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MAUREEN TAN, FAIRCHILD TROPICAL BOTANIC GARDEN

NSTA Reports
National Science Teachers Association

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Combining Science and Civic Literacy

Why should teachers blend science with civic literacy? Because "happiness comes from being part of something bigger than yourself…Students get to understand and research community issues…[and] serve as ambassadors in the community," asserts Tom Condon, who co-teaches the Citizen Science Institute (CSI), a districtwide magnet, alternative program housed at Marshall Middle School in Olympia, Washington. CSI involves about 60 students in grades 6–8 in rigorous scientific and civic investigations that help them "become experts who can teach other students," Condon contends.

"We do field investigations, not field trips. Students tend to think of field trips as days off," maintains Matthew Phillipy, who co-teaches CSI with Condon. "We work really hard. By eighth grade, students have done about 50 different investigations," Phillipy reports.

For example, students worked with the U.S. Fish and Wildlife Service (FWS) to track the endangered bull trout, which are native to the Northwest. "We used an idea from a *Science Scope* [article] about tracking endangered species using GPS [the global positioning system]," says Condon. Students explored the impact on the bull trout of a dam built in the 1940s to control floods on nearby farmland. "Dams impede their migration paths," he notes.

When students tracked the trout, amazingly "one fish showed up at a local saloon," Condon recalls. "Dan Spencer of [FWS]...talked about how the tracking worked and why the fish appeared near the saloon, 100 yards from the river." Students had to weigh the benefits of the dam to farmers versus its effect on the trout. "They experience science in the field and being part of the solution," he emphasizes.

TOM CONDON

Students in the Citizen Science Institute, a magnet, alternative program housed at Marshall Middle School in Olympia, Washington, do scientific and civic investigations. These students are doing seasonal bird counts at the Billy Frank Jr. Nisqually Wildlife Refuge in Olympia.

CSI students complete two STEAMposium (science, technology, engineering, arts, math) and civics research projects each year. Projects include a written paper and oral presentation. "We invite scientists to see what students are learning," says Phillipy.

"The sixth graders have less experience with getting in front of people and talking. By eighth grade, they're much more confident talking to audiences" as a result of their three-year CSI experience, notes Condon. "They serve as leaders and mentors to the younger students."

The civics projects can focus solely on social issues or integrate science. Phillipy recalls a student with a learning challenge who couldn't always recognize colors. "To her, it was a social issue because she was less accepted by the other students," he explains. For her project, "she pulled in the science" by discussing what happens with the brain's synapses with this condition, he relates.

Students find that "if you can tie in the science, it makes your arguments more relevant because you can back

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NSTA National Science Teachers Association

COMMENTARY: **Julian Willard and Carolyn Neuhaus**

Why Bioethics Belongs in Science Class

By Julian Willard and Carolyn Neuhaus

COFFEE POND PHOTOGRAPHY

Julian Willard

Carolyn Neuhaus

Is anyone more acutely aware of fairness and unfairness than a teenager? High school and middle school students find discussion of fairness, justice, and ethics in everyday life extremely engaging. Whether on the sports field, at home, or on social media, they grapple with ethical questions related to the meaning of fairness, the nature of a just world, and the management of personal relationships: *Is it a fair competition if a member of the opposing team is a year older than everyone else? What's wrong with blocking a friend on Instagram if they really upset me? Why do some people go hungry as others make millions? Should I be a vegan?*

Ethical questions also permeate science class. Topics like genetic testing, robotics and artificial intelligence, or the impacts of climate change raise serious ethical and social issues. Discussion of these issues can promote critical-thinking skills and scientific understanding.

Bioethics refers to the study of ethical, legal, and social issues that arise in health care, health policy, and scientific research. It draws on a variety of disciplines, including philosophy, political science, and the social sciences, to answer ethical questions arising in these sectors and to recommend future action. Should parents select the traits of their children through the use of reproductive and genetic technologies? Should we allow machines to make medical diagnoses and decisions for us? Should we genetically modify plants, insects, and other animals to protect crops, human health, or the planet?

Productively discussing these questions requires understanding and applying scientific concepts, making science class one of the most natural vehicles for introducing bioethics. This way, students see why it is essential to understand science and "know the facts" when answering ethical questions, for example, about the benefits and risks of certain technological innovations.

Additionally, introducing ethics in science class helps students develop critical-thinking skills, equipping them to work through ethical conflicts they encounter in their own lives. Today's students will inevitably confront issues related to genetic testing in their families and will be asked to vote on issues related to new technologies like artificial intelligence. We need to prepare them to both understand basic scientific concepts and critically analyze the meaning and impacts of science for society.

Many science teachers, however, report feeling ill-equipped to lead discussions on bioethics, which often touch on religious beliefs and sensitive issues. A number of free online resources aim to overcome this and other challenges to having ethical discussions. These resources provide background information about bioethics, ethical decision-making frameworks, cases, and curricula on a variety of topics. For example, the Exploring Bioethics curriculum supplement available from the National Institutes of Health (NIH, see sidebar) provides detailed curricula on a range of bioethical topics and a clear rubric for evaluating student work.

Another reason science teachers might hesitate to incorporate bioethics into their classes is a lack of time to dedicate to bioethics discussions and limited opportunities to engage students in rich, extended dialogue. Outside science classes, complementary vehicles for bioethics learning include starting a school bioethics club or participating in the annual High School Ethics Bowl. Co-advising a club or team along with teachers from other disciplines can be mutually beneficial as teachers learn content and skills from one another.

A study of the implementation of Exploring Bioethics in 50 high school science classrooms across the United States found that bioethics is an entry point for stimulating interest in science among students who were not otherwise motivated to engage with scientific topics. After joining her high school ethics club, one teen reported that "clearly vocalizing your thoughts about a nuanced issue is extremely hard…It has given me so much more respect for other people's realities and experiences because every perspective is important to consider when dealing with an ethical issue."

Whether developed in science class or in a club context, bioethical learning can enliven the intellectual and ethical culture of the school community and break down barriers between the science classroom and the wider world. ●

Julian Willard, PhD, a recent fellow at Harvard's Center for Bioethics, chairs the Interdisciplinary Studies Department at The Rivers School in Weston, Massachusetts.

Carolyn Neuhaus, PhD, is a research scholar at The Hastings Center, a nonprofit bioethics research institute that addresses fundamental ethical and social issues in health care, science, and technology.

General Resources

- Presidential Commisson for the Study of Bioethical Issues (*https://bit.ly/2Mdst5K*)
- The High School Bioethics Project (*https://bit.ly/2M5zkPi*)
- *Exploring Bioethics*, NIH (*https://bit.ly/2OVMA6M*)
- Bioethics 101, Northwest Association for Biomedical Research (*https://bit.ly/2OrJ3wb*)
- Bioethics Club (*www.bioethicsclub.org*)
- National High School Bioethics Bowl (*https://nhseb.unc.edu*)

Bioethics and Design Thinking

- Ethics Lab, Kennedy Institute of Ethics (*https://ethicslab.georgetown.edu*)
- Radius, Technology and Culture Forum at MIT (*https://radius.mit.edu*)

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your opinions up with the facts," according to Phillipy.

CSI students "learn how to behave in society. Our eighth graders leave us civically minded and understand how science works," Phillipy relates.

The Value of Water

"I lead a series of Water Workshops with Friends of the Chicago River [a nonprofit advocacy organization working to improve the health of the Chicago River system]…called Teens H2O," says Linda Keane, professor of architecture and environmental design at The School of the Art Institute of Chicago (SAIC). She established Teens H2O for students ages 11–14 because "when the water cycle is introduced in second grade, [the material] doesn't go deep enough [for students] to understand how water gives us life…I wanted to get [Chicago-area] students to understand—[in a way that's not always possible in school]—that we are on the Great Lakes Basin, [which provides] 84% of the surface freshwater for the United States," she explains.

In addition, the teen years are "critical years to capture students' [interest] before they graduate,…especially for the two-thirds of students who are not going on to college," Keane maintains.

Once students apply for or are chosen by teachers for Teens H2O's free workshops, "we meet them at designated places [in] downtown [Chicago]—the McCormick Bridge on the River Walk, The Chicago Line Cruise Boat Company, or SAIC—and start our water workshops. Each site has different activities," Keane relates. Workshop themes are "Water and Me" (SAIC), "Freshwater and Lake Michigan" (The Chicago Line Cruise Boat Company, which provides an eco-cruise for the students), and "Life On, Along, Above, and Below the River" (McCormick Bridge on the River Walk).

"At first, we talk about what we need to live. Students sometimes forget air, but almost always think of water, as Chicago is on Lake Michigan. They take it for granted," she observes, "but many of the students have never been on the river."

Students use water interactives, simulations (water cycle, watershed, water pollution), and games (water equivalencies) to study water's role in society. For example, they can calculate the relationship among water, energy, and climate change using WECalc (*www.wecalc.org*) or simulate improved water infiltration by replanting prairies, wetlands, and forests with WikiWatershed (*https://wikiwatershed.org*). "In WikiWatershed, they can see a map of Chicago and see the effects of heavy rainfall," Keane points out. The workshops access material from NEXT.cc (*www.next.cc*), a free e-learning website Keane co-founded and directs that provides informal learning opportunities for students and teachers to explore project-based learning (PBL).

Students learn key principles in water quality and conservation while conducting field research outdoors and creating place-based projects. "We want to engage students as citizen scientists, [without them thinking they] have to be hydrologists," Keane contends, although "we mention and they think about [science, art, and design] careers in the workshops as well. As citizens, they can do water testing and contribute" to the health of water sources.

"We show that everyone pollutes the water because of what they do. Students learn what kinds of garbage come from what businesses and why it needs to be addressed. Students learn about the role green roofs play in storm water management." Many students, she adds, "never had thought of caring for water before or how special where they live is in relationship to freshwater."

Most of all, they experience "science used as advocacy to make change. Helping people help others is a passion most scientists have," Keane emphasizes.

Healing From Harvey

"A year ago, Hurricane Harvey devastated our community, flooding 16,000 homes, 3,300 businesses, and [a high school in Kingwood, Texas]. I won a grant from our district's education foundation to coordinate a district-wide PBL on learning about, restoring, and protecting the Lake Houston Watershed. Eighteen teachers and 13 campuses in our district signed up to participate, with more teachers and students asking to participate as [we publicize] the project," says Kathleen Goerner, secondary science coordinator for Humble Independent School District (ISD) in Humble, Texas. "People are trying to understand how [the devastation] happened and how to prevent it from happening again," she explains.

Residents also tried to grasp why certain decisions were made, such as the opening of the floodgates by the San Jacinto River Authority, which resulted in "even more flooding; the whole Lake Houston area was devastated," Goerner reports. Teachers told her it was important for students to understand as well. "We had lots of parent input, too," she adds. "Harvey brought us a big community issue that everyone wants to learn about."

One teacher who is a Federal Aviation Administration–certified drone pilot won a grant to buy drones. "He intends to have students do drone surveys of the river and lake as dredging projects proceed…I [reached out to] conservation groups in Houston…; they hope to partner with schools and provide speakers," Goerner relates.

The hurricane coincided with changes in Humble ISD. The district traditionally hadn't done a lot of PBL, "but this past year, several campuses brought in BIE [Buck Institute of Education; *www.bie.org*] for PBL training for teachers and administrators," says Goerner. The district is also transitioning "from a traditional learning district to a more personalized learning district [in which] students have options to plan their own time and choose their own projects within a structure," a change that aligns well with creating hurricane-related units and community projects that students will relate to personally, she observes.

Some of the teachers' ideas and driving questions for units include Save Our Soil: How Can We Reduce the Amount of Erosion on Lake Houston?; Harvey: What Else Did He Bring to the Ecosystem Besides Water?; and Rockin' Awesome: How Can We as Environmentalists Create a Natural Filter to Clean Our Water in Our Local Watershed Due to the Impacts of Harvey?

"We have a new superintendent who led the community in creating our Portrait of a Graduate," which lists the traits Critical Thinker, Communicator, Personally Responsible, Creative Innovator, Global Citizen, and Leader and Collaborator. This portrait is guiding teachers in helping students learn the science behind the disaster while becoming civically engaged in the community, she relates.

"There's still work to do; we're not back to normal," says Goerner. For students, "the damage from flooding doesn't heal quickly, even if you're back in your home. Some students are terrified of rain now." She hopes the PBL units and opportunities for students to do conservation work will not only help them become more involved with the community, but also will give them "a way to process the flood" and heal from the trauma.●

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TOSHIBA NSTA National Science Teachers Association

Inspiring Students Via a NASA ISS Downlink

In March, attendees of NSTA's National Conference on Science Education in Atlanta had the chance to participate in a NASA In-Flight Education Downlink. Attendees read questions submitted by students and teachers from across the country, and astronaut Scott Tingle on the International Space Station (ISS) responded in real time via video link. The event was part of NASA's A Year of Education on Station program. While many of the downlinks have connected astronauts with students at schools across the country, others have taken place at informal education venues like the Tulsa Air and Space Museum (TASM) in Tulsa, Oklahoma, and the Fairchild Tropical Botanic Garden in Coral Gables, Florida.

"Our mission supports STEM [science, technology, engineering, and mathematics] engagement, and this aligned with our mission," says Tonya Blansett, the TASM's executive director. "We wanted to engage local students in a moderately high-profile event…We really strive to get students excited about aviation careers."

TASM held an essay contest, inviting students statewide to submit questions they'd like to pose to astronauts aboard the ISS. "We reviewed the questions and tried to have a good selection from each age group," explains Blansett. Selected questions were sent to NASA for final approval, and winning students were invited to attend the downlink at the museum. The event included students from public and private schools, as well as homeschooled students.

She says that for many of the students, the May event was the "biggest thing that had ever happened in their lives. If our goal is to inspire children, this did that. It was pretty amazing.

"I think the astronauts [Ricky Arnold and Drew Feustel who] participated did a great job of communicating the human side of a job in space," Blansett continues. "They shared their daily struggles with stuff like laundry and work schedules. They made it very realistic, very attainable for kids so they could make that a goal, a dream for the future themselves."

MAUREEN TAN, FAIRCHILD TROPICAL BOTANIC GARDEN

Students posed questions to astronauts Ricky Arnold and Drew Feustel aboard the International Space Station during a downlink event at the Fairchild Tropical Botanic Garden.

Fairchild works closely with area schools on the Growing Beyond Earth (GBE) project, which is funded through a NASA grant. The garden hosted a downlink with Arnold and Feustel in April.

"There are 150 schools replicating NASA research to identify edible plants for space travel [as part of GBE]," explains Amy Padolf, Fairchild's director of education. "The schools have systems analogous to [one aboard] the space station." Participation in the downlink was an opportunity for the students to "understand the implications of their research…and be inspired by these two brilliant gentlemen."

The experience helped the students "think about science in a different way, allowed them to see the role plants play beyond the botanical garden," Padolf continues.

Jolynne Woodmansee, research and experimental design instructor at BioTECH @ Richmond Heights 9–12 High School in Miami, Florida, says the downlink at Fairchild "validated the research they're currently doing and motivated them to consider future careers in plant science."

Woodmansee gave her students an assignment designed to "guide and inspire them to ask questions that were more thought out" by having them reflect on their GBE work, but "some of their questions were just based on curiosity," she acknowledges.

Getting Prepped

If TASM has an opportunity to participate in a similar event, Blansett notes she would do at least one thing differently: "I would schedule it for after the end of the school year." Scheduling conflicts with the schools, which were complicated by the 2018 Oklahoma teacher strikes, resulted in some selected students being unable to participate. Their questions were read by other students.

Timing was also a concern at Fairchild. Padolf says they "had to jump through hoops to get students here" due to state testing.

"We had to plan around the time of the downlink to make sure [students] weren't sitting around doing nothing," states Padolf, because the exact time of the downlink was subject to change up to the day of the event.

"The downlink is very stressful," she admits. "We were responsible for making sure the technology worked. We had to ask three times if [the astronauts] could hear us."

Blansett says watching videos of earlier downlinks (available online at *https://go.nasa.gov/2p2cGcz*) helped TASM staff prepare for the event. "We modified what we were doing after watching the downlinks. We put the questions on notecards and had an extra set of notecards and a master list of questions. We tried to accident-proof it all the way through. We showed students how to hold the mic. We did warm-up activities, basically made sure the kids were comfortable. We wanted to make it fun for them so they could really enjoy the moment.

"NASA was fabulous to work with; they were communicating hourly updates the day of the downlink," she says. Because it was always a possibility the event would need to be canceled due to technical problems or an unexpected event on the ISS, Blansett asserts, "It's definitely important to have a backup plan." ●

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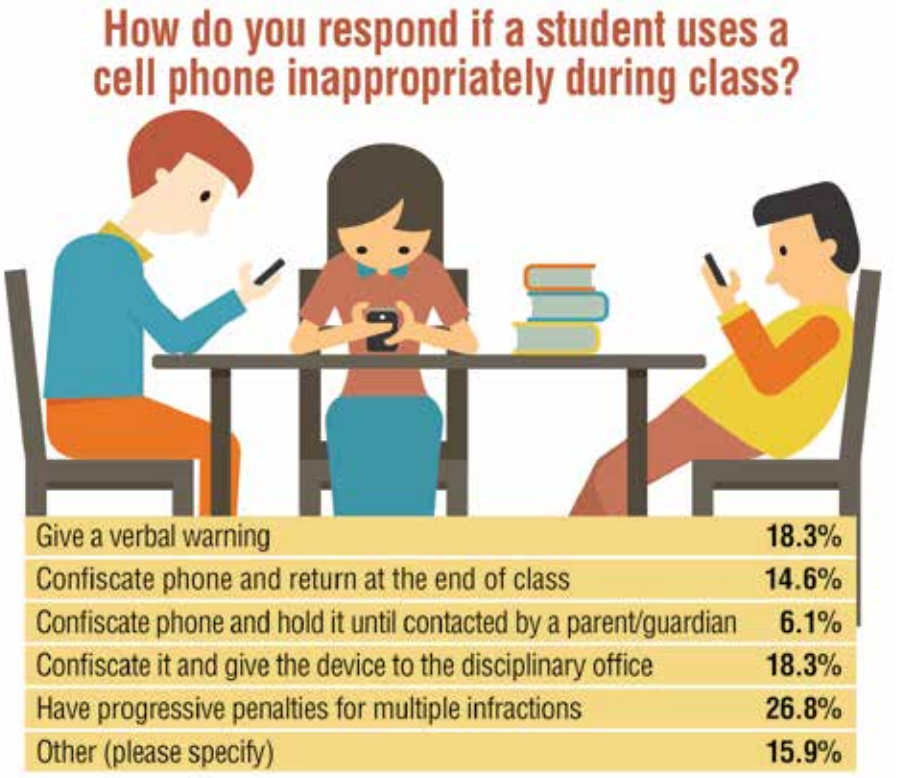
Science Teachers Weigh In on Cell Phones in the Classroom

Cell phones have become ubiquitous in schools, with 93% of educators in a recent informal *NSTA Reports* poll reporting their schools allow students to carry personal cell phones during the day. More than 40% reported that students are allowed to keep them at their desks, but the devices must be turned off/inaccessible; only 6.5% reported collecting the devices before beginning class. Nearly three-quarters (73%) said they incorporate mobile phones in lessons to record labs, collect data, and do other activities.

Enforcing classroom policies continues to present challenges, with 37.8% of participants reporting students violating the policy at least once a month and 19.5% a few times a month. Only 17.1% said students never violate the policy more than once. Nearly 27% report having progressive penalties for multiple infractions of the cell phone policy, 18.3% say they give a verbal warning, and another 18.3% said they confiscate the device and give it to the disciplinary office.



Here's what educators are saying about students having personal cell phones in school:

I honestly wish they couldn't bring them to school, or that the network was blocked on campus.—*Educator, High School, California*

I think [cell phones] decrease their attention [span], and there has been increasing evidence to support this. —*Educator, High School, Pennsylvania*

It can be a great resource when used for good and with the understanding that not everything they read is true. —*Educator, High School, Colorado*

They need help learning how to overcome cell phone addiction, but should have access so they can contact their family.—*Educator, High School, New York*

I want them turned off to eliminate some of the distractions that keep students from focusing in class.—*Educator, Middle School, Tennessee*

It's distracting unless they are part of the lesson.—*Educator, Middle School, New York*

I'd prefer we ban cell phones.—*Educator, Middle School, Oklahoma*

Cell phones are annoying! Should not be seen during class.—*Educator, High School, Pennsylvania*

I'm fine with it as long as we use it as a learning experience to teach proper use and etiquette.—*Educator, High School, Pennsylvania*

I hate them. After 40 years of teaching, [I think] they are the biggest distraction in a classroom!—*Educator, High School, Pennsylvania*

I'm fine with cell phones as long as they are being used responsibly. —*Educator, Middle School, California*

I have mixed feelings about it. In one way, they are helpful for taking pictures, [using as a] stopwatch, and [doing] instant research. On the other side, the students have a very difficult time not being distracted by them. —*Educator, High School, Colorado*

I understand it, but I worry about the impact on learning and their ability to collaborate effectively in the future in person.—*Educator, High School, Idaho*

Given that every student in my school is issued a laptop, the phones are in no way necessary and should not be brought to class.—*Educator, High School, Ohio*

[A cell phone is l]argely a distraction. It can be used [as] a great tool (built-in probes), but the lure for social media and "fear of missing out" is high among students.—*Educator, Middle School, High School, Tennessee*

Phones have had a negative effect on student engagement, particularly [among] those who are weaker academically.—*Educator, High School, Maryland*

I think it is a reality and opportunity to learn discipline and responsible, appropriate use. It is a tool that when used correctly, can be a benefit.—*Educator, Elementary, Middle School, Washington*

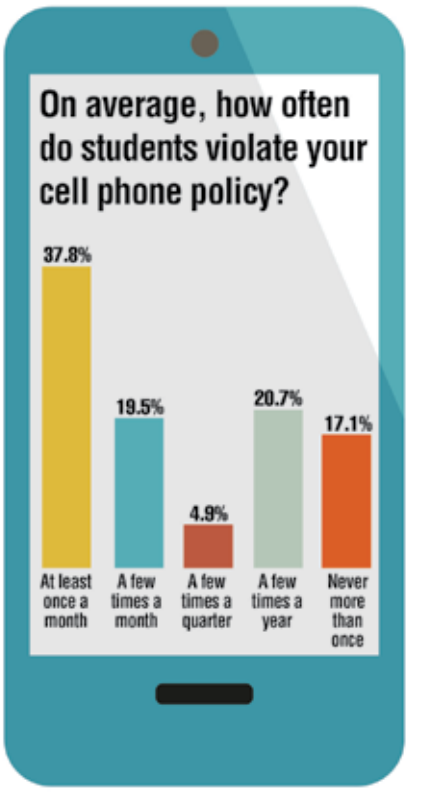
It allows me to integrate more technology in my lessons since we are not 1:1.—*Educator, Middle School, Florida*

I am not in favor of students having cell phones in class. They are a constant distraction, they keep kids from interacting with [one another] face to face, they impede pre-planning (parents text or call student[s] throughout [the] day to make plans instead of talking to student[s] before they leave for school like in the old days), and students are more likely to [use them to] cheat. —*Educator, High School, Minnesota*

When we allowed [students] to have them on their person instead of [in] the locker in the middle school where I teach, it was a major headache. The students used a lot of energy trying to find ingenious ways to be on their phones undetected. It was a major time waster for all.—*Educator, Middle School, Pennsylvania*

Students with cell phones in school are distracted and also disengaged from dialogue with their peers. There needs to be more taught to students about appropriate use of such devices so that they understand how they can be a valuable tool when needed.—*Educator, Middle School, Michigan*

I understand for some students, it is the most valuable thing they own. For others, it is a security blanket. I do not mind them being present, just



not being used during inappropriate times. I think more needs to be done to help students disconnect from the 24/7 exposure to social media and social lives.—*Educator, High School, Maine*

It is okay to use it outside classrooms for essential communications like a doctor's appointment, but not for chatting. The school-going generation has

become addicted to its use, which is detrimental for studies. Cell phone use may make students surface learners. —*Educator, Institution of Higher Learning, Sri Lanka*

We live at a private boarding school, so students sometimes need their phones to contact parents/guardians during the day. We are okay with that. —*Administrator, High School, Utah*

I don't think it is necessary academically. Students use them primarily for social networking, which only distracts from their academics and focus in class. —*Educator, High School, Washington*

[They're t]oo distracting. Negatives outweigh the positives.—*Educator, High School, Alaska*

I think that students know how to entertain themselves with smartphones but don't really understand how to leverage them to be a tool in their education. —*Educator, Middle School, California*

I support it for the sole purpose of emergency situations: if we are evacuated and students need to contact loved ones.—*Educator, Middle School, High School, Pennsylvania*

An amazing tool and opportunity to access information, but students need to come in with an understanding that cell phones can be highly distracting as well. I believe this message must be trumpeted by all educational stakeholders.—*Educator, High School, Maryland*

When districts do not have a 1:1 computer access in all rooms, cell phone use can often be the next best thing (if used appropriately).—*Educator, High School, Illinois*

I wish [students] could learn to be responsible because they are a great tool; however, [students] are just too sneaky and use them to text during class when they should not be using them, so they ruin it.—*Educator, High School, Washington*

Research shows that cell phone use disrupts long-term memory formation. If [students] were responsible about it, I wouldn't mind, but they can't use them while learning something.—*Educator, High School, Idaho*

I think [cell phones are] a huge distraction to learning, but…they are used for all sorts of things that are useful [for] some students (planner, homework, etc.).—*Educator, High School, Wyoming* ●

Quotable

The future cannot be predicted, but futures can be invented.

—Dennis Gabor, Hungarian-British electrical engineer and physicist (1900–1979)

Connecting Businesses and STEM Students

How can teachers help students explore science, technology, engineering, and math (STEM) career paths? One way is to have them do a project with a local business, according to David Lockett, STEM teacher at Edward W. Bok Academy in Lake Wales, Florida. With funding from the Polk Education Foundation of Bartow, Florida, and a Motorola Solutions Foundation Technology and Engineering Education Grant, Lockett's Duke Energy Project was "a career workforce development" project "that was capped with a visit to" the Walt Disney World Solar Facility in Orlando, he explains. The five-megawatt solar farm is part of an agreement allowing Duke Energy to own and operate the farm on Disney World's land. In return, the farm provides solar power to Disney World.

"The project focused on the different types of energy produced in Florida," says Lockett. The Motorola grant guidelines required the inclusion of public safety elements, vocational skills, and engineering and/or information technology concepts. "I went for both," he notes. "I wanted students to understand more about how electricity is provided and generated to the area, interact with diverse engineers in the field, and [hear from] scientists and other Duke Energy speakers"—including some of the students' parents who work there—"about the range of energy careers." he explains.

"No one had approached [Duke Energy] from the renewable energy aspect. I wanted to have students more deeply understand it than they could from just one class visit there," says Lockett. His students spent about 20 hours either visiting Duke Energy or hearing from its employees when they visited Bok Academy.

Lockett created hands-on STEM learning activities to increase students' awareness of energy-related STEM careers. For example, his students built solar cars and solar robots, designed and tested wind turbines, did coding projects, designed circuits, and built miniature houses to show how electricity travels. As a culminating project, his students created a display showing how electricity is supplied to a miniature house they built and demonstrating their knowledge of renewable versus nonrenewable resources, closed and open circuits, the importance of solar power, and "the benefits and challenges in technology that play a role in our energy system," says Lockett. Duke Energy plans to show the display to other visiting schools, he adds.

"My students said, 'Now we understand why you drive a hybrid car,'" Lockett relates. The project "increased their interest in different forms of energy and why technology has to be efficient."

Lockett and his students then visited the Walt Disney World Solar Facility to discover "where Disney gets all the power for its operations," he adds. "We were the first school group to visit there. It was not a glamorous trip, but it was very helpful" in increasing their understanding of how solar panels work. "After the trip, the students wanted to talk to their parents about getting solar panels on their homes," he recalls.

The project informed his students about a myriad of careers: line workers, coding technicians, engineers, engineering technologists, cybersecurity engineers, information technology software analysts, and data science consultants. Lockett told students, "Every worker has a skill set or interest to lead them into a career path…Try it all, and see what you like best."

Real-World Exposure

"I help students find their passion by exposing them to as many opportunities as possible" to connect with local businesses, says Peter Suchmann, coordinator of the Science Research Program for Grades 9 and 10 at North Shore Hebrew Academy High School in Great Neck, New York. "There's a lot of industry on Long Island."

For example, Suchmann chooses a group of students to attend an open house at Lifetime Brands, a kitchen product company headquartered in Garden City, New York, to learn about the company's marketing, manufacturing, and packaging operations. Before the visit, Suchmann says he and his students "discuss the invention process for new and exciting kitchen gadgets. I hold a contest for students to come up with new kitchen gadgets, and the most developed ideas get pitched to [Lifetime Brands] executives." He notes that "preparing a 30-second elevator pitch is tough and a good skill for ninth graders," and he works with them on "body language, eye contact, and bubbling enthusiasm."

DAVID LOCKETT

Students in David Lockett's STEM classes at Edward W. Bok Academy in Lake Wales, Florida, demonstrate to Duke Energy Business Energy Manager/Senior Energy Engineer Derick Farfan a display they created for the company that illustrates their knowledge of energy concepts.

At company headquarters, "we meet with their [executives] and actually discuss ideas the kids come up with for new products, and then we visit the showcase floor and study new products that have been successful. It is a great opportunity to see the 3-D printers used to make new prototypes and some of the new products that might actually make it to the market," he relates.

Some of Suchmann's students are working with the Great Neck Breast Cancer Coalition as part of a student science fellowship. "Two of my students took over [the coalition's] newsletter...and updated it, and made it much better," using their writing and computer science skills, he reports. "They talk to their teachers about topics to be able to explain them, and help summarize [cancer] research for a general audience…In this world of fake science news, science communication is very important."

He points out that students chosen for this fellowship have presented their work at science competitions and have gone on "to top labs in the Northeast to work on cancer prevention."

Suchmann's students have also participated in focus groups for Brainly, an international social learning and tutoring network for high school students (*https://brainly.co*). "I answered their call for teachers [to have students provide input on the website]. On Brainly, people are ranked by how many questions they answer [accurately]," he explains. "They want students to have their questions answered by teachers and students who know the material."

His students "gave feedback on the platform and its potential use by American students. My students each earned $20 for their focus group experience," Suchmann reports.

He says the focus for his school and his class is "internships lead to career tracks." By connecting his students with businesses, some have landed internships with those companies that ultimately can lead to employment. ●

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NSTA National Science Teachers Association

MULTIVIEW

PULL-OUT SECTION

SCIENCE TEACHERS' GRAB BAG

Inside this Convenient Pull-Out Section you will find:

Freebies for Science Teachers

Kelp Forest Resources. E Introduce marine science and learn about one of the world's most diverse ecosystems—the kelp forest—with two apps from San Francisco's Monterey Bay Aquarium. The Kelp Forest: My Aquarium game lets students in grades 3–5 explore the plants and animals of the kelp forest and signs of healthy forest as they design custom aquariums for an exhibit. *The Kelp Forest: A Young Explorer's Guide,* an accompanying interactive e-book, highlights the kelp forest ecosystem's importance and teaches students how to protect it. The publication also features stories from scientists and others working at Monterey Bay Aquarium's live Kelp Forest exhibit, giving students a glimpse of interesting careers in marine science. The apps support the *Next Generation Science Standards* (*NGSS*), *Common Core State Standards,* and Ocean Literacy Principles and are available for both Android (*https://goo.gl/gwAZY8*) and iOS (*https://goo.gl/1aE5yv*) platforms.

Interactive Science Notebook Resources. M H Oakland, California, science educator Rebecca Newburn shares her collection of resources for setting up and using Interactive Science Notebooks. Adaptable for use with middle and high school levels, the resources include pages highlighting the crosscutting concepts and science and engineering practices emphasized in the *NGSS,* as well as rubrics, graphic organizers, and other worksheets to help students learn to effectively collaborate, communicate science ideas, and write about scientific claims using evidence and reasoning. Access the resources at *https://goo.gl/Qq1WFT.*

#WomenInScience Posters. M H Celebrate women and science with custom posters from TED Talk presenter/neuroscientist/designer Amanda Phingbodhipakkiya and the Beyond Curie project. The illustrated posters feature six pioneering women—NASA mathematician Katherine Johnson, biologist (and DNA photographer) Rosalind Franklin, mathematician Maryam Mirzakhani, neuroscience researcher May-Britt Moser, physicist Chien-Shiung Wu, and astronaut Mae Jemison—along with brief descriptions of their notable contributions in their fields. Share the posters in middle and high school classrooms as inspiration for girls and all students interested in science, technology, engineering, and math (STEM) careers. Download the posters at *https://www.beyondcurie.com/mfs.*


NASA

Serendip Studio's Biology Topic Overviews. M H HE Teachers can access "minds-on analysis and discussion" activities on a broad range of biology topics from molecules and cells to ecology and evolution at *https://goo.gl/Bf8fxB*. Targeted for middle, high school, and introductory college levels, these mostly worksheet-style activities present Student Handouts with questions, diagrams, and information about a topic along with Teacher Notes that expand on the information, offer suggestions for guiding students through the handouts, and provide links to additional resources. Many activities were recently revised to support the *NGSS;* users can also provide comments and feedback. Titles include Cell Differentiation and Epigenetics; Food, the Carbon Cycle, and Global Warming; Evolution by Natural Selection; and Enzymes Help Us Digest Food.

Rock Cycle and Water Cycle Games. E M Two board games from Educational Tabletop Games introduce students to the rock cycle and the water cycle. Rockominoes (grades 4–7), a tile-laying game, helps students understand that all rock cycle processes start and end with a rock and have a force of nature in the middle. Make It Rain (grades 5–9), a card-based game, teaches water cycle processes and terms (e.g., evaporation, condensation, precipitation, surface runoff, infiltration, transpiration, groundwater flow, groundwater storage, and spring/vent/well) as students follow instructions on informational cards to move tokens (i.e., water) through the water cycle and earn points. The games, which support the *NGSS,* include lesson plans, worksheets, and assessments for classroom use. Visit *www.educationaltabletopgames.com.*

Photo Stuff With Ruff. P E Based on *The Ruff Ruffman Show,* an animated digital series from PBS KIDS, this app helps students in grades preK–2 discover the "stuff" their world is made of. Students use the app to investigate their surroundings, taking pictures of different materials, textures, and patterns as guided in the app and learning science vocabulary (shiny, fuzzy, etc.) along the way. Students then use the pictures to complete silly scenes in the app.

The app can be used in the classroom as part of lessons exploring materials science. With more than 80 properties to find on the app, students can search for items with specific properties in the classroom, on the playground, or in other locations. Also, since Ruff tells players what to

See Freebies, pg G2

P: PreK E: Elementary M: Middle H: High HE: Higher Ed A: All K12: K–12

Freebies, from pg G1

do audibly (and in print, if captions are turned on), the app works well with pre- and struggling readers. Visit *https://goo.gl/ckaqGy.*

MBOVERLOAD

AK EnergySmart. K12 Raise the energy literacy of K–12 audiences with this Alaskan-based curriculum. Through interdisciplinary lessons at *www.akenergysmart.org*, students investigate the energy around them and learn why we need energy and how energy can be conserved. The lessons support the *NGSS* and are designed to be used to supplement existing units or as after-school activities or in other informal settings.

Several activities teach practical information to share with families. Phantom Load Detectives (grades K–2) teaches students about appliances and electronics that use electricity when plugged in, even when turned off, and what people can do to conserve electricity and save money at home and in school. Reading Your Electric Meter (grades 3–5) teaches students to read an electrical meter, record the amount of energy used, and write a science report. In Designing Your Energy-Efficient House, Parts One and Two (grades 6–8 and 9–12), students use builders' equations to calculate the insulation needed for houses, then use a computer model to explore how design choices in a house can affect energy consumption, costs, and savings.

Empatico. E M This global initiative developed by the KIND Foundation provides opportunities for students ages 7–11 to practice social skills such as respectful communication, perspective taking, cooperation, and critical thinking as they share ideas on a topic (science topics included) and compare information with peers in partner classrooms worldwide. In the program, partner classrooms in different parts of the world complete preparatory activities, then interact with one another via a live video visit. Afterward, the classes reflect on the interaction, discussing how their experiences were similar or different from those of their partners. The standards-based activities, which can be used as is or adapted to meet specific classroom needs, address science and social studies themes, including geography (Community Cartographer), energy (Everyday Energy), and weather (Weather Out the Window). Visit *https://empatico.org/activities.*

NJCTL Phenomena-Based Courses for Middle Level. M The New Jersey Center for Teaching and Learning (NJCTL) has posted complete materials for its Physical Environment, Living Environment, and Mathematical Physics courses. Designed for grades 6, 7, and 8, and supporting the *NGSS,* each editable unit is structured around a different set of phenomena and features several chapters and accompanying resources (e.g., presentations, labs, assessments). Engaging real-world topics at *https://goo.gl/b7Ho1v* include Hurricanes, Biodiversity, and Cell Phones.

Cincinnati Engineering Enhanced Math and Science (CEEMS) Program Units. M H CEEMS, an Ohio-based educational initiative, has developed more than 150 science learning units for middle and high school levels. The units, which support Ohio's New Learning Standards for Science and the *NGSS,* are centered in real-world applications and incorporate the engineering design process and challenge-based learning in every topic. Middle level units address topics in Earth, life, and physical sciences, while high school units address topics in biology, chemistry, environmental science, physical science, and physics. Middle level unit titles include Eco Friendly Products (rocks and minerals), Build Me Up to Break Me Down (chemical reactions), and Crazy Coaster (energy transfer). High school units include Biomedical Engineering (anatomy and physiology), Hand Warmers (heat and calorimetry), Caring for Our Watershed (water pollution), and Costly Collisions (Newton's Laws, conservation of energy). See *https://goo.gl/WoCQxV.*

STEVE JURVETSON FROM MENLO PARK, USA

Robotics Resources. K12 Access downloadable lesson plans and links to other materials (e.g., contests, websites, teacher training workshops) for incorporating robotics in K–12 classrooms at *https://goo.gl/T7Zfbc.* Some materials use robotics as a tool to extend learning about a STEM topic, such as in elementary units on weather or simple machines. Other resources focus on robotics as the topic itself, such as middle level units that guide students through hands-on experiences working with LEGO MINDSTORM or other robotics kits. In addition, the site has materials purely designed to generate student excitement about the field, such as robot trading card sets from the Institute of Electrical and Electronics Engineers.

Those Amazing Engineers. M Introduce middle level students to engineering careers through real-life examples of what engineers do and where they work. Developed by Those Amazing Professionals, a nonprofit dedicated to educating students from all backgrounds about careers in underserved professions, the site features information, photographs, and video links showcasing the field's diversity. Learn about different types of engineering; see examples of workplaces; find tips for getting started in the field; and explore engineers' innovative work. Also featured are resources and classroom activities to excite students about engineering and spark their imagination. Visit *www.thoseamazingengineers.com.*

Phenomenal Science. E A regional collaboration among Central Michigan University, Oakland Schools, the Michigan Science Center, and others has developed K–5 science units through professional learning. The standards-supported (*NGSS* and Michigan State Standards) units are available at *http://phenomscience.weebly.com* (free registration required) and include a comprehensive curriculum for three-dimensional science instruction that integrates science and engineering practices as well as English language arts and mathematics. Teachers also can access a free training course for implementing the Phenomenal Science curriculum, covering everything from learning to identify essential characteristics of an exemplary elementary science lesson (e.g., science discourse, modeling, and inquiry) to applying key instructional strategies in their own classrooms.

LewisLe@rning. M H For video-based lessons that teach middle and high school students about the Moon and space, visit *www.lewislearning.org.* The Lunar Crater Observation and Sensing Satellite (LCROSS) curriculum (grades 7–8) is based on the 2009 NASA mission of the same name; LCROSS discovered water in permanently shadowed craters on the Moon's south pole and found that the Moon is chemically active and has an active water cycle in lunar shadows. Through three activities and labs—Kinetic Energy, Momentum, and Phase of the Moon—students explore the natural forces and technologies that made the LCROSS mission possible.

Global SPHERE Network Database. H A coalition of U.S. educational institutions created a database of STEM research opportunities worldwide for high school students. Part of the global network STEM Programs for High-schoolers Engaging in Research Early (SPHERE), the database aims to increase the number of mentors—researchers who work with students in their labs—and the number and diversity of high school students doing authentic STEM research. The database also provides a networking space for programs and mentors already offering research opportunities. Member programs can use it to connect with other programs, share resources, and engage with high school students. Consult *www.globalspherenetwork.org.* ●

News Bits

- **School districts in Florida and Rhode Island are struggling to fill secondary science and math teaching positions, highlighting a disconnect between prospective teachers' majors and schools' needs, as well as a decline in the number of teachers graduating, according to the American Association of Colleges for Teacher Education (AACTE).** M H HE

A recent AACTE report states the most popular major among university students is elementary education, despite a teacher shortage in secondary science and math. In addition, the number of graduates from teacher preparation programs has decreased by 23% from 2007–2008 to 2015–2016.

Quiana Peterson, instructional recruitment partner for Florida's Lake County Schools, said the district has developed a "grow-your-own" teacher program to convince high school students interested in teaching to return home after college. Seminole County Public Schools recruits at university science and education departments and offers students mentoring, financial support, and jobs after graduation. In Orange County, school district administrators are meeting with college students majoring in science fields, touting their programs and efforts to support new teachers, and even hiring science majors to serve as high school tutors to build a pipeline.

In Rhode Island, the demand for high school math and science (especially chemistry and physics) teachers is so huge that districts are poaching from one another, superintendents say. In response, University of Rhode Island offers scholarships to science, math, and technology majors willing to teach in high-need school districts. And Colleen Callahan, director of professional issues for the American Federation of Teachers, Rhode Island, is developing a program called Educators Rising that aims to reach middle and high school students. See *https://goo.gl/Q8hV5i* and *https://goo.gl/N3nm9r* to learn more.

- **As part of its Discovery Research K–12 program, the National Science Foundation awarded Smith College and Springfield Technical Community College (STCC) in Massachusetts a $1 million grant to collaborate with Springfield Public Schools to bring an imaginative approach to engineering into classrooms.** M H HE

STCC physics and engineering professor Beth McGinnis-Canvanaugh says approximately 900 students in eight middle schools will participate in this four-year initiative, which will incorporate storytelling across media to introduce science, technology, engineering, and mathematics (STEM) concepts. For example, students might learn about engineering materials and their applications by building a "super suit" for a child who becomes trapped in a video game. For a unit on light and electricity, "we have stories about time travel going back to Tesla and Edison and the war between AC and DC current…That's how we would reframe it," she explains.

McGinnis-Cavanaugh promises the project will not require teachers to cover more content, but to consider STEM in a new way, such as by establishing partnerships with teachers of other disciplines. Launching in fall 2019, the project will focus first on sixth grade before moving to higher grades. STCC will eventually expand the curriculum nationwide. Read more at *https://goo.gl/kvL5Wc.* ●

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NSTA National Science Teachers Association

In Your Pocket

Editor's Note

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

October 31

State Farm Good Neighbor Citizenship Company Grants K12
State Farm awards grants of $5,000 or more to K–12 public schools for teacher development, service learning, and education reform or systemic improvement. Its foundation aims to advance access, equity, and inclusiveness through these funds. Apply by **October 31;** see *https://goo.gl/Ytfrcg.*

Future City Competition M
In this competition, students in grades 6–8 use the engineering design process to design sustainable cities that will last for 100 years. This year's "Powering Our Future!" theme requires students to include a resilient power grid that can withstand and quickly recover from natural disasters. Students present their design, a 1,500-word essay, a scale model built from recycled materials, and a project plan to a panel of science, technology, engineering, and mathematics (STEM) professionals in their region in January.

The winning team in each region, along with its educator and engineering mentor, will receive round-trip transportation and accommodations for the national finals in Washington, D.C., in February. First-place winners get a cash award and a free trip to Space Camp in Huntsville, Alabama. Register your team by **October 31.** Visit *http://futurecity.org.*

November 1

American Radio Relay League Education and Technology Grants K12
The organization offers two types of grants for teachers who currently use or want to use amateur radio in their classrooms. School Station Grants provide $1,500 worth of equipment to those who plan to use amateur radio as part of an enrichment or in-class project. Progress Grants of $500 go to teachers who already use amateur radio in the classroom and want to purchase license manuals and instructional guides, do station upkeep and maintenance, or need resources for wireless technology instruction. Grantees must seek funding from their local communities to help sustain their programs.

K–12 teachers in U.S. schools may apply by **November 1.** Visit the website *https://goo.gl/a9Xrwp.*

Annie's Grants for Gardens P K12
These grants go to edible school gardens in the United States. Funds can be used for seeds, plants, raised beds, fencing, wheelbarrows, greenhouses, drip irrigation systems, and other items to help create or sustain the garden. Apply by **November 1** at the website *https://goo.gl/tCs9j2.*

The Lawrence Foundation Grants A
Organizations, including public schools and libraries, that support the environment, human services, disaster relief, and other causes may apply for the grants. Both program and operating grants are available. The average grant amount ranges from $1,000 to $5,000. Apply by **November 1.** Consult *https://goo.gl/UxxkqJ.*

George C. Pimentel Award in Chemical Education K12 HE
The American Chemical Society (ACS) presents this award to recognize outstanding contributions to chemical education. This can include training professional chemists, integrating chemistry into the educational system, and disseminating reliable information about the field to prospective chemists, students in other fields, members of the profession, and the general public. The activities recognized by this award may be in the fields of teaching (at any level), administration, research, writing, or public enlightenment. The winner will receive $5,000, a certificate from ACS, and $2,500 for travel expenses to accept the award. Submit nominations by **November 1** at *https://goo.gl/q5EtoK.*

James Bryant Conant Award in High School Chemistry Teaching H
ACS honors one outstanding high school chemistry teacher in the United States or its territories. Nominees should demonstrate quality teaching, the ability to challenge and inspire students, extracurricular work that stimulates student interest in the field, and a willingness to stay current. The winner will receive $5,000, an ACS certificate, and up to $2,500 in travel expenses to attend the meeting at which the award is presented. Nominations are due **November 1;** see *https://goo.gl/Hdm9fd.*

November 10–17

Dreyfus Foundation Educational Grants K12
The Max and Victoria Dreyfus Foundation provides grants of between $1,000 and $20,000 to community-based nonprofit programs in the United States. Schools; museums; educational and skills training programs; environmental and wildlife protection activities; cultural and performing arts programs; and programs for youth, seniors, and the handicapped may apply. Proof of 501(c) (3) status is required. Applications must be postmarked by **November 10;** refer to the website *www.mvdreyfusfoundation.org.*

SeedMoney Garden Grants Program A
These grants go to school, community, food bank, and other public garden projects. Fifty gardens that raise $600 via crowdfunding between November 15 and December 15 will receive $400. Those that don't raise $600 but are worthy of support will get $200. An additional $600 will be awarded to the project that raises the most funds during the fundraising period. Apply by **November 12.** Visit *https://seedmoney.org.*

Albert Einstein Distinguished Educator Fellowship K12
This U.S. Department of Energy program provides STEM teachers from K–12 public and private schools an opportunity to work in public policy. Fellows spend 11 months working in Washington, D.C., in a federal agency or U.S. Congressional office to help bridge the gap between the legislative and executive branches and the STEM community.

Applicants must be U.S. citizens with at least five years of full-time teaching experience in a STEM discipline. They should also be currently employed by an elementary or secondary school and be able to obtain a leave of absence for the fellowship period. Fellows receive a $7,500 monthly stipend, a $5,000 housing allowance, and reimbursement for moving expenses. Apply online by **November 15** at *https://goo.gl/d33j7B.*

Real World Design Challenge H
This competition asks students in grades 9–12 to work in teams of 3–7 on a pressing engineering challenge, supported by a coach and mentor. Teachers leading teams get access to $1 million in professional engineering software and training, curriculum, and mentors. Students first compete in a state-level Governor's Cup; the team with the best design competes in the national finals in Washington, D.C. Each student on the winning team will receive a $50,000 scholarship to Embry-Riddle Aeronautical University. Register by **November 17** at *https://goo.gl/geF5h3.* ●

What's New

FROM U.S. GOVERNMENT SOURCES

National Oceanic and Atmospheric Association (NOAA)

NOAA OER Facebook Page for Educators K12

Visit *https://goo.gl/eN9vxK* to stay updated on resources and materials that bring the excitement and wonder of ocean exploration and discoveries into K–12 classrooms. Created by NOAA's Office of Exploration and Research (OER), the page's recent posts reflect a wide range of available resources, highlighting everything from webinars for educators on climate literacy to materials for classroom use, such as The Ocean Today video collection, links to Meet the Explorers and Expedition Education Module web pages, live camera streams from current expeditions, news briefs about new ocean discoveries, and opportunities to connect with scientists aboard research vessels.

U.S. Environmental Protection Agency (EPA)

Generate: The Game of Energy Choices M H

Generate, an interactive board game for middle and high school levels, teaches students about the complex relationships between energy choices and environmental quality. The game helps students understand the costs and benefits of the energy choices we make; discover what happens if the mix of energy sources changes in the future; and learn what energy choices mean for our climate, air, water, and overall environmental quality. Teachers can download a printable version of the game and accompanying materials (e.g., introductory presentation, game board and pieces, score sheet, and instructor's guides for middle or high school levels) at *https://goo.gl/an7QJM*. Teachers can also access an archived NSTA Web Seminar presentation on the game in which EPA physical scientist Rebecca Dodder discusses energy issues in the United States, along with various ways the game can be used in the classroom.

Centers for Disease Control and Prevention (CDC)

Recognizing Poisonous Plants A

Most kids know to be wary of poison ivy, but many may not know how to spot other harmful plants, such as poison oak and poison sumac. With photographs for plant identification, information about the plants' geographic distribution, recommendations for protecting yourself, treatment suggestions, and links for additional resources, this CDC resource at the website *https://goo.gl/xqJRrT* teaches students and teachers of all ages how to identify common poisonous plants, as well as what to do if they were to encounter one of them. Teachers can also download a bookmark-style card with fast facts about dealing with poisonous plants.

National Aeronautics and Space Administration (NASA)

Christa's Lost Lessons E M

Due to the Challenger disaster in 1986, Christa McAuliffe—crew member and the first educator selected for NASA's Teacher in Space program—never had the chance to complete her mission and share space education curriculum with K–8 classrooms while aboard the shuttle. This year, as a tribute to McAuliffe and her legacy, educator–astronauts Joe Acaba and Ricky Arnold conducted McAuliffe's lessons while aboard the International Space Station as part of NASA's A Year of Education on Station. Watch the astronauts' video demonstrations of McAuliffe's lessons on chromatography and access corresponding classroom lessons at *https://goo.gl/Ugv8nU*. Titles include Chromatography (grades 5–8), Leaf Chromatography (grades 5–8), and Walking Rainbow (grades K–5).

Aviation Leveled Readers K12

Bring the history of American aviation to life in K–12 classrooms with this series of Leveled Readers from NASA's Aeronautic Research Mission Directorate (ARMD). Versioned for elementary, middle, and high school levels, the readers address topics such as Amelia Earhart; STEM careers (e.g. consulting engineer, master technician) at NASA ARMD; and the story of the Tuskegee Airmen. Supplementary materials—including a reading response comprehension choice worksheet, a comprehension question quiz, and a graphic organizer—are available for each topic. Access these materials at *https://goo.gl/Qa2qh1*.

Glenn Engineering Design Challenges E M H

NASA's Glenn Engineering Design Challenges allow students in grades 5–12 to experience the same real-world challenges faced by NASA scientists and engineers designing the next generation of aeronautics and space vehicles, habitats, and technology. Appropriate for both in-class and out-of-classroom settings, each standards-based unit presents a main challenge based on a current research topic and provides opportunities for students to work collaboratively in teams as scientists do.

For example, Powered and Pumped Up challenges students to design and build a solar-powered pumping system that quickly moves water between storage tanks, while in Let It Glide, teams must design and build a shoebox glider, then improve their design (e.g., by adjusting the glider's materials, shape, or structure) so it demonstrates the best glide properties when thrown. In Gaining Traction on Mars, student teams design a set of wheels for a Martian rover that performs best on a simulated extraterrestrial soil bed. Each unit includes an introductory video, a Facilitation Guide and Presentation, information about how the unit content supports *Next Generation Science Standards,* and links to related NASA resources. See *https://goo.gl/YHhGgS*.

What Is Earth? E M

Are your students curious about our home planet? Check out the "What Is Earth?" features from the NASA Knows! series for elementary (grades K–4) and middle level (grades 5–8; click link at bottom of page) learners at *https://goo.gl/ukUe8K*. Featuring illustrations and grade-appropriate text, the articles answer essential questions about our planet, such as What Does Earth Look Like? How Do We Know the Earth Is Round? How Does Earth Move? Why Do We Have Day and Night? Why Does Earth Have Seasons? What Are Earth's Different Parts? and Why and How Does NASA Study Earth? The articles also include links to grade-appropriate resources to learn more about Earth.

U.S. Department of Energy (DOE)

Fission vs. Fusion H HE

Many people—including high school and college students and teachers—are confused about the terms *fission* and *fusion* and use them interchangeably or incorrectly. While both terms describe physical processes that produce energy from atoms, the processes are quite different. Fission describes the splitting of a larger atom into two or more smaller atoms, while fusion describes the joining of two or more lighter atoms into a larger one.

To help clarify the meaning of the terms, the DOE's Office of Nuclear Energy has published an article and infographic detailing the differences between the two processes. Read the article and download the infographic at the website *https://goo.gl/y2W9uo*.

Teachers can also download fact "cutouts" from the infographic, highlighting differences between the two processes in fuel type, byproducts, uses, and energy output.

U.S. National Archives and Records Administration

DocsTeach.org K12

The National Archives houses a huge number of primary sources—letters, photographs, speeches, posters, maps, videos, and other document types—spanning the course of American history. At *https://goo.gl/adMvN1*, K–12 educators can search a growing collection of document-based activities that incorporate these primary sources in instruction, including science instruction.

For example, a search of the keyword "science" turns up several activities for middle and high school levels, including The Space Race: Project Mercury (grades 8–12). In this activity, students read and discuss a memorandum from the seven Mercury astronauts to the Mercury director encouraging an exchange with astronauts from the Soviet Union.

Another activity, Analyzing The Cotton Gin Patent (grades 6–12), challenges students to examine Eli Whitney's drawing of the Cotton Gin and read a petition for the renewal of its patent. Students must decide, based on their interpretation of the document, whether they would have voted to renew or deny the patent request, citing evidence from the text to support their decision.

U.S. Department of Agriculture (USDA)

Dig In! Posters K12

Motivate K–12 students to choose more fruits and vegetables at meals and as snacks with this poster series from the USDA. Developed as part of the nutrition education unit Dig In!, the posters inspire healthy choices through colorfully illustrated vegetables and student-friendly themes. Titles include "Race Car—You've Got the Power"; "Roller Coaster—A Lot Can Happen When You Eat Your Colors"; "Veggie Rock Stars—They're Tasty and They Know It!"; and "Leafy Green DJ—Dark Green Veggies in the House Tonight!" Visit *https://goo.gl/x1zWJx* to download PDFs of the posters; schools participating in the USDA's Team Nutrition program may also order a print copy of the poster set.

U.S. Department of Education (ED)

***Paths Through Mathematics and Science: Patterns and Relationships in High School Coursetaking* H**

This report examines the sequence of courses that high school graduates take in science, technology, engineering, and mathematics (STEM) through their high school years using data from the 2009 National Assessment of Educational Progress (NAEP) High School Transcript Study. The 44-page report starts with an executive summary highlighting the report's key findings and follows with a more detailed analysis of each summary finding. Clearly designed, with informative, easy-to-read graphs and tables, the report provides insight into how students are engaging with different components of STEM throughout school. Access it in PDF format at *https://goo.gl/jHW5a2*.

U.S. Forest Service

ClimateChangeLIVE: A Distance Learning Adventure! K12

ClimateChangeLIVE features a comprehensive collection of K–12 climate education resources produced by the U.S. Forest Service and 26 other federal and nongovernmental partners. The resource, which includes materials for both teachers and students, presents a mix of webcasts, webinars, lesson plans, videos, and opportunities to learn about climate change science.

Of particular interest are Climate ChangeLIVE's electronic field trips (EFTs)—Educate, Inspire, and Engage and Join the Climate Conversation. These EFTs bring climate science directly to the classroom, making the topic come alive for students as they watch a climate science presentation, then hear (and see) in other students' own words and videos the impacts of climate change they have experienced in their lives. Access ClimateChange LIVE at *https://climatechangelive.org*. ●

P: PreK E: Elementary M: Middle H: High HE: Higher Ed A: All K12: K–12

Summer Programs

Editor's Note

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

Miami University's Earth Expeditions A

This program pairs university courses with field experiences that allow teachers to engage in inquiry and action research projects at conservation hot spots around the world. Participating educators build relationships with scientists, naturalists, and conservationists in Africa, Asia, Australia, and the Americas. Educators will spend long days in the field, and participate in online conversations with peers about project work. After they return home, they will continue work on these projects in their schools and communities.

Earth Expeditions are open to all preK–12 teachers, administrators, and university faculty, as well as educators, naturalists, and other professionals from non-school settings. Courses are for stand-alone graduate credit or can be applied toward a master's degree.

Apply by **January 28, 2019.** For more details, see *www.EarthExpeditions.org.*

National Agriculture in the Classroom Conference K12

This year's conference will take place June 18–21 in Little Rock, Arkansas. Workshops, tours, keynote speakers, and networking events will help K–12 educators increase agricultural literacy and learn how to integrate agricultural content into science, social studies, language arts, and nutrition classes. Visit *https://goo.gl/9h2P9Z.*

24th ChemEd Conference H HE

North Central College in Naperville, Illinois, will host this conference for high school and undergraduate chemistry educators during July 21–25. Holding the conference at a college allows attendees to experience hands-on labs and demonstrations. Participants will collaborate and exchange ideas with other educators, learn best practices and new techniques, and participate in the Mole Day breakfast, 6.02 K Mole Stroll, and other conference traditions. Learn more at *https://goo.gl/YSMHY3.*

DAN BISACCIO

Educators taking the Field Course in Measuring and Monitoring Biodiversity next summer will travel to Quintana Roo, Mexico, to study tropical botany while learning field method protocols in conducting biological diversity research.

Field Course in Measuring and Monitoring Biodiversity A

This course will take place during August 6–13 at Nuevo Durango Maya Community in Quintana Roo, Mexico, located 100 kilometers southwest of Cancun in the central region of the Yucatan Peninsula. This area's enormous biological diversity is recognized by Mexico's Center for Ecological Studies and the World Wildlife Fund as a global natural resource. It is only open to field researchers and is home to more than 400 species of birds (equal to the number of bird species found in all of North America) and stable populations of jaguar, ocelot, and spider monkeys. Additionally, a one-acre plot has more tree species found than in all of North America.

Participants will study tropical botany while learning field method protocols in conducting biological diversity research. Invertebrate and vertebrate field surveys will introduce participants to sampling methods, and subsequently, the variety of wildlife found at the reserve. Evenings will include night hikes and seminars discussing issues in conservation biology. Lodging will be in traditional Maya cabins in a Mayan community located near the famous Coba archeological site (to be explored during the week).

Participants will spend the first and last few days exploring the marine ecology of the world's second-largest barrier reef, snorkeling on the reef on weekend 1, and spending the last full day offshore snorkeling with migratory whale sharks (Earth's only shark species feeding on plankton). E-mail Dan Bisaccio at *Daniel_Bisaccio@Brown.edu* for more details and to register. ●

P: PreK E: Elementary M: Middle H: High HE: Higher Ed A: All K12: K–12

Looking for an opportunity to shape high school science education on a national scale?

The National Science Teachers Association is in search of a veteran high school teacher to serve as the next Field Editor of *The Science Teacher*.

The Field Editor's responsibilities include:

- Identifying essential topics for our high school teacher journal;
- Soliciting articles on these topics from a genuinely diverse mix of engaged educators and columnists; and
- Overseeing the manuscript review process to ensure articles demonstrate good sense, exemplary safety practices, scientific accuracy, classroom usefulness, and alignment with the *Next Generation Science Standards*.

The Field Editor has ultimate responsibility for the journal's content, and therefore must aim high to illustrate best practices while including the everyday activities most likely to achieve our goal of "...excellence and innovation in science teaching and learning for all."

The ideal candidate is a smart, articulate, and effective educator, team player, and communicator who can tap into a network of exemplary secondary level science educators. In particular, the successful candidate must have the following qualifications:

- Experience as a classroom teacher of science (high school);
- A solid science background with a working knowledge of the *Next Generation Science Standards*;
- Insight into enduring objectives and current trends in science education;
- Ability to network in search of suitable content for the journal; and
- Ability to communicate effectively with authors as well as NSTA members, committees, board of directors, and staff.

This is a part-time, three-year appointment, renewable for additional terms. Travel required (two to four trips per year). Stipend and training provided.

To apply, e-mail a concise vita and a letter that specifies related experience and background to the Publisher, Ken Roberts (*kroberts@nsta.org*), by **October 30, 2018.**

BLICK ON FLICKS

Biology, Physics, and *Black Panther*

By Jacob Clark Blickenstaff

One of the most popular movies of 2018 so far—and one of the top 10 highest grossing films of all time—*Black Panther* is an unqualified commercial success. As one of the few superhero films focusing on a black main character, *Black Panther* also has been lauded as a milestone in the genre.

For anyone who somehow missed the *Black Panther* phenomenon, here is a quick synopsis. The Black Panther is king of a small African nation known as Wakanda. To the outside world, Wakanda appears to be an impoverished, agricultural nation. The country is actually built on top of the only known supply of vibranium, the strongest material in the Marvel Universe. Captain America's virtually unbreakable shield is made of vibranium. Using vibranium, Wakanda is secretly the most technologically advanced civilization on Earth, with items like hover bikes, invisible aircraft, and energy weapons.

The storyline of this (first?) Black Panther film follows the ascendance of the new king, T'Challa (played by Chadwick Boseman), and the conflict with his cousin, N'Jadaka/Killmonger (played by Michael P. Jordan) who also wants the throne. We also meet his sister Shuri (played by Letitia Wright), who seems to be the leading doctor/engineer/scientist for all Wakanda, and Nakia (played by Lupita Nyong'o), T'Challa's ex-girlfriend and Wakandan agent.

While this is a fairly typical comic book movie in terms of the action sequences, *Black Panther* has some nice connections to history (Wakanda's investment in Oakland recalls that city as a center of civil rights activity in the late 1960s and the location of the founding of the Black Panther Party) and scenes biology teachers can use to make connections to genetics and plant growth, and physics teachers can use to discuss energy conservation.

Black Panther vs. Melanistic Leopard

It's first important to point out that for scientists, "panther" refers to the whole group of large cats that includes tigers, lions, leopards, and jaguars. No single panther species exists. Second, what is commonly called a black panther can be a leopard or a jaguar depending on what part of the world it lives in. African black panthers are more properly "melanistic leopards": leopards with more melanin than is typical in the species. That extra melanin colors their coat black, though often their leopard markings still show through a bit. The trait that causes melanism is recessive in leopards, which means that both leopard parents must carry the gene for offspring to have the melanistic coloring.

On the other hand, South American black panthers are jaguars, and in that species, melanism is dominant. This means that if either parent is a black jaguar, the offspring will be black as well. It is not known why some leopards and panthers have such dark coloration, but the higher prevalence in mountain forests had led scientists to theorize that the dark color provides better camouflage in those regions.

Photosynthesis

The majority of Black Panther's powers of speed, strength, and healing come from drinking a preparation made from something called the "heart-shaped herb," which grows in only one place in Wakanda. As depicted in the movie, the herb is a green, flowering plant, which means it needs sunlight to make sugar from carbon dioxide and water, and some mechanism for fertilization of the flowers. The film avoids the pollination problem because attendants are shown tending the herb, and one of their jobs could be to hand-pollinate the flowers. (Hand-pollination is not uncommon in gardening, particularly when gardeners want to control which plants cross-breed.)

The real problem is sunlight. It looks like the only place the heart-shaped herb grows is in a cave, so light for photosynthesis is going to be very hard to come by. Under those conditions, chlorophyll is basically useless, and the plant would not stay green. The plants would be consuming their sugar and putting out carbon dioxide, rather than consuming it in the production of sugar.

Students often think of plants only as consumers of carbon dioxide and generators of oxygen, probably because we emphasize that our atmosphere wouldn't be oxygen-rich without plants doing this photosynthesis all the time. While making their own food through photosynthesis is a key way that plants differ from animals, when plants consume the sugar they made, they release CO_2, just like we do.

The Super Suit

In addition to the powers conveyed by the heart-shaped herb, Black Panther wears a suit his sister Shuri designed and built that has some amazing characteristics. When not in use, the suit collapses into a necklace that T'Challa can wear all the time, so he's never unprotected. The shoes eliminate the sound of his footsteps, and the fingers and toes include claws for running and fighting. The suit's material stops bullets and edged weapons.

The combination of two pieces of technological magic, vibranium and nanites (nanorobots), give the suit a major super power: It is able to absorb energy from bullets and other blows to Black Panther's body, then redirect that energy when he wants to deliver a "super punch." The suit is collecting the kinetic energy of the bullets that hit it, storing that energy, then releasing it later when Black Panther is ready to do so.

This idea works fine in terms of energy conversion and conservation. A windmill converts the wind's kinetic energy into lifting water or generating electricity, with some loss of energy to heat. It appears that the suit is able to store kinetic energy and re-emit it with almost no loss to heat, which runs against the laws of thermodynamics. Perhaps the nanorobots or the vibranium make that possible?

Science teachers can take advantage of the hugely popular Marvel movie *Black Panther* to generate discussion of genetics, photosynthesis, and energy conversions. (Now that it is available for rent or purchase, most students may have seen the movie more than once and may recall specific scenes, even if you don't take time to show them in class.) ●

Note: Rated PG-13 for prolonged sequences of action violence, and a brief rude gesture

Jacob Clark Blickenstaff is an independent science education consultant in Seattle, Washington. Read more Blick at http://goo.gl/6CeBzq, *or e-mail him at* jclarkblickenstaff@outlook.com.

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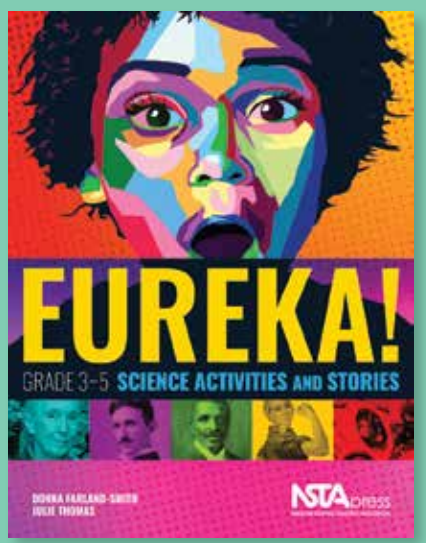

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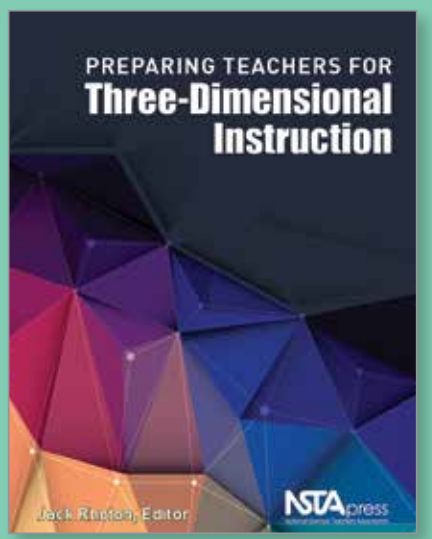

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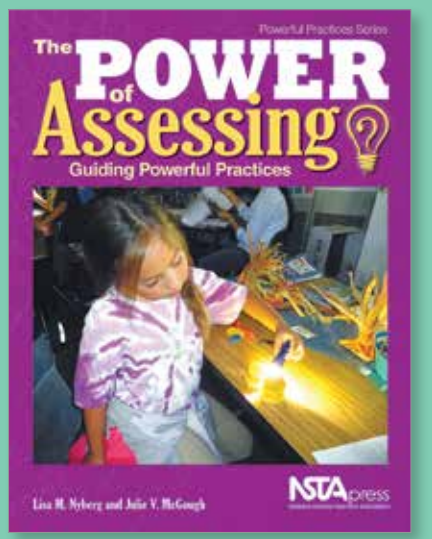

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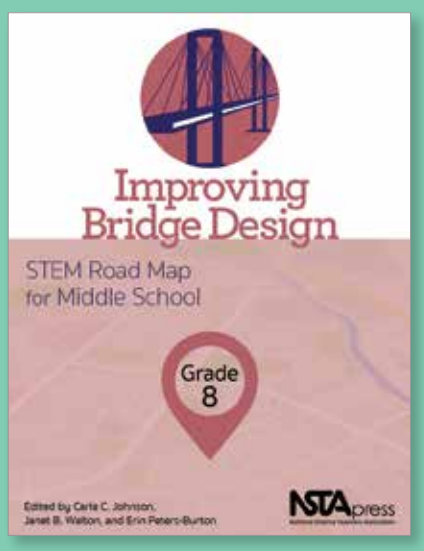

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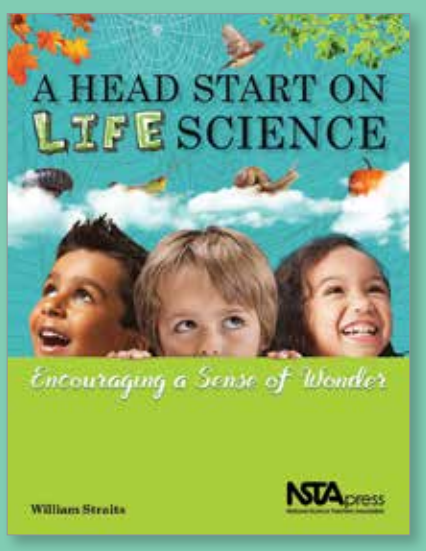

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NSTA National Science Teachers Association

Engaging Students Through Citizen Science

Citizen science offers a way for people of every age to contribute to the body of scientific knowledge. Educators around the country also have found it can provide paths for students to develop leadership skills as well as deeper understanding of the subject matter when they participate over multiple years.

At the California Academy of Sciences in San Francisco, high school youth in the Careers in Science (CiS) internship program have been contributing to the Long-term Monitoring Program and Experiential Training for Students (LiMPETS, *http://limpets.org*) since 2003, according to Laura Herszenhorn, director of Expanded Learning and Youth Engagement. Each summer, a group of 10–12 CiS interns conduct field studies, collecting sand crabs and examining them for parasites and microplastics. The interns submit their findings to the LiMPETS database, and use them to judge the health of the ecosystem. Building on the data collected during prior years, interns also identify and investigate original research questions and have presented their analyses in poster sessions at the annual American Geophysical Union conference.

"Youth join [CiS] in the summer after their sophomore or junior year [of high school] and stay through the summer after their senior year," she explains. First-year participants are trained by Level 2 and Level 3 interns in a "near peer" leadership model.

The Academy uses citizen science as an engagement strategy for teaching youth scientific skills, she says. "They work with Academy staff to think through what would be a good research question, and are learning…concrete skills they can apply throughout their academic career."

Daniel Shaw, a teacher at the Bosque School in Albuquerque, New Mexico, and co-director of the Bosque Ecosystem Monitoring Program (BEMP, *http://bemp.org*), notes the project monitors 33 different sites along the Rio Grande's riverside forest with assistance from students in elementary through high school levels. "One site was created with older (fifth grade) leading younger (second grade) students… second graders in three short years are fifth graders. They know where they're going and what's coming up," he says. "At other sites, we use [University of New Mexico] college students as interns…Upper-level undergraduates and grad students are deployed to various sites to provide quality control and act as mentors to the younger students."

Shaw says both anecdotal evidence and small studies support the program's effectiveness. "At one elementary school in southern New Mexico, scores on standardized science tests improved by 19%. The only variable was BEMP," he notes.

At Trinity Valley School, a K–12 private school in Fort Worth, Texas, sixth-grade students teach kindergartners how to identify Monarch butterfly eggs and larvae as part of a Journey North project. "Eventually those kindergartners come to my class," says sixth-grade life science instructor Julie Frey.

Frey calls translating what they're learning in sixth grade to a vocabulary appropriate for kindergartners the biggest challenge for her students. Her students also collect larvae and tag butterflies through Monarch Watch before they migrate.

The citizen science aspect is important. "It empowers them that they are giving data, information that is actually useful to scientists…It's connecting with the real world. They understand their influence on the real world.

"When they teach it, they become more passionate. They're proud of themselves, and the little kids get so excited. [The former kindergartners now in sixth grade] can definitely identify different butterflies faster," says Frey.

Before retiring this year as a fifth-grade science teacher in New London, Minnesota, Laura Molenaar had worked on a citizen science project with her students for more than 15 years. She started with students the summer before they entered fifth grade, inviting those who had demonstrated "a high interest in science and ecology" to participate in the Monarch Larva Monitoring Project.

"After the first year, those students kept monitoring," she recalls. They would train new students on the protocols and mentor them. "Students come

DANIEL SHAW

As part of the Bosque Ecosystem Monitoring Program citizen science project, sixth-grade students assist 11th-grade students as they swab frogs for Chytrid fungus.

up with a question that is answerable from their observational data...[Older students] would be peer reviewers for younger students. Some students became quite accomplished at doing investigations and identifying roadblocks and asking penetrating questions," Molenaar says.

"I also think, because it was multiple years that students could come back,…students got a great picture of what's going on in the environment," she states. "It was an opportunity to understand that there is fluctuation in the environment."

For Mary Carbone and Jeanne Deslich, science teachers at the Maret School in Washington, D.C., their citizen science project with the Anacostia Watershed Society has come full circle.

"We're educating students about watersheds and the impact people have on them," says Carbone. "This year, the project was a highlight for the older students who experienced it when they were in first grade."

The students study the watershed's shad population as a marker of the pollution level and hatch and release fish. Sophomores, juniors, and seniors taking chemistry guide first graders as they collect water samples, build a hatchery, and observe the fish. The upper-level students "have a different perspective. Their understanding is deeper from having gone through the process before," Carbone explains.

"This project demonstrates a real-life application of chemistry that students wouldn't be able to see in a traditional chemistry laboratory setting," adds Deslich.

Steven Frantz has been incorporating citizen science projects into his curricula in Akron, Ohio, for about 13 years. Working with seventh and eighth graders, Frantz has second-year students train the new students on research protocols, noting that the citizen science and self-directed aspects of his course are a "whole new learning process" for many of them.

His first-year students conduct comparative studies and write research reports. The second-year students "grow their projects exponentially," he says. "They also learn a project doesn't end just because 'this is the date it's due,'" as many of his students continued to build on their projects after leaving his classroom.

"I have seen such direct benefits to the students that I've [worked with on citizen science projects] as a duty period, during my lunch, and as a scheduled class," says Frantz. "When [students] are in programs like this, generally speaking, their academics across the board go up. They're taking care of business." ●

NSTA PRESS: *Eureka, Again! K–2 Science Activities and Stories*

Scientists and Engineers Are Persuasive

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 Eureka, Again! K–2 Science Activities and Stories *by Donna Farland-Smith and Julie Thomas, edited for publication here. To download the full text of this chapter, go to* https://bit.ly/2Nxpk16. *NSTA Press publications are available online through the NSTA Science Store at* www.nsta.org/store.

Lesson: Walk and Wonder

Description

Students will collect observations on a walk outdoors to look for living creatures in their natural habitats.

Objectives

Students will consider how the character trait of being persuasive helped Rachel Carson convince others that habitats are important.

- Students will hear the book *Rachel Carson: Preserving a Sense of Wonder* by Thomas Locker and Joseph Bruchac read aloud and discuss how it relates to the word *persuasive.*
- In the Predict portion of the lesson, students will complete the formative assessment probes Is It a Plant? and Is It an Animal? by Page Keeley.
- In the Observe portion of the lesson, students will take a walk outside to use their senses, find living animals, and identify the animals' habitats.
- In the Explain portion of the lesson, students will describe the habitats of the animals they observed.

Learning Outcomes

Students will (1) discuss why being persuasive is an important trait for scientists and engineers and (2) analyze and interpret the data they collected on their walk.

Overview

In this lesson, students will be introduced to a scientist who was persuasive about the risks of chemical applications. Rachel Carson argued that citizens had the right to know how pesticides were being used on their private property. The character trait of being persuasive refers to Rachel Carson's ability to convey her passion about the environment through her writing. As an advocate for the environment, Rachel often argued in such a way that everyday people would be able to understand scientific research. In this way, she communicated what the scientific community understood to common people. In doing so, Rachel, the citizen-scientist, spawned a revolution. Rachel believed that people would protect only what they loved, so she worked to establish a "sense of wonder" about nature.

Safety Notes

(1) Caution students about touching poisonous plants, insects, trash, and so on. They can have an allergic effect. Trash containing broken glass and other sharps can cut or puncture skin. (2) Wash hands with soap and water upon completing this activity.

Making Sense

Observe

Students will be going outside for a walk to look for living creatures in their natural habitats. *(Teacher Note: You should scope out an appropriate area around your school for such a walk. You may be struggling to find living creatures, but remember that squirrels and ants count. You can leave out some bait [e.g., something sweet along the trail a few hours before the walk] to increase the likelihood of observing ants. It is not the species of the living animals or insects that is important, but rather the process of getting students outside and asking them to use their senses to make observations.)*

The *How* of the Observe

Pass out the Walk and Wonder worksheets and clipboards. Remind students that they will need to bring their pencils. Review the five senses in each box on the worksheet, and encourage them to make as many observations as possible. Discuss the components of a habitat (food, water, and shelter) and encourage them to think not only about how to identify the living creature, but also about how that creature lives (i.e., how it finds food, water, and shelter). Review expectations for behavior as students prepare to journey outside the classroom. Set an appropriate time limit that fits with your school schedule. Wander outside! Have students record words or pictures of living animals they find in each of the blocks on the Walk and Wonder worksheet. A great follow-up, depending on what you see, is to supplement the activity with books. For example, if you find a log that looks like it could have life on it, but does not at the time of the observation and walk, you could read either *A Log's Life* by Wendy Pfeffer or *Who Lives Here?* by Rozanne Lanczak Williams. If you find ants, you could read *If I Were an Ant* by Amy Moses. If you see a squirrel, you could read *Squirrels All Year Long* by Melvin Berger. These books will help augment the ideas that students have already included on their worksheets.

The *Why* of the Observe

It is important to get students out in nature observing because the more they hone their observation and reasoning skills, the better science students they will be.

Explain

The focus of this lesson is on analyzing and interpreting data. Therefore, after the walk is complete, collect everyone's papers from their clipboards and begin to look for trends in the data they collected. *(Teacher Note: It's a good idea to look over their papers first to anticipate trends so you can better facilitate discussions with students in the coming days. This way, you can prepare and decide which kinds of questions will lead them as they analyze the data of living animals.)* You may find, for example, that all students saw a squirrel with their eyes. As much as possible (and developmentally appropriate), allow students to analyze data and encourage pattern thinking. This can sound really intimidating if you are a K–2 teacher who has never attempted this before, but you can simply ask, "What true statements can you make from the information we collected?" *(Teacher Note: If it's your first time doing this with your students, you can ask for three true statements and then build to more as students become more comfortable with analyzing and interpreting data.)*

Evaluate

Summative evaluation of this lesson will include assessment of students' (1) understanding of the character trait of being persuasive and (2) ability to analyze and interpret the data collected on their walk to observe diverse living things near their school.

Character Trait

Have students answer the following question:

1. Why is being persuasive an important character trait for scientists? Being persuasive is important because scientists who are knowledgeable about any one particular area, such as biology and environmental science, can inform people like us how to make good decisions that help our environment. Rachel Carson was persuasive and became famous for her ability to convince others to alter the use of pesticides. *(Teacher Note: Helping students think about Rachel Carson's persuasive skills will encourage them to think about how scientists improve the lives of many people.)*
2. Describe a time when you were persuasive.

Content

Evaluate students' ability to analyze and interpret the data collected on their walk using their Walk and Wonder worksheets. ●

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NSTA National Science Teachers Association

ASK A MENTOR, **Advice Column**

Using Everyday Items, Grounding Lessons in Phenomena

Do you have any advice for creating bottle ecosystems with my seventh-grade class? I would like them to do two-tier systems with terrestrial and aquatic organisms.

—S., Missouri

Students can learn a lot when they create these microhabitats in plastic bottles with plants and invertebrates. The bottles can be stacked to form interdependent aquatic and terrestrial ecosystems. I've collected some resources in the NSTA Learning Center (*https://goo.gl/o6ovVd*) with more information.

Start the project by discussing the different types of ecosystems and organisms. To get the organisms, you can sample a pond, flip over rocks, and even visit a pet store before "build day." I always kept a stock of these year-round in terraria and aquaria in my classroom.

After spending a class researching the organisms available, students create a "shopping list" of the materials they need to add in their ecosystem. Have students bring in the two-liter bottles, or ask colleagues for donations. Spend a class building the ecosystems and starting seeds of fast-sprouting plants like oats, radishes, greens, and alfalfa.

Some students may want to use samples from an aquarium in their aquatic ecosystems. Have them explain why in their journal. A fleece wick between the lower, aquatic ecosystem to the upper, terrestrial ecosystem will facilitate water movement. In a few days, the plants will sprout, and students can add the invertebrates.

Have the students write journal entries at least twice a week, and stress accurate observations. If available, use oxygen and carbon-dioxide sensors as part of their data collection. Biogeochemical cycles, pyramids, and food chains/webs that depict their bottles can be incorporated into their journals.

I love bottle ecosystems, and so did my students!

I have accumulated a large number of the freezer gel packs from a meal service. I'd like to find a way to use them in a classroom activity.

—P., Georgia

The best thing about these freezer packs is that they provide a constant that will help your class design and conduct a lot of experiments. Reusing these in your classroom is also a great environmental message.

A few ideas for experiments follow:

- Engineer the best picnic cooler. (Save plastic foam boxes and pellets from shipments you have received.)
- Determine the optimum place to put a freezer pack in a standard cooler.

- What conditions speed up/slow down warming or cooling? Correlate the data with ambient temperature.
- Investigate the heat conductivity of different solids and liquids. Put the packs in resealable zipper storage bags, and immerse them in oily/messy liquids.
- Surface-area experiments—curl them up, lay them flat, stack them vertically/horizontally, spread them out. Relate this information to physical science, chemistry, and even biology.
- The contents of freezer packs are non-toxic. Open them up and do carbohydrate, lipid, protein, and other chemical tests on the contents.
- Place them on different parts of the hands and arms to create a cold sensitivity map.

As useful tools, consider these options:

- Keep them in the freezer to use instead of ice cubes for chemistry or biology activities.
- Putting live insects in a freezer for a few minutes will slow them down. Place the gel packs under the insects to keep them cool while observing them with microscopes or magnifying glasses.

I've been teaching science for three years. My students seem to see science as an abstract subject and have trouble imagining it. How can I help my students appreciate the lessons more with limited time and resources?

—R., Philippines

I think the way to teach science with less abstraction is to ground your lessons in observable phenomena. Students build up knowledge and understanding by examining and investigating commonplace events. These don't have to be expensive demonstrations—just simple, everyday observations, pictures, or videos.

Many websites provide these phenomena and storylines to make just such learning happen. The NSTA Learning Center and NGSS@NSTA Hub are excellent places to search for these. One example—A time-lapse video of tree shadows moving during the day can be a springboard to investigating the motion of planets. Case studies are similar to using phenomenon-based teaching, and many websites provide examples to use in science classrooms.

Inquiry projects allowing students to select their topics are another way for students to dive into a concept and demystify it. They will take ownership for their learning, and it will be more meaningful to them.

Integrate the nature of science and how scientists think and work into your teaching. I think people disbelieve scientific claims and call them abstract because they don't understand how scientists draw conclusions or the continual change inherent in the nature of scientific knowledge. Students should discover that science isn't magical or arcane, it is hard work and conclusions based on the best evidence.

You can accomplish all these things with the smallest of budgets.

Keep it grounded. Keep it real. And, of course, keep it fun! ●

Check out more advice on diverse topics or ask a question of Gabe Kraljevic from Ask a Mentor at www.nsta.org/mentor, *or e-mail* mentor@nsta.org.

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#NSTA19

NSTA National Science Teachers Association

(All dates are deadlines unless otherwise specified.)

October 11—Come to **Elevating Science: Digging Deeper, NSTA's Area Conference on Science Education in Reno, Nevada!** Onsite registration costs $235 for members of NSTA, Nevada State Science Teachers Association, American Association of Chemistry Teachers (AACT), American Association of Physics Teachers (AAPT), American Chemical Society (ACS), American Society for Engineering Education (ASEE), and National Association of Biology Teachers (NABT). For more information and to register, visit *www.nsta.org/reno.*

October 19—Applications for the NSTA Board of Directors and Council are due by 11:59 p.m. Eastern Time (ET). Open positions include President; Division Directors for Coordination and Supervision, High School Level Science Teaching, and College Level Science Teaching; and District Directors for NSTA Districts III, V, IX, XI, XV, and XVII. For eligibility information and to apply, visit *www.nsta.org/nominations* or e-mail *nominations@nsta.org.*

October 19—Register now for early bird pricing for **Energize Science: Educate and Engage, NSTA's Area Conference on Science Education in Charlotte, North Carolina.** The conference will be held November 29–December 1. Early bird registration for members of NSTA, North Carolina Science Teachers Association, South Carolina Science Council, AACT, AAPT, ACS, ASEE, and NABT costs $190. For more information and to register, visit *www.nsta.org/charlotte.*

October 24—Do you want to receive recognition for your science teaching expertise and win awards to support your efforts? Don't miss **Developing a Competitive Teacher Award Application**, a free NSTA Web Seminar. Gain insight into the NSTA awards application process and learn tips for creating a strong application. The session will run from 6:30 to 8 p.m. ET. For more information on NSTA Web Seminars or to register, visit *https://goo.gl/PRmPR2.*

November 1—Help your fellow middle level educators teach about agriculture by submitting a manuscript on the theme **"Farm to Table (Agriculture, Soil Chemistry, Botany, Animals)"** for the July 2019 issue of ***Science Scope.*** Possible topics include chemical components of soil, factors affecting erosion, plant growth investigations, and field trips. General-interest manuscripts, as well as manuscripts focused on making, technology, practical research, and more, are accepted anytime. Read the call for papers at *https://goo.gl/l6bNbz.*

November 14—Find out how to craft a strong submission for the Shell Science Teaching Award during **Developing a Competitive Application for the Shell Science Teaching Award**, a free NSTA Web Seminar. Learn about the application process and how to showcase your efforts. The session will run from 6:30 to 8 p.m. ET. For more information on NSTA Web Seminars or to register, visit *https://goo.gl/PRmPR2.*

November 15—Science Education: A National Priority, NSTA's Area Conference on Science Education in National Harbor, Maryland, opens today! Registration costs $235 for members of NSTA, Maryland Association of Science Teachers, AACT, AAPT, ACS, ASEE, and NABT. For more information and to register, visit *www.nsta.org/nationalharbor.*

November 28—Do you dream about the effect a new science lab could have on your students' learning? Find out how you can win a $20,000 lab makeover for your school during **Developing a Competitive Application for the Shell Science Lab Challenge**, a free NSTA Web Seminar. The challenge recognizes middle and high school science teachers who share how they get the maximum educational benefits for their students using only limited supplies and budgets. The session will run from 6:30 to 8 p.m. ET. For more information on NSTA Web Seminars or to register, visit *https://goo.gl/PRmPR2.*

December 3—Session proposals for the Eighth Annual STEM Forum & Expo in San Francisco, hosted by NSTA, **are now due!** Proposals for NSTA's 2019 Area Conferences are being accepted through **January 15, 2019;** and for the association's 2020 National Conference on Science Education through **April 15.** The STEM Forum & Expo will be held July 24–26, 2019. The area conferences will take place in Salt Lake City, Utah (October 24–26, 2019); Cincinnati, Ohio (November 14–16, 2019); and Seattle, Washington (December 12–14, 2019). The national conference will be held April 2–5, 2020, in Boston, Massachusetts. For more information on presenting at an NSTA conference or to submit a proposal, visit *www.nsta.org/conferenceproposals.* ●

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Educators Connecting to Talk Aerospace

Aerospace educators can connect with colleagues around the country to share insights, resources, and more using *aerospace@list.nsta.org*, NSTA's newest e-mail list. NSTA e-mail lists are a benefit to association members. Other lists focus on chemistry, biology, *NGSS,* and STEM. To learn more and subscribe, visit *https://goo.gl/JnAkYM*.

"The new aerospace e-mail list is a great way for science teachers to connect with peers across the country. They will be able to share ideas, as well as successes and struggles, with other educators," says David Lockett, chair of NSTA's Aerospace Programs Advisory Board.

NASA Marks 60 Years

NASA is celebrathing the agency's 60th anniversary this year. The Aerospace Programs Advisory Board encourages NSTA members to share their aerospace education efforts via social media and include the hashtag #NSTAaero. In addition, NSTA is hosting a Tweet chat with analog astronaut Sian Proctor on November 8 at 9 p.m. Eastern Time. To participate, follow the hashtag #NSTAchat. ●