CHRIS RANDALL

NSTA Reports
National Science Teachers Association

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Partnering With Scientists

While it's common for many teachers to have a scientist visit their classroom once or twice a year, some teachers have formed long-term partnerships that enable scientists to spend significant time with their students. Cindy Hopkins, science teacher at Kaffie Middle School in Corpus Christi, Texas, met one of her scientist partners—Janel Ortiz, a graduate student from Texas A&M University-Kingsville (TAMUK)—at a professional development session on quail that Ortiz led at TAMUK. "There is no extra money for field trips, so I actively seek science professionals to come to my class and connect students with real-world science," Hopkins explains.

"This past spring, I had Janel come to my class [twice a week for two months] and teach a unit about quail (her area of expertise)…Researchers and scientists are another voice for my students, and they pay more attention [to them]," Hopkins contends.

"Janel brought good binoculars, and my students used them...to [examine] bird bands...She asked students to give her evidence, and taught them how to do it…When [scientists do] this, students make connections from the classroom to the field," Hopkins maintains.

"I did activities alongside the students. They got to see me as a learner. I asked questions to help students connect her material with what I've taught them," she relates. Having Ortiz teach the unit also "allowed me to sit down with students that need one-on-one attention and connect with them," she notes.

A Vanderbilt University Scientist in the Classroom Partnership fellow helps middle school students in the Nashville, Tennessee, area test their car design for speed.

David Lockett, middle-level science, technology, engineering, and math (STEM) teacher at Edward W. Bok Academy in Lake Wales, Florida, benefitted when Principal Damien Moses helped bring Keith Young, CEO of Detroit-based Ecotek—a research organization promoting science education and careers for students ages 10 to 17 (*www.ecotek-us.com*)—to the city's charter school system for two semesters. Young co-taught "and deliver[ed] lessons on citrus greening and alternative battery and fuel options with our STEM classes," says Lockett. "We had a community need because a plant and tree disease was affecting citrus crops."

Young even took some middle school and high school students to the U.S. Department of Agriculture National Lab for Genetic Research Preservation in Fort Collins, Colorado. "Students made bactericide and did directional drone studies of infected trees. [The trip] showed students how something in Florida could also affect the rest of the country and the world," Lockett reports.

"In grad school, one of my friends was working on his thesis and was required to do outreach as part of his own graduate work. That school year, Dr. J. P. Trasatti (J.P.) came to my classroom to share his research with the students," recalls Nichole Mantas, a biology teacher in New York, "then he and I designed a hands-on activity to simulate his research. He had been

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TEXAS INSTRUMENTS

COMMENTARY: **Melanie LaForce and Liz Noble**

Defining 'Success' for Inclusive STEM Schools

By Melanie LaForce and Liz Noble

Melanie LaForce

Liz Noble

Over the past decade, an explosion of science, technology, engineering, and mathematics (STEM) schools has occurred across the United States and beyond. Traditionally, STEM schools were seen as the realm of elite students: Until recently, nearly all STEM-focused schools were populated through selective enrollment. Students in these STEM schools were (and still are) those with high test scores and the social capital to identify the opportunity. However, due to an increasing need for a larger and more diverse STEM workforce, districts and states are broadening enrollment with "inclusive" STEM high schools: STEM schools that enroll students of all ability levels.

The goals of inclusive STEM schools often differ from those of selective schools. Instead of preparing elite students for high-level math and science careers, inclusive STEM schools typically have broader goals. Some strive to increase college-attendance rates; others seek to improve STEM career opportunities for students immediately after high school. Still others seek to graduate a population of critical thinkers and strong communicators ready for any potential career.

Most often, the schools have a combination of goals for students. These various goals may not always align well with high-stakes testing outcomes—some of the most commonly used metrics for researchers in gauging the effectiveness of a program or policy. To correctly evaluate whether inclusive STEM schools are working, then, we need to clearly understand what they are working toward, and how they are doing it.

Research has struggled to keep up with the rise of inclusive STEM schools, for several reasons. First, no consistent definition exists of what a STEM school is or should be. Second, school-level innovations are complex, and thus difficult to evaluate. Recent research, including the STEM School Study (S3) project funded by the National Science Foundation (NSF), has attempted to untangle what it means to be an inclusive STEM school.

Through in-depth interviews with school leaders, stakeholders, and staff at 20 inclusive STEM high schools across the United States, we identified 80 critical components of inclusive STEM high school models. From these, we derived eight overarching themes, which we call the 8 Elements of Inclusive STEM High Schools. Of these elements, four focus on instructional practices [Personalization of Learning; Rigorous Learning; Problem-/Project-Based Learning (PBL); and Career, Technology, and Life Skills], two center on non-instructional strategies and culture (School Community and Belonging; and focus on the External Community), and two concentrate on supports for those strategies (Staff Foundations and External Factors). More details on each of the Elements are available at *https://goo.gl/q17d6K*. The 8 Elements describe an inclusive STEM school framework and serve as a template for evaluating outcomes.

Interestingly, when we asked STEM school leaders about the critical elements of their schools' models, they *rarely* mentioned science, technology, engineering, and math. While all of our study schools said they focus on these disciplines, they expect a similar level of rigor across STEM *and* non-STEM–specific disciplines. It became clear during our interviews that when school leaders referred to "STEM," they typically did *not* mean the disciplinary subjects. Rather, to many inclusive STEM school leaders, "STEM" refers to the instructional and cultural strategies summarized in the 8 Elements. The schools participating in this study seek to transform learning in all of the disciplines they teach; as such, the disciplinary STEM focus may be more implicit than other goals. When we asked school leaders about their schools' missions and goals, they often cited the importance of engaging students with real-world problems and developing them as critical thinkers and active citizens.

While S3 focused on inclusive STEM high schools, our work with inclusive K–8 STEM schools indicates that elementary STEM leaders have many of these same goals for students (i.e., developing problem-solving, communication, collaboration, and interdisciplinary learning skills).

Given the broad goals of inclusive STEM schools we have seen, it may not always be appropriate to examine math and science test scores as the primary metric of success for inclusive STEM schools. In the S3 study, we have begun to widen our definition of success. We are examining how the implementation of various STEM practices (e.g., PBL, teacher emotional support for students, student autonomy) can influence attitudes toward STEM subjects and STEM careers, which may be viewed as the first critical benchmark toward growing and diversifying the future STEM workforce. In addition, we are examining grades across all disciplines. As a field, STEM school researchers should consider studying the effectiveness of STEM schools by broadening the outcomes they measure to better reflect the work of the schools themselves, and to better understand how attending a STEM school can influence long-term success, be it in an elite STEM career, a successful postsecondary transition, or a high-quality job after high school graduation. ●

Melanie LaForce, PhD, is the principal investigator of STEM schools research studies funded by the NSF and the U.S. Department of Education. She has developed STEM policies and benchmarks at the district and state level, as well as internationally. (Contact laforce@uchicago.edu.*)*

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studying a particular protein that worked similar[ly] to a zipper in the blood-brain barrier," Mantas notes.

"In recent years, J.P. has moved on from his graduate work, and our lessons have changed as well…For two years, J.P. came [to my classroom] and shared how tissue engineering works," she relates. "It helped engage a group of students who might have just considered science a hobby."

Forming Partnerships

Scientist in the Classroom, a program of the National Center for Science Education in Oakland, California (*https://goo.gl/enR2gb*), connects scientists with middle and high school teachers "because teachers feel more confident teaching potentially contentious issues" like climate change and evolution "with a scientist [there] to answer questions," says program coordinator Claire Adrian-Tucci. Early career scientists, such as graduate students and postdocs, participate because they "tend to have more flexible schedules," she points out.

After the program's required two visits, some teachers continue their conversations with the scientists, often via Skype, Adrian-Tucci notes.

"Teachers need to plan ahead and communicate with scientists," she advises. "Don't set your goals too high; find a fun activity, and get everyone involved."

The New York Academy of Sciences (NYAS) Scientist-in-Residence program (*https://goo.gl/z12Q8C*) matches scientists from all disciplines with public school teachers in New York City, Syracuse, and Utica. Scientists commit to 10 hours a month, January through May. "Teachers are becoming more comfortable with outside experts visiting. Scientists can seem intimidating, [but we're finding they're] more welcome than in years past," says NYAS Director of Education Kristian Breton.

The program's graduate students and postdocs "are interested in checking out possible teaching careers. [About] 10–15% of [these] scientists go into teaching," he notes.

Schools chosen to participate "are [located] 35–40 minutes from where the scientist lives or works" to spare scientists a long commute, Breton explains.

In Vanderbilt University's Scientist in the Classroom Partnership (SCP; *https://goo.gl/kh1q23*) Program, scientists work in classrooms in the Nashville, Tennessee, area "one full day per week all year," says program director Jennifer Ufnar. Scientists have "run competitions (middle school), developed PBL [Problem-Based Learning] units, infused science across the curriculum, started science clubs, pushed science into other disciplines, infused inquiry-based science and PBL across the school, and co-taught curriculum they've developed with the teachers," she reports.

In addition to taking teachers to meetings and conferences at universities, "fellows provide an extra set of hands, plus materials and kits. It takes a load off the teachers," she asserts.

A Scientist's Advice

Retired scientist and engineer Rick McMaster of Austin, Texas, regularly visits classes. The first teacher who invited him "provided all the details—schedule, location, asked what I needed, etc.—to minimize the effort on my part," McMaster recalls.

Teachers should support visiting scientists with "logistics, materials (if needed), [and] classroom discipline. They should arrive early to meet the visitor," he emphasizes.

Teachers should also "follow-up with feedback. Thank-you notes from the students go a long way. The local administration should also provide encouragement for a long-term relationship," he stresses.

And be sure to invite students' parents who are scientists, McMaster suggests, because some "continue to visit...even after their children are no longer there." ●

MONEY 101

Should You Be Worried About Retirement?

By Kelly Kenneally

Americans are stressed about their financial security, particularly regarding their retirement. Recent polling (*https://goo.gl/BfGfxR*) from the National Institute on Retirement Security (NIRS) finds that 76% of Americans are concerned that economic conditions are impacting their ability to achieve a secure retirement. Even more alarming, 88% of Americans agree that the nation faces a retirement crisis.

We have good cause for concern. Data from the U.S. Federal Reserve's Survey of Consumer Finances reveals that the typical working-age household has virtually no retirement savings. For all households, the median retirement account balance is $2,500. For those near retirement, the median retirement account balance is $14,500. Yes, you read that correctly: a meager $14,500 for those approaching retirement.

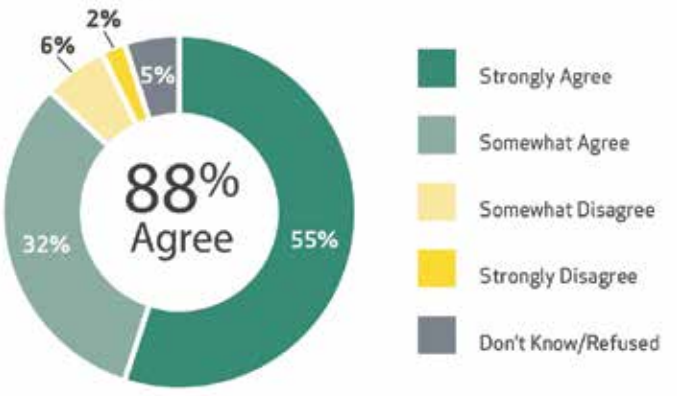
You don't have to have to be a math teacher to calculate this massive shortfall. In most areas of the country, that amount of money won't last a year, much less 20 or 30. Even when adding Social Security into the equation (this year, the average retired worker will receive $1,360 per month), many will hover around the poverty line in retirement.

With numbers like this, the "golden years" look like the "in-the-red years." The Boston College Center for Retirement Research (*https://goo.gl/T9yiVC*) calculates that more than half of U.S. households are at risk of being unable to maintain their standard of living in retirement.

So what is the outlook for education professionals concerning economic security in retirement? We know that educators typically earn less than their private-sector counterparts with comparable experience and education: as much as 14% less in some states, according to the Economic Policy Institute. One could conclude that retirement security is an unattainable goal for educators, but the opposite is true for most educators.

Figure 7: **88% of Americans say the nation faces a retirement crisis.**

To what extent do you agree or disagree with the following statement: America is facing a retirement crisis.



Source: Retirement Security 2017: A Roadmap for Policy Makers *from the National Institute on Retirement Security*

Public-sector educators actually are well-positioned to maintain their standard of living in retirement compared to the typical middle class American. Why? Because most public-sector educators have a defined benefit pension, a retirement plan that is disappearing for most private-sector workers.

Pensions provide retired employees with a stable and secure income each month (usually based on their salary and years of service) that won't run out. Typically, public school education professionals must contribute to their pension from every paycheck from their first day on the job until they retire. The employer also contributes, and the money is professionally managed and invested. Because of this structure, investment returns (ideally) do most of the work, covering more than 60% of retirement benefit costs.

And with this retirement structure, the average pension benefit for public workers, including teachers, is about $2,200 per month, and many have cost-of-living increases. Moreover, that pension income can be supplemented with individual savings (often called 403(b) plans) and Social Security (in 12 states, though, public employees are not eligible to participate in Social Security).

Certainly, this isn't a luxurious retirement. But most public school educators can count on a regular income without worrying about watching stock market fluctuations, making complex investment decisions, and running out of money.

In contrast to pensions is the 401(k) defined contribution plan structure, which is increasingly prevalent in the private sector. Originally, 401(k) plans were set up to supplement pensions. But today, private-sector employers are shifting away from pensions and placing more retirement costs, risks, and investment decisions onto employees.

In typical 401(k) plans, employees and employers can choose to make contributions, but contributions are not required. Employees make investment decisions, as well as decisions on how to spend down the account balance in retirement. Employees often are permitted to borrow against their retirement plans or can drain the accounts before retirement (with tax consequences). It's also important to note that 401(k) accounts can run out of money during retirement. Remember that $14,500 median retirement account balance amount for near retirees mentioned earlier? A 401(k) with a balance that low likely will run out quickly.

Given this trend away from pensions in the private sector, why isn't this shift occurring for public school employees? To be sure, some states are making significant changes to teacher pensions, such as increasing retirement ages and contribution levels, to ensure they are sustainable over the long-term. Just a few states have made a wholesale switch to 401(k)-type plans because the shift is mistakenly sold as a way to close pension underfunding.

It turns out that government employers are sticking with pensions for a few reasons. First, pensions are a workforce management tool that helps recruit and retain qualified employees when employers can't offer high salaries. Also, pensions are the most cost-efficient means to deliver a modest retirement income, providing the same retirement benefit as 401(k) plans at half the cost because they pool longevity risk, earn higher returns, and have lower fees. Also, pensions enable workers to be self-sufficient in retirement with a dependable and stable income that lasts. States and localities know firsthand that when their citizens can't make it on their own in retirement, they often turn to government for financial assistance.

Ultimately, pensions provide a triple win: Educators have retirement security, taxpayers have qualified and experienced teachers in the classroom (even more important today given the teacher shortage issue), and employers only cover about 25% of the retirement benefit costs.

Does this mean that public school educators can put their feet up on their desks and not worry about retirement? Public school educators certainly are better positioned than many of their private-sector neighbors. Take, for example, women in education. Research from the NIRS (*https://goo.gl/7Uu8nz*) indicates that despite lower wages, women ages 65 and older currently

retired from the education sector generate higher average household incomes in retirement when compared to women in all other sectors (including women with higher salaries), thanks to pension income.

But that's not a hall pass to forget about retirement. It is critical for public-sector educators and especially for educators outside of state or local pension plans (e.g., university and private school educators) to keep retirement foremost. Here are four steps every education professional can take to help ensure you are on track for a secure retirement:

1. **Really understand your retirement benefits.** Do you have a pension, 403(b), 401(k), and/or Social Security? Does your plan provide survivor benefits for your dependents and/or spouse? At what age can you collect? Can you save more? How are investments and allocation decisions made? Don't wait until you are near retirement age to start this education process. The more you understand and save early in your career, the more secure you'll be, thanks to compound interest. So take time now to get educated.
2. **Make a monthly appointment to monitor your retirement plan.** Even once you fully understand what you have in retirement benefits, don't stop there. If you're fortunate enough to have a teacher pension plan, monitor the plan's performance. Most public pension plans are well-funded, but some (including Illinois, New Jersey, and Kentucky) have significant funding challenges because they skipped required payments. Public pensions have a wealth of information on the plans' websites, along with public meetings. In some states, anti-pension groups are lobbying policymakers to switch to 401(k)-type plans, so it is advisable to stay abreast of these issues and advocate to protect your benefits. For educators without public pensions, you have a greater burden to be vigilant about monitoring your retirement. Read your statements, and seek professional advice to make sure your investments and asset allocation are aligned with your financial goals and are performing to meet your financial goals.
3. **Pay yourself first.** Save as much as you can throughout your entire career: Really stretch yourself. Closely examine your spending, and find ways to save more for your retirement. For example, can money spent on small indulgences be socked away instead in your 401(k) retirement account? And find a way to save the maximum amount allowable in your 401(k) plan, and capture the maximum contributions, if any, from your employer. If you have a public teacher pension, squirrel away more money in a 403(b) plan.
4. **Get educated about Social Security.** Some public school teachers are not eligible to participate in Social Security, so their pension and savings are all the more important. It's also important to understand the best time to collect Social Security. Typically, it is advisable to wait as long as possible to begin collecting benefits. Starting too early can significantly impact long-term benefits, cutting them by as much as 25%. Also, be sure to monitor your Social Security account (*https://goo.gl/KC6ByQ*) at least annually. It's advisable to stay abreast of the Social Security Board of Trustee annual report to understand the long-term financial health of the program.

The bottom line—We all need to worry about retirement to some degree. It's harder and harder to save, and the days of generous employer benefits are long gone. But if you check early and often, you won't find yourself worried when you reach retirement age. Worry early when you can take action. Starting to worry at age 65 will likely be too late.●

Kelly Kenneally has 25 years of public policy experience including serving in the White House, and she has worked for more than 10 years with retirement organizations to help improve retirement prospects for Americans. She has co-authored a biennial report on Americans' sentiments regarding retirement.

Teaching STEM With a Food Computer

Teachers and students around the country are building and using Personal Food Computers (PFCs) to learn about science, technology, engineering, and math (STEM), and other subjects. Created by Caleb Harper, principal investigator and director of the Open Agriculture (OpenAg) Initiative at the MIT Media Lab, the PFC is a tabletop-size agriculture growing chamber that grows plants in reservoirs of water instead of soil, and allows users to control and monitor climate and energy and direct the plant's growth toward a specific outcome, like flavor, nutrient density, or yield. Growers can control variables such as carbon dioxide, air temperature, humidity, dissolved oxygen, potential hydrogen, electrical conductivity, and root-zone temperature, according to OpenAg's website (*https://goo.gl/3ems7T*).

The instructions for building PFCs are open source, so anyone can construct them. And PFC sensors provide data that can be shared with other growers worldwide.

In 2015, OpenAg enlisted six Boston-area schools to pilot an early PFC prototype "to see what happens with this technology with students of different ages and with different teachers' resources," says Hildreth England, OpenAg's assistant director. "We wanted to figure out if Food Computers had a place in classrooms…We want kids to consider agriculture as a career and be part of the next generation of farmers worldwide."

The pilot schools tested a lesson plan for incorporating PFCs into the curriculum. The lesson plan was "bare bones because each school varied in terms of resources, the socioeconomic statuses of students, and the education levels and ages of students," explains Paula Cerqueira, OpenAg special projects manager. "The lesson allowed teachers to show creative influence."

Teachers in the pilot typically did two growth cycles: one in which the "climate recipe"—the coding to manipulate the hardware inside the PFC—was standard for all, and the second with one modification to the climate recipe, such as a change in the light cycle or the temperature. "They could see how plant growth changed along the way," observes Cerqueira.

Tracy Polte, lower school science specialist at Shady Hill School in Cambridge, Massachusetts, tested the prototype with first graders. "Our curriculum in first grade is Food From Farm to Table, so we [used the PFC] when we began talking about how plants grow. We compared how plants grew in the computer versus outdoors or in a greenhouse," she recalls.

"We grew lettuce, basil, radishes, bok choy, and other herbs. We had three growing cycles of 2–4 weeks during the year," says Polte. Students collected data on how fast the plants were growing, such as by measuring their roots and shoots, and observed that they grew faster in the PFC. "It gives them an immediate idea of what plants need and how they grow. The computer helped them see their results as they happen. Growth in [the PFC] is much more reliable" than it is outdoors because you can control variables like water and light, she contends.

"We could look at the computer and see that the carbon dioxide level was too low…Two students went up to the vent [of the PFC] and started blowing into it to get the carbon dioxide level higher. For a first grader, that's an abstract concept, but they got it," she asserts.

"Integrating agriculture and technology is the way to go [because] we need to find new ways of growing food in confined spaces and to learn about how to grow food without shipping it across the country," Polte maintains. "By having this machine in your classroom for a long time, you can do extended experiments with it, which is a model for good science teaching, especially for elementary teachers, [who may be limited to only] 20 minutes per day for science." To integrate literacy, students wrote about their plant observations.

CHRIS RANDALL

Tracy Polte, lower school science specialist at Shady Hill School in Cambridge, Massachusetts, tested the early food computer prototype with first graders.

Crossing Disciplines

In the 2015 pilot test, teachers were given pre-built PFCs. In a 2017 follow-up test, "we gave classrooms a test kit to build Version 2.0 (v2.0) PFCs, but using only open-source instructional materials, to see if teachers and students [in grades 1–11] could easily build and use them, to assess the skill level needed," says Cerqueira.

Jennifer Hesseltine, social studies department coordinator at Malone Middle School in Malone, New York, connected with MIT's OpenAg at TEDYouth 2015, an event for middle and high school students featuring speakers and hands-on activities. Caleb Harper was one of the speakers, and Hesseltine recalls he had set up a PFC with spinach growing in it. She says the PFC intrigued her because her school "is in a rural area." She began corresponding with OpenAg to see if her school's eighth graders could participate in the beta test of v2.0, and in 2016, Cerqueira notified her that her school was one of those chosen.

"Our school is set up as cross-curricular teams, which makes it a good match with the [PFC] because all content areas could be covered," says Hesseltine. In addition, "[science teacher] Mike [Botto] had started hydroponics in his class," she notes.

The PFC extended his students' work with hydroponics systems, says Botto. "It helped them make bigger connections to the farming community,…how farming is evolving, the use of technology [like] sensors and computers [to gather data about plants]… In the computer, we set up an isolated habitat for the plant."

"Our challenge was how to get 72 students all building [the PFC]," Hesseltine points out. "We divided students into seven groups to [build] various parts of the computer and to do parts of the project." One group was responsible for communicating with OpenAg's online forum, for example, while other groups tackled electronics and research.

"One outcome was it gave [students] experience with perseverance. [The task was] overwhelming for adults, too; there were many parts and instructions," reports English Language Arts (ELA) teacher Dan Tusa.

"Two OpenAg engineers helped students with building…They talked about their path in getting to MIT and problems this technology can solve. This communication was just as valu-

able as the machine itself," Hesseltine maintains.

"We had to plant everything outside first, and the first problem was germination: The seeds weren't planted at the right depth, so we had to re-plant them," recalls Botto. "With different amounts of sunlight and water and amounts and kinds of fertilizer, students saw the effects on the plants and had to figure out the right levels." After transplanting the plants in the PFC, "we had to deal with technical issues like settings for nutrient dumps," he notes.

"Students learned [that] engineering is knowing how things work and changing them when problems occur. They gained confidence, and [the project] made engineering accessible to them," Hesseltine observes.

"It would have been easy just to study the history [of food growing] and read articles, but the [PFC] became a unifying foundation for us [and] allowed us to connect to global [food] issues," including those experienced by refugees worldwide and in areas like the south Sudan, where people are dealing with civil war, Tusa asserts. "And it went beyond the global food crisis; [we examined] issues with clean water availability, differences in climate and the effects on growing food. It went far beyond the growing of lettuce [in the PFC]."

"Students worked with the library media specialist and me to come up with an inquiry-based question about food. They chose areas to research and produced digital stories and videos, one on school lunches, for example," Hesseltine relates. "All these things had a connection to the social studies content. Students could visually see the progress of traditional agricultural methods versus high-tech methods with the [PFC]…The connection between STEM and the humanities was a lot easier to make with a project like this."

"It was an ongoing investigation, not a typical lab experience, with inquiry throughout, manipulating their own variables," says Botto. "We saved the data so [future classes] can compare it with what students did before."

Looking Ahead

OpenAg is developing a new version of the PFC that will be easier to build. Learn more at *https://goo.gl/9UE8wk*. ●

Quotable

The duties of a teacher are neither few nor small, but they elevate the mind and give energy to the character.

—Dorothea Dix, U.S. activist and educator (1802–1887)

NSTA Area Conferences Make Professional Development Accessible

NSTA's Area Conferences on Science Education celebrate advances and innovations in science education across the country as they help educators enhance their classroom practices and connect with colleagues. Thousands of science educators will gather in Baltimore, Maryland; Milwaukee, Wisconsin; and New Orleans, Louisiana, for intensive professional development.

Freeman Hrabowski

Sean B. Carroll

Debbie Silver

Baltimore

Themed "Making Science Accessible: Full Speed Ahead," the conference opens on October 5 in Baltimore. Keynote presenter Freeman Hrabowski, chair of President Obama's Advisory Commission on Educational Excellence for African Americans, will discuss innovative approaches to science, technology, engineering, and mathematics (STEM) teaching and learning, as well as increasing diversity among students pursuing these fields by Holding Fast to Dreams: Creating a Culture of STEM Success. Conference attendees can opt to focus their professional development by following one of the three strands: Charting the Course for Innovation, Anchoring Our Natural Treasures Through Environmental Literacy, or Tying the Knot: Coherence in 3D Science Learning. Featured presenters also include Jay McTighe, Andrew Coy, and Gregg Treinish.

"Making Science Accessible" also will include four short courses: Data, Data Everywhere; Promoting Children's Science Inquiry and Thinking About Living Things in Preschool and Kindergarten; NSTA Press® Short Course: Introducing a New *NGSS* (*Next Generation Science Standards*)–Focused Curriculum Unit—Toward High School Biology; and Using Your School as a Laboratory: Air Quality.

Milwaukee

On November 9, "Making Waves: Moving Science Forward!" opens in Milwaukee, offering three strands: Preparing All Students for the Voyage, Navigating STEM Through the *NGSS*, and Buoying Up Literacy With Science. Award-winning scientist, author, and educator Sean B. Carroll will present the keynote address, *The Serengeti Rules: The Quest to Discover How Life Works and Why It Matters*. Featured presenters will be Jo Handelsman, Will Allen, and Rita MacDonald.

In addition, the Wisconsin Society of Science Teachers (WSST) is hosting a Preservice Exploratorium on November 10, which will feature op-

portunities for preservice teachers to share lesson plans on discrepant events.

New Orleans

Educator, author, and humorist Debbie Silver will reflect on the active nature of science during her keynote presentation, Science Is a Verb—Exploring, Engaging, and Expanding Thinking, on November 30 at the New Orleans area conference, themed "Celebrate Science: Inspire, Integrate, Innovate." The conference offers three strands—Innovate Science Education for Tomorrow; Integrate Science Education for *All;* and Inspire Our Young Learners—and features presenters Milton Chen, Okhee Lee, Carla Zembal-Saul, and Marshall Shepherd.

The conference also includes four optional short courses: Marine Debris Education and Prevention Program; Crashing Black Holes, Gravitational Waves, and Your Classroom; Science Standards From the GUT: Guidance for Unpacking with Teachers; and Stretch Your Legs for Science!

Register Online

Earlybird member registration for the NSTA Area Conferences costs $185; on-site member registration, $230 (deadlines vary by conference). Members of the American Association of Chemistry Teachers, American Association of Physics Teachers, American Chemical Society, and American Society for Engineering Education can register at the NSTA member rate for any of the area conferences. In addition, members of the Maryland Association of Science Teachers, Louisiana Science Teachers Association, and WSST receive the NSTA member rate for the conferences in their states.

Short courses require conference registration and an additional ticket purchase; prices vary by course. Conference attendees may apply for graduate credit sponsored by Framingham State University (Baltimore), University of Wisconsin–Oshkosh (Milwaukee), and Dominican University of California (New Orleans) for an additional fee.

Download the conference preview brochure at *https://goo.gl/iH1Dih*. More information, including session browsers and online registration, is available at *www.nsta.org/conferences.* ●

Quotable

Technology is just a tool. In terms of getting the kids working together and motivating them, the teacher is the most important.

—Bill Gates, U.S. entrepreneur and philanthropist

STEM Camps Showcase PBL

Project-Based Learning (PBL) enhances science, technology, engineering, and math (STEM) teaching because "kids get a better understanding of concepts when they do a project [while learning them]," contends Dan Van Pelt, physics teacher at West Brook High School in Beaumont, Texas. Van Pelt attended a Tapia Professional Development (PD) camp at Rice University in Houston to learn how to integrate PBL in his classroom. "It's a good learning tool," he asserts. "It helps me see how to teach abstract concepts more concretely."

Hosted by Rice's Tapia Center for Excellence and Equity, the week-long summer Tapia camps in physics, math, and computer science immerse teachers in PBL. Rice also holds Tapia camps in the three subjects for students in grades 8–12 (*https://goo.gl/nUejTb*). "We want to show students that math and science can explain cool things about the world around them," says Paul Hand, assistant professor of computational and applied mathematics and the camps' director of curriculum and instruction. "The camps target women and underrepresented students" and "draw students from across the country," he notes. Students live on campus, and most attend at no charge because their school or district funds their attendance.

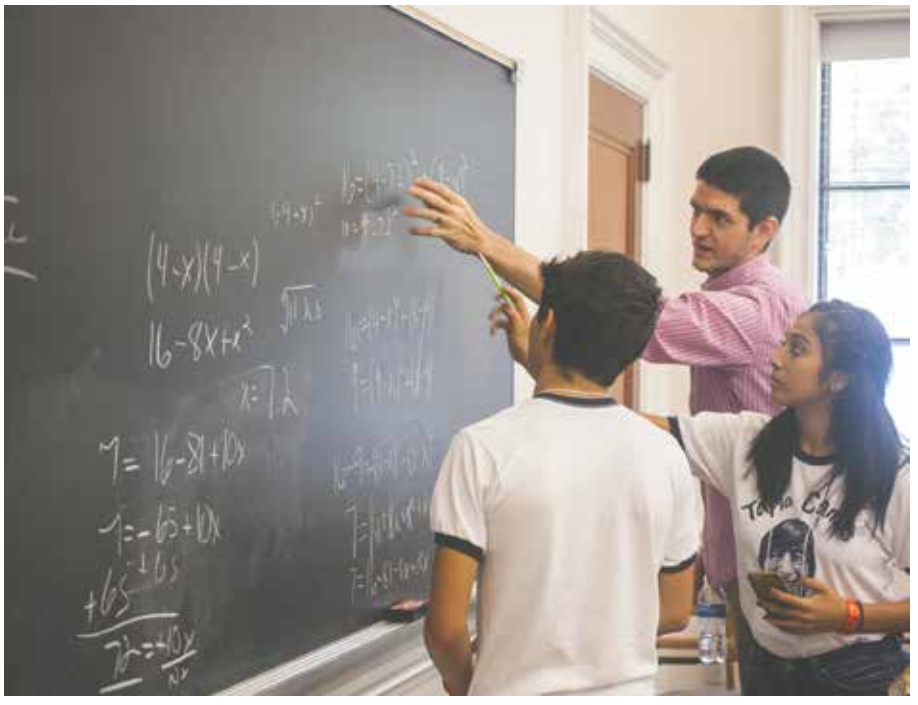


PHOTO COURTESY OF TAPIA CAMPS

Students in a Rice University Tapia physics camp work on a problem related to how the Global Positioning System operates.

In the camps, students learn STEM content and develop skills in communication and design. They complete two projects: an oral presentation and a graphic "that make people want to learn about [various topics] and that also explain the science and math behind them," says Hand. "We want students to be able to explain science and math concepts so that everyone will understand them. If you can explain cool things in math and science, you're more likely to enter those fields."

"We use the same projects for teachers and students," says Ben Olsen, lead

physics instructor. In a physics project involving exoplanets, for example, "students can use a small amount of data and high school algebra to calculate the size of exoplanets and their distance from a star. This is an area of physics that is new to today's high school students; it's cutting-edge to them.

"There's enough data cataloged online of numbers of exoplanets, so [students] can do some computations to see if [the exoplanet] is habitable. They can find raw data and use simple computations for other exoplanets," he adds.

Olsen emphasizes that in the projects, "we link topics students encounter daily with problems [researchers work on]. Linking these scenarios shows students that the same physics is happening and that physics isn't full of complicated equations, and they can do it."

More than 300 students attended the camps this summer. "Not all of them will [pursue STEM careers], but they all will understand how to communicate complex ideas. This is helpful even to those who don't become scientists," Hand maintains.

"Students come with a wide range of abilities, [so] the curriculum is designed to work at a wide range of levels," he explains. "One member may be a whiz at math, one may be a whiz at graphics, and the rest may be less knowledgeable. Students with less background knowledge can still give a good presentation… They enhance the group because they help the whizzes break down the concepts for good communication."

Teacher Camps

Teachers attending Tapia PD Camps earn 40 hours of PD credit and receive training in PBL, the camp curriculum, and communication. Though many STEM teachers attend these camps, they are open to teachers of any subject and to administrators. "Many school districts are considering integrating PBL and want to see it in action," says Hand.

"We get teachers to think about how to adapt the [student] projects to their classroom using the PBL framework," Olsen maintains. The exoplanet project "could be extended beyond the one-week camp, but one week is long enough to get interesting results and discuss them." Teachers also consider how to develop curriculum so that all students, including English language learners, "could work through the problems…Our criteria for choosing [physics] problems include [having] a clear message, [being] relatable [to students], and [having] a small amount of math," he relates.

Physics teacher Van Pelt admits he "had a hard time doing [the exoplanet calculations] without all the physics and math. We could figure it out using Kepler's third law…That never would have occurred to me to teach that aspect." He continues, "Kepler's stuff is way abstract for the kids, but [PBL] makes it more concrete for them."

Ruben Gonzalez, science teacher at James "Nikki" Rowe High School in McAllen, Texas, says the physics PD camp presented "tough ideas and concepts and getting through them in more than just a handout way, in a hands-on and interactive way." The graphic his group created explained the physics behind how safety reflectors work. "It's a lot more complicated than I had previously thought," he observes. But his group learned that "big concepts can be simplified by giving students options on how to present them…For example, Newton's laws can be presented in a comic style, explaining how the laws apply and are relevant."

Instructors lead the teachers on walkthroughs of the students' classrooms. Teachers "can analyze PBL" after observing students and get to "see the whole experience through exposure to different classes taught by different people with various instructional styles and personalities. They can compare and contrast," Hand says. Teachers assess student work and serve as judges during students' oral presentations.

"With the exoplanet graphic, [my group of teachers] didn't hit the target, but we saw how the students did it, and they got it right," reports Van Pelt. "Seeing the kids' graphic projects gave me a new perspective." He hopes to try a graphic project with his students this year. "I think they'll enjoy it! Get some art into physics class." ●

SAVE THE DATE

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Imagining Science as the Foundation for STEM
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National Science Teachers Association

PULL-OUT SECTION

SCIENCE TEACHERS' GRAB BAG

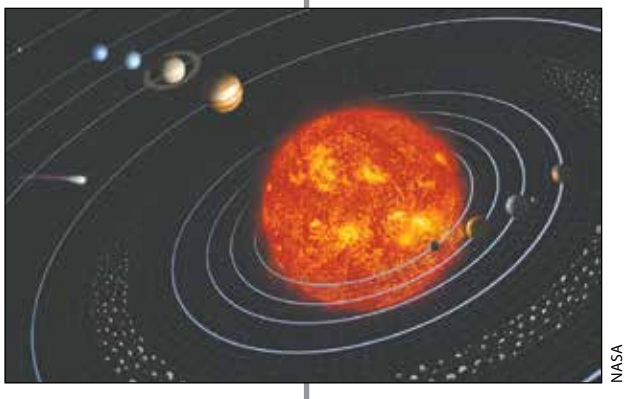
Inside this Convenient Pull-Out Section you will find:

Freebies for Science Teachers

Citizen Science Toolkit. **K12** Developed by the California Academy of Sciences, this 50-page guide for K–12 educators is designed to integrate citizen science projects into classroom curricula or after-school programming. The toolkit presents lessons, readings, and worksheets that communicate the value of citizen science and cultivate a sense of empowerment when conducting science investigations. The toolkit addresses all aspects of choosing, planning, conducting, and expanding the learning from citizen science projects and features advice for conducting citizen science projects with students of all ages, including children younger than age 13. In addition, model case studies describe successful citizen science projects at various schools. Consult *https://goo.gl/Fa2krr.*

Nitrogen From the Atmosphere. **A** This booklet from the National Atmospheric Deposition Program describes the importance of nitrogen in our landscape and its movement through natural systems. The document—appropriate for teachers of all levels and students in grades 9–12 and college—focuses on nitrogen from the atmosphere and discusses the basics of nitrogen science, the different chemical forms present, the sources of nitrogen, and the cascade of effects from nitrogen fertilizers and other uses. The booklet also includes helpful infographics and a glossary. Refer to *https://goo.gl/vef5xX.*

Virtual Reality Tour: Journey to the Birth of the Solar System. **A** *Quanta* magazine recently published a virtual reality (VR) tour of the birth and evolution of the solar system that could be useful to science teachers of all levels and their students. It can be viewed as a 360-degree video on YouTube or Vimeo, but it is even better as an immersive experience in a VR headset like Oculus Rift or Google Cardboard. Narrated by theoretical physicist David Kaplan, the video shows how the Sun, Earth, and other planets originated. Access the video along with basic viewing instructions at *https://goo.gl/mDvnef.*



NASA

Climate Change Narrative Game. **H** Make climate change personally relevant and understandable to high school students (grades 9–12) through the lessons and activities in the University of South Florida's CHANGE curriculum. The futuristic, place-based curriculum addresses global climate change and its potential long-term effects through narrative stories, role play, and simulations based on scientific data. The curriculum examines the effects of climate change on marine science environments; unit titles include Ocean Exploration; Marine Geology; Marine Chemistry; Estuaries; Populations: Producers; Populations: Invertebrates; Populations: Vertebrates; and Capstone: Apollo Beach. Learn more at *http://climatechange.usf.edu.*

ChemReaX Simulation App. **H** **HE** This chemical reaction simulation app makes it easy to create virtual labs for advanced high school chemistry students and undergraduates (grades 11–16). With thermodynamic properties for more than 1,200 chemical species, students can construct a virtually unlimited variety of chemical reactions or choose from more than 80 predefined reactions. The app simulates a given reaction from initial conditions to a final equilibrium state and accurately models the effects of concentrations, temperature, and pressure. Access information, tutorials, and a set of virtual lab exercises exploring Le Chatelier's Principle (i.e., law of equilibrium), chemical kinetics, phase change, solubility and precipitation, and other chemistry topics at *https://goo.gl/jkTHJs.*

Paleontological Research Institute's Teacher-Friendly Guide Series. **H** Looking to strengthen your knowledge of Earth systems science? Check out these educator guides from the Paleontological Research Institute. Targeted for high school Earth and environmental science teachers (grades 9–12), and designed to support teachers in introducing challenging environmental science concepts in the classroom using familiar organisms and landscapes, the guides explore climate science, geology, and two perspectives on evolution (e.g., using bivalves as a model organism and using the maize plant). Each guide discusses the big ideas related to the topic, then presents chapters explaining the topic's key aspects in more detail. Access the guides at *https://goo.gl/R2emS9.*

See Freebies, pg G2

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

Freebies, From pg G1

Science Over Everything. H Founded by Cincinnati educator and science writer Chris Anderson, this blog analyzes current events in science and makes the content relevant to students. Recent posts highlighted issues such as the future of the Environmental Protection Agency, microplastics in the ocean, and the tantalizing potential of the Hyperloop, a new proposed transit mode that aims to be as fast as a plane, cheaper than a train, and continuously available in any weather—all while emitting no carbon from the tailpipe. The blog content is most appropriate for the high school level (grades 9–12), though teachers of any level who love to learn about how science affects our daily lives will likely be intrigued by it. Use the posts as conversation starters in the classroom, or click on the Teacher Resources section to access "Explainers," short explanatory documents about challenging topics such as Natural Selection and Types of Chemical Bonds. Read the blog at *http://scienceovereverything.com*.

SBROUSSEAU

Skype a Scientist. K12 This program matches scientists with classrooms worldwide. Available for any level along the K–12 spectrum, a typical Q & A–style video chat lasts between 30 to 60 minutes and covers topics in the scientist's area of expertise and what it's like to be a scientist. The program aims for students to have positive experiences with scientists and form a personal connection with someone working in a scientific field. More than 500 scientists are ready to chat, and teachers can choose the type of scientist who best fits their classroom. To learn more about the program or to sign up, visit *www.skypeascientist.com*.

STEM Spotlight: Scientific Modeling. K12 This short video from the Education Development Center presents a conversation with leading education researchers about what scientific modeling looks like and why it's important for K–12 science classrooms. The website (*https://goo.gl/QYQ8HR*) also features curriculum and other resources, developed by National Science Foundation–funded projects, that support modeling in science education for a range of grade levels and subjects. High-Adventure Science (for middle and high school levels), for example, offers interactive, computer-based Earth system models integrated into five-day curriculum units on energy, climate, freshwater availability, land management, air quality, and the hunt for extraterrestrial life. In addition, it has stand-alone interactives exploring air pollution, groundwater movement, land management, fracking, planet hunting, and climate change.

MoDeLS, a curriculum unit for grades 5–6, provides opportunities for students to develop and revise models of how water moves (evaporation and condensation) in a solar still.

Energy, a Multidisciplinary Approach for Teachers (EMAT). H This online course for high school science teachers features high-quality classroom videos, content animations, and interactive learning experiences on various energy topics. Teachers are encouraged to take the course to deepen their personal understanding of key energy concepts, but they can also use the course resources in their own classrooms to improve their instruction and become more effective at teaching complex energy concepts and engaging students in energy issues. Six forms of energy are addressed in the course: coal, nuclear energy, wind, geothermal energy, biofuels, and solar energy. For more information, consult *www.bscs.org/emat* and *https://goo.gl/3YqniK*.

Motivate Students With Citizen Science! A Teachers and students of all ages and levels (from elementary to college and beyond) can use the SciStarter Project Finder at *https://goo.gl/BNSvG2* to locate hundreds of citizen science projects to participate in, inside the classroom or outdoors in nature. Search for projects by topic, location, activity, age group, or keyword. The Project Finder was developed to expand the reach of *The Crowd and the Cloud,* a four-part public television documentary highlighting some of the people and projects on the frontlines of citizen science. Meet surfers collecting ocean chemistry data, online gamers contributing to Alzheimer's research, volunteer mappers aiding in natural disaster efforts by building online maps, and many other inspirational contributors. Watch full episodes online, or incorporate multiple short (five- to 10-minute) clips from individual segments into your lessons.

The *Am I Like You?* Teacher's Guide. E Excite young students (grades K–3) about birding and observing nature with the activities in this educator's booklet from the Cornell Lab of Ornithology's BirdSleuth program. Take a neighborhood bird walk, move like a bird (e.g., fly, walk, swim, soar, or hop), play "Birdy Says," eat with a "beak" (e.g., toothpicks, clothespins, straws, or tweezers), or make pine cone birdfeeders for the schoolyard or backyard. In addition, the website has videos of bird behaviors and other digital content that complement the printable guide. Find the guide at *www.birdsleuth.org/likeyou*.

RUHRFISCH

WikiWatershed. M H HE This web toolkit is designed to help middle, high school, and college educators and students—as well as citizens, conservationists, municipal decision-makers, and researchers—advance their knowledge and stewardship of fresh water. Developed by the Stroud Water Research Center, the toolkit enables users to share watershed-model scenarios, watershed-monitoring data, and watershed-management stories as an open, collaborative community. Through the Model My Watershed and Model Micro Site Runoff apps, students analyze real land-use and soil data in their neighborhoods and watersheds; model stormwater runoff and water-quality impacts using professional-grade models; and compare how different conservation or development scenarios may affect runoff and water quality. Learn more and access archived training webinars for educators on the toolkit at the website *https://wikiwatershed.org*.

Disneynature Explore. P E This app for iPads and iPhones combines an Augmented Reality experience with animal behavior gameplay to encourage young students (grades preK–3) and their families to get outside and connect with nature. In the app, 3D images of animals appear in the camera's viewer, providing students with "wild adventures" in their own backyard. For example, students can see their surroundings through a butterfly's eyes, follow tracks along with a bear to find its cub, and crack a nut like a chimpanzee. Students can also photograph their adventures and create a photo journal.

The app includes a parent page with suggestions for outdoor play and a Spanish language option. Access the app at *https://goo.gl/0pBZPc*.

#ProjectPhenomena. E M H Want to learn more about phenomena-based instruction in *Next Generation Science Standards* (*NGSS*) classrooms? See *www.sciencephenomena.com*. Teachers can access an annotated database of more than 50 science phenomena, including Mercury's Transit Across the Sun; An Ocean Predator's Travel Patterns Across the Pacific Ocean; Magnet Interactions; The World's Fastest Runners: Slowed Down and Up Close; and other engaging occurrences or events. Each entry features a brief description of the phenomenon, suggestions for classroom use, key Disciplinary Core Ideas, and a targeted grade level (among grades 3–12). The website also presents the criteria required for selecting phenomena useful for *NGSS* instruction. Once teachers are familiar with the criteria, they can submit additional phenomena to the database. ●

News Bits

- **Educational technologies can help improve collaborative learning in science, technology, engineering, and math (STEM) settings—particularly when visual representations are involved—says an article in *Computers and Education*.** **HE**

Martina Rau of the Wisconsin Center for Education Research and her team conducted a quasi-experiment with 61 undergraduates in an introductory chemistry course. Some students worked collaboratively on problem-solving activities embedded in an educational technology that provided an adaptive script; the students had to work together to make sense of the connections among several visual representations and were prompted to engage in certain collaborative behaviors based on their actions in the program. The other students worked collaboratively on a traditional worksheet with the same set of problems.

The researchers found that those working with the collaborative script performed better and showed higher learning gains. The findings suggest that scripts like this can help students collaborate more effectively and better see and connect visual representations in STEM. See *http://goo.gl/k5Ykwb.*

- **A free mobile app quickly helps Utah teachers looking for STEM mentors or resources.** **K12**

The STEM Mentor Exchange, or STEM MX, app connects K–12 teachers with volunteers working in STEM fields. Teachers can use it to find guest speakers, schedule industry tours, provide work-based learning experiences for students, or get help with science fairs or other special projects. Industry professionals can create their own profiles, to make scheduling easier for them and the teachers seeking assistance.

The state predicts STEM jobs will grow by 25% over the next 10 years, compared to 20% for all other fields, according to *Utah Business*. "I invite all of our teachers to create STEM MX profiles and list their needs for the coming year. This will help industry volunteers know what's needed and where they can serve," Utah State School Superintendent Sydnee Dickson told *Utah Business*.

STEM MX will also give industry and educational employers access to their employees' data, so they can help pair teachers with employees. Read more at *http://goo.gl/RtYSQp.*

- **Students and teachers in Kansas City will soon have a new destination for STEM field trips: a repurposed jumbo jet.** **K12**

TriStar Experience, a Kansas City nonprofit organization, is converting the former Flying Hospital, a 40-year-old Lockheed L-1011 jumbo jet, to an interactive STEM education lab for students. The plane will be permanently docked at the Kansas City International Airport in Missouri.

"Imagine several busloads of kids show up, board the aircraft, and the whole STEM program can take place on board," educational program director Phil Liming told *The Kansas City Star*. "There [are] cabin compartments that are fully open to do fun science experiments and activities." Students will have the chance to interact with aerospace professionals and learn about flight and aircraft systems.

Field trips will begin this fall and will be tailored to Kansas and Missouri education standards. Liming also hopes to secure funding and offer different modules to make the trips accessible to all area schools. The hope is that the hands-on, project-based aspect of these field trips will encourage more interest in STEM fields, says Deborah Caywood, TriStar Experience's director of STEM program development. Read more at *http://goo.gl/kDjCpY.*

- **Microphones aren't just for large lecture halls anymore—at least not in Irvine, California. Six schools in one Irvine public school district have installed microphones and speakers in all classrooms.** **K12**

Teachers at Woodbury Elementary, Westpark Elementary, Portola Springs Elementary, Cypress Village Elementary, Beacon Park School, and Portola High wear microphones around their necks, and students pass one around when they speak during class discussions or activities. Newer schools like Portola Springs have speakers built into classroom ceilings. "Some of my students are quiet or shy or have a soft voice," Elicia Ehlers, a fourth-grade teacher who co-wrote the grant application for Woodbury's sound systems, told the *Orange County Register*. "It gives them confidence."

"Sound field amplification devices" like the ones installed in the Irvine Unified School District were initially designed to help students with hearing difficulties. But researchers have found they can also improve the academic performance of other students. Ehlers says the microphones and speakers also help her English language learners. One in four students at Woodbury doesn't speak English at home and hasn't reached proficiency levels in the language yet.

Judy Hawley, who has taught sixth grade at Woodbury for 30 years and was skeptical about the microphones at first, says, "You can get (students') attention a lot quicker. You don't ever have to shout." Read more at *http://goo.gl/GzdoWB.* ●

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

What's New

FROM U.S. GOVERNMENT SOURCES

National Institutes of Health (NIH)

The Chemicals Around Us Activity H

In this simple lesson targeted for grades 9–12, students access one of several TOXNET databases from NIH's National Library of Medicine (NLM) to study the chemical structures of common household products and gain awareness of environmental toxins found in many everyday products and understand their potential health effects. By answering a series of questions about each product, students learn to differentiate between organic and inorganic compounds and to identify functional groups of carbon molecules, thus deepening their knowledge of the structure and properties of various chemicals. The database also includes information about safe handling of the chemicals. Refer to *https://goo.gl/g4zWdd*.

TOXinvaders Game E M H

Save the world from toxic chemicals! Developed by the NLM, this interactive game for iPad and iPhone reinforces middle level (grades 5–9) science concepts in environment and health and can be used as an engaging homework assignment or quick review. In the fast-paced game, players are challenged to stop toxic chemicals falling from the sky and capture "good chemicals" to earn protective shield points. To unlock the next level, students must take a brief quiz to review information about chemicals. The quizzes provide an opportunity for students to refresh their knowledge about environmental health and toxicology, either from the game's embedded chemical information sheet or from NLM websites. Download the app at *https://goo.gl/PFDbAH*.

National Oceanic and Atmospheric Administration

Exploring the National Marine Sanctuaries: A Lesson in Habitats and Human Impacts M

In this lesson, students in grades 7–8 work in groups to explore the national marine sanctuaries found in the Pacific and Atlantic oceans and off the coast of American Samoa. These sanctuaries include breeding and feeding grounds of whales, sea lions, sharks, and sea turtles; significant coral reefs and kelp forest habitats; and the remains of the U.S.S. Monitor, a Civil War ironclad that sank off the coast of North Carolina. After researching the biodiversity, ecological integrity, and cultural legacy of these marine sanctuaries, students create a poster presentation describing what they've learned about the interdependence of living things on Earth. The lesson, which includes a teacher lesson plan and student handouts, can be found at *https://goo.gl/QSwhr7*.

Ocean Guardian Activity Book E

Created by the NOAA Office of National Marine Sanctuaries and the NOAA Marine Debris Program, this activity book features games, word searches, fact sheets, and coloring pages that teach K–3 students about the ocean and why we should protect it. Did you know, for example, that the Earth has one big connected ocean, yet many ocean basins, such as the Atlantic, Pacific, Indian, Arctic, and Southern? Or that an estimated 13 million pounds of litter enters the ocean each year? After completing the activities, students can sign a pledge in the book to become an Official Ocean Guardian. Download the resource at *https://goo.gl/iaKz2l*.

National Aeronautics and Space Administration (NASA)

How to Do a Science Fair Project E M H

This five-part video series from NASA's Jet Propulsion Laboratory (JPL) guides students in grades 3–12 through the process of developing a successful science fair project from start to finish. Featuring input from a JPL scientist, an engineer, and an educator, the videos help students learn to ask testable questions about the things they observe in the world around them and mold the observations into viable science inquiry investigations. The videos address topics such as how to choose a science fair project topic, how to conduct research and design an experiment, and how to examine the results and communicate the experiment. PDF transcripts of each video are also available. Visit *https://goo.gl/ka7nfd*.

Robotic Arm Challenge E M

NASA uses robotic arms to accomplish tasks that are too dangerous, difficult, or impossible for astronauts to do. In this engineering design challenge—created by NASA's JPL and adaptable for students in grades K–8—students model the experiences of NASA scientists as they design, build, and operate a robotic arm model and use it to move objects. Through the activity, students make connections between classroom learning and authentic science. Download the lesson plan, which includes teacher background and vocabulary, procedures, discussion, assessment, extensions, and links for further exploration, at *https://goo.gl/gcPPyo*.

All About Mars K12 HE

Packed with Mars-related facts, images, history, news, research updates, and opportunities, this website can be useful for K–college students and teachers, as well as for parents or other space fans. Scroll across the tabs at the top of the page to access drop-down menus with information organized by category, or click on the site's search button to find information of interest. Don't miss the Mars Facts page, which features a collection of infographics about the planet's science, mass, volume, density, structure, distance, speed, and more. See *https://goo.gl/21KEkf*.

U.S. Department of Energy (DOE)

Wind for Schools Project K12

The DOE's Wind for Schools project brings in students from higher education institutions as project consultants for small wind turbine installations at rural elementary and secondary schools. The project also provides teacher training and hands-on curricula for K–12 audiences that explore wind energy and involve students in age-appropriate, interactive research tasks using data collected from wind turbines. Resources include National Energy Education Development curriculum guides for all levels (e.g., Wind Is Energy, grades K–2; Wonders of the Wind, grades 3–5; Energy From the Wind, grades 6–8; and Exploring Wind Energy, grades 9–12) and short activities (e.g., Kite Flying, How to Make a Wind Sock, Assembling Your Pinwheel), as well as information about careers in the wind industry. Visit *https://goo.gl/WuyYeK*.

Top Ten Things You Didn't Know About…Wind Power M H

We may consider wind power a "new" environmentally friendly renewable energy source, but did you know that humans have harnessed wind power for thousands of years? Or that in 2016, wind power capacity in the United States surpassed 81 gigawatts, enough electricity to power 20 million homes annually—more than the total number of homes in Alaska, California, Delaware, Hawaii, Idaho, Maine, Montana, Nebraska, New Hampshire, North Dakota, Rhode Island, South Dakota, Vermont, and Washington, D.C., combined?

Developed as part of Energy.gov's informational online publication series Top Ten Things You Didn't Know About…, this hyperlinked document presents facts and links describing the growth, development, current status, and future potential of the wind power industry. Most appropriate for middle and high school levels (grades 5–12), the document's links include diagrams showing how a wind turbine works, as well as wind resource maps from the DOE. Other topics addressed in the series include Energy, Solar Energy, America's Power Grid, Hydropower, and Electric Vehicles. Teach students about wind power using the links at *https://goo.gl/IE7Tn4*.

Energy 101 Video Series M H

Introduce middle and high school students to the fundamental concepts behind renewable energy sources and energy efficiency using this collection of short (about 3 minutes each) videos from the DOE. Titles include Electric Vehicles, Wind Turbines, Geothermal Heat Pumps, Concentrating Solar Power, Biofuels, Algae to Fuels, Hydropower, and Lighting Choices. The videos can be incorporated into multimedia lessons on energy. Watch them at *https://goo.gl/y47Rav.*

National Science Foundation (NSF)

Thunderstorms at Night K12

Are thunderstorms at night more dangerous than thunderstorms during the day? Teach students more about these storms with these 10 facts presented by three atmospheric scientists interviewed by NSF and an accompanying video that provides insights on how night thunderstorms form. Use the information to create a new lesson plan about nighttime thunderstorms or to add to your content knowledge. Read the interview at *https://goo.gl/up731P.*

The Noyce Program K12 HE

Everything you want to know about NSF's Robert Noyce Teacher Scholarship Program can be found in this document at *https://goo.gl/BUu1uz*. The program aims to encourage talented science, technology, engineering, and mathematics (STEM) majors and professionals to become K–12 science (including engineering and computer science) and mathematics teachers. It accomplishes this goal by providing funds to institutions of higher education to support scholarships, stipends, and academic programs for undergraduate STEM majors and post-baccalaureate students holding STEM degrees, and professional development and salary supplements for K–12 STEM teachers.

The program accepts proposals representing four different tracks: Robert Noyce Teacher Scholarships and Stipends; NSF Teaching Fellowships; NSF Master Teaching Fellowships; and Noyce Research. The document describes these tracks in detail and specifies the maximum award amounts higher education institutions can receive. Also included are contact information for NSF's Division of Undergraduate Education and a link to the latest solicitation, deadlines, and project abstracts.

U.S. Environmental Protection Agency (EPA)

Acid Rain Learning Activities K12

At *https://goo.gl/YsHVKu,* educators can find suggestions for teaching K–12 students about acid deposition in new and interactive ways, both in and out of the classroom. The suggestions can be adapted to suit learners of all ages from elementary to high school. For example, elementary and middle level students can try a topical role play in which each student assumes the role of an "interested party" (e.g., a fish, bird, coal miner, factory owner, smokestack, fisher, farmer, stream, lake, tree, or forester) in a group discussion on acid rain. Students can research the effects acid rain has on their characters, then present arguments for or against laws to control acid rain. High school students can participate in small-group projects, such as producing a "weather segment" on the effects of weather patterns on the movement of acid rain over large distances, or research and report on the various power sources used in the community.

Basic Ozone Layer Science H

Written for teachers and students in grades 9–12, this EPA website presents a comprehensive, yet straightforward explanation of the ozone layer and ozone depletion. The site also includes links to key resources on the topic, such as Twenty Questions and Answers About the Ozone Layer, as well as links to additional information and resources from organizations dedicated to ozone layer research and protection. Another useful page describes the health and environmental effects of ozone depletion on humans, plants, marine ecosystems, biogeochemical cycles, and materials. Refer to *https://goo.gl/6zmN2U.*

U.S. Department of Agriculture (USDA)

The Great Garden Detective Adventure E

Excite elementary students (grades 3–4) about gardening and nutrition with this curriculum from the USDA's Team Nutrition program. The curriculum presents a series of 11 investigations and fun experiences connecting the school garden to the classroom, school cafeteria, and home, enabling students to discover for themselves which fruits and vegetables are sweetest, crunchiest, and juiciest. In addition, the curriculum features fruit and vegetable flash cards, bulletin board materials, veggie dice, and a nutrition newsletter for parents, *Garden Detective News.* Download the materials at *https://goo.gl/akvDZx;* print versions of the curriculum are available by request to schools participating in the USDA's National School Lunch Program or other Child Nutrition program.

USA.gov

Career Spotlight: Veterinarian E M

In this short video from USA.gov's Career Spotlight series, elementary and middle school students will meet Megan, a veterinarian who helps working dogs, such as those that help detect illegal narcotics. She discusses why a dog's teeth need to stay healthy. After viewing the video at *https://goo.gl/TNgxYA,* teachers can access a quick quiz and veterinarian job information from the Bureau of Labor Statistics.●

In Your Pocket

Editor's Note

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

September 22–30

FirstEnergy STEM Classroom Grants P K12

These grants support classroom projects and professional development initiatives focused on science, technology, engineering, and math (STEM). Those that enrich student learning and include the study of electricity are of special interest. PreK–12 educators and youth group leaders in FirstEnergy service areas (in Maryland, New Jersey, New York, Ohio, Pennsylvania, and West Virginia) can apply for grants of up to $1,000. Apply by **September 22;** application materials are available at *http://goo.gl/MVsFLa*.

Harley-Davidson Foundation Grants P K12

The foundation provides these grants to support communities where the company's corporate facilities are located: in Yucca and Mohave County, Arizona; Chicago, Illinois; Kansas City, Missouri; Valley View, Ohio; York, Pennsylvania; Plano, Texas; and Milwaukee, Wauwatosa, Menomonee Falls, and Tomahawk, Wisconsin. Grants are awarded to charitable organizations in three areas—education, health, and the environment—and should help underserved populations or improve the lives of community stakeholders.

Applicants must complete an eligibility quiz before they begin the online grant proposal. Apply by **September 22** at *http://goo.gl/cwsFrF*.

Captain Planet Foundation ecoSolution Grants K12

These grants go to solution-oriented, youth-led projects that result in real environmental change. Grants of between $500 and $2,500 are available for educators or nonprofits with an operating budget of less than $3 million. Preference is given to those who have secured matching or in-kind finding to support the project. Apply by **September 30** at *https://goo.gl/efxcnp*.

Green Thumb Challenge Grant K12

The Green Education Foundation and Gardener's Supply Company present this $250 grant to an exceptional youth garden program that has demonstrated success and impacted the lives of K–12 students and their surrounding communities. A video chronicling the success of your garden, a digital portfolio, or scanned artwork with descriptions is required to apply. The deadline is **September 30;** see *http://goo.gl/Zetghz*.

P. Buckley Moss Foundation Teacher Art Grants P K12

The foundation awards these grants to teachers who employ art as a learning tool for all preK–12 students, including those who learn differently. Grants of up to $1,000 can be used for new or evolving programs that integrate art into the curriculum. Apply by **September 30** for funds to be used during the 2018–2019 school year; learn more at *https://goo.gl/u5ooPU*.

Project Learning Tree GreenWorks! Grants K12

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

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

The Meemic Foundation's Grants K12 HE

These $500 grants go to teachers in Illinois, Michigan, and Wisconsin for classroom projects, field trips, school assemblies, and professional development. Teachers in most subject areas, including science and STEM, are eligible. Projects should have a lasting impact on students. Applicants must be Foundation Club members; registration is free for educational employees of all schools, colleges, and universities.

Register and apply by **September 30** at *http://goo.gl/UI8713*.

October 1

Westinghouse Charitable Giving K12

Westinghouse gives grants of up to $5,000 to nonprofit programs that support STEM education, environmental sustainability, or community safety and vitality. STEM programs should enhance the subject matter and encourage career interest in the field among youth. Environmental programs should help preserve or restore land, water, air, or biodiversity.

Grantees must be within 50 miles of Westinghouse sites in Alabama, Arizona, California, Connecticut, Florida, Georgia, Illinois, Kansas, Maryland, Michigan, Minnesota, Missouri, New Hampshire, New Jersey, New York, North Carolina, Pennsylvania, South Carolina, Tennessee, Texas, Utah, Virginia, Washington, Wisconsin, or Washington, D.C.

Submit proposals by **October 1.** Consult *http://goo.gl/nQxr3l* for more information, and see the list of Westinghouse locations at *http://goo.gl/J6UJE4*.

Association of American Educators Classroom Grants K12

These grants of up to $500 fund a variety of classroom projects and materials, including books, software, calculators, audiovisual equipment, and lab supplies. Full-time educators who have not received a scholarship or grant from the Association of American Educators (AAE) in the last two years are eligible, though AAE members receive additional consideration. Teachers in Arkansas, Colorado, Idaho, Kansas, Oregon, and Washington compete for state-specific funds and complete a separate application. Apply by **October 1** at *http://goo.gl/eWCd5N*.

Clif Bar Family Foundation Small Grants K12 HE

The foundation provides grants of $7,000 to small and mid-sized groups working to strengthen our food system and communities, enhance public health, and safeguard our environment and natural resources. Those that protect Earth's bounty and beauty, reduce environmental health hazards, increase opportunities for outdoor activity, create a robust food system, or build stronger communities are encouraged to apply. Priority is given to those that demonstrate strong community ties and operate at the community level.

Applicants must take a short eligibility quiz before applying. Apply by **October 1** at *http://goo.gl/guiG7V*.

Samull Classroom Herb Garden Grants E M

The Herb Society of America offers these grants to public and private school teachers of grades 3–6 with classes of at least 15 students. Ten schools will receive $200 "seed money" grants to establish indoor or outdoor herb gardens. Funds may be used for soil, plant trays, containers, or tools. Apply by **October 1** at *http://goo.gl/pfTD3P*.

Frances R. Dewing Foundation Grants P E M

These grants fund projects or programs focused on early childhood education. Of particular interest are those at new, untried, or unusual educational organizations that aim to introduce

new methods for young children, ages 2 to 12. Grants range from $1,000 to $20,000, though the average is $5,000.

Programs must be located in the United States and have tax-exempt status. Submit proposals by **October 1;** see *http://goo.gl/iDxXtc.*

Toshiba America Foundation Science and Math Improvement Grants E

These grants of up to $1,000 go to science and math teachers of grades K–5 with innovative classroom project ideas. Successful projects often tap into students' natural curiosity, enable them to ask their own scientific questions, and incorporate the expertise of community partners. Apply by **October 1** at *www.toshiba.com/taf.*

Pilcrow Foundation Children's Book Project Program Grants P K12

The foundation provides a 2-to-1 match for rural public libraries that receive a grant through its Children's Book Project and contributes $200–$400 through local sponsors for the purchase of up to $1,200 worth of new, quality, hardcover children's books. The foundation provides a list of 500 such books libraries can choose from.

To qualify, libraries must be located in rural areas, have a limited operating budget and an active children's department, and raise $200–$400 through a local sponsor. Those with operating budgets of less than $50,000 receive priority, though town libraries with budgets of more than $150,000 and county libraries with budgets of more than $450,000 may also apply. Applications must be postmarked by **October 1.** Visit *http://goo.gl/DpEh2U.*

Target Field Trip Grants K12

Target provides these grants to K–12 schools within 100 miles of a Target store. Field trips should connect students' classroom curricula to out-of-school experiences and take place between January and the end of the school year. Grants of up to $700 are available.

Apply by **October 1.** Visit *http://goo.gl/jsaFYv.*

Apply Year-Round

High Mowing Organic Seeds Donation Program A

This program provides free seed packages to school gardens, summer camps, seed libraries, community gardens, disaster relief groups, and other farm or nutrition education programs. Groups receive pre-bundled sets of 25 seed packets, which include a variety of flower, herb, and vegetable seeds. Contact *donations@highmowingseeds.com* or 866-735-4454 year-round for more information and to receive a bundle.

VWR Foundation Grants K12 HE

VWR Foundation provides grants to schools supporting grades K–12 for STEM programs that go beyond the textbook (not funded through government or tuition dollars), grant programs to provide training for science teachers, or scholarships for students attending science-related camps. Dollars can be applied to support the purchase of supplies and equipment or for scholarships to cover the cost of the programs for students. At the college/university level, dollars can be applied to programs, including scholarships, equipment, and products, that are science-related. In addition, science-related institutions (e.g. science museums) can apply for grants that help further science education.

Successful completion of the Eligibility Quiz is the first step in the application process. Applications will be reviewed on a quarterly basis. Learn more at *https://goo.gl/qKCMnD.*

Fruit Tree 101 Program P K12

The program brings fruit-tree orchards to schoolyards so students can improve the quality of the air and water while creating a source of tasty snacks for decades to come. Recipients must be nonprofits, public schools, or government entities that own the planting site (or have long-term arrangements to remain at the planting site), are committed to caring for the trees in perpetuity, have a source of irrigation nearby, and can help coordinate local volunteers to participate on the day of planting.

Applications will be accepted on a rolling basis. Consult the website *www.ftpf.org/apply.htm.* ●

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.

Save the Rainforest Take Flight Fellowships H

High school teachers who want to learn more about rainforest ecology and conservation efforts in the tropics can apply for Take Flight fellowships for Save the Rainforest's summer trips to Belize, the Galapagos/Ecuador, and Panama. Fellows' food, travel, and lodging expenses will be covered, and teachers can earn up to three graduate credits from Edgewood College.

Apply by **October 1.** For more information, visit *www.saverfn.org.*

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. After they return home, they 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, 2018;** for more details, see *www.EarthExpeditions.org.*

Announcing Summer PD A

Are you holding a summer professional development (PD) program? Want to announce it in the Summer Programs section of *www.nsta.org/calendar,* our online calendar, and possibly in this column? E-mail the following information to *nstareports@nsta.org:*

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

All summer PD announcements will be posted on the online calendar. To appear in *NSTA Reports,* a program must meet one of these conditions:

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

If your program qualifies for publication in *Reports,* we must receive the information at least two months before the issue in which you want the announcement to appear (remaining issues are October 2017, November 2017, and January 2018 through May 2018). Announcements in the Summer Programs column will be published one time only on a space-available basis and will be edited for style and length.

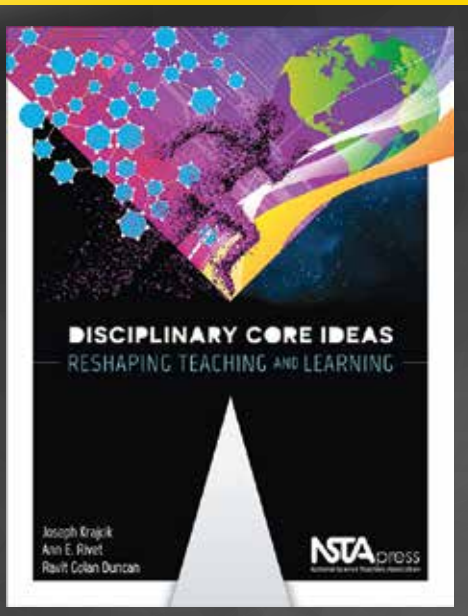
Get even more visibility for your program by advertising it in NSTA publications. Learn more by visiting *www.nsta.org/exhibitsadv.* ●

New School Year

I can trust that resources from NSTA are aligned to the *NGSS* and will offer practical / workable ideas for teachers.

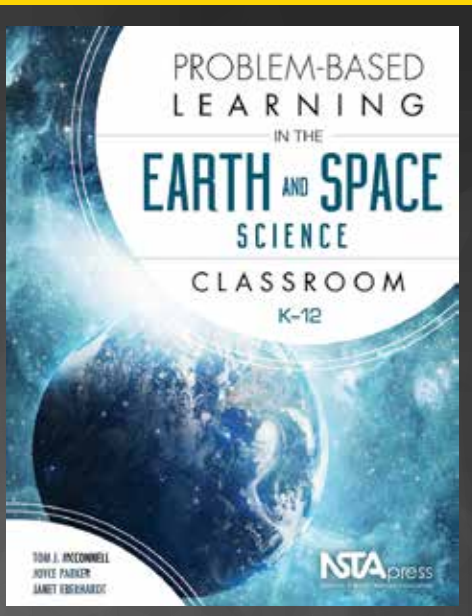
– NSTA Press Reader Lesley S.

New Books



Grades K–12

Book: Member Price: $31.96 | Nonmember Price: $39.95
E-book: Member Price: $23.97 | Nonmember Price: $29.96
Book/E-book Set: Member Price: $38.35 | Nonmember Price: $47.94



Grades K–12

Book: Member Price: $31.96 | Nonmember Price: $39.95
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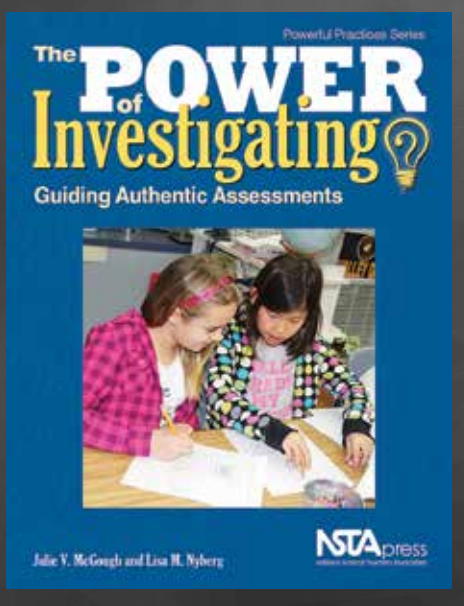

Grades K–5

Book: Member Price: $18.36 | Nonmember Price: $22.95
E-book: Member Price: $13.77 | Nonmember Price: $17.21
Book/E-book Set: Member Price: $22.03 | Nonmember Price: $27.54

Grades 5–8

Book: Member Price: $31.96 | Nonmember Price: $39.95
E-book: Member Price: $23.97 | Nonmember Price: $29.96
Book/E-book Set: Member Price: $38.35 | Nonmember Price: $47.94

To place an order or download a free chapter, visit

www.nsta.org/store

National Science Teachers Association

Engaging *All* Students in Science

By David Crowther, NSTA President 2017–18

NSTA's mission is to "promote excellence and innovation in science teaching and learning for all." This mission has additional meaning for me as a teacher, teacher educator, and researcher. Almost 21 years ago, I took students from my first science methods class to a local school in which 100% of the students were eligible for free or reduced-price lunch, 92% were English Language Learners (ELLs), and most were from a very low socioeconomic background.

My students taught their science lessons, and at the end of the day, we met to debrief and share our experiences. One of my students asked, "What do you do when no one in your class speaks English?" I stuttered a bit, then replied, "I am not sure, but I think that if we use the inquiry methods that we have learned in class, this would be a great starting place." I added that I would examine the research and ask what my colleagues who teach the ELL methods course would advise.

This inquiry has led to many years of research on making science excellent, innovative, and accessible to all students, especially ELLs. Thus, it only makes sense that my presidential theme is "Engaging All Students in Science."

To explain further, as *A Framework for K–12 Science Education* (National Research Council 2012) states, "Arguably, the most pressing challenge facing U.S. education is to provide all students with a fair opportunity to learn. Many schools lack the material resources and instructional supports needed to provide exemplary science instruction to all students on a regular basis." The *Framework* further explains that "[p]romoting scientific literacy among all of the nation's people is a democratic ideal worthy of focused attention, significant resources, and continuing effort." However, "[s]cience and engineering are growing in their societal importance, yet access to a high-quality education in science and engineering remains determined in large part by an individual's socioeconomic class, racial or ethnic group, gender, language background, disability designation, or national origin."

To provide an opportunity for all students to succeed equally in science at all levels of education, we as science teachers need to know not only the science we teach, but also the research-based strategies that allow for equitable science instruction. Once again, this leads us to the *Framework* (2012) and the resulting *Next Generation Science Standards (NGSS)* (Lead States 2013).

The *Framework* advocates for a three-dimensional approach to teaching science. You know these as the Disciplinary Core Ideas (DCI), Science and Engineering Practices (SEP), and the Crosscutting Concepts (CCC). When we teach content through the practices of science and engineering,

and then make sense by attaching the ideas to real-world applications via the crosscutting concepts, we take the first step in making science more accessible to all students; this provides a context for learning the topic at hand. We rely less on traditional methods of teaching and encourage more interaction with phenomena that enable children to understand the world around them.

When children actively try to answer scientific questions by gathering evidence, a natural connection to language forms. Children use their innate motivation to increase receptive language skills (reading and listening), as well as their productive language skills (writing and speaking) to answer questions and make evidence-based claims. Academic language grows through the natural process of experiential learning, rather than by rote memorization. Children increase their conversational skills and confidence as they work in group settings and ultimately acquire language concurrently with science content. Children have a context and an experience in which to label the content, and this works for all students.

Science is more important now than it ever has been in school settings. A basic understanding of how the world works and by what means we understand these processes will lead to new discoveries (such as improved access to clean drinking water and increased food production) that will make life easier for people around the world, new discoveries that will slow climate change and reduce the impact on the environment, a better understanding of how our planet works, and the development of new and more efficient technology. As you ponder the brighter future that science can make possible, consider this: Does your teaching involve equitable science instruction for all students? Will one of these new discoveries come from one of the many diverse students in your classroom or from a student taught by a teacher whom you prepared to teach science? ●

Quotable

The best way to get a good idea is to get a lot of ideas.

—Linus Pauling, U.S. chemist, biochemist, and educator (1901–1994)

"This online master's in biology program was perfect for me. It opened up opportunities and also moved me on the pay scale."

Curtis Reese, Graduate

Online Biology, MS ▸ University of Nebraska at Kearney

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Application deadline for spring semester is October 15.

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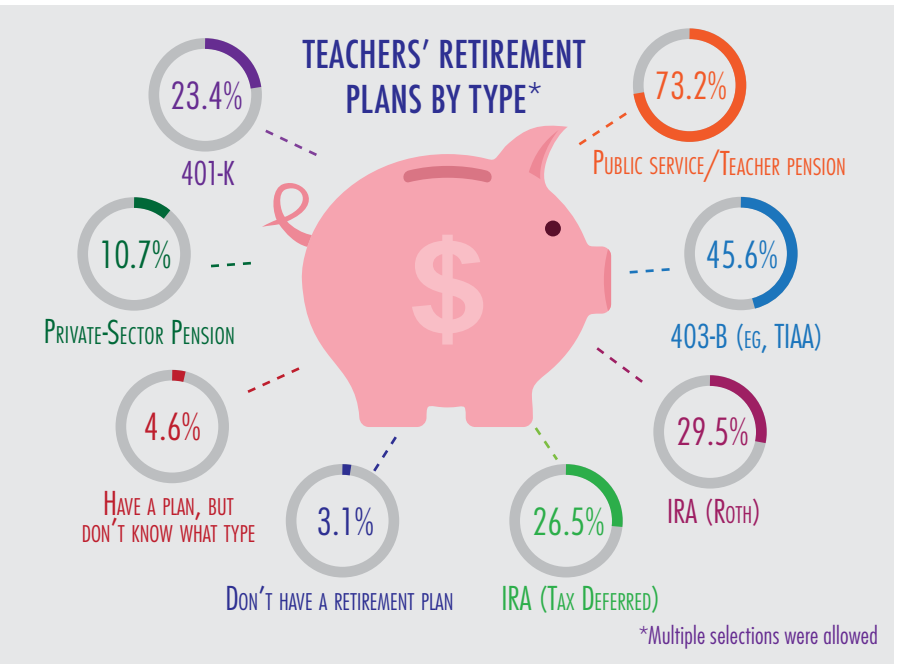
Science Educators' Top Financial Challenge? Retirement



In a recent informal survey, almost 44% of NSTA members rated retirement as teachers' most important financial planning challenge, with health care costs the second most important, followed by lack of time, small paychecks, and lack of personal expertise.

When asked about the type of retirement plans they have, 73% reported having a public service or teacher pension, 45% have 403(b) accounts, 29% own Roth individual retirement accounts (IRAs), and 26% have tax-deferred IRAs. Four percent reported having a retirement plan but didn't know which type, and 3% said they don't have a retirement plan. (Respondents were able to select all the options that applied.)

When asked to rate their confidence levels in their own retirement planning, only 13% said they felt secure about their own retirement planning, while 10% were "freaking out." (*NSTA Reports* is debuting a new periodic column, Money 101, on page 6 of this issue to help science teachers increase their financial savvy.)

NSTA asked members what other challenges teachers face regarding financial planning and money management. Common themes at every career stage include planning summer finances, paying for classroom supplies out of pocket, earning low salaries, repaying student loan debt, lacking financial knowledge, and not knowing how to find a trustworthy adviser. Other concerns were common at various career stages.

New Teachers (1–5 years) are concerned about

Job insecurities.
Second-career teachers take a serious pay cut to become teachers.
Ability and know-how to adjust with changes in career, status, and economy.
Effective lack of raises. (Often our pay declines relative to increases in cost of living.)
Investments—we make so little; how do we make the most of it?
Knowing how to choose the best options when offered many.
The amount of time and personal expense is not represented in my paycheck. I love my job, but it is hard to pay my bills.
When age is used to calculate pension like in the [California State Teachers' Retirement System] program, it puts young teachers at a disadvantage.
Short teaching careers.

Early Career (6–15 years)

The inability to transfer to other school districts without losing ground on [the] step scale.
Disrupted career path when raising children. I need to know the best way to maximize saving in the last 5–10 years of teaching.
We have [Public Employees Retirement System], so I should have a retirement [plan], but it keeps coming up as a state budget issue, and I have no idea if I can depend on it to be there.
No direct control over retirement funds.
Understanding how Medicare will fit in.
Teaching as a second career. Can't get in enough years to collect decent retirement.
Paying for continuing education and certification out of pocket.
How to budget creatively and find affordable housing in urban areas.
Losing spousal Social Security.
Lack of raises with inflation.
Very little income, exorbitant health care costs, and out-of-pocket education expenses.
No time to meet with financial planners during the school day.
Getting grants for conferences and travel.
Maxing out retirement fund options.

Mid-Career (16–25 years)

State-based retirement funds used by legislators as "extra money," so [the money] won't be there when we retire.
Aging parents.
Reliability of pension; fewer options for saving; once invested in a pension for 10–15 years, it's hard to change careers to the private sector without a great loss.
Uncertainty of cost-of-living increases in paychecks.
Too much information, none of it in lay[person]'s terms.
Paying off student loans while preparing to pay for my own kids' education.
Worrying that our teacher pensions will be stripped away.
Lack of control of outrageous union dues.
Contracts that have nine-month limits, insecure options for the future, changing health care options, limited potential for increased earnings.
Not having control over how our [Teacher's Retirement System] funds are invested.
Knowing optimal time to retire, to maximize retirement benefits and social security.
Social security and teacher pensions: How does one affect the other?

Late Career (26 or more years)

Limited options.
Where to put money in a [health savings account].
What to do after retire[ment] to earn a little money.
Continuing education costs.
Lack of assurance of the future. Will the state raid our retirement fund again?
Not knowing what to expect in the upcoming years.
Teachers in states with a state retirement system not receiving social security even if they paid into the system and would otherwise be entitled.
It is so confusing. Not recognizing value of benefits. Portability.
Debt reduction.
Health care after retirement.

Retired

Making the [money] stretch.
Determining just how much money one needs in retirement.
How to remove myself from adult children's financial problems.
Finding the money to save and invest.
Poorly written financial documents that make topics more complicated than they need [to] be.
State changing pension regulations after retirement initiated.
Penalty of job change.
Some districts (the one I retired from) provide only a single option for retirement plans and no assistance on setting up an IRA.
Changing public pension systems. After a [number] of years, we are locked in and counting on it, and it is suddenly changed. ●

BLICK ON FLICKS

Wonder Woman Applies Energy and Pressure to Save the World

by Jacob Clark Blickenstaff, PhD

One of 2017's popular summer blockbusters was *Wonder Woman*, starring Gal Gadot as Diana/Wonder Woman and Chris Pine as U.S. pilot and spy Steve Trevor. Gadot's Diana made a brief appearance in *Batman vs. Superman: Dawn of Justice* in 2016, but this movie tells her origin story. This film is unusual not only because the main character is a female superhero, but also in that the director is Patty Jenkins, the first female director of a major superhero film.

Diana is an Amazon, a group of female warriors living on a Mediterranean island magically hidden from normal humans. That isolation breaks in 1918 when Trevor crashes his airplane just offshore, and Diana saves him. The pursuing German soldiers attack the island, and though the Amazons repel them, Diana's Aunt Antiope is killed. From Trevor, the Amazons learn a World War is raging.

Trevor knows of secret German research to make an even deadlier chemical weapon than the poison gasses already used by both sides in the war. He enlists Diana's help to prevent the use of the gas, and she leaves with him to track down Ares and end the war.

Physics teachers can use scenes to discuss energy conversions and pressure, and chemistry teachers could use this film to initiate a conversation about the human consequences of scientific research.

Bow Energy

In the battle between Amazon and German soldiers early in the film, Antiope shoots three arrows simultaneously and kills three Germans at once. Physics students can consider how the energy of each arrow would compare to the energy of a single arrow fired from the same bow.

Energy is stored in a bow when the string is pulled back and the limbs of the bow are bent, much as energy is stored in a spring when it is compressed or stretched. Energy transfers to the arrow when the string is released, and it pushes on the arrow, converting the bow's stored energy into the arrow's kinetic energy. The process is not perfectly efficient, however, and serious archers work to "tune" their bow/arrow system so that the mass and flexibility of their arrows match the push that the bow provides.

Since the energy Antiope puts into the system by drawing the bow is the same no matter how many arrows she has on the string, the three arrows share that potential energy. Each receives one-third and leaves the bow with one-third as much kinetic energy as a single arrow would have had. That does not mean that the arrows are one-third as deadly, though. Momentum is at least as important as kinetic energy when considering the impact of an arrow, and momentum is not reduced as much as energy in this situation.

Boots and Pressure

In another scene, Diana lifts a tank into the air during a battle in Belgium. I wondered if the *ground* would be able to support Diana as she lifted the tank. The issue is the pressure, or force per unit area under her boots. Similar tanks weighed about 30 tons or 27,000 kg, which means it would take 270,000 Newtons to hold it up. To avoid getting stuck, tanks have wide, long tracks that spread that load over a large area. When Diana holds the tank in the air, that force is concentrated where her wedge-heeled boots touch the ground. I've estimated the combined area of the sole of both boots to be about 270 square centimeters, and the pressure is enormous:

$$P = \frac{F}{A} = \frac{270{,}000\ N}{0.027\ m^2}$$

$$P = 10{,}000{,}000\ Pascals$$

That is about 100 times atmospheric pressure, or about 1,500 psi. (I am really rounding my numbers since I'm making estimates in several places.) I'd expect her to sink into the ground, even though she can hold up the weight. If you'd like more footwear physics, check out my review of *The Devil Wears Prada* (*https://goo.gl/JVBR7V*).

Chemical Warfare

Wonder Woman and Trevor do all they can to prevent a new gas weapon from being used. Chemistry teachers could connect this to a documentary film I reviewed several years ago: *Haber* (2008). Fritz Haber was the German chemist who discovered how to use chlorine gas as a weapon, and his lab developed some of the more deadly gasses used during WWI and precursors to the gas used in the Holocaust. Read my review (*https://goo.gl/oGRNA1*) for ideas for discussing the relationship between science and warfare.

Wonder Woman will be familiar to students when they return to class this fall, and the film gives physics and chemistry teachers some clever ways to address energy, pressure, and the ethics of science research. ●

Jacob Clark Blickenstaff is Director of K–12 Engagement at the Pacific Science Center in Seattle. Read more Blick at http://goo.gl/6CeBzq, *or e-mail him at* jclarkblickenstaff@pacsci.org.

Quotable

There is no failure except in no longer trying.

—Elbert Hubbard, U.S. writer, publisher, and artist (1856–1915)

MS. MENTOR, **Advice Column**

Moving Forward Professionally

I have assumed an administrative position in my high school. Although I'm sad to leave the classroom, I'm looking forward to this challenge. I have the credentials, but not much experience, so I need insights on making the transition.

—C., New York

Congratulations on your new professional adventure! If you have not formally been assigned a mentor, find an informal one in your school district or through social media. Networking is an important part of being a leader, and social media provides many ways to work with and learn from others.

The best leaders I've worked with spent a lot of time communicating with both students and teachers: listening attentively (even if you've heard the same comment or complaint before), explaining the rationale for decisions, celebrating the achievements of students and teachers, and being approachable in the hallways and classrooms. They also had a sense of humor and the ability to differentiate between the trivial and the important.

It's easy to become overwhelmed with events and commitments before, during, and after school. One of my administrative mentors would come to school early to check the calendar and plan out his day of classroom visits, meetings, and other duties (in pencil, since unanticipated events would occur). Keep a log or journal of what you do, and reflect often on what you're learning.

You can be a resource for the science faculty. You have experienced a teacher's responsibility for safety in the labs and security in the storage areas. You know how much behind-the-scenes work science teachers do and are aware of the hazards (and possible liabilities) of scheduling non-science classes or study halls in lab classrooms.

It's eye-opening to go beyond your own classroom to viewing the school as a larger system. Ask questions and be willing to observe, listen, and learn.

Do you have any ideas for faculty meetings for a new science department chairperson? I'm sure I can handle most of the responsibilities, but I'm terrified of leading meetings.

—S., Indiana

Facilitating a meeting is not unlike teaching a class, so apply your classroom management strategies to "meeting management."

- Send out an agenda before the meeting. Attach information items so the meeting time can be spent on more productive and interesting topics.
- Be respectful of time. Give people a few minutes to tidy up their classrooms, but start and end the meeting at the designated times.
- Stick to the agenda, but be flexible enough to accommodate any great discussions.
- Set aside a few minutes to recognize new issues or other concerns. Celebrate any teacher successes or accomplishments, too.
- Snacks/treats might be appreciated at the end of a long day.
- Send meeting minutes to all members of the department, and keep the principal in the loop.

You could also use a "flipped classroom" strategy. For your meeting topic, send out readings or links to video segments to watch prior to the meeting. (The NSTA journals and web resources would be good sources.) Your meeting can focus on active discussion, decision-making, or teacher reflection related to these topics. Teachers can use the meeting time to work collaboratively on tasks that they would otherwise have to do on their own.

As a new chairperson, you may run into resistance from teachers who are used to the old ways. Participating in discussions or group activities may take some getting used to. If meetings previously were seen as a waste of time, you may have to be persistent to demonstrate that things are going to be better. And they will!

THINKSTOCK

I coach teachers at an elementary school. One teacher is trying to improve his science instruction (one of the school goals), but he's struggling with classroom management and organization during class activities. I've shared some ideas, but I'm looking for more.

—S., Pennsylvania

Many teachers did not experience hands-on science as students and may be unsure how to create planned and purposeful opportunities for their own students. If science is the only time in which students are expected to work in groups, with hands-on materials, or with less structure, they may think of science as free time or not as important as teacher-directed lessons.

In addition to observing the teacher, notice what the students are (or are not) doing and how the classroom is arranged. Ask the teacher questions like these: What went well—and why? What were the greatest challenges? What do you think about…? Did you notice today when…? What would happen if…? What works well for you in other subjects?

His responses and your observations could lead to an action plan that could include the following strategies (and these were among those suggested to me by a mentor when I was struggling!):

- Begin the activity or investigation by stating the purpose, outcomes (e.g., report, graph, drawing, summary, notebook entry), and connections with the learning goals or expectations of the unit.
- Establish routines so students know what kinds of behaviors are expected and acceptable.
- Prepare and label materials in advance, and have designated places for them to be accessed and returned.
- Assign and explain group roles before starting the activity.
- Stop an activity when students engage in unsafe behaviors.

Above all, encourage the teacher to give himself time to persevere and to reflect on each activity as part of a continuous effort to improve. ●

Check out more of Ms. Mentor's advice on diverse topics or ask a question at www.nsta.org/msmentor.

DISTRICT PROFESSIONAL LEARNING PACKAGES

The National Science Teachers Association (NSTA) meets your teacher professional learning needs around critical science topics, including three-dimensional standards, science and literacy, and argumentation in the classroom.

Long known for high-quality books, NSTA's authors and trusted experts are now delivering these classroom-tested approaches to schools or districts.

Blending on-site and online strategies tailored to your needs, NSTA stimulates sustained change in classroom practice.

Here are a few examples of the professional learning packages NSTA can customize for your district.

NEXT GENERATION SCIENCE STANDARDS (NGSS)

"In my own continued understanding of my work, and to inform the work we are currently doing to implement the NGSS, this workshop has helped me provide a rationale for moving the change forward. It definitely helped my understanding of three-dimensional learning. I appreciated how we continuously went back to all three aspects to gain a further understanding of the entire process."

— Past NGSS Workshop Participant

PICTURE-PERFECT SCIENCE LESSONS

"The *Picture-Perfect Science Lessons* series became a foundation for the district-wide K-5 STEM curriculum building project. This initiative gave an opportunity for students in 54 schools to integrate science, engineering, and literacy in a rigorous and meaningful way. These lessons are an example of Science-Literature integration 'done right'."

— Katya Denisova, PhD, Project Director, SABES at Baltimore City Public Schools, Baltimore, MD

ARGUMENT-DRIVEN INQUIRY

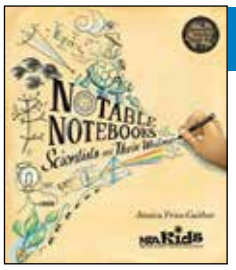
"I have been to many workshops where presenters either danced around a question or failed to answer the question as it was intended completely. What I found most useful was that Victor Sampson addressed every question thoroughly. Just knowing that there are answers to my questions made me feel more confident about implementing the *Argument-Driven Inquiry* strategy in my classroom."

— Past Argument-Driven Inquiry Workshop Participant

NSTA National Science Teachers Association

For more information, contact Kim Stilwell at *kstilwell@nsta.org*.

www.nsta.org/district



NSTA PRESS: *Notable Notebooks*

Notable Notebooks

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 Notable Notebooks, *by Jessica Fries-Gaither, edited for publication here. To download the full text of this chapter, go to* https://goo.gl/xsnSNk. *NSTA Press publications are available online through the NSTA Science Store at* www.nsta.org/store.

Of all a scientist's tools, objects rare and common, the lowly science notebook is most easily forgotten.

Scientists write in notebooks about every plant and crater; notebooks help them understand what they observe in nature.

What makes a notebook special? It's a place to think and dream, to write down thoughts and questions about all that you have seen.

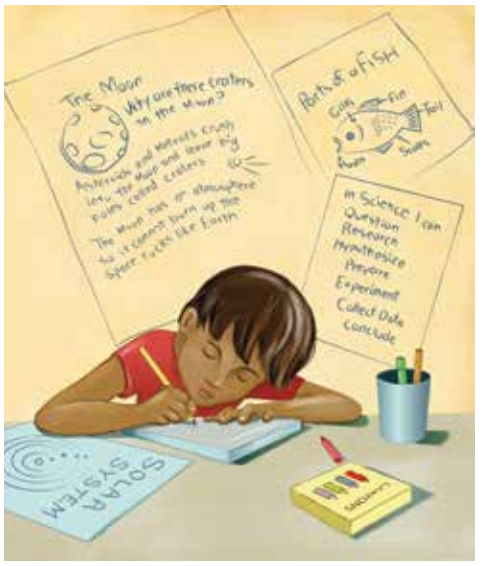
If you find a science notebook, open it and have a look. You will surely be amazed by what's inside this book.

Reading such a notebook is a great way to explore. We can learn so many things from those who came before.

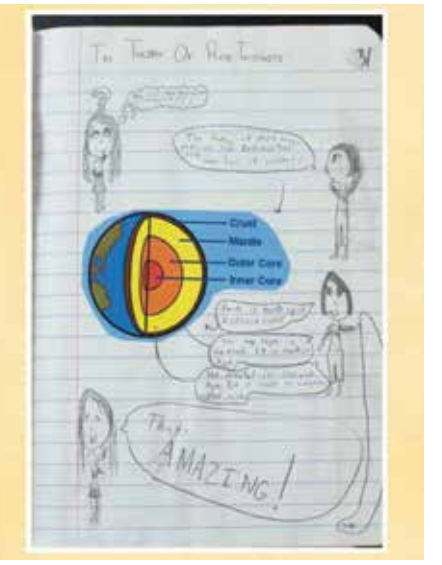
Don't believe me? Then let's go! Let's travel through time and see exactly how important one notebook just might be.

***

You can start your own science notebook! Here's how:



1. Choose a notebook. It doesn't have to be fancy or expensive; even some paper stapled together will do! Your notebook can have lined or unlined paper or even graph paper. Whatever you like best will be fine.
2. Decide what you'd like to study. Maybe you'd like to watch birds or sketch pictures of flowers. Maybe you'd like to try experiments with liquids or look at pond water through a microscope. Whatever you do, your notebook is a great place to record what you are studying.
3. Write about your findings and wonderings. Observing and drawing pictures often aren't enough to understand what you see. Writing about what you find can help you understand it better.
4. Share your work. Just like the work of the scientists in this book, your work is important! Share it with your family, friends, or teachers at school. ●



NSTA, NCTM Name 2017 STEM Teacher Ambassadors

In July, NSTA and the National Council of Teachers of Mathematics (NCTM) selected 10 math and science teachers to serve as the 2017 STEM (science, technology, engineering, and mathematics) Ambassadors. The STEM Ambassadors, all previous winners of the Presidential Award for Excellence in Math and Science Teaching, will advocate for STEM education in their home communities and states.

"I think [the STEM Ambassador program] allows us to create a synergy with other stakeholders—teacher leaders, coordinators, administrators, legislators, business community—around our [individual state] science standards," explains STEM Ambassador Kenneth Huff, a middle school science teacher. Huff also serves on the New York State Education Department's science education steering committee. "I offer guidance on implementation of our K–12 science standards. Being able to collaborate with my fellow members of the steering committee and department personnel allows me to bring my perspectives as a classroom teacher into those discussions."

Huff notes the STEM Ambassadors will use their training from NSTA and NCTM to help raise awareness around STEM education. "One of my jobs is also to be able to explain innovations of new standards to the public—school boards, [parent teacher associations, and] interviews in the media. It's very important that the public know what we're doing in science education: that it is research-based and what's best for the children. Talking with [parents] about how science education is going to be different based upon the new vision will enable them to better understand the innovations. Parents are a critical piece in advocacy development."

The 2017 STEM Ambassadors are Christine Herald, STEM project coordinator for Manhattan-Ogden Unified School District in Manhattan, Kansas; DeLene Hoffner, an elementary science teacher at the School in the Woods Academy, District 20, in Colorado Springs, Colorado; Kenneth L. Huff, a middle school science teacher at Williamsville Central School District in Williamsville, New York; Anne Moore, a secondary gifted resource teacher and dual enrollment coordinator for Goochland County Public Schools in Goochland, Virginia; Margo Murphy, a science teacher at Camden Hills Regional High School in Rockport, Maine; Julie Neidhardt, a lead science teacher, preK through second grade, at Hutchens Elementary School in Mobile, Alabama; Julie Olson, a science teacher at Mitchell High School and Mitchell Second Chance High School in Mitchell, South Dakota; Jeff Remington, a science teacher at Palmyra Area Middle School in Palmyra, Pennsylvania; Elaine Vaughan, a math teacher at Oak Ridge High School in Oak Ridge, Tennessee; and Bruce Wellman, a chemistry, engineering, and robotics teacher at the Engineering Academy, Olathe Northwest High School in Olathe, Kansas.

NSTA and NCTM provided communications, media, and policy training to help the ambassadors become stronger advocates for STEM education. They will receive additional support through the NSTA Learning Center. ●

The NSTA Learning Center

High quality interactive content for K–12 science teachers

Earn graduate credits and advanced degrees

Affordable and user-friendly

Moderated by world-renowned faculty

Gain knowledge exclusive to your area of instruction

American Museum of Natural History

Seminars on science, six-week online graduate courses in the life, Earth, and physical sciences, incorporate the museum's resources plus interaction with scientists and educators. CEUs and graduate credits.

California University of Pennsylvania

Designed for elementary and middle level teachers, Cal U's online masters degree focuses on teaching inquiry across the STEM disciplines. Each course in the 30-credit program also develops your teacher leadership skills so you can take your career to the next level.

Montana State University – Bozeman

Online graduate credit courses for K–12 science teachers through National Teachers Enhancement Network, as well as online offerings for Masters of Science in Science Education.

NSTA Virtual Conferences

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

http://learningcenter.nsta.org/onlinecourses

National Science Teachers Association

(All dates are deadlines unless otherwise specified.)

October 5—**The NSTA Baltimore Area Conference** opens today. Join science educators from around the region as they launch into this event, themed "Making Science Accessible: Full Speed Ahead." Advance registration for NSTA members received by **September 15** costs $195; on-site member registration costs $230. For more information or to register, visit *www.nsta.org/baltimore.*

October 12—The Shell Science Teaching Award recognizes innovative science teachers with a $10,000 award, but you can't win if you don't submit a strong application. Learn how to do so from Gary Koppelman, chair of the Shell Science Teaching Award Judging Panel, during **Developing a Competitive Application for the Shell Science Teaching Award, a free NSTA Web Seminar**. The session will run from 6:30 to 8 p.m. Eastern Time (ET). New users should log in 15 minutes before the scheduled start time for an introduction to NSTA Web Seminars. For more information on NSTA Web Seminars or to register, visit *http://bit.ly/1Iwpg4w.*

October 13—Don't miss today's earlybird deadline to register for the **NSTA Area Conference in Milwaukee!** The conference, taking place November 9–11, features the theme "Making Waves: Moving Science Forward!" Earlybird registration costs $185 for NSTA members. For more information or to register, visit *www.nsta.org/milwaukee.*

October 18—PreK–16 science educators can win up to $10,000 for their outstanding efforts through the NSTA Teacher Awards program. Learn how to craft a strong application during **Developing a Competitive Teacher Award Application, a free NSTA Web Seminar** with Ruth Ruud, chair of the NSTA Teacher Awards and Recognition Committee. The session will run from 6:30 to 8 p.m. ET. For more information on NSTA Web Seminars or to register, visit *http://bit.ly/1Iwpg4w.*

October 25—Do you teach grades 6–12 science? Does your school need a lab makeover? Don't miss **Developing a Competitive Application for the Shell Science Lab Challenge, a free NSTA Web Seminar**. Learn about the application process and tips for creating a strong application from Ruth Ruud. The session will run from 6:30 to 8 p.m. ET. For more information on NSTA Web Seminars or to register, visit *http://bit.ly/1Iwpg4w.*

November 3—Don't miss today's earlybird deadline to register for the **NSTA Area Conference in New Orleans**, November 30–December 2. Take advantage of this chance to "Celebrate Science: Inspire, Integrate, Innovate." Earlybird registration costs $185 for NSTA members. For more information or to register, visit *www.nsta.org/neworleans*.

December 4—Today's the final day to **submit a proposal for the Seventh Annual STEM Forum & Expo,** hosted by NSTA. The forum will be held in Philadelphia July 11–13, 2018. To submit a proposal, visit *www.nsta.org/conferenceproposals*.

January 16, 2018—Don't miss this deadline to **submit a proposal** for one or more of **NSTA's 2018 Area Conferences** in Reno, Nevada; Charlotte, North Carolina; and the Gaylord National Harbor, Maryland. The dates for these conferences are October 11–13 (Reno), November 15–17 (Gaylord National Harbor), and November 29–December 1 (Charlotte). To submit a proposal, visit *www.nsta.org/conferenceproposals*.

February 9—Plan ahead for the **2018 NSTA National Conference on Science Education**! Register early to receive the lowest rate. NSTA and Georgia Science Teachers Association members who register by this date pay only $285 for the conference, taking place March 15–18 in Atlanta, Georgia. For more information or to register, visit *www.nsta.org/atlanta.*

April 16—Today's the final day to submit a proposal for the **2019 NSTA National Conference** in St. Louis (April 11–14). To submit a proposal, visit *www.nsta.org/conferenceproposals*.

Take the Lead at NSTA!

Do you want to help guide the direction of science education? NSTA is now accepting applications for its 2018 Board of Directors election. The three-year terms will begin in June 2018. Applications are being accepted for

- President
- Preschool/Elementary Division Director
- Middle Level Division Director
- Informal Science Division Director
- Professional Development Division Director
- District II Director (Maine, New Hampshire, and Vermont)
- District IV Director (New Jersey, New York, and Pennsylvania)
- District VIII Director (Kentucky, Virginia, and West Virginia)
- District X Director (Indiana, Michigan, and Ohio)
- District XIV Director (Arizona, Colorado, and Utah)
- District XVI Director (American Samoa, California, Guam, Hawaii, Nevada)

Visit *www.nsta.org/nominations* for more information. Members may apply themselves or nominate qualified candidates. Applications must be received by **October 16.**

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Space Out With NSTA Kids Books

Two NSTA Kids books are out of this world—literally. On August 14, *Next Time You See a Sunset* (by Emily Morgan) and *Notable Notebooks: Scientists and Their Writings* (by Jessica Fries-Gather) were launched on Space X to the International Space Station (ISS). The children's books, along with others with science, technology, engineering, and mathematics (STEM) themes, will be read by astronauts this fall as part of the Story Time From Space (STFS) program. Astronauts will make video recordings of themselves reading the books, and the videos will appear on *www.storytimefromspace.com* by the end of the year.

Before being selected for the launch, all books were reviewed for accuracy of science content. NSTA also provided details on the inks, papers, and glues used to produce the books for review by NASA. STFS is supported by the Global Space Education Foundation and the Center for the Advancement of Science in Space to foster literacy and STEM learning. (An excerpt from *Notable Notebooks* appears on page 24 of this issue of *NSTA Reports*.) ●