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Pull-Out Section!

Teaching Science at a Museum Magnet School

Museums and school districts around the country have partnered to create museum magnet schools, which combine formal and informal learning. These schools offer some advantages for science classes. "Partner[ing] with The Discovery Museum and Planetarium lends itself to many opportunities exclusive to a 'space' museum," says Janine Walsh, seventh- and eighth-grade science teacher at Interdistrict Discovery Magnet School (IDMS) in Bridgeport, Connecticut. The museum "has exposed my primarily urban students to events that they would not experience [in] their neighborhood schools,…[including] teleconferencing with NASA scientists from Operation IceBridge, a polar ice cap survey mission, [and] live viewing of the Orion Spacecraft."

"Museum staff [co-teach] at the school, [and] our student coaches and interns [work] with younger children at the museum," says Claire Gold, IDMS founder. She also notes that "most elementary teachers are weak in science and need expert, knowledgeable support" that museums can provide.

"A lot of people have a misconception about the word 'museum;' they associate it with having no interaction with the exhibits, just looking," says Josh Hunter, seventh-grade science teacher at Moore Square Magnet Middle School in Raleigh, North Carolina. "Our idea is it's all about interaction. [For example,] our students do experiments with scientists at the North Carolina Museum of Natural Sciences."

"We're able to take students to...an active research museum, and [they] see how the science they learn...is useful in the real world," says Krista Adair, sixth-grade science teacher at Moore. "We scaffold so at the beginning of the year, they do little experiments and some data tracking. Then they can see how it works in the museum setting, [which has] a lot more resources and equipment."

Last year, "we took all 500 [Moore] students to the museum" for an event featuring "scientists with many different research areas and talents," says Julianna Martinez, seventh-grade science teacher. "We [also] had an opportunity for young scientists to come to our school and present their work." At these events, students heard from scientists who have succeeded despite having disabilities. "These kinds of experiences really touch the students," she observes.

ANN MCGLAUFLIN

Fifth graders from Ortega Elementary Museum Studies Magnet School in Jacksonville, Florida, use a hands-on wet lab at the Marine Science Education Center in Atlantic Beach, Florida, one of Ortega's seven museum partners.

Museum magnet teachers cite the benefits of assessing students' knowledge through the exhibits they create about what they learned. "Our students create exhibits that are more than just a bulletin board item. They try to make them museum-quality," says Ann McGlauflin, fifth-grade science teacher at Ortega Elementary Museum Studies Magnet School in Jacksonville,

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CONNECTING TEACHERS THROUGH CITIZEN SCIENCE PG 18

New study confirms that *Project-Based Inquiry Science*™ has a positive effect on how <u>all</u> students learn science

The study is the first to examine use by middle-school teachers and students of science curriculum aligned with the new *Framework for K-12 Science Education* and ***Next Generation Science Standards (NGSS).***

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COMMENTARY: **Joyce Gleason**

The Next Phase of Life: Transitioning Successfully to Retirement

by Joyce Gleason, past chair of NSTA's Retired Members Advisory Board

Joyce Gleason

The beginning of a new school year leads many teachers to contemplate the end of their teaching careers. At a session presented during the NSTA National Conference in Chicago last spring, future retirees were discussing their plans for this new period: spending time with grandchildren, pursuing art, volunteering, traveling. All worthwhile endeavors, but one theme emerged from the discussions: "Who will I be in this next phase of my life?"

NSTA members identify as educators, in particular science teachers, with defined roles in classrooms, schools, and wider communities. But what happens when that identifier, "science teacher," no longer applies? Sure, we have "earned" our retirements and have much to be excited about. But will we stop being ourselves? How much of our identities have been wrapped up in this professional mantle?

The transition may be smooth for many. But how will it be for those who view themselves as professionals first? Over and over these questions were asked, directly or indirectly, in that conference session. The topic bears some scrutiny.

Many experience confusion and incoherence following this major life change. Change feels like both loss *and* liberation. Sure, change can make our lives feel out of balance and unfocused. We can even feel the *loss* of our typical workweek, with its structure and purposefulness.

A retired professional often asks, "What do I *call* myself?" Emory Daniels, who also writes about personal change, opines that this quandary can result in a positive outcome—a *liberation*! What is needed is to discover your *essential* identity.

Sara Lawrence Lightfoot analyzes many thinkers in her book, *The Third Chapter: Passion, Risk, and Adventure in the 25 Years After 50*. For example, she quotes Anatole France as saying, "All changes, even the most longed for, have their melancholy; for what we leave behind us is part of ourselves; we must die to one life before we can enter another." Was he right? Must we say goodbye to *all* of our identity as science teachers?

We could maintain part of that old role as a volunteer. Many NSTA retired members do just that. For example, Virginia Baltay works with the National Park Service (NPS) in Connecticut. She assists with educating students weekly and has approached the NPS to make similar arrangements easier for other NSTA retirees in their locales.

Lloyd Barrow, a recently retired professor of science education at the University of Missouri, straddles both phases of life. For years, he has been active in state and national education organizations. Now he remains involved by scoring conference proposals, presenting at conferences, reading professional journals and corresponding with authors, and volunteering on committees.

After leaving the classroom, many educators transform themselves into consultants and explore new opportunities. Mary Bigelow, known to many of us as "Ms. Mentor" through her blog posts and *NSTA Reports* advice column, uses her varied experiences as a classroom teacher and resource consultant to statewide programs in elementary reading and math-science partnerships to provide support to new and advancing young teachers with specific answers to common dilemmas faced in the classroom. Her research-based knowledge and sensible responses make for excellent starting points for new teachers, and she even reassures those with many years of experience with her practical advice. She has also co-authored the NSTA Press book, *Rise and Shine: A Practical Guide for the Beginning Science Teacher*, with NSTA Past President Linda Froschauer.

Many educators have discovered their essential identity includes continued "work" with NSTA, as both freelance consultants and in other roles. Serving on the NSTA Board, Council, or committees can be fulfilling and make use of your years of expertise and knowledge. You would be contributing to benefit your colleagues, known and many more unknown, and helping to mentor the next generation of professionals. More information on the NSTA Board, Council, and committees can be found at *http://bit.ly/1fYxfQV*.

Similarly, many state science teacher organizations need leaders and volunteers. Informal science nonprofits also require assistance in a variety of roles. You just have to search these out!

So get out there, and *find the benefits* of retirement! Make the next phase of your life an *adventure*. ●

Joyce Gleason retired after more than 35 years as a science educator. She taught high school biology, supervised student teachers, coordinated science for an urban district, provided professional development for teachers nationwide, and worked as a consultant. Her volunteer duties for NSTA included serving as a district director, program coordinator for two national conferences, and other committee appointments.

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Museum Schools, from pg 1

Florida. Students' exhibits "integrate more than just the topic" and can include "language arts, art, and music," and "more critical-thinking skills [are involved], such as communication and language skills," she contends.

For the science fair last year, her students created a large "wall quilt," with each block illustrating a student's project. "The artistic representation made them think at a different [and more creative] level," she observes.

McGlauflin's students scored two percentage points higher on state tests last year. "I knew it wasn't a fluke; what we're doing seems to be working," she asserts.

"The magnet museum format has helped students understand the importance of reading and writing in English class as well as in science class," says Raji Menon, grades 6–8 science teacher at New York City's Museum Magnet School. After researching their topics and writing reports, four of her students presented their projects at the American Museum of Natural History last June.

"My students felt so proud. They were talking about their projects like experts—taking ownership of their own understanding," says Menon. The museum gave them the opportunity "to explain their work to other people besides their teachers and classmates."

Support for Teachers

Seven area museums work with teachers from Normal Park Museum Magnet School in Chattanooga, Tennessee. "We meet with museum partners two or three times a year [to] talk about what studies are coming up. They give us ideas, and we collaborate," says Kara Semtner, sixth-grade science teacher.

Erin Woodrow, seventh-grade science teacher at Normal Park, worked with an art teacher on a unit that engaged students in "looking at how an artist conveys force and motion" in an exhibit at Chattanooga's Hunter Museum of American Art. "Though the museum's paintings and sculptures are stationary, they convey motion," she maintains.

When Trey Joyner taught science at Normal Park, he was able to take "a backstage tour of the exhibits" at the Tennessee Aquarium. "The aquarium was breeding new species of jellyfish… The jellyfish exhibit fit right into our content," he notes.

The aquarium offers courses for county teachers. "It's like an open door. I can go and learn as much as I want to, anytime," Joyner relates. In addition, museums "have access to the most current research," he points out.

Maintaining Partnerships

As in any relationship, these partnerships face some issues. "[Our] partnership is still relatively young," says IDMS's Walsh. "Hampered by [the museum's] leadership changes and staffing gaps, we have not had the ability to experience the full potential of this partnership."

When grant funds ran out, "we bought less programs [from the museum]," says Mary Servino, IDMS science specialist. The museum also started charging fees for services that had been free. "We're hoping [there will be] sufficient funding for the school and the museum to rebuild the relationship… We're very positive it will happen," she observes, noting that communication has improved since the museum's new education director has attended school governance council meetings.

When it lost Title I funds in 2005, Normal Park created an Education Fund and hired a part-time executive director to raise money. "We're paying $25,000 a year to raise $250,000 a year," Principal Jill Levine explains.

Nevertheless, the teachers encourage colleagues at traditional schools to reach out to their local museums. "There's a lot you can duplicate on a smaller scale," with free resources from museums, says Woodrow. "Allow yourself to look at new ways to teach through an art or museum perspective. It helps teachers stay excited about what they're doing, and will help kids stay excited about what they're learning."●

Exploring Early Nature-Based Education

Turning over logs and splashing in puddles may seem like activities reserved for playtime at home, but some preschools and kindergartens are incorporating nature-based programs to engage young children in hands-on exploration of their world.

"Science education in the early years is a combination…of experiences [in which children] get to explore materials and ideas over and over again and have conversations with adults about what happened, and possible reasons why," says Peggy Ashbrook, who writes about early childhood education for NSTA's Early Years blog. Noting that she is not an expert in natural programs, she remarks, "You're in a natural system all day; there are changes to observe around you all the time."

For example, a day at Fiddleheads Forest School, a nature preschool affiliated with the University of Washington, may include individual and group work, small group explorations, or a large group walk—all in the outdoors. "Every day looks almost completely different [from] any other day because so much of what we do is driven by the interests of the children and what the natural world presents," write Kit Harrington and Sarah Heller, Fiddleheads Forest School directors and lead teachers. These activities allow students to develop the "ability to identify senses and use them to observe the world around them; interest in and desire to find a variety of solutions to questions, tasks, or problems; [and recognize and solve] problems through active exploration, including trial and error," they note.

"We believe strongly in empowering students to guide their own learning process, and work to help each of them develop the tools to do just that through use of a curriculum that expressly teaches self-regulation," they add.

At Guelph Outdoor Kindergarten in Guelph, Ontario, students spend about three and a half hours of the day outdoors, engaging in activities like building willow shelters, making bark ropes, reading stories, and looking for wildlife.

"We expect students to gain confidence in their abilities to ask questions and solve problems," states Masha Kazakevich, the school's facilitator and operator. She adds, "When they are playing outside, they spend a lot of time testing hypotheses and conducting spontaneous or repeat experiments. The outdoor model is real and complex and allows children to engage with the world/life/science with their whole being."

At Arlington Unitarian Cooperative Preschool (AUCP), in Arlington, Virginia, staff maintain a high ratio of adults to children (6:15 in one class last year) in the outdoor program, according to the school's director, Susan Parker. As a cooperative preschool, the adults include the classroom teacher, other school staff, and parents. Parker notes all staff carry cellphones and they "set boundaries for where children can go and can't go...Because they're outside, the kids are far more engaged. There are fewer problems keeping people safe outside than inside," she says.

Although AUCP's outdoor program is only in its second year, Parker asserts, "I can tell the learning that goes on is incredibly genuine…One question I ask myself is, 'Why [did] we ever put walls around our kindergartens and preschools?' Kids have the constant ability to challenge themselves outdoors."

Some proponents of outdoor early learning programs claim that in the outdoor setting, fewer disciplinary problems and even a lower incidence

of learning disabilities such as attention deficit disorder (ADD) occur.

"I think there is a lot of qualitative assessment, but not a lot of quantitative assessment" of the long-term impact of nature-based programs on students with ADD, says David Sobel, senior faculty in the Education Department at Antioch University New England in Keene, New Hampshire. The university offers a certificate program for nature-based early childhood education. "Qualitatively, teachers and administrators recurrently comment that nature-based programs reduce behavior problems in ADD students. [However,] I'm not sure if anybody knows if that is a) a short-term or b) a persistent effect over the long term."

Sobel recently completed a research study of the impact of nature-based preschool programs compared to other high-quality academic-based preschools. Although his findings were inconclusive, he says a number of previous studies have shown that children who had attended a play-based program did better academically after fourth grade, when curriculum changes placed more emphasis on independence, creativity, and peer interaction. He is now investigating the feasibility of a study of nature-based preschool programs.

"Qualitatively, all reports show kids in nature preschool doing just as well, but the quantitative data showed otherwise," Sobel explains, noting the difference could be a problem with the data, which is based on teachers' subjective assessments of children's progress on a development continuum. "With quantitative data contradicting qualitative data, we're trying to figure out what's going on," he said. In the community studied, "there's upward pressure [from families] to do more nature-based programming beyond preschool in the early elementary grades in the public school. Qualitative data [shows] that parents are invested; everybody thinks this is working really well."

For educators considering an outdoor preschool or kindergarten program, Sobel suggests outlining clear procedures of what kids can do and can't do. "If these outdoor activities have been thought through, and translated into policy, [educators will be] okay in terms of liability," he says.●

Quotable

Nearly every man who develops an idea works it up to the point where it looks impossible, that precedes what the world calls success.

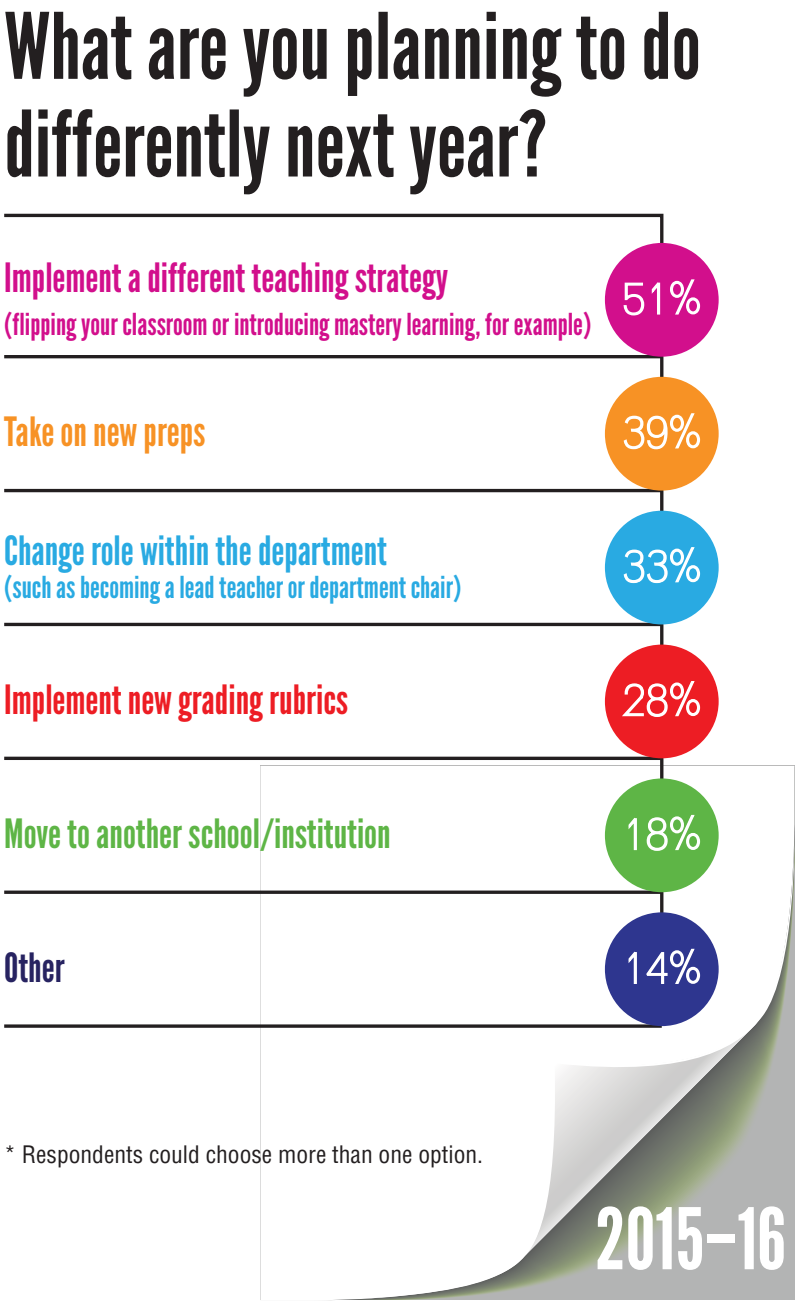
—Thomas A. Edison, U.S. inventor (1847–1931)

Using Summer Activities to Enhance a New School Year

For educators, summer isn't just lazy days by the pool. *NSTA Reports* asked science educators in June how they were planning to spend their time away from campus. Slightly more than half of the respondents (53%) said they would spend 25% or less of the summer earning additional income; 18% said they would devote more than 75% of the summer to do so. Forty-four percent said they would dedicate more than 75% of the summer to catching up with family and friends. Only 38% said they would commit half the summer or longer to resting.

More than half (57%) said they would allocate 25% or less of their time to researching new teaching strategies. Most (89%) said they would reserve less than 10% of their summer for writing grants. Unsurprisingly, virtually all respondents planned to participate in a professional development (PD) activity such as a workshop or seminar, with 40% estimating they would spend 26–50% of the summer on these activities, 23% devoting 10–25% of the season to PD, and 17% allotting more than 75% of their time.

The most common reason cited for attending PD events was having "a personal interest in the topic" (72%). Fifty-eight percent said they hoped to "enhance my teaching credentials" through PD activities. In addition, 64% of educators indicated they were planning significant changes for the new school year, including implementing a different teaching strategy (51%), taking on a new prep (39%) or a new role within their current department (33%), and moving to a new school/institution (18%). [Respondents were able to select multiple responses to both questions.]



Here's what science educators are saying about how their summer activities will influence their expectations for the coming school year:

Applying knowledge gained to enhance lessons and projects.—*Educator, High School, North Carolina*

By having my classroom purged of old materials, all loose papers filed, and my lab prep-room as well as my classroom cleaned out, my classroom should run more efficiently next year.—*Educator, Middle School, California*

Find new ideas to engage reluctant learners.—*Educator, Elementary, Michigan*

Help me to feel more prepared and ready for the new environment: high school science.—*Educator, High School, Georgia*

Helping at space camp is teaching me new activities I can do with my gifted kids and the [science, technology, engineering, and math (STEM)] program I facilitate at my two schools, and I expect to help the classroom teachers integrate that and the robotics I learn in another workshop into their classroom STEM projects this year. —*Educator, Elementary, Virginia*

I always learn something new from the summer PD I attend and implement it to the benefit of my students. —*Educator, High School, Michigan*

I hope to be well rested and feeling like my life is more balanced.—*Educator, High School, Illinois*

I am spending two weeks working on the [*Next Generation Science Standards* (*NGSS*)]. I hope this will help me teach to the three dimensions of science. —*Educator, High School, Washington*

I hope that I can incorporate the two direct science subject experiences directly. The district [rollout] of the mandatory [professional learning community] will have its influence, as will the science training on the argumentation method. Using the [curriculum mapping tool] of CPALMS [Curriculum Planning and Learning Management System] should influence planning. —*Educator, High School, Florida*

I hope to come in with fresh ideas. —*Educator, Middle School, South Africa*

I will have new tools to use, like robots, and want to introduce computer coding. My class will have more real-world activities next year.—*Educator, Middle School, Georgia*

I will return to my Head Start classroom rested and ready to take on my duties with new teachers. There

may be four staff-member changes, which can be positive but nonetheless stressful. Overall, however, I expect a productive year as we roll out new standards that have been implemented.—*Educator, Informal Education Setting, Alabama*

I will be using my summer experience on polymer engineering research to [supplement] my income and my lesson plans.—*Educator, Middle School, Ohio*

Planning for new curriculum at a different grade level with additional technology resources integrated.—*Educator, High School, Ohio*

Rest and time away will provide perspective on school issues that can seem larger than they should in the context of what's really important.—*Educator, High School, Massachusetts*

Increase learning outcomes for students through more effective engagement.—*Educator, High School, California*

I will be attending AP Physics 1 [and] 2 workshops to prepare for courses. I also will be attending [a] U.S. FIRST [For Inspiration and Recognition of Science and Technology]/[Annual Air Force Leadership Experience for FIRST Teachers and Mentors] workshop for high school robotics sponsors to better my leadership skills.—*Educator, High School, Arkansas*

Make physical science more relevant to my eighth-grade students.—*Educator, Middle School, Illinois*

Last year (being summer one of two for research), I was able to bring more genuine inquiry to my classroom. The bar is raised higher, by me, for the next school year.—*Educator, High School, New York*

Mainly, my time at the zoo will involve planning with two [nongovernmental organizations about] how our students can be more involved next academic year as part of meaningful service learning.—*Educator, High School, Accra, Ghana*

Teaching something new, and expect students to be open to the experience and challenges of learning as we go along.—*Educator, High School, California*

The information I use will help me to explain things better to my students, and at least one of these classes will give me a vocabulary to use in working with my professional learning community when we are planning the curriculum for next year.—*Educator, High School, South Carolina*

The new school year will be influenced by my new conceptual understanding of *NGSS*. Attending a regional collaboration summit at [the University of Wisconsin]-Stout.—*Educator, Elementary, Wisconsin*

Try and implement new strategies learned through the summer to enhance my students learning.—*Educator, Middle School, New Jersey*

I am independently researching earthquakes, architecture, and engineering in San Francisco because of a grant awarded by the Fund for Teachers.—*Educator, Middle School, Tennessee* ●

Teaching Scientific Practices Using GMOs

A report released in January by the Pew Research Center revealed a wide disparity between the views of U.S. scientists and adults on the safety of eating genetically modified organisms (GMOs). More than half of adults said it was generally unsafe to eat GMO food products, while 88% of scientists connected to the American Association for the Advancement of Science said it was generally safe to do so. Across the country, science educators are challenging students to consider the evidence for themselves, using GMOs as a platform to teach students how to evaluate information sources, argue from evidence, and draw conclusions.

Brian Shmaefsky, a biology professor at Lone Star College in Kingwood, Texas, and a former president of the Society for College Science Teachers, teaches both college students and upper-level high school students earning associate degrees while finishing high school.

"Early in my career, I worked in agricultural biotech. I have several pub[lication]s on GMOs. My students are aware of that and think I have biases," Shmaefsky explains. "I give them resources to start with" including the Public Broadcasting Service's (PBS) science series *NOVA,* other PBS science resources, and BBC programs and resources. "They're good basic background. [The] shows are balanced, scientifically accurate. If I just let students out on the web, they don't know how to separate science [from] someone ranting without backing up with facts."

His students watch videos and animations and delve into resources from the National Library of Medicine, the National Institutes of Health, and other groups. "They like gathering what people are saying. It gives them a general idea of what research is out there, and gives faces [to] the researchers," Shmaefsky continues. "This is layered for me; I cover it a couple [of] times as part of environmental issues and medical issues."

His goal is to have his students "apply sound science" as they consider various medical and agricultural uses of GMOs. Shmaefsky challenges his students to consider whether a particular information source is using sound science and reporting data accurately before they weigh the costs and benefits of the GMO they are studying.

MARIO PATINO

Students at Kamehameha Schools-Hawai'i weed taro beds and place organic inputs as part of their hands-on education about GMOs.

"I'm trying to get students to use their biology—particularly high school students—[to see] what's going on and understand the process of it," he adds.

Mario Patino, a high school biology teacher at Kamehameha Schools-Hawai'i in Kea'au, Hawaii, takes a "multifaceted" approach to teaching about GMOs that includes discussing the "controversy around GMOs" while learning "how to make scientific arguments on evidence."

He maintains that students also need to know GMOs have a long history. "I identify GMOs as all domesticated crops because they have all been genetically manipulated compared to their wild ancestors. My strategy [is to address] the history of manipulation all over the world." Patino wants his students to understand that GMOs are not a recent phenomenon produced in labs. He uses old books on Hawaiian agriculture to show how farmers historically developed plants with desirable traits.

Patino's students grow crops in a school garden, including genetically engineered (GE) papaya and conventional taro. He notes the GE papaya is particularly relevant for his students: Not only is papaya a major agricultural crop on the island, but the first GE variant was developed by a Kamehameha alumnus.

"I use evolutionary theory to drive a lot of content…and provid[e] the context they need to learn about GMOs. I have a balance between practicum—stuff they are actually growing—and evolutionary big ideas.

"They do a lot of deep investigations, testing nutrient content, how soil affects growth, assays [to determine if] you can detect GE [organisms]," Patino explains. His students also conduct taste surveys of GE and conventional papaya.

GMOs are not a single unit for Patino's students. "We're talking about the whole year," he contends. "By the end of the year, they can make decisions based on evidence." Patino's students complete an assessment of their perceptions of GMOs at the beginning of the year and then reflections when the year ends. He says the reflections show most students' misunderstandings are gone.

"By teaching them how to do research, they can make their own decisions on GMOs. I think that's powerful," Patino says. "Because I used to work in biotech, I'm very comfortable with the topic…Some students may think I have a bias, but I tell them, 'It's up to you to decide if I am [biased].' I teach them the skills to validate information."

While teaching in Dublin, California, Catherine Melton had her seventh-grade life science students participate in a "GMO symposium" after completing a unit on genetics. She assigned students to groups representing scientists, consumers, environmentalists, farmers, and politicians. Each group had to develop and answer a central question. Melton shared some resources, including news articles, with her students and had them do further research. Students shared their findings and conclusions during a whole-class discussion.

She says the hardest part was "just dealing with articles, learning how to look for reputable sources...They were pulling out evidence from these text sources, which is a huge focus of the *Common Core* [*Standards*]…They were super-excited; they'd been asking to debate all year. It was not regular debate, but… research was done and they were ready to defend their positions," Melton notes.

"It was cool to see them asking [one another] questions, cool to see this big scary thing they didn't know much about become something they could discuss and understand," she adds. At the end of the discussion, Melton's students had to write responses to the central question of two other groups based on the information they'd learned.

Former AP Environmental Science and biology teacher Heather Bryan now teaches educators about GMOs and helps them create lesson plans as a consultant for Education Projects and Partnershisp, LLC (EP&P).

Bryan arranges professional development events for educators with presenters ranging from farmers to university researchers. "You need to be very transparent with your information, make sure information is peer-reviewed," she says.

Asserting that "it's really important that students take part in a problem-based project," Bryan often directs educators to the biotechnology unit on the Ohio Corn Marketing Board's education website, which can be found at *http://ohiocorneducation.org*. (In her role with EP&P, Bryan consulted with the board to develop site resources.) She suggests students have the opportunity to grow GMO plants and conventional ones and monitor the impact of pests and other factors on the plants so they can discuss the benefits and drawbacks of GMO in agriculture. ●

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Learning STEM as Entrepreneurs

What if your school was transformed into a small town, and your students could learn science, technology, engineering, and math (STEM) by running the town's businesses, including STEM–related ones such as farms, science museums, and weather stations?

That's what happens in the Micro Society program, a real-world learning model for K–8 students. In MicroSociety schools, which number "about 250 across 40 states and five countries," students learn "science, technology, engineering, and mathematics completely through entrepreneurship," says Carolynn King Richmond, president and CEO of MicroSociety, Inc. (*www.microsociety.org*).

In addition to STEM-related businesses, or "ventures," students work in banks, restaurants, stores, and government agencies—"whatever kids' interests are and wherever their imaginations take them to," she relates. Schools typically hold the program one period per day, three to five days per week.

In MicroSociety schools, student entrepreneurs learn how to balance the books from their own businesses, or "ventures."

The program is "school-wide, not classroom-based; students leave their classrooms and experience cross-grade [learning]," Richmond explains. When the school year begins, students and teachers discuss their society's values and common purpose, sign a citizenship contract, and decide what businesses will operate there. "A STEM theme can impact all of these activities," she points out, and students' "hands-on use of the content helps [them] understand why they're [studying these subjects]."

"We have anecdotal evidence that [MicroSociety] boosts [students'] interest in STEM," she reports. "Kids start thinking more like scientists."

MicroSociety creates all of the curricula, including curriculum for teacher training. "In every [U.S.] school, there's concern about *Common Core State Standards* objectives. Micro Society gets teachers thinking about curriculum not just by grade level, but in depth, with horizontal and vertical inclusion," says Suzanne

Downing, MicroSociety national trainer.

Trainers help teachers orient themselves to a "kid-focused" curriculum "concentrated on learning and…customized to their school," Downing relates. "The question becomes, 'How will this be useful to you as a citizen and in your work in a business or agency?'" she explains. "MicroSociety answers the question, 'Why do I need to learn this?' and becomes a powerful learning motivator."

When Stephanie MacDonald heard about MicroSociety, she says she thought, "How awesome! A school where the kids can decide what they're interested in, and they can really take direction with their own learning." MacDonald teaches at Noah Webster MicroSociety Magnet School, a preK–8 school in Hartford, Connecticut.

"With Micro, there's two different types of time," says MacDonald. "On Work Days, the kids who are a part of that venture come up with the idea they want to focus on, what they want to do, what their jobs are going to be. The Work Days are really the planning days. And Discovery Days are the days we open up to everybody in the school to come in and visit. [Students] carry passports [that] get stamped at every venture that they go to. The goal is for them to go to as many ventures throughout the year as possible."

In each grade level, "we try to have…one literacy-based venture, one math-based venture, and one science-based venture," she explains.

Early on, "we had designated days and times...for Micro…; we didn't have Micro running all throughout the whole day [then]. As it progressed, we actually incorporated some of the Micro during the day in each classroom," recalls Paul Wallen, preK–4 science resource teacher at Webster MicroSociety Magnet.

When MacDonald was the preK–4 science resource teacher last year, she says she used "Micro time" to "supplement what [students] were getting in the classroom with the curricular standards. For example, my venture last year was a third-grade venture, and I focused on second- and third-grade standards on matter…And the kids designed and conducted experiments every week [in which] they would investigate properties of matter. That way, I knew that I was reaching all of the third graders and all of the other students who would come into the room during that time… What's good about the themed ventures is that whatever time we use for Micro, we're reinforcing the concepts that we're teaching in the classroom."

She continues, "We had a first-grade venture [focused on] zoo animals...The kids who ran [it] would teach all of the kids who came in to visit about the zoo animals." In another venture, students "started seeds. Kids who would go to the venture could purchase seeds using their Micro dollars [and] could take the seeds home with them. We had community gardeners that would come in, and they would take the kids outside to do planting. So we were really able to use that as additional science time."

"One of the things I found that gets better and better each year is the management level of some of the [seventh and eighth graders who] have been with MicroSociety since the beginning… They've learned how to do good management. They've learned how to count the register drawers, [handle money], delegate responsibilities. It's a great learning process," Wallen observes.

For kids struggling with science concepts, MicroSociety "offers a very different environment for them to experience those particular lessons. When they come to the ventures, they're kind of driving their own learning. They're working at their own pace, and they're asking their peers questions," says MacDonald.

The teachers "try to let the kids have the authority over their venture, [and] manage their own problem solving... [I]t's great to see the kids solving problems on their own," she contends. ●

The NSTA Learning Center

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Free Online Webinars allow educators to interact live with WCS scientists and educators - all from the comfort of your own home! Walk away with valuable resources – including classroom lesson ideas. All sessions are also recorded for future reference! Visit – *http://bit.ly/WCSWebinar for more information*.

NSTA Virtual Conferences

A day-long series of live web sessions delivered via an interactive distance-learning tool. Each conference features content and/or pedagogy from experts in a particular topic. Participants can log on from anywhere with an internet connection and interact with presenters and educators from across the country.

http://learningcenter.nsta.org/onlinecourses

National Science Teachers Association

Studying STEM by Building Guitars

When Debbie French introduced material from the National Science Foundation (NSF)–funded National STEM Guitar Project in her physics classroom to teach about topics like sound waves, electricity, and magnetism, her students were eager to learn physics by building electric guitars. "When I first started [teaching physics at New Philadelphia High School in New Philadelphia, Ohio], I had 14 students: nine gentlemen and five ladies. [Eight years later], I had 62 students and 50% girls and guys equally…My numbers really increased [after year three] when I implemented the guitar program."

Few of her students "had experience with hand tools, soldering, electronics. So this was a really good experience for my 'academic' students to gain more hands-on, real-world skills," she maintains.

"That's part of the intangibles that this project brings: confidence in actually making something, something I think we've lost in high school. We no longer make things," contends Tom Singer, professor of Mechanical Engineering Technology at Sinclair Community College in Dayton, Ohio, and the project's principal investigator. "Having hands-on, kinesthetic-based learning is really important to capture a variety of students because not all students learn just from lecture and lab, or from reading it in the book, or watching the video. They actually want to learn using their hands."

In addition, says French, "there is a lot of problem solving [involved, like] diagnosing a wiring problem, such as 'Why is the jack buzzing? Is there a missing ground? Is there a crossed wire?'"

The National STEM Guitar Project hosts Guitar Building Institutes around the country to give educators the chance to build a solid-body electric guitar and use it to teach science, technology, engineering, and math (STEM). Thirty-two states now have at least one program that has implemented the STEM Guitar Project, notes Singer, adding, "We've got all levels of academic involvement, from middle schools all the way up to universities."

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Teachers participating in the National STEM Guitar Project's institutes build a solid-body electric guitar and use it to teach STEM and other subjects.

David Parker, physics teacher at Noble High School in North Berwick, Maine, implemented the program three years ago. "The guitar program was important because it helped us reach out to students who didn't think of themselves as STEM candidates at first. We had a lot of students who were not necessarily excited about physics, but really liked music. I knew I could get them interested by building a guitar and teaching them about how a guitar makes sound," he explains.

Teachers need not be guitar players to attend the institutes. Dawn Nguyen—a homeschool instructor for EarthSchool of Maine and a participant this past summer—says, "I contacted Tom Singer immediately to see if a non-guitar-playing, homeschool educator would be eligible to participate in the institute. Happily, I was accepted to the program."

During the institute, "we went from Tom's kits [of materials for building the guitars] to pretty wonderfully finished guitars in about 35 to 40 hours," reports Bruce Gamage, eighth-grade science teacher at Oceanside High School-West in Thomaston, Maine. "We even received a $300 stipend for the workshop," he adds.

"Participants in our institutes get financial support through the NSF as part of the implementation plan," Singer notes.

The project's curriculum, available free at *www.guitarbuilding.org,* supports the *Next Generation Science Standards* and *Common Core State Standards,* and features "plug-and-play modular learning activities [teachers] can use for any type of course, whether it's science-based, engineering-based—even in English you could use some of our curriculum," observes Singer. "Part of what we provide is a writing curriculum," he adds. "My students actually have to do a research paper as part of the class itself, researching the importation of wood products."

French and other members of the grant team "have designed learning activities for particular disciplines," and "invite teacher-participants at the workshops to develop their own lesson plans" for publication on the website, she notes.

Several activities, including those related to "the chemistry of swirl finishes, allow us to integrate the science, engineering, and artistic aspects," she relates. "We've experimented with different paints; water quality affects how we can apply the paint to the surface of the guitar."

Arts integration also can occur with 3D modeling. "We have participants sketch their headstock design in a 3D modeling software, such as Inventor or [others]. And then they either print out the paper and cut the headstock out manually, or they use a [computer numerical control] router to electronically cut out their headstock," French explains.

"Creating a guitar from wood is like sculpting a work of art; as the process continues, the guitar comes to life from the wood," Nguyen contends. "Students will benefit from not only the math and science topics covered, but [also] by the confidence and creativity that is evoked during the project."

Costs and Benefits

Teachers implementing the program have their schools purchase the project kits, which contain materials for building the guitars. "Most schools have students pay at least partially for the guitar kits. One teacher in Indiana had his students do a fundraiser," French explains.

"We also have school districts that fund the guitars themselves, and then the districts own the guitars until the students graduate,…then the students get to take the guitar with them. [It's a] graduation incentive," Singer remarks.

Gamage says his school received a grant from the Perloff Family Foundation for startup funds. "We will supply the kits for students who can't afford them, and hope to auction the finished instruments to raise funds for next year's guitar program."

The institute also offers participants "a graduate credit option through the University of Wyoming," says French. Teachers can earn "three credit hours for a total of $150…They have to do some additional work, including designing lesson plans."

"There's a huge amount of support out there" for teachers interested in implementing the program, Parker maintains. "All teachers have to do is decide they want to do it. The curriculum, kits, and funding models are there [for them]." ●

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eCYBERMISSION is a web-based STEM competition, free for students in grades 6-9.

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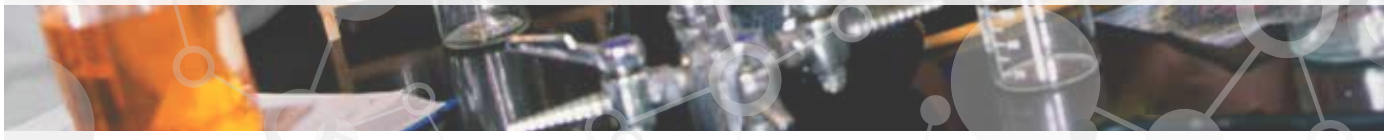
www.ecybermission.com



ACCEPT THE CHALLENGE

PULL-OUT SECTION

SCIENCE TEACHERS' GRAB BAG

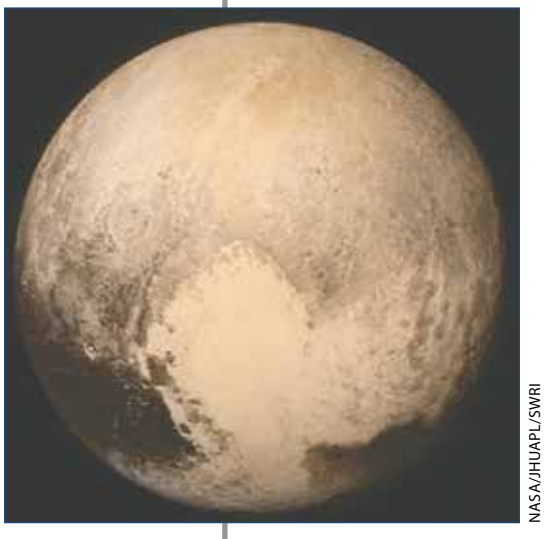
Inside this Convenient Pull-Out Section you will find:

Freebies for Science Teachers

4SciFunFree. Targeted for preK–6 students, this iPad app presents simple but intriguing hands-on science experiments that kids can do (with parental supervision) using materials found in and around the house. The experiments address Biology, Chemistry, Physics, and Space topics and include activities like making a Canister Rocket, Balloon Kebab, Bottle Tornado, Slime, and Solar Oven. Each experiment features "How-To" instructions, a "Why" explanation, and a follow-up "Quiz" that reinforces understanding. See *http://apple.co/1DuaCsB*.

Geoscience Careers Videos. Two new videos for high school students from the National Ground Water Association (NGWA) spotlight the diversity and potential of careers in groundwater science. In the animated *Groundwater Is Cool,* students learn about the importance of groundwater as a freshwater resource for humans and the environment through arresting facts and statistics. In *Geoscience Careers*, students, professors, and professionals in the field discuss the benefits and unique qualities of groundwater careers. Both videos reflect the key factors that research has shown to influence students in pursuing careers in geoscience: i.e., taking a geoscience course or lab, having an influential teacher/professor, and desiring to work outdoors. Watch them online at *www.NGWA.org/CareerCenter.*

Journey to Pluto. This interactive course from Versal, a platform for online course creation, brings the excitement of the NASA New Horizons mission to Pluto to the classroom. Open to all, but most appropriate for the high school level, the course features 12 lessons covering everything from mission launch in 2006 and spacecraft and instrumentation to the Jupiter flyby, the history of Pluto, and early discoveries from New Horizons. The course can be easily embedded into most websites and includes both public domain and Creative Commons–licensed content from NASA. The course also includes original content and interactive exercises, such as timelines, diagrams, flashcards, and quizzes. Visit this website: *http://bit.ly/1KbqaGu*.


NASA/JHUAPL/SWRI

ActivEpi Web. This multimedia electronic textbook for high school and college students and health professionals presents the fundamentals of epidemiology while emphasizing the links between health and medical sciences and mathematics and statistics. Developed by David Kleinbaum, professor of epidemiology at Emory University, the interactive resource includes 15 narrated lessons with video and animation; interactive study questions and quizzes; and homework exercises. Topics include study designs, measures of frequency and effect, potential impact, overview of validity, selection information and confounding bias, effect modification, analysis of 2x2 tables, options for control of variables, stratified analysis, matching, and introduction to logistic regression. Refer to *www.activepi.com*.

Mosa Mack Science. The latest tool for educators interested in addressing gender and cultural diversity in science, technology, engineering, and mathematics (STEM) learning is this library of inquiry-based science units for middle level students. The units begin with an interactive cartoon starring Mosa Mack, an ultracool African American heroine who models scientific thinking and processes and breaks the mold of the "average" scientist. Each cartoon presents a mystery and ends with a question that challenges students to solve the mystery using evidence from the cartoon. Students are then launched into a series of hands-on science and engineering activities to help them do just that. Topics include Climate Change, Food Chains, Adaptations, Diabetes, and Cells. Download the units at *http://bit.ly/1U2yehk* (free registration is required).

FunScienceDemos. Imagine a YouTube channel with nothing but attention-grabbing science demonstrations exploring the Big Ideas in science that every elementary and middle level student should know. Produced by George Mehler, Jared Hottenstein, and the science education lead teachers of the Central Bucks (Pennsylvania) School District, the channel offers demonstrations in Physical Science (Matter, Motion/Forces, Energy, Sound, and Light), Earth/Space Science (Weather, Rocks, Our Solar System, Water on Earth, and The Changing Surface of the Earth), and Life Science (Organisms, Habitats, Life Cycles,

See Freebies, pg G2

Freebies, from pg G1

Recyclers, The Human Body). Each demonstration connects to a concept from the *Next Generation Science Standards* (*NGSS*). The videos can be used as stand-alone presentations or a professional development platform for elementary and middle level teachers. Consult *http://bit.ly/16zEpWc*.

Nobel Conferences. Every year, Gustavus Adolphus College in St. Peter, Minnesota, hosts a conference on a selected theme featuring speakers who are among the world's best in their fields, including one or more Nobel Laureates. The talks are streamed live and archived. Accompanying conference materials prepare high school and college students for the content of the talk (e.g., background information), and post-conference activities summarize understanding afterward. This year's conference explores the science behind addiction; however, educators can also access materials from past conferences, which have examined topics like The Universe at Its Limits, Our Global Ocean, The Brain and Being Human, and Where Does Science Go From Here? (click on Past Years at the website *http://bit.ly/1h3PqVD*).

HAGERTY RYAN, U.S. FISH AND WILDLIFE SERVICE

Adventures in Ecology. This publication features three environmental science activities for middle level and high school students. Produced by TERC, a nonprofit research and science education organization in Cambridge, Massachusetts, the activities explore what can be inferred from animal skulls (Bony Skulls), the factors involved in an animal's energy use (Moose Are Not Mice), and the effects of predation on communities and ecosystems (Predator and Prey). The activities are drawn from TERC's full-year curriculum, *Ecology: A Systems Approach,* and include both teacher and student guides. Refer to *http://bit.ly/1fEbq8r*.

EDC Earth Science Activity: Patterns in Surface Currents. Give high school students valuable practice in working with data visualizations while learning about Earth's physical processes. This activity from the Education Development Center helps students understand that uneven heating of the Earth by the Sun provides the energy that drives the ocean currents. Using maps representing average sea surface temperatures during a one-month period, students compare the temperature patterns in April and July, 2011, and relate these patterns to the movement of ocean water via warm and cool surface currents. Then they consider the impact of ocean currents on the climate of coastal communities. See *http://bit.ly/1JReIx3*.

Mysteries of the Brain. An eight-part video series produced by NBC Learn in partnership with the National Science Foundation (NSF) presents the latest research in neuroscience and profiles the scientists who are leading it. Each video segment explores a different aspect of how the wonderfully complex brain functions. For example, viewers will learn about how the brain works to learn and remember, how emotions are formed and processed by the brain, how neural circuits develop, and how the brain works during sleep. Accompanying lesson plans from NSTA for middle and high school students will be posted soon. Access the videos at *www.nbclearn.com/brain*.

Living Schoolyard Month Activity Guide. Creating "green" or "living" schoolyards is a growing movement in California and elsewhere that gets students outside to connect with nature, develop curiosity, and become stewards of their school and neighborhood environments. With this guide from Green Schoolyard America, preK–12 educators have more than 40 hands-on explorations that promote outdoor learning. Culled from leading environmental and education organizations in California, the guide presents activities in categories such as Wildlife Habitat (e.g., Butterfly Habitat Hunt), Watershed Stewardship (e.g., Calculating Rainwater Runoff), Schoolyard Agriculture (e.g., Roots and Shoots), Energy and Climate (e.g., Make a Solar Etching), Thoughtful Use of Materials (e.g., Compost Gourmet), Place-Based Understanding (e.g., Reflection Writing in Your Green Schoolyard), Art (e.g., Creative Painting with Garden Paintbrushes), Recreation (e.g., Photosynthesis Tag), and Health (e.g., Jump Rope Activities). Access them at *http://bit.ly/1O8L6Ob*.

Race ≠ DNA. To speak meaningfully about race, we need to truly understand its various perceptions and definitions—and how they all fit together. This article from Teaching Tolerance.org contains a biological, social, and ancestral breakdown, along with a link to a toolkit that provides a professional development framework for educators for examining common misconceptions surrounding race and ancestry. With these resources, teachers and administrators can begin debunking misconceptions and building identify-safe classrooms and schools. Read the article at the following website: *http://bit.ly/1g1EaZ2*.

LARS KLINTWALL MALMQVIST

Henry's Handwashing How-To. Promote hygiene with Henry the Hand! This short video is a fun way to remind elementary students about the importance of washing hands to reduce the spread of germs and the risk of infection or illness. The video discusses four principles of hand awareness: Wash your hands when they are dirty and before you eat; do not sneeze into your hands; do not cough in your hands; and do not put your fingers into your eyes, nose, or mouth. In addition, the video shows students the proper technique for handwashing. See *http://bit.ly/1LRJeLA*.

Web Literacy Tools. Mozilla Education offers new tools and curriculum to help learners of all ages—including K–college educators—achieve web literacy, or the ability to read, write, and participate online. For example, Webmaker, an open source Android app at *http://bit.ly/1TSJgWp*, teaches the art of digital storytelling, helping users create content like scrapbooks, photo galleries, memes, and comic strips. In addition, Mozilla offers lesson plans and tutorials on topics such as learning how to code, understanding why privacy matters, and creating open-license content at *http://mzl.la/1Rd910q*.

Careers in Computer Science. Middle level and high school teachers can learn the "dets" on careers in computer science (CS), such as schools with CS degree programs; job descriptions, certification requirements, and salary information; and a personality quiz to discover where you might fit best in the field. See *www.computerscienceonline.org*. The site also offers guides to encourage specific populations to pursue careers in the field for

- all students (*http://bit.ly/1D93h0f*);
- women (*http://bit.ly/1Cserkx*); and
- African American and Hispanic students *(http://bit.ly/1JxnNPJ*).

Fracking and Energy, a Classroom Guide. *Wall Street Journal* reporter Russell Gold has covered fracking, a drilling technique used to extract oil or natural gas from deep underground, for more than a decade. He recently released *The Boom,* a book on the history of the practice, which presents both the pros and cons. An accompanying Readers Guide provides thought-provoking questions that present various perspectives of this complex energy issue, making it particularly suited for use in high school environmental science and other classes to promote students' critical-thinking skills. Find the guide at *http://bit.ly/1KMiT2Z*. ●

News Bits

- **The *Next Generation Science Standards* (*NGSS*) succeed in preparing students to use data in the real world—but could do even better, says the Oceans of Data Institute's (ODI) new white paper.**

The ODI examined how well the data-usage expectations in the *NGSS* align with the "big data–enabled specialist" (BDES) occupational profile the organization compiled last year. A BDES analyzes large or complex data sets and uses the results to make discoveries or improve outcomes in various fields. The profile ODI created represents the knowledge and skills needed for these kinds of jobs.

The good news, states the white paper, is that the *NGSS* do emphasize skills necessary for using big data, such as developing an analysis plan and evaluating results. But the *NGSS* don't stress three key areas: tasks related to data management, data quality, and data ethics. Read more at *http://bit.ly/1h5Ies2*.

- **Oregon State University (OSU) has launched the first-ever endowed professorship in humanitarian engineering—an emerging field that seeks to improve the human condition and increase access to basic human needs, such as clean water or renewable energy.**

OSU alumni Richard and Gretchen Evans of Northern California donated funds to establish the program two years ago in response to a growing number of engineering students who wanted to make a positive impact on the world. OSU's program—and the new professorship—focus on disadvantaged communities in the Pacific Northwest and worldwide.

"The technical skills of engineering are essential, but so are abilities we might call human skills—such as communication, problem-solving, leadership, and the ability to work across cultures," says Richard Evans, an OSU College of Engineering alumnus who was president and CEO of Alcan, a Fortune-100 mining company. "The humanitarian engineering curriculum is a structured way for engineers to practice those human skills in challenging, real-world settings."

Kendra Sharp, an OSU mechanical engineering professor who heads the humanitarian engineering program, will be the first to hold the new professorship. "One of the things that's most exciting about humanitarian engineering is that it captures the interest of a more diverse group of prospective students than we typically see in engineering, including a significant number of women," she says. Read more at *http://bit.ly/1I2GbOb*.

- **University of Wisconsin (UW)–Madison faculty have created virtual internships that help students develop metacognition, or "reflection in action."**

David Williamson Shaffer, a UW–Madison learning sciences professor, and researcher Naomi Chesler, a professor in the College of Engineering, found metacognition a common trait among successful professionals. Their digital internships simulate science, technology, engineering, and math (STEM) jobs and help students think and make decisions intuitively, as well as make that thinking visible for students and their potential employers. So far, the internships have placed students in hypothetical engineering jobs in biomedical and mechanical device design. More than 800 students at four U.S. universities, one U.S. high school, and the Munich University of Applied Sciences have completed a virtual internship.

"In many ways, businesses want the same thing as middle schools and high schools: tools to develop and assess complex thinking," Shaffer says. The digital internships use Epistemic Network Analysis (ENA), which the researchers created to measure the development of complex thinking. ENA monitors changes in students' thinking by examining their notebook entries and digital conversations with peers and mentors.

The internships also seem to encourage female participants' interest in and commitment to STEM careers. "It's extremely exciting that these virtual internships could have that effect and could do so at a national scale," observes Chesler. The pair plans to create additional internships in medicine, architecture, and law. Learn more at *http://bit.ly/1KkpXlr*.

- **A new science podcast can teach you something *and* make you laugh. Boston's WBUR-FM's new series, *You're the Expert*, is hosted by comedian Chris Duffy.**

Each episode features a guest expert in a specialized field; guests have included a doctor who studies Neanderthal DNA and a researcher who examines bacteria from the New York Transit System. The series' regular panel of comedians uses questions and games to try to guess the experts' fields and why those fields are important.

The program highlights "some of the groundbreaking work being done by the brightest minds in science—research most people would never hear or know about otherwise," says WBUR General Manager Charlie Kravetz. *You're the Expert* airs on WBUR (90.9 FM) on Wednesdays at 9 p.m. and Saturdays at 6 p.m. Eastern Time. Listeners everywhere can also stream or download the podcast for free on iTunes. Learn more at *www.theexpertshow.com*. ●

What's New

FROM U.S. GOVERNMENT SOURCES

National Institutes of Health (NIH)

Cell Day

Enrich your cell biology or biochemistry classes by joining the free Cell Day web chat on November 5, 10 a.m. to 3 p.m. Eastern Time. Middle and high school students can get real-time answers to questions about cell biology, biochemistry, and research careers from scientists at NIH's National Institute of General Medical Sciences. Last year, Cell Day fielded questions like these: How many cells are in the body? How do scientists study cells? How do we stop bacterial infections that can't be controlled with antibiotics? Register for the chat and access Cell Day materials, including an interactive cell diagram, at *http://nigms.nih.gov/cellday.*

National Park Service (NPS)

Channel Islands Live

Introduce middle and high school students to the Channel Islands without leaving the classroom! The NPS has a series of virtual programs and webcams that provide a live glimpse of the Channel Island landscape and the plants and animals found there. Activities support the *Next Generation Science Standards* and *Common Core State Standards.*

For example, students can participate in a virtual live dive to the giant kelp forests around Anacapa Island, a remote island off the southern California coast. As students follow and interact with the scientist, they learn about kelp forest ecology, marine protected areas, and scientific monitoring. Students can also take a live "hike" through the remote landscapes of Anacapa Island, as a park ranger shares information about island isolation/biogeography. Or check out the Channel Island Live webcams to view bald eagle nests, seabird rookeries, iconic Arch Rock, and the underwater kelp forest. See *http://1.usa.gov/1h8gdjA.*

U.S. Fish and Wildlife Service (FWS)

Fish and Aquatic Conservation (FAC) Education Page

Looking for educational activities and games or outdoor skills websites for K–12 students? Among its many resources, this FWS site offers FAC fact sheets, a Salmon Dissecting game, information on FAC careers, and a booklet on Outdoor Discovery Zones. Refer to *http://go.usa.gov/3fdKT.*

U.S. Department of Energy (DOE)

Energy Literacy Framework Webinar

Want to "energize" the teaching of energy in your middle or high school science classroom and earn an hour of professional development credit? Watch this on-demand webinar exploring the nature and role of energy in our lives. Led by DOE education specialist Erin Twamley and middle level science teacher Josh Sneideman, the DOE's 2013–2015 Albert Einstein Distinguished Educator Fellow, the webinar covers how to teach about energy from the natural to the social sciences using the Energy Literacy Framework. Teachers will see demonstrations of hands-on activities, videos, interactive tools, and resources to engage students on energy. Register at *http://bit.ly/1KDlhsV.*

U.S. Geological Survey (USGS)

Water Science School

At the Water Science School, K–12 educators can access information on many aspects of water, along with pictures, data, maps, and an activity center that lets users share opinions and test water knowledge. An interactive Water Cycle diagram—available for beginner, intermediate, and advanced levels—allows students to "mouse around" the parts of the water cycle and view explanations, pictures, and more. Other highlights include *The Story of Dryville,* a class play for upper-elementary students that helps them understand how water is critical to developing a new town. See *http://water.usgs.gov/edu.*

U.S. Environmental Protection Agency (EPA)

Carbon Footprint Calculator

How much of your daily activity results in greenhouse gas emissions, which comprise a household's "carbon footprint"? EPA's updated calculator estimates your footprint in three main areas: home energy, transportation, and waste.

Carbon footprints vary by location, habits, and personal choices. Small actions add up. Have middle and high school students track their footprint and learn new ways to reduce their impact. They'll develop an awareness of energy issues and understand how to be more active in energy conservation. Consult *http://go.usa.gov/3KGdG.*

U.S. Department of Agriculture (USDA)

Preschool/Child Care Garden Resources

The USDA Team Nutrition program's website contains resources to help early childhood educators and child care professionals promote better nutrition through gardening. Culled from various organizations with nutrition education and school gardening programs, the resources include curriculum, fact sheets, videos, and gardening safety tips. For example, the Institute of Child Nutrition's More Than Mud Pies curriculum offers more than 50 age-appropriate activities exploring growth, nutrition, and food preparation. The Wisconsin Department of Health Services' Got Dirt? explains the basic steps of starting and maintaining a youth fruit and vegetable garden, and gives examples of successful school gardening, community, and child care projects. See *http://1.usa.gov/1gFxhgS.*

Library of Congress (LOC)

The Dust Bowl

LOC Student Discovery Sets feature historical artifacts and unique documents on a range of topics. Designed for iOS devices and Mac platforms, the books have interactive tools allowing students to zoom in, draw to highlight details, and conduct open-ended primary source analysis. The latest addition to the collection is *The Dust Bowl,* which presents songs, maps, and iconic photographs documenting the daily ordeals of rural migrant families during a disastrous decade. Teachers can incorporate the set into interdisciplinary science and social studies lessons that encourage critical thinking and develop students' abilities to consider multiple sides of an issue. View the set at *http://apple.co/1MXqPf9.*

Kids.gov

Titanic Classroom Resources

The tale of the *Titanic* is not just a tragedy. It's also an example of countries collaborating to prevent future sea disasters. Shortly after the sinking, countries on both sides of the Atlantic agreed to create new lifeboat requirements, better communications standards, and an ice patrol to help ships avoid icebergs. These requirements exist today.

Protecting the *Titanic* wreckage is also a joint-nation effort, with the National Oceanic and Atmospheric Administration (NOAA) leading U.S. involvement. Listed below are lessons and a poster about the *Titanic;* many lessons feature primary documents. The materials were developed by educators and scientists from the National Archives, NOAA, and other federal agencies.

- The "Return to *Titanic"* Expedition (Social Studies, grades 5–6; Physical Science, grades 7–8; Physical Science/Biological Science, grades 9–12. *http://1.usa.gov/1MwEBYe*)
- "Surviving Disaster—The *Titanic* and Safety of Life at Sea" (a poster describing the factors contributing to the disaster and how countries acted to prevent them; *http://1.usa.gov/1E6v6I7*)

- Inevitable Accident or Wrongful Act: Judging the *Titanic* Disaster (History, grades 6–12; *http://bit.ly/1DdEWgf*)
- The *Titanic* Disaster: Measuring Loss of Life, Property, and Injuries (History, grades 6–12; *http://bit.ly/1IO1oyW*)
- The *Titanic:* Shifting Responses to Its Sinking (Language Arts, grades 6–12; *http://1.usa.gov/1VQ8V43*)

National Institute of Standards and Technology (NIST)

The League of SI Superheroes

This animated cartoon series offers a way for middle and high school students to develop fluency with the SI, or metric, measurement system—an essential skill in many science, technology, engineering, and mathematics careers. The heroes use their awesome powers of measurement to fight uncertainty, imprecision, and inaccuracy and to improve daily life. In their latest adventure, "Running Out of Time!" (refer to *http://bit.ly/1ODYpra*), the League encounters Major Uncertainty, who is meddling with the atomic clocks responsible for the accuracy of the Global Positioning System (GPS). The episode highlights the importance of precision timekeeping in the widely used GPS and shows students how measurement enables the GPS system to work.

Meet the characters in the pilot episode, "Desperate Measures!" (*http://1.usa.gov/1DT2kdO*).

National Aeronautics and Space Administration (NASA)

Space Station Research Benefits

NASA's new book, *Benefits for Humanity,* tells how research aboard the International Space Station (ISS) helps improve lives on Earth while advancing NASA's human-exploration goals. The book describes benefits in areas such as human health, disaster relief, and education. For example, ISS research has produced devices to help control asthma and sensor systems that improve our ability to monitor and respond to natural hazards and catastrophes. Read the book at *http://1.usa.gov/1eG5Hyq*. ●

Quotable

One of the things that fascinates me most is when people are so charmed by the universe that it becomes part of their artistic output.

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

In Your Pocket

Editor's Note

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

September 25–30

Pathways Within Roads to Reading Initiative

This initiative provides new books to literacy programs in underserved communities. Public and private schools and their libraries, nonprofit organizations, after-school programs, and community centers are eligible; preference is given to those that provide remedial reading instruction and have been operating for at least six months. Visit *http://bit.ly/1LUIDKD* for details. E-mail applications by **September 25** to *bookdonations@pwirtr.org*.

Captain Planet Foundation Grants

These grants go to schools and nonprofit organizations that share the foundation's mission: to help youth better understand the world through active, hands-on learning projects that improve the environment in their schools and communities. Grants of between $500 and $2,500 are available, though preference is given to those that have secured 50% in-kind or matching funding. Ideal projects will incorporate both environmental education and service opportunities for youth. Organizations with operating budgets of less than $3 million can apply by **September 30;** consult *http://bit.ly/N4BTqL*.

Green Thumb Challenge Grant

Calling all youth garden projects: The Green Education Foundation and Gardener's Supply Company are seeking entries for this year's Green Thumb Challenge Award. This $250 award honors exceptional youth garden programs that have demonstrated success and impacted the lives of young gardeners in grades K–12, and their surrounding communities. A 10-minute video chronicling the success of your garden, a digital portfolio, or scanned artwork with descriptions are required to apply. Apply by **September 30;** see *http://bit.ly/NMYblp*.

Kids in Need Teacher Grants

These grants help preK–12 teachers provide innovative learning opportunities for their students. Projects that use common teaching aids creatively, approach the curriculum from an imaginative angle, or connect nontraditional concepts to illustrate commonalities are encouraged. The ability to replicate original project ideas is also important, since the winning projects will be published on the Kids in Need Foundation website.

Grants of between $100 and $500 are available; 300 to 600 grants are awarded. All applicants will receive poster-making materials and bulletin board supplies. Apply by **September 30.** See *http://bit.ly/13V2nJZ* for details.

P. Buckley Moss Foundation Teacher Art Grants

The foundation awards these grants to teachers who use art as a learning tool for all preK–12 students, including those who learn differently. Grants of up to $1,000 can be used for new or evolving programs that integrate art into the curriculum. Submit proposals by **September 30;** see *http://bit.ly/1qOPF9q*.

Project Learning Tree GreenWorks! Grants

GreenWorks! grants fund environmental improvement projects that help students learn about the world around them through a mix of academic curriculum and community service. Previously funded projects have included school gardens, outdoor classrooms, habitat restorations, recycling programs, and energy conservation projects. Grants of up to $1,000 are available.

Applicants must have attended or be registered to attend a Project Learning Tree workshop; projects must secure at least 50% matched funds and involve at least one community partner. Apply by **September 30** at *www.greenworks.org*.

New England Environmental Education Alliance (NEEEA) Awards

NEEEA awards recognize outstanding environmental educators and programs in New England in three categories:

- The Nonformal Environmental Educator Award recognizes those outside the classroom who provide innovative approaches to environmental education (EE) and are involved in the state or regional EE community;
- The Formal Environmental Educator Award goes to public or private school teachers who promote and inspire environmental stewardship and serve as an example for their colleagues in the EE community; and
- The Maria Pirie Environmental Education Program Award goes to EE programs that have been implemented broadly and successfully and can be easily replicated in other regions.

Awards are presented at NEEEA's annual conference. Nominate yourself or a colleague at *http://bit.ly/1LDTsj1* by **September 30.**

American Horticultural Society Great American Gardeners Awards

The awards honor those who have advanced the art, science, and environmental responsibility of horticulture in North America, and several are available for educators. The Jane L. Taylor Award recognizes an individual, organization, or program that has inspired and nurtured future horticulturists through youth gardening. The Teaching Award goes to someone whose own horticultural knowledge has contributed to others' understanding of the plant world and its influence on society. And the Liberty Hyde Bailey Award honors an individual who has made a significant lifetime contribution to the study of horticulture in at least three of the following fields: teaching, research, communications, plant exploration, administration, art, business, and leadership.

Learn more or nominate a colleague at *http://bit.ly/18oXgQr* by **September 30.**

Target Field Trip Grants

Target provides these grants for K–12 schools within 100 miles of a Target store. Field trips should connect students' classroom curricula to out-of-school experiences and take place between February and December 2016. Grants of up to $700 are available. Visit *http://bit.ly/1M8lzai* to apply by **September 30.**

EPA's Campus RainWorks Challenge

This contest is open to undergraduate and graduate students with creative ideas for managing stormwater at its source on their campuses. Entries should provide plans for green infrastructure projects that incorporate climate resiliency and use soils, vegetation, and natural processes to create healthier, more sustainable urban environments. They should also show how the project will benefit both the campus community and the environment.

Teams enter the contest in one of two design categories: the Master Plan category or the Demonstration Project category. Teams must have at least one faculty advisor, and members must be enrolled in a degree-granting public or private higher education institution in the United States as of August 31. Interdisciplinary teams are encouraged. Winners in each category will receive up to $2,000 to be split among the student members and up to $3,000 for the sponsoring faculty member.

Register by **September 30.** Visit *http://1.usa.gov/1LKxIDa* for details.

October 1–16

Toshiba America Foundation Science, Math Improvement Grants

K–5 science and math teachers with innovative classroom project ideas may apply by **October 1.** Proposed projects should make learning math and science fun for students and have measurable outcomes. Grants of up to $1,000 are available for project materials only. Refer to *www.toshiba.com/taf.*

Association of American Educators Classroom Grants

These grants of up to $500 fund a variety of projects and materials, including books, software, calculators, audiovisual equipment, and lab supplies. Full-time educators who have not received a scholarship or grant from the Association of American Educators (AAE) in the last 18 months are eligible, though AAE members receive additional consideration. Teachers in Arkansas, Colorado, Idaho, Kansas, Oregon, and Washington compete for state-specific funds and complete a separate application. Apply by **October 1** at *http://bit.ly/LC3Evc.*

Donald Samull Classroom Herb Garden Grant

The Herb Society of America offers these grants to public and private school teachers of grades 3–6 with classes of at least 15 students. Four schools will receive indoor windowsill herb gardens, with the necessary kits and educational materials, and five will receive $200 "seed money" grants to establish outdoor herb gardens, in addition to seeds and educational materials. Apply by **October 1** at *http://bit.ly/MpoSsc.*

Frances R. Dewing Foundation Grants

These grants fund projects or programs focused on early childhood education. Of particular interest are those at new, untried, or unusual educational organizations that aim to introduce new educational methods for young children, ages two to sixth grade. Grants range from $1,000 to $20,000, though the average is $5,000. Programs must be located in the United States and have tax-exempt status. Submit proposals by **October 1**; see *http://bit.ly/Nj43la.*

Jamba Juice It's All About the Fruit and Veggies Garden Grant

This program offers 30 awards to school and youth garden programs that promote nutrition education, incorporate fruits and veggies in the curriculum, and are sustainable over several years. Twenty-nine programs will receive $100 for fruit and vegetable plantings and $400 in gardening supplies. One grand-prize winner will receive $1,500 and may be asked to host a garden event at his or her school.

School, community, and nonprofit garden programs with at least 15 children ages 3–8 are eligible for these awards, which are distributed in two regions. Fifteen will be awarded to programs in the West region, which includes Arizona, California, Colorado, Hawaii, Idaho, Montana, Nebraska, Nevada, Oregon, Utah, and Washington, and 15 will go to programs in the East region (Alabama, Arkansas, Connecticut, Delaware, Florida, Georgia, Iowa, Illinois, Indiana, Kansas, Kentucky, Louisiana, Maine, Maryland, Michigan, Minnesota, Missouri, Mississippi, North Carolina, New Jersey, New York, Ohio, Oklahoma, Virginia, Wisconsin, and Washington, D.C.). Programs must be located within 50 miles of a Jamba Juice store.

Apply online by **October 2** at *http://bit.ly/1LFWQda.*

N-Vision a Brighter Future Grants

Westinghouse Electric Company provides grants for teachers and K–12 schools that want their students to learn about science, technology, engineering, and math (STEM) through hands-on projects. Projects that directly involve students, incorporate community resources, and use interdisciplinary or team-teaching strategies are preferred. Three schools will receive grants of $2,000: $1,000 to complete their projects and $1,000 for the schools' STEM needs. Proposed projects must be completed during the current school year. Apply by **October 9;** see *http://bit.ly/1RdDW26.*

Global Teacher Prize

The Varkey Foundation provides this $1 million award for an exceptional, innovative teacher who inspires his or her students and community and has made an outstanding contribution to the profession. Those currently teaching children between the ages of 5 and 18 in any school worldwide—full-time or part-time, in person or online—are eligible. Teachers with innovative and effective instructional strategies, evidence of teaching achievement, community recognition, and significant contributions to the profession are encouraged to apply. Nominate yourself or a colleague by **October 10** at *www.globalteacherprize.org/#about.*

Air Force Junior ROTC Grant

The Air Force Association offers grants of up to $250 to promote aerospace education in classrooms and Junior ROTC units. Grants may be used for aerospace-related items, such as books, materials, or field trips to an aerospace museum, Air Force base, or other aerospace facility. Classrooms and units can apply every other academic year. Visit *http://bit.ly/18sWJ3p* to apply by **October 10.**

NEA Foundation Student Achievement Grants

The National Education Association (NEA) Foundation provides these grants to support work at public schools and universities that improves academic achievement and encourages critical thinking and problem solving in any subject area. Grants of $2,000 and $5,000 are awarded to programs featuring inquiry, critical reflection, and self-directed learning.

Some funds may be used to support professional development, but most should pay for student materials or educational experiences. PreK–12 public school teachers, public education support professionals, and faculty and staff in public higher education institutions are eligible. Support professionals and teachers with fewer than seven years of experience who are also NEA members receive preference. Apply by **October 15** at *http://bit.ly/Xo4n8W.*

NEA Foundation Learning and Leadership Grants

The foundation also provides funds to individual teachers and support professionals or groups of them through this program. Individual grants support participation in professional development programs, summer institutes, conferences, or action research. Grants to groups fund study groups, lesson study, action research, or mentoring experiences for faculty and staff.

Individuals receive $2,000 grants; groups get $5,000. PreK–12 public school teachers, public education support professionals, and faculty and staff in public higher education institutions are eligible. Apply by **October 15;** visit *http://bit.ly/XMe5xB.*

Lorrie Otto Seeds for Education Grant Program

This program offers grants of up to $500 to schools, nature centers, and other nonprofit organizations for environmental stewardship projects. Projects should focus on native plants and cultivate an appreciation for nature.

Successful projects might include wildflower gardens with habitat for pollinators or rainwater gardens that capture runoff and feature native plant communities. Funds must be used to purchase native plants and seeds. Apply by **October 15;** see *http://bit.ly/1JSgWwc.*

Lowe's Toolbox for Education Grant Program

These grants help public K–12 schools and associated parent-teacher groups fund projects, especially those encouraging parental involvement and community building. Funding requests with a permanent impact—such as facility enhancements or landscape and cleanup projects—are preferred. Grants of between $2,000 and $5,000 are available. Schools must register before they can apply (by **October 16);** registrations can take up to 24 hours to process. See *http://toolboxforeducation.com.* ●

Summer Programs

Editor's Note

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

July 2016

2016 Mickelson ExxonMobil Teachers Academy. Sponsored by pro golfer Phil Mickelson and his wife Amy of the Mickelson Foundation and Exxon Mobil, this week-long professional development program provides teachers of grades 3–5 the knowledge and skills they need to motivate their students to pursue careers in science and math. Instructors from NSTA and Math Solutions will lead daily sessions designed to deepen teachers' content knowledge and model instructional strategies to support connections and student learning in these subjects.

The 2016 academy will take place in late July at the Liberty Science Center in Jersey City, New Jersey. The academy covers all expenses for this program, including travel, lodging, and meals. Teachers from across the country can be referred by a student, parent/guardian, or other adult or apply to the program themselves.

Approximately 150 teachers will be selected; NSTA will notify those chosen in mid-April. For more details, visit *www.sendmyteacher.com*. Apply by **October 31.**

Tell Our Teachers About Your Summer PD

Planning to hold a summer professional development (PD) program for science educators? You'll want to publicize it in this column in *NSTA Reports* (depending on when your registration deadline falls) and in the Summer Programs section of *www.nsta.org/calendar,* our online calendar. Once you have made your plans, e-mail the following information to *nstareports@nsta.org*:

- program dates and application deadline,
- location,
- relevant websites,
- registration fees (if applicable),
- contact person(s), and
- the grade levels/positions eligible to attend (i.e., elementary teachers, teachers of grades 7–12, science education supervisors, etc.).

All summer PD announcements will be posted to the online calendar. Those chosen to appear in *NSTA Reports* must meet one of these conditions:

- offer a stipend for all participants,
- offer tuition-free credit to all,
- reimburse all participants for some expenses (such as travel costs), or
- be offered by/through a nonprofit group, government entity, or university.

If your program qualifies for publication in *Reports,* please e-mail the information at least two months before the issue in which you want the announcement to appear (remaining issues are October 2015, November 2015, and January 2016 through May 2016). Announcements in *Reports'* Summer Programs column will be published *one time only* on a space-available basis.

Get even more visibility for your program by advertising it in NSTA publications. For more details, visit *www.nsta.org/exhibitsadv*. ●

The Biology of SKIN COLOR

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www.biointeractive.org/skin

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Connecting Teachers Through Citizen Science

FUTUREMAN1199

Members of the Science Teachers of Missouri (STOM) collected data on two broods of cicadas that emerged statewide—13-year Magicicada *and 17-year* Magicicada*—as part of STOM's new Citizen Science Project. Shown here is a 17-year* Magicicada septendecim *from Brood II in New Paltz, New York.*

Last spring, the Science Teachers of Missouri (STOM), an NSTA State Chapter, launched a Citizen Science Project that challenges members to identify questions and collect local data to form a statewide picture of Missouri's natural environment. "The idea came from a recognition by the board [of directors that we needed] to be more united as a state," says Phyllis Balcerzak, the association's college division director, who is leading the Citizen Science Project. "This year, we thought it would be fun to do some science projects involving contributing data from around the state."

STOM's membership includes "a lot of rural teachers," and the board was seeking ways to include more of them in association activities, Balcerzak points out.

The Citizen Science Project is part of the association's recent restructuring to boost membership, according to STOM President Carrie Launius. STOM's board now has three regions: urban, rural, and suburban. "The urban and rural regions had been overlooked, so we changed things around to [remedy that]," Launius explains.

The Citizen Science Project "is one of the exciting pieces in all of this," she observes. "Phyllis came up with this idea to strengthen STOM so teachers could see what they're getting out of their membership."

"I'm a big proponent of citizen science," notes Balcerzak. "We wanted to come together around something positive that showed why teachers [choose to teach science]" and "[unite] the state in an empirical study that would give us a common focus."

In addition, "we want to support [one another] in high-quality science teaching as framed by the *Next Generation Science Standards* [*NGSS*]," she maintains. "We said, 'Let's do science together and put the *NGSS* in action as a collective group of teachers.'"

The first data collection began last May, when two different broods of cicadas—13-year *Magicicada* and 17-year *Magicicada*—emerged simultane-

"We want to support [one another] in high-quality science teaching as framed by the NGSS."

—Phyllis Balcerzak

ously in Missouri. "Within 24 hours of announcing it on our website—as summer break began—we had 10 inquiries," says Balcerzak. Eventually, participants will create a state map showing the data about the various cicada species observed, and the map will be displayed at STOM's conferences and made available for teachers to show their students, she relates.

Because the cicada data collection began over the summer, teachers weren't able to include their students in the effort, but Balcerzak says future citizen science activities will involve students. Starting in September, teachers and students will explore how the size of particulate matter in the air compares around Missouri.

Another study would examine the Urban Heat Island effect, a slightly warmer envelope of air that exists over urban areas when compared to surrounding rural areas. Participants will collect data on temperature variations around the state and note patterns that can affect local weather, says Balcerzak.

"We're choosing projects that are simple and observational in nature because some teachers don't have [funds for] all the tools and equipment" needed for more complex studies, she explains. STOM members are invited to propose future studies.

"We'll have a common set of data that teachers can discuss at conferences around the state…and get to know one another," Balcerzak contends. "We'd [also] like to get the attention of our legislators [and] let them know how [Missouri] teachers and students are engaging in high-quality scientific practices."●

Quotable

Failure is the opportunity to begin again, more intelligently.

—Henry Ford, U.S. industrialist (1863–1947)

Building Scientific Creativity for All Students

By Carolyn Hayes, NSTA President 2015–16

In 2010, a *Newsweek* article grabbed the attention of many educators—especially those teaching science. "Creativity Crisis" raised many questions about the quality of science education and the impact it was having on U.S. students and their problem-solving abilities. Fast-forward to 2013 and the release of the *Next Generation Science Standards* (*NGSS*). NSTA, 26 lead states, and Achieve, Inc., collaborated to produce this document based on research from the *Framework on K–12 Science Education,* which focused on teaching science as a process rather than facts found in a book.

So how does *NGSS* relate to creativity? Most individuals would agree that creativity is defined as producing something that is pleasing to the eye and useful.

However, creativity in science focuses on our students addressing real-world problems by brainstorming many different ideas (divergent thinking), then merging those ideas to develop the best solutions to the problems (convergent thinking). When students are provided opportunities to use the three dimensions of the *Framework,* they are able to engage, explore, and explain the phenomenon in their world. Thus we have creativity!

Many educators claim they do not have time to include creativity because of the demands of the standards set out by their states' Departments of Education. If educators approach teaching science as a process, they will not only allow students to be creative, but also would find their students achieving more.

To help our students develop creativity in science, educators need to provide a classroom environment that supports creativity. Students have many questions about the world: Most started asking questions as soon as they could talk. The classroom must be a place where questions are welcomed and not pigeonholed because no time is available for discussion or investigation. By beginning with real-world problems related to the curriculum, educators can pique students' curiosity. Students will start building their science and engineering skills by "asking questions and defining problems." They will "plan and carry out investigations," as well as "construct explanations and design solutions."

As one observes student activities in this type of environment, one notices that mistakes are seen as learning opportunities, not as failures. The educator is viewed as the facilitator and models the practices of scientists and engineers by questioning the students. Opportunities are provided for communicating ideas and results from experimentation. Students are encouraged to compare data and to look for crosscutting concepts such as "patterns" or "structure and function" within the data.

Ultimately, students are encouraged to determine if their ideas will actually solve the problem. Students are learning disciplinary core ideas by using their science and engineering skills during these activities. They will not only apply the crosscutting concepts to current problems, but also to future problems they encounter.

Join me this year as we develop creative attitudes in science, technology, engineering, and mathematics by implementing the three dimensions of the *NGSS,* encouraging our students to be both divergent and convergent thinkers, and teaching science as a process. We will enable *all* students to become productive citizens of our country and our world. In the words of Albert Einstein, "Learn from yesterday, live for today, hope for tomorrow. The important thing is not to stop *questioning.*" ●

MS. MENTOR, **Advice Column**

Finding Out What Students Know, Going Metric

I teach sixth-grade science, and my students come from five district elementary schools and several private schools. Some schools emphasize science more than others, so it's hard to know what knowledge and experience each student has. My principal suggested giving a pretest at the beginning of the year or for each unit, but that sounds time-consuming, and I question how effective it would be. Do you have any suggestions to help me figure out what students know?

—A., California

I worked on a project that required students to complete a multiple-choice pre- and posttest to assess the effectiveness of an instructional program. The students were upset during the pretest because they didn't know many of the answers. Even though we explained that they weren't expected to know everything and the pretest wouldn't count as a grade, it was still a frustrating experience.

A pretest in your case at the beginning of the year would attempt to assess what students already know. Students would be asked to recall what they learned a year or more ago without a context or prompt or time to think. This isolated, once-and-done assessment could be stressful for students as well as time-consuming for you.

On the other hand, what students already know about a topic is just as important as the activities you plan or the materials you use. You could look at your school district's curriculum guide for the elementary grades, but as you noted, some topics may have been emphasized more than others depending on the teacher and available resources.

Preliminary activities can help you and the students determine the knowledge, skills, and experiences they bring to the learning unit. I'd suggest using activities that stimulate student thinking about the concepts, provide a context for their thinking, and relate to the learning goals. For example,

- KWL charts are three-column graphic organizers on which students note what they already (K) now about a topic, what they (W)ant to know, and finally what they (L)earn about a topic. The K and W columns can provide information before instruction on students' knowledge and interests. The L column is a self-assessment during and at the end of the unit. This strategy has been around for a while and has many variations. See "KLEWS to Explanation Building" in the February 2015 issue of *Science and Children* (*S&C*).
- Using a visual as a prompt, ask students to list in their notebooks what they know about a topic or to generate a list of related words. As with a KWL chart, students can include what they've learned about a topic from a variety of sources.
- On a list of key vocabulary or concepts, ask students to put a plus sign

next to those they're comfortable with, a check mark next to those they've heard of but are not sure about, and a question mark next to those with which they are completely unfamiliar. At the end of the unit, students can revisit the list.

- Using letters in a term from the unit, ask students to think of a related word or idea that starts with each letter. Students enjoy working together or sharing their lists. It's interesting to do this again at the end of the unit to see if students respond differently or in greater detail.

Assessing students' prior knowledge can also identify misconceptions or incomplete understandings. Page Keeley has written a series of books on *Uncovering Student Ideas in Science*. The "probes" in these books are brief activities that help teachers of all grade levels identify students' preconceptions or misconceptions about a topic. If you would like to preview what these probes look like, *S&C* publishes one in each issue.

To assess more than content knowledge, at the beginning of the year have students complete an activity or investigation with minimal directions from you. As you observe them, you'll have a chance to note their thinking and problem-solving skills, as well as their measuring, data-organizing, graphing, and writing abilities. In terms of interpersonal skills, you also can start to identify who are the leaders, bosses, followers, thinkers, creative minds, disrupters, class clowns, and bystanders.

Students may claim to be unfamiliar with a topic until they think about it. I found that some students had had teachers who used different terminology, which often confused those students. And I also learned that students knew more than they (and I) thought.

Do you have any suggestions for how I can help my middle school students understand and use the metric system? We struggle with this at the beginning of every year.

–E., Indiana

It's hard for U.S. students to understand meters, liters, and grams when in their everyday lives they are surrounded by references to miles, feet, inches, quarts, and pounds (one exception being a two-liter bottle of soda). We can't change what's on television or online, but we can require students to use International System (SI or metric) units and measurements in their science activities, investigations, and reports.

The first textbook I used had a chapter devoted to the metric system, so I would dutifully "cover" it at the beginning of the year, supposedly to prepare students for future investigations. The students memorized the prefixes, and the book contained exercises in measuring classroom objects. The chapter had a heavy emphasis on converting units from metric to English or vice versa. What a disaster! I felt like I was teaching more arithmetic than science. Even though we practiced measuring things with metric rulers, graduated cylinders, and balances, I found when asked to actually apply those skills in investigations, my students had forgotten (or claimed to have forgotten) much of what they had "learned."

When I reflected on this, I realized that I had expected the students to master these concepts, skills, and vocabulary without a meaningful context. It seemed difficult for them to apply processes introduced at the beginning of the year to an activity weeks later. I was certainly teaching the material, and the students seemed to know the material at the time. But they weren't learning it well enough to apply it to new activities without a lot of review and re-teaching.

So after that, I changed my approach. I decided to introduce only those SI/metric measures that are commonly used: kilograms, grams, and milligrams; liters and milliliters; kilometers, meters, centimeters, and millimeters. That's it. I mentioned that other units such as decigrams or centiliters exist, but are seldom used. (I've traveled a lot in Europe, Canada, and Australia, and I never saw anything measured in hectograms or kiloliters!)

I introduced or reinforced these units within the context of investigations, rather than as separate and isolated topics of instruction. When we came to an investigation requiring liquid measurements, we first practiced with graduated cylinders and discussed the relationship between milliliters and liters. Students had a section in their notebooks for notes and drawings on measurements that they could use as reminders in future activities. I also found that students knew more than I had assumed.

We didn't spend time on problems converting miles to kilometers or grams to ounces. It's not worth it, and now most smartphones, tablets, and computers have apps that do these conversions. Students should know which SI units correspond to the ones they are more familiar with in the United States. For example, in much of the world, meat and butter are sold in kilograms instead of pounds; distances between places are expressed in kilometers; gasoline and milk in liters; and so on.

I always had a few students ask, "Why do we have to measure this way?" A good question! I would mention that science research around the world uses SI measurements. The United States, Myanmar, and Liberia are the only nations in the world that do not use SI as the official system of weights and measures. But I clinched the discussion by asking students, "Who likes to play with fractions?" When the students compared adding 1/8 inch and 3/16 inch versus adding 3 mm and 4 mm, they were convinced.

See these websites:

- Meaningful Metrics with Dramatic Demonstrations (*http://bit.ly/1KmHRD4*)
- Dr. Parkinson's Help Pages on: Metric Units (*http://bit.ly/1CX9D9p*)
- U.S. Metric Association's Frequently Asked Questions (*http://bit.ly/1JAMGWz*) ●

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.

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WHAT TEACHERS ARE SAYING:

*"Attending an NSTA conference was one of the **most influential experiences** I have had since becoming a teacher. Attending an NSTA conference should be a requirement for every teacher. I could not wait to get back to my classroom to **implement the incredible ideas** I had been immersed in at the conference."*

*"**The experience was absolutely unbelievable.** Not only did the experience positively impact me, but it has influenced fellow teachers as well as **increased my students' excitement for science.**"*

*"I am extremely grateful to NSTA for giving me the opportunity to attend one of the greatest professional development opportunities available for elementary science teachers. **I grew so much** professionally while at the conference, and I **implemented many of the strategies** I learned at the conference as soon as I returned to my classroom. My students and I have both **benefited greatly** from this opportunity."*

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BLICK ON FLICKS

Ant-Man Saves the World With Biology

by Jacob Clark Blickenstaff, PhD

I did not grow up with an addiction to comic books, but I was, of course, familiar with the big names in the superhero genre, like Superman, Batman, and the Fantastic Four. I was unfamiliar with Ant-Man before the marketing for the latest film in the Marvel Universe came to my attention a few months ago. One consequence of my ignorance of the comic book is that changes from the original to the film version don't bother me (unlike those made in the world of Middle Earth). I entered the theater with no preconceptions about *Ant-Man*—the film or the character—and left with some ideas about how teachers could use the film to introduce the behaviors of real ants and discuss the concept of *eusociality* in insects, and some ideas about scaling.

Paul Rudd stars in *Ant-Man* as the good-hearted criminal Scott Lang. After his release from San Quentin State Prison, Lang has difficulty finding work, and eventually agrees to join three other criminals for a safecracking job. Instead of the "good stuff" Luis (Michael Peña) promised, Lang finds a suit and helmet in the safe, and predictably, he eventually tries them on. The suit shrinks him to about the size of an ant, and the experience terrifies him.

While trying to return the suit, Lang is arrested and meets the suit's creator and owner, Hank Pym (played by Michael Douglas). It turns out that more than 20 years earlier, Pym discovered "Pym particles," which enabled him to "shrink the distance between atoms" at will. When S.H.I.E.L.D. (the Marvel Comics fictional espionage, law-enforcement, and counterterrorism agency) wanted the technology for an offensive weapon, Pym chose to hide it. Now Pym's former protégé Darren Cross (Corey Stoll) is close to re-discovering the breakthrough, and Pym wants Cross stopped. Pym taps Lang to be the new Ant-Man, though Lang needs training in martial arts and use of the suit to be prepared. Pym's daughter Hope (played by Evangeline Lilly) provides this training, as she is familiar with the suit and close to Darren Cross. With time, Lang becomes adept at changing his size quickly to surprise his enemies and take full advantage of the suit.

I appreciate that the filmmakers depict real ant behavior at several points in the film, and describe a number of real ant species fairly accurately. Thousands of different ant species exist, and many have not yet

been carefully classified or studied. Ants also range greatly in size from less than 1 mm to more than 50 mm long. The majority live in colonies and carry out specialized functions within the colony (a queen and drones handle reproduction, while workers tend the young, forage, and defend the colony from intruders). This division of labor in ants and bees is referred to as *eusociality* and is almost exclusively a social structure of insects.

Eusocial organisms also look different depending on their role in the colony: Queens are generally larger than workers, and drones are usually intermediate in size. Naked mole rats are one of only two species of mammal to engage in a version of eusocial behavior. If you'd like to observe a colony of naked mole rats, check out the web cameras at *http://bit.ly/1MN0Nv8*.

Ants communicate with one another through chemical signals called pheromones, passing alarm signals through the colony, leading the way to food sources found by foraging workers, and even signaling to a clean-up crew when a worker dies and her body should be removed from the nest. Ant-Man uses some type of electronic device to communicate with his ant allies, but it isn't clear whether it uses pheromones to do so.

We see several examples of real ant behavior in *Ant-Man*. One of the most dramatic is when Lang is carried through a water pipe on an ant raft, a flat disc of ants locked together that floats on top of the water. In nature, this behavior protects the colony from flooding rains; it isn't used to travel down pipes, but the principle is the same. Since the hairs on ants' bodies trap air around them, even the ants forming the bottom of the raft generally survive.

Later, the rafting ants form an ant tower to lift Ant-Man to the top of the pipe. This is very similar to an ant bridge. These ants are clearly closing a gap along a route they want to take, and use their bodies to build a structure capable of supporting the other workers.

Not all of the film is so well-based in real science, though. Pym particles supposedly shrink objects by decreasing the distance between the atoms in the object. This would mean that the object (or man) would still have all of his original mass, even when tiny. Hope even mentions this when training Lang, saying that he has all the force of a 200-pound man in a tiny area, and comparing him to a bullet. Most of the time, however, objects that shrink also become proportionally less massive. (A plot point relies on one of these transformations, so I won't elaborate here. You will recognize it when you see it.)

Changes in scale can have surprising consequences when we do some basic calculations of volume. I'll assume that Lang shrinks by a factor of about 70 in each dimension, since he went from about 6 feet tall to about 1 inch tall. Since volume is length times width times height, this means his volume would be about 70^3 or 340,000 times smaller. If he kept all his atoms, and so retained all his mass, his density would increase from about that of water (1 g/cm^3) to more than 340 kg/cm^3. (Compare this to the density of lead, which is about 10 g/cm^3, and you'll see that that is incredibly dense.)

GEOFF GALLICE

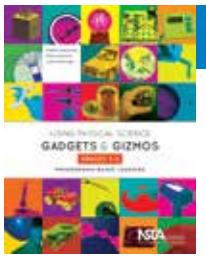
Ants form a bridge.

Another quick calculation to check is to estimate the pressure under his foot. Pressure is force per unit area, and area is length times width, so the area of Lang's foot would be about 5,000 times smaller ($70^2 = 4900$) when shrunk than when he is normal size. So if he kept his initial mass, the pressure under his foot would be 5,000 times larger than normal, and he'd probably damage most floors just walking on them.

Ant-Man gives biology teachers a chance to discuss real ant behaviors in nature, and can also inspire students to do some simple calculations of density, volume, and area. ●

Note: This film is rated PG-13 for sci-fi action violence.

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.



NSTA PRESS: *Using Physical Science Gadgets & Gizmos, Grades 3–5: Phenomenon-Based Learning*

Gravity

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 Using Physical Science Gadgets & Gizmos, Grades 3–5: Phenomenon-Based Learning, *by Matthew Bobrowsky, Mikko Korhonen, and Jukka Kohtamäki, edited for publication here. To download the full text of this chapter, go to* http://bit.ly/1MnjffP. *NSTA Press publications are available online through the NSTA Science Store at* www.nsta.org/store.

You might have heard the phrase "What goes up, must come down." People say it a lot. Although some rockets do not come back down, most things you see do. You can see things go up and then come down every day.

Imagine you are holding a one-kilogram mass in your hand. Feel the force that is pulling the mass toward the ground. Then imagine holding a five-kilogram mass. You would probably notice that the force pulling down is stronger now. In fact, it is five times stronger. There is always a force between the Earth and other masses. This force is called *gravity* or *gravitation*.

In both of the imaginary experiments you just did, you felt the pull from a second mass: the Earth's mass. That mass is so big that you can feel the gravitational force. The strength of the force depends on the masses of the objects.

Let's explore!

Propeller Puzzle

Safety Notes

- Wear safety glasses or goggles.
- Make sure all fragile items are removed before launching the flyer.

To take off, an object such as an airplane must fight gravity. To stay in the air, the force pushing upward must be as strong as the gravitational force. If the object stays at the same height in the air, the upward and downward forces are equal. To make an object that was not moving start to go higher, the upward force must be stronger than the gravitational force.

Gravitation tries to pull things toward the ground. There are many ways to fight against gravity. In the next experiment with an Infrared-Controlled UFO Flyer, you will explore one.

1. First, it is important to learn how to fly the UFO Flyer.
2. Hold the flyer about two feet from the ground. Turn it on and release it.
   - Try to fly the flyer so that it hovers about as high as you are tall.
   - Now practice takeoffs and landings. When you can do both smoothly, you are ready to move to the next step.
3. Keep the flyer steadily in the air. Move your hand under the flyer as it hovers. What do you feel? Use this information to explain why the flyer stays in the air.
4. Next, cut out a circle of paper about the size of a compact disc. Put it on the table. Attach the flyer's landing skids to the paper.
5. Now, take off! What happens—and why?
6. Remove the paper.
7. Put a table in the middle of the classroom. First, set the flyer at the front of the classroom. Then, try to fly it over to land on the table.
8. Can you create some wind to make the flyer move sideways?
9. Try to lift a piece of adhesive or mounting putty with the flyer. Find out how much cargo it can lift. *Hint*: Attach it to the bottom of the flyer.

Balancing Bird

Safety Notes

Wear safety glasses or goggles.

When an object is balanced, the forces in opposite directions are equal, and the object does not accelerate. In addition,

there are at least two forces affecting it: One force is gravity pulling downward, and another is whatever force pushes or pulls upward and keeps the object from falling. You can balance an object by supporting it at only one point. It can be tricky, but in the next experiment, you will learn how to do it.

1. Try to balance a small schoolbook on your fingertip. You need to find just the right spot. When you have found this spot, the book will be balanced.
2. Next, try to do the same for the Balancing Bird you were given.
3. Why is the shape of the bird important for how you balance it?

What's Going On?

Propeller Puzzle

Imagine filling up a balloon with air and then letting it go. The air blows out one way, pushing the balloon in the opposite direction.

The UFO Flyer works in the same way. The flyer's propellers push air downward, and pushing the air downward causes a force upward—just like when you release a balloon. That force is as strong as the gravitational force downward. This is true when the flyer is hovering. When you attach paper to the flyer, the rotors' airflow pushes the paper *and* the flyer downward. This is why the flyer cannot take off with the paper attached, but a piece of adhesive heavier than the paper can be lifted up with the flyer. Finally, although the flyer is at balance vertically, it can still move sideways with the wind.

Balancing Bird

When an object is held up by its balance point, it stays in balance. You might imagine that the entire mass of the object is located at the balance point. It really is not, but it seems as if it is when you balance it. This balance point is sometimes called the center of mass.

The Balancing Bird's balance point is on its beak. This is because weight was added at the end of the bird's wings, which are spread wide and extend forward. The weights in the tips of the bird's wings spread out the bird's weight so that its center of mass is at its beak.

Another thing that affects the balance of an object is the amount of supporting area. For example, the larger the area between the four legs of a chair, the better the chair stays in balance. In fact, the Balancing Bird is also balanced when lying on the table—the supporting area is bigger than just the beak.

Relevant Standards

Note: The Next Generation Science Standards *can be viewed online at* http://bit.ly/1hyoZHL.

Performance Expectations

3-PS2-1: Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.

5-PS2-1: Support an argument that the gravitational force exerted by Earth on objects is directed down. [Clarification Statement: "Down" is a local description of the direction that points toward the center of the spherical Earth.] [*Assessment Boundary: Assessment does not include mathematical representation of gravitational force.*]

Disciplinary Core Ideas

PS2.A: Forces and Motion

Each force acts on one particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion. (Boundary: Qualitative and conceptual, but not quantitative, addition of forces are used at this level.)

PS2.B: Types of Interactions

Objects in contact exert forces on each other. ●

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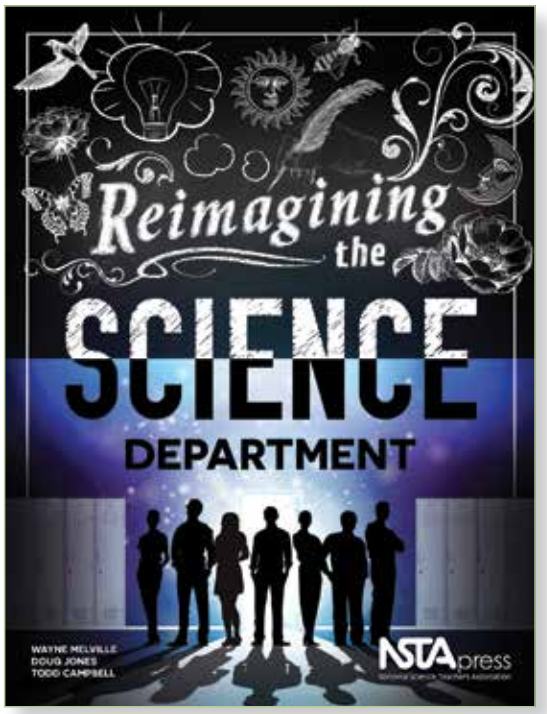
BACK TO SCHOOL



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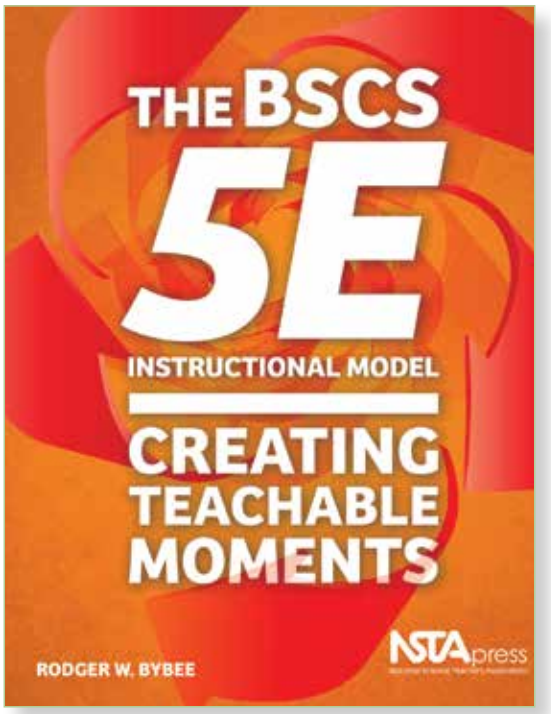

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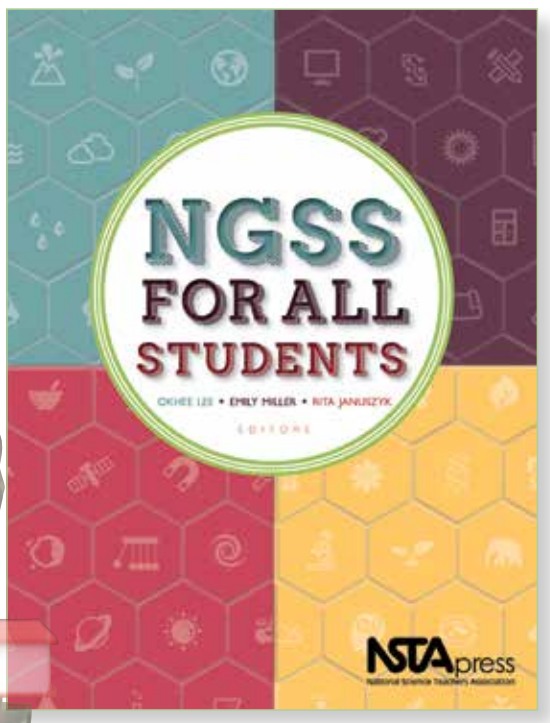

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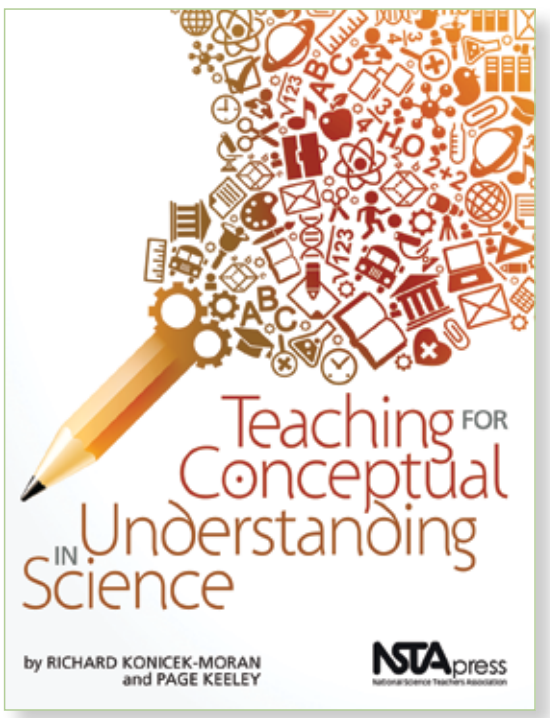

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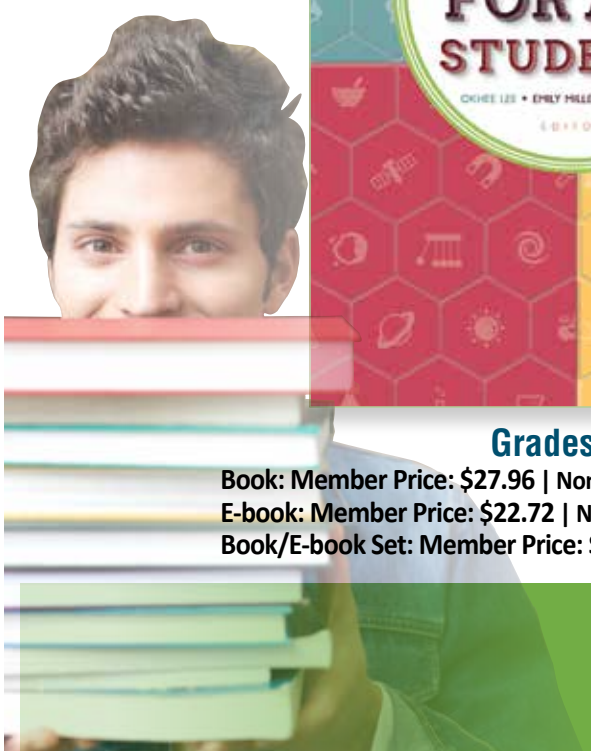

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NSTA National Science Teachers Association

(All dates are deadlines unless otherwise specified.)

October 14—Excellence deserves to be rewarded—especially teaching excellence that has impacted students, schools, and communities—but the application process can be daunting. Learn about the application process for the Shell Science Teaching Award from presenter Lori Lancaster, the Shell Science Teaching Award Judging Panel chair, during **Developing a Competitive Application for the Shell Science Teaching Award, a free NSTA Web Seminar** for K–12 educators. Lancaster also will offer insight into ways to strengthen your application. 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.*

October 21—It takes more than great teaching to earn a coveted award. Find out how you can win up to $10,000 by showcasing the outstanding teaching you already do during **Developing a Competitive Teacher Award Application, a free NSTA Web Seminar**. Diana Wiig, NSTA Teacher Awards and Recognition Committee chair, will discuss the application process for 2014–15, sharing insights into completing applications and tips for strengthening submissions for a chance to win prize money, materials, and equipment for your classroom! NSTA Teacher Awards recognize preK–16 science educators in the United States and Canada. More information about the NSTA Teacher Awards program is available at *www.nsta.org/awards*. For more details about NSTA Web Seminars or to register, visit *http://bit.ly/1Iwpg4w.*

October 22–24—**NSTA's three-day Area Conference**—themed "Science and Literacy: Creating Connections!"—opens in **Reno**, Nevada. Attendees can follow one of three strands—Bundling the *Next Generation Science Standards* (*NGSS*) and the *Common Core State Standards*; *NGSS*: Connecting Standards to Practice; and Creatively Engineering Future Resources—to focus their professional learning or select individual sessions that best meet their needs. Advance registration costs $190 for NSTA members by **October 2**; on-site member registration costs $225. For more information or to register online, visit *www.nsta.org/reno*.

November 12–14—The **NSTA Area Conference** in **Philadelphia** explores "Revolutionary Science" at the Pennsylvania Convention Center. Three strands—Revolutionizing Engineering for the Future, Integrating Literacy Strategies to Revolutionize PreK–12 Science Instruction, and Technology: Teaching Revolutionary Science in the Digital Age—allow attendees to focus on specific areas of interest. NSTA members must register by **September 25** to receive the $180 earlybird rate. On-site registration costs $225. For more information or to register, visit *www.nsta.org/philadelphia*.

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.*

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 earlybird rate. On-site registration costs $225. For more information or to register, visit *www.nsta.org/kansascity*. ●

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.*

- **NSTA Member-Only E-Mail Lists.** Where do you turn for quick advice on teaching environmental science—or chemistry, or physics—if you don't have a colleague available? Every day, NSTA members turn to colleagues across the country via these lists. To ask a question or share your own insight and experience, subscribe to any (or all) of the 18 topic areas: biology, chapters and associated groups (CAGs), chemistry, computer science, early childhood, Earth science, elementary, environmental science, general science, middle school, new teacher, *Next Generation Science Standards (NGSS)*, pedagogy, physical science, physics, retired teacher, STEM [science, technology, engineering, and mathematics], and technology education. Find out more about the e-mail lists and sign up at *http://bit.ly/WG5naw.* ●

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While we teach, we learn.

—Seneca, Roman philosopher (4 BC–65 AD)

NSTA Area Conferences Focus on PL

NSTA Area Conferences provide focused professional learning (PL) opportunities across the country, allowing science educators to build content knowledge, connect with other educators, learn more about the *Next Generation Science Standards* (*NGSS*), and more. The 2015 area conferences will be held in Reno, Nevada; Philadelphia, Pennsylvania; and Kansas City, Missouri.

From October 22 to 24, science educators in Reno will explore "Science and Literacy: Creating Connections!" Conference strands—Bundling the *NGSS* and *Common Core State Standards*; *NGSS:* Connecting Standards to Practice; and Creatively Engineering Future Resources—help attendees identify sessions to tailor their experience.

Science educators will delve into "Revolutionary Science" in Philadelphia, November 12–14. Conference strands are Revolutionizing Engineering for the Future, Integrating Literacy Strategies to Revolutionize PreK–12 Science Instruction, and Technology: Teaching Revolutionary Science in the Digital Age.

Educators will be "Raising the Stakes in Science" in Kansas City, December 3–5. Strands focus on The Art and Craftsmanship of Teaching, Combining Science With Agriculture, and Achieving Success With the *NGSS*.

The American Chemical Society and the American Association of Physics Teachers are sponsoring special programs at the area conferences. Chemistry Day at NSTA and Physics Day at NSTA will be held in Reno, Philadelphia, and Kansas City.

The American Society for Engineering Education is hosting Engineering Day at NSTA in Philadelphia and Kansas City. The National Association of Biology Teachers will host Biology Day in Kansas City.

For more information on NSTA conferences or to register, visit *www.nsta.org/conferences.* ●