Courses on astronomy, biology, cryptography, immunology, psychology, spectroscopy, and more are available.

Those with a strong interest in science but little formal training are welcome to apply. Register for Term I by **June 20;** Term II by **July 4.** See *http://bit.ly/1hZK0oN.* ●

Students handle a Giant Millipede in the animal handling practical in University of Cambridge's International Summer Programmes' Interdisciplinary and Science Summer Programmes.

Science Educators Are Prepping for the *NGSS*

NSTA Reports recently asked science educators to share their experience in preparing for the implementation of the *Next Generation Science Standards* (*NGSS*). The standards, which have been adopted by 15 states and the District of Columbia, focus on having students do science, not memorize facts.

Most respondents to the informal poll (83%) are in an adopting state or district. Of those, 39% reported that classroom instruction is expected to align with the standards within a year from adopting the standards, 35% within two to three years, 4% within four to five years, and 22% said they didn't know when. Of those in states or districts not adopting the *NGSS,* 81% reported that they are planning to incorporate facets of the standards into their curriculum, while 19% said they didn't know. Educators working toward implementation of the standards said the most common steps they've taken to prepare were reading and studying *A Framework for K–12 Science Education* and the standards as well as attending an introductory professional learning event or conference session on the *NGSS* (82% each). Fifty-nine percent of respondents said they have modified lesson plans to make them more consistent with the *NGSS,* and 54% have attended full- or multi-day training sessions on the *NGSS.* (*Note: Respondents were allowed to select multiple responses*.)

When asked to name the one thing they would request for help in transitioning to the *NGSS*, 35% of respondents selected access to curricular materials and resources aligned to the *NGSS,* 30% opted for high-quality professional learning opportunities, and 22% indicated they wanted support for science from school and district leaders. Educators reported the most common challenge to implementing the *NGSS* is determining how to assess whether students have achieved the standards (57%). Forty-four percent cited adapting lesson plans and finding and selecting instructional resources as challenges. Only 4% reported not encountering any challenges to implementation. (*Note: Respondents could select up to three responses for this question.*)

Many science educators are not sure what to expect about the standards' potential effect on their profession and careers.

Here's what science educators are saying about the impact of the *NGSS*:

[I expect] frustration. My state had the standards grade-banded (which helped), but at the same time, their arrangements don't make sense (in my opinion and those of my colleagues).—*Educator, Middle School, Kentucky*

This will be a major change in what we teach and how, and as a science specialist in a K–6 school, I expect to be very involved in the transition.—*Educator, Elementary, New Jersey*

I am pleased that content and analytical applications and critical-thinking skills are returning to the classroom. I have reservations about the significantly

reduced subject-matter content and how testing will be conducted for the one-size-fits-all curricul[a]. This has been presented as "science for everyone" at the lowest possible level, and our high school honors and AP science classes will be deferred to the student's senior year. Currently our leading students complete two honors science classes and up to three AP science classes before graduation. This does not fit with the sequencing and testing for *NGSS*. Either our students must be redirected to the *NGSS* testable content, or our school test scores suffer. For example, our college-bound science students do not take a fundamental Earth Science class, which could be up to one-third of the *NGSS* test, but these same students will score a 5 in AP Biology, Chemistry and Physics.—*Educator, High School, California*

The *NGSS* ha[s] helped me bring my teaching to a higher level.—*Educator, Elementary, Nevada*

[It means] teaching in a way that gives more ownership to students.—*Educator, Elementary, Middle School, Illinois*

The *NGSS* help me make science relevant for my student[s].—*Educator, Middle School, Massachusetts*

Working through the timing of incorporating the standards and our time in the classroom.—*Educator, Elementary, Louisiana*

I expect it to be a convoluted mess as districts work to interpret what they mean.—*Educator, High School, California*

Time to implement.—*Educator, High School, Tennessee*

I have always taught inquiry-based science. The biggest impact will be interpreting *NGSS* and see[ing] how it aligns to what I am already doing. Time will be spent on writing new versions of standards. I do not think that it will change how and what I am teaching to any great extent, as I am already doing many of the things I have heard about.—*Educator, High School, California*

Improved standards to use for teaching.—*Educator, High School, Idaho*

I am not sure.—*Educator, High School, West Virginia* ●

BLICK ON FLICKS

The Martian Survives Through Science

By Jacob Clark Blickenstaff, PhD

It is beginning to feel like an annual autumn ritual that I should add to raking leaves and carving pumpkins: getting excited about a new "hard" science fiction film. In 2013, it was *Gravity*; in 2014, I was looking forward to *Interstellar*; and in 2015, it is *The Martian*. I first learned about this film from one of my favorite web comics, XKCD (*www.xkcd.com/1536*), and I enjoyed the buildup to its October release.

The film is based on the book of the same title by Andy Weir, a computer programmer and self-described space nerd. Weir discussed the book, and his research for it, on *Science Friday* back in February 2014, when the film was in the early stages of development (listen at *http://bit.ly/1MWWUon*). The movie was released the same week that NASA announced the discovery of evidence of liquid water on Mars, so the Red Planet has been getting more attention than usual this fall, which may have helped out the film at the box office.

The Martian tells the story of Mark Watney (played by Matt Damon), a NASA astronaut in the Ares program who is stranded alone on Mars by a storm and has some very bad luck as his crewmates make the long journey back to Earth. Watney is a botanist (in the book, he is a mechanical engineer as well), and he uses all his skills and sense of humor to try to survive on his own in very harsh conditions. The whole problem of survival is about as cross-disciplinary as a task can be: Watney uses math, chemistry, physics, botany, geology, geography, anatomy, and psychology to stay alive and relatively sane.

To generate enough food to survive for an extra year, he turns his living quarters (the hab) into a potato farm. This includes carting in a huge amount of Martian dirt, fertilizing it with his waste, and creating enough water to keep the plants alive. This last step is the most dangerous, as it involves starting a fire inside the hab. Making water by burning pure hydrogen can be done as a class demonstration (the United Kingdom's Royal Society of Chemistry offers guidelines for this demo at *http://rsc.li/1hounN8*) and could be a neat way to connect the film to chemistry work on stoichiometry, energy conservation, or gas laws.

The press has already devoted quite a bit of coverage to the scientific accuracy (and inaccuracies) in the film. Most notably, the thin atmosphere of Mars couldn't really produce a sandstorm of the violence portrayed in the film, and all six astronauts would need substantial shielding from radiation during such a long trip in space. (Read a review in *Time* at *http://ti.me/1j4epsq* and in the Huffington Post at *http://huff.to/1Msuhg1*.)

Portrayal of Scientists and Engineers

In addition to Watney's efforts to survive on Mars, hundreds—if not thousands—of scientists, engineers, computer programmers, and technicians spend thousands of hours working to bring him home. NASA Director Teddy Sanders (played by Jeff Bridges) often clashes with Ares Mission Director Vincent Kapoor (Chiwetel Ejiofor) and Crew Mission Director Mitch Henderson (Sean Bean). I appreciated the depiction of reasoned conflict among smart, capable people, as they did not disagree simply based on personality; they were wrestling with very tough problems and had scientific and/or engineering reasons supporting their positions. The scientists and engineers we see working for NASA in the background also appear to be fairly diverse: Women and people of color serve on the engineering teams working to communicate with Watney and redesign the Mars Ascent Vehicle. I was glad to see this positive prediction of NASA's future diversity.

Issues

The filmmakers made a few choices that I understand on an artistic or dramatic level, but they bothered me on a scientific or factual level. The main one is they frequently showed Watney working outside the hab and driving at night. This provided dramatic shots of his helmet lights and the lights of the rover piercing the darkness. The problem is that it is very cold and very dark at night on Mars. With very little atmosphere to retain heat, Mars' surface cools very quickly as soon as the Sun is below the horizon. Nighttime temperatures are well below zero even when daytime temperatures can reach a comfortable 25 or 30 degrees C (77 or 86 degrees F). It would be very hard to stay warm in the spacesuit at night, and unreasonably dangerous to be working then.

Also, most electronic equipment has a minimum operating temperature well above the typical nighttime temperature on Mars. Time is one thing that Watney is unlikely to run short on, so limiting his work to daytime would not have been a problem.

Book vs. Film

I've seen some traffic on NSTA teacher e-mail lists discussing the possibility of using the book *The Martian* in science class. Watney details many of his calculations in the book, and I think it could be a great exercise for high school students to check his work (in calculating how much water he could get from burning hydrogen and oxygen, for example). The film does not include much of the mathematical details, but students could still do some cool calculations using data from the film. For example,

- How many potatoes will he need to survive until he is rescued? (Students would need to get information on the calorie content of potatoes, and the energy needs of an astronaut.)
- Given the distance he needs to travel from the hab to the *Ares IV* launch site, and his average distance per day, how long will his trip take?
- How much water would he need if he did not have the water reclaimer (which takes moisture out of the air in the hab to replenish his water supply)? How much mass would all that water have?

Note that the book contains much more strong language than the film does, so you may need to check with a building administrator before using the book even in a high school setting.

Effects of Semi-Starvation

Though he is able to grow potatoes in the hab, and has the food supplies intended for the rest of his crew, Watney spends a long time on Mars on very short food rations. Near the end of the film, he is shown to be very thin, and his face is quite gaunt. Living for a long time with little food is known to have profound physical and psychological impacts on people. During WWII, an experiment on the effects of starvation was conducted at the University of Minnesota (see *http://bit.ly/1VDcXtu*), and researchers found that not only did the subjects become very weak, but they also became obsessed with food. Thinking about things other than food and being hungry became almost impossible. I doubt that Watney would be able to do the physical or mental labor shown in the film after eating so little for so long.


NASA/JPL/MSSS

Teachers working on engineering design challenges, stoichiometry, thermodynamics, or human physiology could use clips from *The Martian* to generate student interest or guide the construction of some interesting calculations.

Note: The Martian *is rated PG-13 for some strong language, injury images, and brief nudity. (The filmmakers did some clever work to limit the strong language enough to keep this rating.)*

Jacob Clark Blickenstaff is the program director for Washington State Leadership and Assistance for Science Education Reform at the Pacific Science Center in Seattle. Read more Blick at http://bit.ly/amBgvm, *or e-mail him at* jclarkblickenstaff@pacsci.org.

Using Hybrid Learning to Enhance Science Teaching

Some school districts in Pennsylvania have adopted the Hybrid Learning Model, which provides "an opportunity to align all the resources in the classroom to meet individual student needs without disrupting the teacher's effectiveness," says Christine Smith, director of blended learning for Dellicker Strategies, a Kutztown, Pennsylvania, consulting firm specializing in blended learning and broadband infrastructure. "Teachers are looking to incorporate multiple modalities of learning, with frequent formative assessment, to target specific learning needs of students instead of teaching to the whole class. [This model helps teachers] look at the class in [terms of] small groups [that] allow students to collaborate and do project-based learning," she explains.

With the hybrid model, "teachers have the flexibility to provide more direct instruction targeted at the students' learning gap," and it can help "ensure students are not just learning [content] for the test; they're learning it as a foundational learning block," she maintains. The model gives students sufficient "learning support" so that no "predictable failure" occurs.

Smith works with 67 hybrid schools in Pennsylvania. Schools adopting the model examine everything from lesson plans, grading, rubrics, and testing to classroom arrangements, technology, and school-wide communication. They explore "new combinations for teachers and students, such as using a science topic to reinforce math content, or connecting social studies and language arts, especially in grades 2–8," says Smith.

Schools receive data to help them make decisions, and "teachers can focus on the data to drive instruction," she points out. The model also makes it easier for teachers to be creative; for example, "the math teacher and the science teacher can align their curricula to support each other," she relates.

She emphasizes that schools adopting the model are not obligated to acquire a lot of new technology. "We help schools make the most of what they have. We right-size it for what teachers have and need, [then] evaluate what the outcomes are…We don't evaluate the teachers; we evaluate what they'd like to see (their goals)… No two implementations are alike," she maintains.


ZACH COLANGELO

Wendy Simpson, chemistry teacher in Pennsylvania's Parkland School District, has students work in small groups structured by task.

Many schools have initial funding from grants, "but we help them plan financially for costs after the grant ends," she points out. Professional services from Dellicker cost about $100,000 for 18 months.

The Model in Action

"We want to break [science classes] out of the mold of 'today is lab day.' Every day is lab day" in a hybrid classroom, where students can be grouped in ways to make it happen, Smith contends.

"My students are working in smaller groups," says Wendy Simpson, chemistry teacher in Pennsylvania's Parkland School District. "My classes are divided into three groups: independent instruction (on laptops), collaborative, and direct (with the teacher). According to my class sizes, no group is larger than nine students."

Biology teacher Laura Bednar of the Parkland district has similarly grouped her students. "I teach in a double period that is 90 minutes long, so my groups will hit each station during the typical day. We will always start in whole group so I can deliver a mini lesson for the day's topic and deliver directions about each station. At direct, I'm trying to work more one-on-one with students to answer their questions and do more small formative assessment pieces to gauge where they are at in their understanding of the topic. We also will be reading short articles and doing some discussion as well.

"The independent station is where students watch supplemental videos and simulations, as well as do practice questions and worksheets depending upon the topic. At the collaborative, my students work together in smaller teams on an assignment. Within these groups, my students will form smaller groups at the collaborative station that will vary between two to four students per group depending upon the activity. Any lab that has any safety concerns will be done as a whole group," she explains.

Both teachers have changed their classroom arrangement to match the groups. "I divided the classroom area into three sections. Students working independently on laptops are in two rows facing the wall, so I can see their computer screens. The collaborative groups are at the center of the room. The direct group is placed in two rows near my front lab table and smartboard," says Simpson.

Changes in technology have prompted changes in teaching. "Our district just purchased a license for Edmentum, a digital course in chemistry [that] is prescriptive for each student's learning level. In the past, I have used tutorials as part of a flipped classroom approach; now, I use them in the independent station," Simpson explains.

"Overall, the big difference I've noticed is that I am able to teach in more depth than in a traditional classroom. I am also able to discern pretty quickly which students need extra help. The biggest challenge has been 'training' the students to take responsibility for their own learning, and to learn to work at a pace that allows them to complete work by due dates with little reminders from me," she observes.

Simpson admits that "[o]perating a hybrid classroom requires a lot more planning time. I do not get extra planning time for this, so I am extremely busy, and it can be mentally exhausting. However, overall the changes are positive. Since my class periods are double periods, teaching in a blended format makes better use of class time and provides students with different learning experiences every class period."

"I would say it has enabled me to hit more teaching strategies/styles to meet every student's learning style," says Bednar. "They still get notes and instruction from myself, the hands-on experience of the labs, and the visual aspect with the videos and simulations. It also allows more opportunities to differentiate instruction." ●

MS. MENTOR, **Advice Column**

Mentoring a Colleague, Positive Parent Communications, Informal Professional Development

My principal asked me as the science department chair if I could help one of our new teachers. From the beginning, she's having issues with classroom management and organization. I'm willing to do what I can to help her, and she is open to this help. Do you have any suggestions on what I can do?

—L., Rhode Island

If your school does not have a formal mentoring program, it seems like you can create your own plan. As a mentor, you can be a role model, a good listener, a provider of feedback, a source of suggestions and resources, a shoulder to lean on, and someone with whom to bounce around ideas. As a colleague, you'll want to be helpful, but not judgmental or evaluative.

Even successful student teachers can have a rude awakening in their first year on their own, when they are responsible for their classes from the beginning. They don't have the advantage of stepping into an established situation in terms of classroom setup, lab equipment inventories, safety procedures, and routines. She may be trying to learn new content, and if she has more than one subject to prepare for, it can be overwhelming.

You could start with an informal conversation. "I understand that you have some challenges with classroom management. This happens to everyone. I had some real difficulties, too." She may not realize that even experienced teachers face new situations every year, so it may help to share some of your own current challenges and how you're working on them.

If possible, it would be good if you could observe this teacher—informally, of course. In addition to watching the teacher, consider what the students are (or aren't) doing and how the classroom is set up. You could ask questions as discussion starters: *What worked well for you when you were student teaching? What are your greatest challenges? What do you think about…? Did you notice today when…? Have you ever considered…?* Her responses and your observations could be the start of an action plan.

In addition to your suggestions, social media could provide new ideas.

From my mentor, I learned that the most important part of classroom management is having routines in place. This frees up time for more important topics and activities, rather than dealing with discipline or logistic issues. Ask what routines she has established for the beginning and end of the class period or when students transition between activities. Disruptions are most likely at these times, and it is important for students to be engaged and to know what is expected of them. Share some suggestions and resources for routines that work for you, ask her to try them for a week or two, and debrief on the results.

A lot of class time can be spent accessing materials and beginning activities. You could suggest she

- Have a tray for each lab group to make it easier to organize and count materials and ensure everything is ready for the next class.
- Assign seats, lab groups, and roles for lab group members to eliminate the time-consuming drama of having students decide where to sit or with whom to work.
- Designate where to turn in assignments and equipment, and label everything, including the shelves or tables, to organize materials students need during class.
- Color-code as a way to organize materials for different classes or subjects.

If classroom management and organization are concerns, you should also ask her about how she deals with safety issues and with students who are disruptive and off-task during labs. Share with her what you have found effective.

It also could be helpful for her to observe other science teachers to understand how they organize their students, learning time, and class materials. Since the school year has started, it will take some time and effort to "reboot" and introduce new routines. If her classes are out of control, you could suggest she postpone labs with safety concerns until students are up to speed on the new routines and understand the importance of safety.

Some of your suggestions would be second nature to a veteran teacher, but to a novice, they can be life savers!

When I taught at the elementary level, it was easy to communicate with the parents of 25 students. Now that I'm teaching middle school science, I'm overwhelmed by the thought of trying to communicate personally with more than 150 parents. I'd like to go beyond quarterly progress reports or just posting grades online.

—B., Massachusetts

Contacting and communicating with parents* is important in forming a positive relationship to benefit students. With 150 students in five to six different classes and several subjects, even a goal of weekly contacts is challenging, given the other responsibilities of teaching science.

From my experience, it seems that secondary parents are not in the schools as much. They are not as involved in parent-teacher organizations or in participating in open-house events or conferences as they might have been when their children were younger. And many parents cannot take phone calls during their work hours or take time off for school events. So at the secondary level, you may have to rely more on other forms of communication.

It may be helpful to develop a plan for parent involvement. What information must be distributed to everyone? What information is student-specific? How can you document both kinds of communications? How much time do you have to spend on this? What kinds of communication are available in your school?

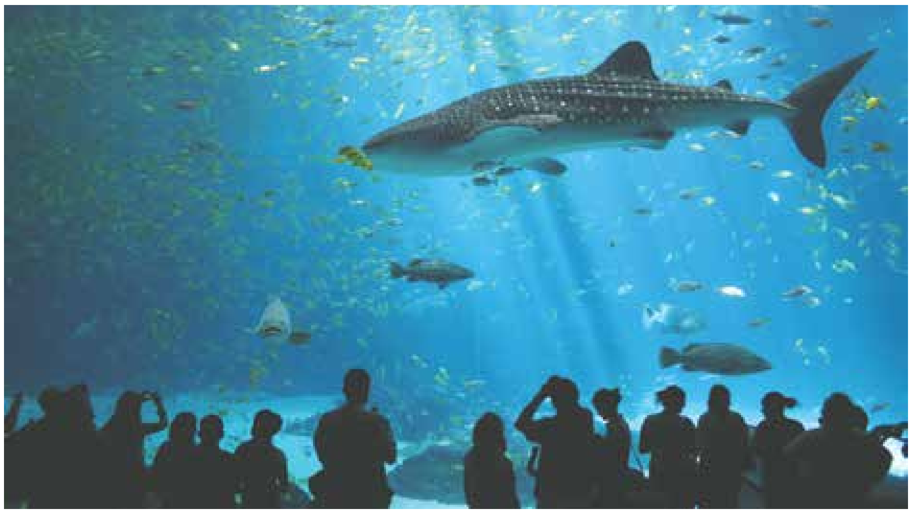
At the beginning of the year, you can send a newsletter or syllabus with information about you, your expectations, and what students will learn during the year. At this time, you could also include your Safety Acknowledgment Form for a parent's review and signature. If your school does not provide parent contact information, this could be a way of getting e-mail addresses or phone numbers. Some teachers send an updated newsletter for the spring semester, too.

Share your school e-mail address (rather than a personal one) to establish a record of your communications with parents. You should carefully consider whether you want to provide your home phone or personal cell phone number to parents or students. (I know teachers who use a separate cell phone for school business. Their greetings provide the school phone number for emergencies and request that callers provide a reason for the call and a time when they are available for a callback.) Explain in your newsletter and phone greeting that you can't always return calls or respond to e-mail or texts immediately when classes are in session, but you will reply as promptly as possible.

Throughout the year, you could send a quick e-mail or text about television programs related to your subject or interesting events at local museums, libraries, or science centers.

Instead of waiting until a problem occurs, take the initiative and contact parents with good news about their child through a quick e-mail or text. Share information about an activity the student is doing in class or a project he or she is working on. Some teachers forward photos of the student engaged in a classroom activity (I'd be cautious about having other students identifiable in the photo because of privacy issues). This may sound like a lot of work, but if you do a few each day, it becomes part of your routine.

My high school had a "Good News" project. Teachers were encouraged to send postcards (provided by the school) to parents to share positive student events. The school secretary would address and mail them. E-mail works, too, but getting something in the mail is special, and it's helpful for parents who do not have e-mail or texting capabilities.



ZAC WOLF

Aquariums, museums, and similar venues offer informal education opportunities for both children and teachers.

It was worth a few minutes of effort on my part and a postage stamp: I had a call from a parent who said that her son was feeling down after not making a traveling soccer squad. When the postcard describing his outstanding project arrived, she said her son was elated. Another parent called in tears: It was the first time she had heard anything positive about her daughter from a school.

You'll eventually find that you have several templates for these communications that can be customized for each student. And you've set the stage for additional communications, if or when a problem occurs.

**Note: I'm using the word "parents" here, but I'm aware that other adults may play important roles in students' lives: guardians, stepparents, grandparents or other relatives, foster parents, and other caregivers. These ideas apply to all.*

I teach in a private school that does not offer much in terms of professional development (PD), especially for science teachers. My colleagues and I would like to visit some science museums and centers. Would that count as PD? Do you have any other suggestions for us?

—*M., Maryland*

To a science teacher, an ideal day away from school might include a stroll through a zoo or botanical garden, an afternoon in a cool planetarium or aquarium, a visit to a science center or natural history museum, or a hike through the woods or on a beach with a camera, a pair of binoculars, and a guidebook. On these personal field trips, we don't need to worry about permission slips and bus counts: We can follow our interests and learn on our own terms.

It's enjoyable to visit one of these places with another science teacher. The level of conversation differs from when you visit these places alone, with students, or with your family. A day exploring one of these venues and discussing science topics is a great way to increase content knowledge and examine different ways of learning.

For example, one day at the American Museum of Natural History in New York, my colleague and I spent a lot of time with the exhibits related to plate tectonics. We learned new content information, and the displays gave us some ideas for sharing this information with our students. We took lots of notes and made lots of sketches.

My school district allowed my colleague and me to count the time we spent in the museum as PD hours. We submitted a report describing where we went, what we did, what we learned, and how that learning will apply to the classroom. You could ask your school administrator if such a procedure would be acceptable in your situation.

With all we can learn available both on-site and online (through websites, e-mail lists, and social media), perhaps this informal, individualized PD should become a viable part of our ongoing professional education. Unlike with more formal, schoolwide PD events, we set the goals and personalize the experience to meet our own needs. This process keeps us informed and current, building on our previous knowledge and inspiring us to continue to learn new things.

NSTA's position statement on informal science education recognizes the contributions of informal science institutions and organizations in providing opportunities for lifelong learning—not just for students, but for teachers, too.

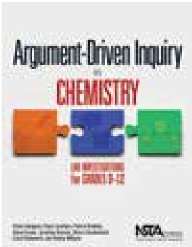
You can also visit science museums and centers through the eyes of your students. What strategies do informal educators use to attract our attention and hold our interest in the exhibits? An article in *The Science Teacher*, "Learning Science Beyond the Classroom" (*http://bit.ly/1k1M72D*), describes some of these techniques. Could any of these apply to the classroom?

As the price of travel increases, don't forget to visit places close to home. To find a new place to visit, check out the website of the Association of Zoos and Aquariums (*www.aza.org/FindZooAquarium*) or the American Alliance of Museums (*http://bit.ly/1NEqyBX*). If you're a member of an organization, check for reciprocal admissions. Many of these organizations offer lectures, field trips, hands-on workshops, graduate study, meet-a-scientist, and other special events that could become part of an individualized or informal PD plan.

Many informal science venues have excellent websites, too. I can spend hours on the website of the Exploratorium (*www.exploratorium.edu*) in San Francisco with its comprehensive collection of lessons and demonstrations for the classroom. These institutions may also have virtual tours. The National Park Service website (*www.nps.gov/index.htm*) has views of the parks: It's not quite the same as being there, but still a good experience.

Adding informal, teacher-selected opportunities to a school's PD plan is a win-win option. Teachers (or groups of teachers) can design opportunities based on individual subject-area needs, and schools can spend ever-decreasing PD funds on schoolwide topics. ●

To maintain anonymity when requested, some letters to Ms. Mentor are signed with a pseudonym. We regret any coincidental resemblance to other educators when a pseudonym is used. Check out more of Ms. Mentor's advice on diverse topics or ask a question at www.nsta.org/msmentor.



NSTA PRESS: *Argument-Driven Inquiry in Chemistry: Lab Investigations for Grades 9–12*

Lab 4. Molarity

What Is the Mathematical Relationship Between the Moles of a Solute, the Volume of the Solvent, and the Molarity of an Aqueous Solution?

Editor's Note

NSTA Press publishes high-quality resources for science educators. This series features just a few of the books recently released. The following excerpt is from Argument-Driven Inquiry in Chemistry: Lab Investigations for Grades 9–12 *by Victor Sampson, Peter Carafano, Patrick Enderle, Steve Fannin, Jonathon Grooms, Sherry Southerland, Carol Stallworth, and Kiesha Williams, edited for publication here. To download the full text of this chapter, go to* http://bit.ly/1ZzeLbQ. *NSTA Press publications are available online through the NSTA Science Store at* www.nsta.org/store.

Introduction

Most of the matter around us is a mixture of pure substances. The main characteristic of a mixture is its variable composition. For example, a sports drink is a mixture of many substances, such as sugar and salt, with the proportions of substances varying depending on the type of sports drink. Mixtures can be classified as either homogeneous or heterogeneous. Homogeneous mixtures have parts that are not visually distinguishable, whereas heterogeneous mixtures have parts that can be distinguished visually. A homogeneous mixture is often called a solution. A sports drink therefore is a solution.

Much of the chemistry that affects us occurs among substances dissolved in water. It is therefore important to understand the nature of solutions in which water is the dissolving medium or the solvent. This type of solution is called an aqueous solution. An aqueous solution contains one or more chemicals (or solutes) dissolved in water (the solvent). The most common way to describe the concentration of a solute in an aqueous solution is to use a unit of measurement called molarity. In this lab investigation, you will explore the relationship among moles of solute, volume of solvent, and molarity.

Your Task

Use a computer simulation to determine the mathematical relationship among moles of solute, volume of solvent, and molarity. Once you have determined this relationship, you should be able to set up various functions that will allow you to accurately predict

- the molarity of a solution given the moles of solute and solvent volume,
- the moles of solute given the molarity of the solution and the volume of the solvent, and
- the volume of the solvent given the molarity of the solution and the moles of the solute.

The guiding question of this investigation is *What is the mathematical relationship among the moles of a solute, the volume of the solvent, and the molarity of an aqueous solution?*

Materials

You will use an online simulation called Molarity to conduct your investigation. You can access the simulation by going to the following website: *http://bit.ly/1Gbnquk*.

Getting Started

The first step in developing your mathematical function is to determine how moles of solute and volume of the solvent are related to the molarity of a solution. The Molarity simulation allows you to mix different moles of solute in different volumes of water (the solvent). It then provides a measure of the molarity of the resulting aqueous solution.

Before you start using the simulation, you must determine what type of data you will need to collect, how you will collect the data, and how you will analyze the data to answer the guiding question.

To determine what type of data you need to collect, think about the following questions:

- What type of observations will you need to record during your investigation?
- When will you need to make these observations?

To determine how you will collect the data, think about the following questions:
- What types of comparisons will you need to make?
- How will you keep track of the data you collect and how will you organize it?

To determine how you will analyze the data, think about the following questions:
- What type of calculations will you need to make?
- What type of graph could you create to help make sense of your data?

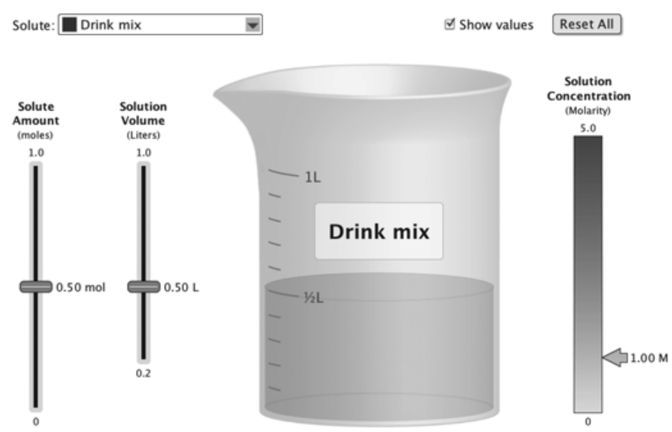
Once you have collected and analyzed your data, your group will need to develop a function that can be used to predict (1) the molarity of a solution given the moles of solute and solvent volume, (2) the moles of solute given the molarity of the solution and the volume of the solvent, and (3) the volume of the solvent given the molarity of the solution and the moles of the solute. You will then need to test your function using the simulation. If you are able to use your function to make accurate predictions, then you will be able to generate the evidence you need to convince others that the function you developed is valid.

Connections to Crosscutting Concepts, the Nature of Science, and the Nature of Scientific Inquiry

As you work through your investigation, be sure to think about
- the importance of looking for proportional relationships between different quantities,
- why it is important to track what happens to matter within a system,
- the difference between data and evidence in science, and
- the wide range of methods that can be used during a scientific investigation.

FIGURE L4.1

A screenshot from the *Molarity* simulation



Initial Argument

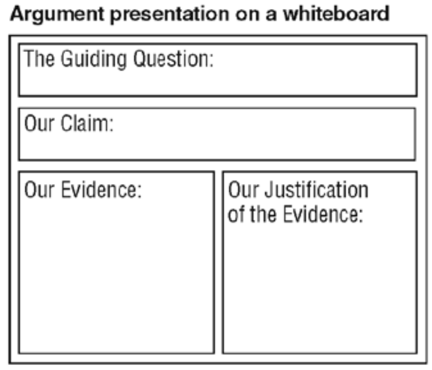
Once your group has finished collecting and analyzing your data, you will need to develop an initial argument. Your argument must include a claim, which is your answer to the guiding question. Your argument must also include evidence in support of your claim. The evidence is your analysis of the data and your interpretation of what the analysis means. Finally, you must include a justification of the evidence in your argument. You will therefore need to use a scientific concept or principle to explain why the evidence that you decided to use is relevant and important. You will create your initial argument on a whiteboard. Your whiteboard must include all the information shown in Figure L4.2.

Argumentation Session

The argumentation session allows all of the groups to share their arguments. One member of each group stays at the lab station to share that group's argument, while the other members of the group go to the other lab stations one at a time to listen to and critique the arguments developed by their classmates. The goal of the argumentation session is not to convince others that your argument is the best one; rather, the goal is to identify errors or instances of faulty reasoning in the initial arguments so these mistakes can be fixed. You will therefore need to evaluate the content of the claim, the quality of the evidence used to support the claim, and the strength of the justification of the evidence included in each argument that you see. To critique an argument, you might need more information than what is included on the whiteboard. You might therefore need to ask the presenter one or more follow-up questions, such as
- What did your group do to analyze the data, and why did you decide to do it that way?
- Is that the only way to interpret the results of your group's analysis? How do you know that your interpretation of the analysis is appropriate?
- Why did your group decide to present your evidence in that manner?
- What other claims did your group discuss before deciding on that one? Why did you abandon those alternative ideas?
- How confident are you that your group's claim is valid? What could you do to increase your confidence?

FIGURE L4.2

Argument presentation on a whiteboard



Once the argumentation session is complete, you will have a chance to meet with your group and revise your original argument. Your group might need to gather more data or design a way to test one or more alternative claims as part of this process. Remember, your goal at this stage of the investigation is to develop the most valid or acceptable answer to the research question!

Report

Once you have completed your research, you will need to prepare an investigation report that consists of three sections that provide answers to the following questions:
1. What questions were you trying to answer and why?
2. What did you do during your investigation, and why did you conduct your investigation in this way?
3. What is your argument?

Your report should answer these questions in two pages or less. The report must be typed, and any diagrams, figures, or tables should be embedded into the document. Be sure to write in a persuasive style; you are trying to convince others that your claim is acceptable or valid! ●

Mark Your Calendar
NSTA Dates to Remember

(All dates are deadlines unless otherwise specified.)

November 17—Learn how free tools in the NSTA Learning Center can help you create, curate, and share your most valuable online learning resources during **Creating and Sharing Collections in the NSTA Learning Center, a free NSTA Web Seminar.** The session runs at 6:30–8 p.m. Eastern Time (ET). For more information on NSTA Web Seminars or to register, visit *http://bit.ly/1Iwpg4w.*

November 18—The first step to winning a lab makeover for your school is discovering the keys to **Developing a Competitive Application for the Shell Science Lab Challenge** during this **free NSTA Web Seminar**. The Shell Science Lab Challenge recognizes middle and high school science teachers (grades 6–12) in the United States and Canada who develop replicable approaches to science lab instruction using limited school and laboratory resources. Participants will learn how they can craft their best entry from presenter Ruth Ruud, judging chair for the Shell Science Lab Challenge. The session runs at 6:30–8 p.m. ET. For more information on NSTA Web Seminars or to register, visit *http://bit.ly/1Iwpg4w.*

November 23—Don't miss this chance for your eCYBERMISSION team to chat with CyberGuides and Mission Control Staff, ask questions about eCYBERMISSION, their Mission Folders, and more during the **CyberGuide Chat**. Team Advisors, individual team members, or the entire team may participate in these sessions. The chats are scheduled for 4 and 7 p.m. ET. Additional chats are scheduled for December 9 and 29, 2015. and January 13 and 21, 2016. For more information, visit *http://bit.ly/1QxPfhc.*

December 3–5—"**Raising the Stakes in Science,"** the **NSTA Area Conference** in **Kansas City,** Missouri, gives educators an opportunity to hone their practice, content knowledge, and more. Three strands help attendees focus their experience: The Art and Craftsmanship of Teaching, Combining Science With Agriculture, and Achieving Success With the *NGSS*. NSTA members must register by **October 26** to receive the $180 early bird rate. On-site registration costs $225. For more information or to register, visit *www.nsta.org/kansascity*.

January 15, 2016—It's your last chance to **submit a session proposal** for the **Fifth Annual STEM Forum & Expo,** hosted by NSTA, and the **NSTA 2016 area conferences**. The STEM Forum will be held July 27–29 in Denver, Colorado. The 2016 area conferences are set for Minneapolis, Minnesota (October 27–29); Portland, Oregon (November 10–12); and Columbus, Ohio (December 1–3). For more information or to submit your session proposal, go to *http://bit.ly/1wI4iQg.*

February 5, 2016—It's your final opportunity to maximize savings on your registration for the **64th NSTA National Conference on Science Education**. The conference, themed "Science: Empowering Performance," will be held March 31 through April 3, 2016, in Music City Center, Nashville, Tennessee. The national conference will feature hundreds of sessions, workshops, networking events, and the exhibit hall with hundreds of vendors. Share ideas, connect with colleagues, and discover something new during this four-day event. For more information or to register, visit *www.nsta.org/nashville*.

April 15—Session proposals for the 2017 NSTA **National Conference on Science Education** are now due. The conference will be held March 30–April 2, 2017, in Los Angeles, California. For more information or to submit your session proposal, go to *http://bit.ly/1wI4iQg.* ●

Are you aware of all the advantages you get as an NSTA member? We will be featuring some of the regular benefits NSTA members enjoy, as well as special offers for our members from other organizations, in this space. For more information on NSTA membership, visit *www.nsta.org/membership.*

- **Leadership Experience.** As an NSTA member, you are connected to leaders in the field of science education. NSTA's Board and Council are composed of dedicated educators whose careers span the gamut of specialties and experience from educators in their first years in the classroom to those entering retirement. These dedicated individuals offer guidance on NSTA's efforts to promote excellence and innovation in science teaching and learning for all. NSTA's standing committees and advisory boards and panels offer members an opportunity to serve their fellow science educators while building their own leadership experience and expanding their own knowledge of the field. For more information on serving on an advisory board, panel, or a committee, visit *http://bit.ly/1jmIlku.* ●

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Some Spiders Control Their Falls

The idea of gliding spiders may be the stuff of nightmares for many, but some researchers were inspired to seek them out in the forests of Panama and Peru.

While some species of ants and other wingless hexapods are known to control their descent when falling from trees, this has not been documented in other arthropods. The researchers dropped 59 arboreal spiders from canopy platforms and treetops, filming them in slow motion to monitor if and how the arachnids could control their fall. Nearly all (93%) were able to right themselves and then glide to a tree trunk, using their forelegs to adjust their direction.

The study authors noted the result "indicates strong selective pressures against uncontrolled falls." Read the abstract at *http://bit.ly/1NJAzxz*. ●

Quotable

Failure is instructive. The person who really thinks learns quite as much from his failures as from his successes.

—John Dewey, U.S. philosopher (1859–1952)