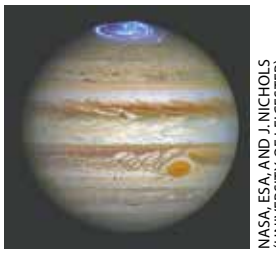
NSTA Member Poll: Should Work Be Assigned During School Breaks? 18

NSTA Reports
National Science Teachers Association



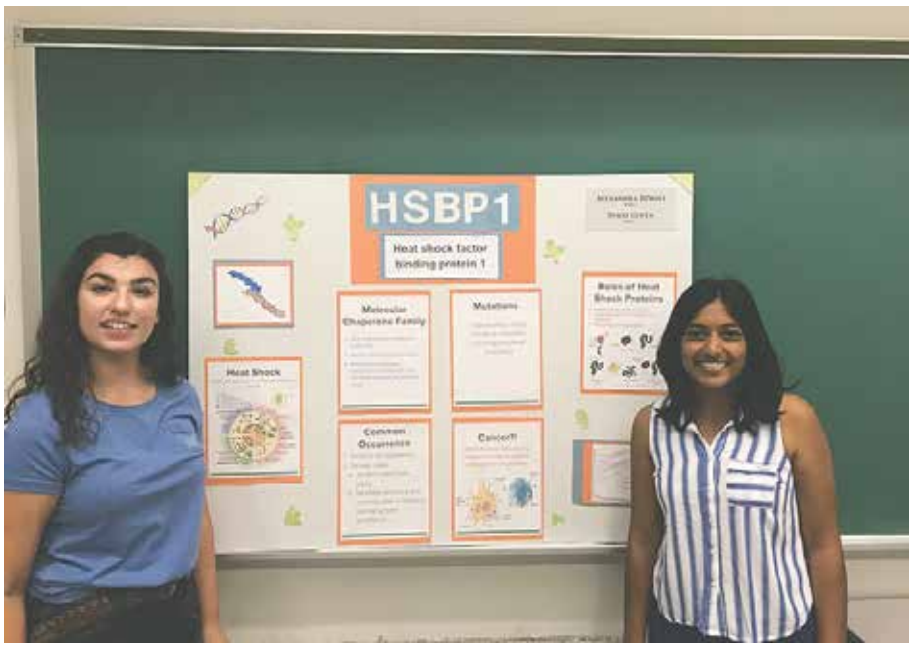
NASA, ESA, AND J. NICHOLS (UNIVERSITY OF LEICESTER)

It's the End of the World, Yet Again 14

CONTENTS

Engaging in Authentic Research

Looking for an opportunity for you and your students to do authentic scientific research? Then programs like Rutgers University's Waksman Student Scholars Program (WSSP) might be for you. "Since 1993, we've been conducting the [WSSP], a year-long program that engages high school teachers and their students in an authentic research project in molecular biology and bioinformatics [the computational analysis of biological data]. Each year, the program begins with a summer institute, then continues back at each school, when additional students contribute to the investigations," explains Sue Coletta, a senior science education specialist with Rutgers University's Waksman Institute of Microbiology in Piscataway, New Jersey.



High school students participating in Rutgers University's Waksman Student Scholars Program spend a year conducting research projects in molecular biology and bioinformatics—the computational analysis of biological data—with their teacher and scientists.

The WSSP began with six schools and 18 students. "Now more than 50 schools and 1,400 students [are participating] this year alone," says WSSP Project Director Andrew Vershon, a professor in the Waksman Institute and Rutgers' Department of Molecular Biology and Biochemistry. The program has "spread beyond New Jersey to other locations: Johns Hopkins University in Baltimore, Maryland, and Lawrence Livermore National Laboratory in Livermore, California," Vershon reports. Schools in those states and in Hawaii and Pennsylvania are also now active in WSSP, doing projects like the 2017–2018 cohort did: "analysis of the mRNA population of *Landoltia punctata*, a duckweed…to determine which genes are expressed in this organism, and how they compared with expressed genes from other species," according to the program's website (*https://wssp.rutgers.edu*).

Typically, schools apply for WSSP. "We get a commitment from the school and the teacher," Vershon notes. "Sometimes the science supervisor identifies a teacher" who would be a good candidate, he adds.

The program begins with a two- to three-week summer institute at Rutgers for the teachers, who each bring with them one or two students. "We go over DNA sequencing, background, experiments, and the rationale [so that teachers] learn how to conduct the experiment," Vershon relates. "They learn how to fit the experiments into their schedules and integrate the program in their setting, how to manage a class of 12 to 24 students to conduct experiments." During their first two years, teachers receive a stipend for the summer program, he adds.

Teachers and students then do the project with other students back at their schools in a classroom setting or in after-school clubs during the academic year. "We [support the teachers by providing] some reagents and loan participating schools the equipment needed to conduct the experiments," explains Vershon. "Some of the equipment is very expensive and not common to high school settings."

See Research, pg 4

NSTA District Professional Learning Packages

Implement Three-Dimensional Instruction with NSTA

Bring NSTA to your district to guide your implementation of *A Framework for K-12 Science Education* and 3D standards. Transform classroom instruction with programs tailored for

- Administrators
- Curriculum leaders
- Classroom teachers

"My teacher facilitators now have a much deeper understanding of what to look for when evaluating materials. I also have a much clearer vision for leading this work. Having this training before the curriculum review process is such a perfect sequence! I believe that this training will lead to continuing work in our region, and I hope to provide a structure to continue the work/learning. Thank you so much for working with me to bring this training to the region."

—Educational Services District Leader

Ask Us About Professional Learning Training for Districts

- **Making Sense of Three-Dimensional Teaching and Learning:** Give teachers a foundational understanding of the standards and shows them what three-dimensional instruction looks like in classrooms (modeled for each grade and discipline).
- **Administrator Institutes:** Help administrators design professional learning around 3D science standards, assessing current capabilities of teachers, and setting goals for professional learning.
- **Designing Three-Dimensional Lessons and Units:** Build your team of experts by giving them a powerful tool kit of resources and a solid understanding of three-dimensional standards. This workshop also empowers participants to work with their colleagues around the new standards.
- **Online Book Study and Discussion Forum:** This series of four web seminars combines asynchronous thought activities with discussions in private forums to give districts a flexible option for learning about three-dimensional instruction.
- **Or let us tailor a program for your needs.**

For more information, visit *www.nsta.org/district* or email *ngss@nsta.org*.

National Science Teachers Association

COMMENTARY: **Kevin Anderson**

A Process for Creating 3-D Assessments

By Kevin Anderson

Kevin Anderson

What is your vision for science learning for your students? At the Wisconsin Department of Public Instruction, we have a science vision statement that comes from the introduction to *A Framework for K–12 Science Education*: "[By] the end of 12th grade, all students have some appreciation of the beauty and wonder of science; possess sufficient knowledge of science and engineering to engage in public discussions on related issues; are careful consumers of scientific and technological information related to their everyday lives; are able to continue to learn about science outside school; and have the skills to enter careers of their choice, including (but not limited to) careers in science, engineering, and technology." From the district to the student level, assessments should provide information about our progress toward realizing that vision.

Assessment could rightfully be viewed as a conversation between a mentor and mentee (student). Students' ability to employ the three dimensions of the *Next Generation Science Standards (NGSS)* as they make sense of phenomena and solve problems moves us closer to realizing our vision. Creating a three-dimensional assessment, however, is not a linear process.

Crafting assessments with specific goals ensures instructional alignment with the vision and richer student conversations. Performance expectations provide some big-picture, end-of-year goals, but Appendices F (Science and Engineering Practices, or SEPs) and G (Crosscutting Concepts, or CCCs), as well as the Evidence Statements of the *NGSS*, list subsets of skills students need to develop as they progress in their learning of the disciplinary core ideas (DCIs). These "subskills" of the SEPs and CCCs can form the basis for a targeted rubric for student learning. Generally, one specific skill within both practices and crosscutting concepts, linked to conceptual understanding of content, will provide plenty of fodder for assessment/learning conversations. Developing a full rubric for these narrowed goals, however, requires analysis of students' work and a practical demonstration of their ability to make sense of a phenomenon.

So what makes a good phenomenon around which to build an assessment? Like regular classroom work, a phenomenon on an assessment should consider students' interests and identities, as well as local connections. Ideally, it will build from the anchor and daily phenomena of the unit, requiring students to connect what they've learned in new ways. The phenomenon also has to connect to the standards at hand; for example, a phenomenon of bat population change with related data would work well for ecosystem variation (DCI), data analysis (SEP), and stability and change (CCC).

Once you have the phenomenon, how do students work with it? This question really comes down to "sensemaking." Students need opportunities to figure out the world around them, not just "receive 'correct' information and practices," so authentic assessment should provide that opportunity (Miller et al. 2018*). Moving beyond simply having students share memorized facts in assessment is relatively easy, but moving beyond simply restating the thinking or the ways of doing supplied by the teacher in class is not. A sensemaking assessment would involve student performances, sometimes collaborative, that require application of SEPs and CCCs in new ways. Students might create a portfolio, design a solution to a local problem, craft a letter to the Environmental Protection Agency, or evaluate a case study.

When designing an assessment, teachers must consider what will be done with the data: How will students' abilities to work with these 3-D standards impact next steps? Educators conducting a collaborative facet analysis of student work—really digging into and itemizing their understanding related to DCIs, SEPs, and CCCs—can build awareness of the assets their students will bring into the next lesson or unit and develop a sense of the continuum of their students' understanding. Students' understandings can lead to a redesign of the rubric to make it better reflect their thinking in relation to the three dimensions.

Ideally, a group of teachers would reflect on student progress as part of a cyclical process in which they co-design the experiences students would next encounter to help them grow in specific, strategic goal areas (knowing that not every goal can be focused on at once). Importantly, teachers would not be considering new ways to explain concepts to students, but would be looking for the next round of opportunities for students to ask questions and discover.

A number of groups are developing 3-D assessment resources and sharing them with educators:

- 3-D Rubric Writing (*https://bit.ly/2FX6jSv*)
- Qualities of a Good Anchor Phenomenon (*https://bit.ly/22gncJ9*)
- Facet Analysis of Student Understanding (*https://bit.ly/2nISJI7*)
- Stanford *NGSS* Assessment Project (*https://stanford.io/2RceNau*)
- Kentucky Through Course Task (*http://bit.ly/2UVeimD*)
- Next Generation Science Assessment Project (*https://bit.ly/2ccdJhU*)
- *NGSS*@NSTA, Conducting Assessments (*https://bit.ly/2FXcYw6*) ●

Kevin Anderson is the science education consultant with the Wisconsin Department of Public Instruction.

*Miller, E., E. Manz, R. Russ, D. Stroupe, and L. Berland. 2018. Addressing the epistemic elephant in the room: Epistemic agency and the next generation science standards. *Journal of Research in Science Teaching* 55 (7): 1053–1075. (Accessed December 10, 2018, on *https://bit.ly/2BsYboU.*)

NSTA Reports

National Science Teachers Association
1840 Wilson Boulevard
Arlington, Virginia 22201-3092
703-243-7100
nstareports@nsta.org

Lynn Petrinjak ..... *Managing Editor*
Debra Shapiro ..... *Associate Editor*
Will Thomas, Jr. ..... *Art Director*
Production Staff ..... Jack Parker
Catherine Lorrain
Kenneth Roberts .. *Asst. Exec. Dir. for Periodicals*
David L. Evans ..... *Executive Director*
Jason Sheldrake ..... *Advertising Director*
jsheldrake@nsta.org
703-312-9273

Research, from pg 1

Participating schools are responsible for supplying consumables, such as tubes and pipettes. "We make sure schools are aware of the [monetary] and space commitment and the need for computers [for] computational modeling programs," he relates. "There's a lot of database searching involved, using databases that scientists worldwide use."

Students use molecular biology laboratory protocols to isolate and analyze DNA samples. The samples are sequenced, and students determine whether the sequences are similar to genes from other organisms using online programs. As they carry out the work during the year, "we stay in contact with the students, teachers, and schools. Six follow-up meetings are held during the school year, and teachers can bring up to 10 students [with them] to each meeting," says Vershon.

During these meetings, "teachers can troubleshoot together," and teachers and students "learn what other schools are doing. It's like a graduate student seminar [because students] present [their work] to the group, [have an] exchange of ideas and findings," Vershon points out.

Students who discover new findings have their results published. "The students can actually contribute to science, and the materials they're contributing are available to scientists for their own research," Vershon relates. "Our goal is to have every participating student be able to publish a DNA sequence analysis on the databases that are maintained by the National Center for Biotechnology Information, which is part of the National Institutes of Health." He estimates 90% of students participating in classes are able to publish, while "68% to 70%" of students in after-school clubs have their findings published.

"The year ends with the annual WSSP Forum [Poster Session], when teams present their findings," says Coletta, and "students [get to] see themselves as members of a community of practice," she concludes.

Astronomical Research

For teachers of astronomy, IPAC at the California Institute of Technology (Caltech) has offered the NASA/IPAC Teacher Archive Research Program (or NITARP) since 2009. (IPAC provides infrared data processing and analysis support to NASA's long wavelength observatories.) NITARP partners groups of U.S. educators with mentor astronomers to do year-long research projects using NASA data from space- and ground-based telescopes, says NITARP Director Luisa Rebull, a research scientist for Caltech/IPAC. After the project concludes, participants are asked to provide professional development based on their experiences to colleagues in their school districts.

While ideally, teachers should have some experience using astronomy data in the classroom, Rebull notes that most participants "have never done real scientific research, or even in some cases, worked with real data." To teach the *Next Generation Science Standards* (*NGSS*), she contends, "teachers have to step up their game, do real science with real data and real tools…This is a gap in teacher education."

NITARP is "very popular and highly competitive…We typically have nearly five times as many teachers apply as spaces available," reports Rebull. Applications become available in the spring and are due in late September to allow teachers time to work on them over the summer. (To learn more, visit *https://nitarp.ipac.caltech.edu*.)

Most participants are high school teachers, but teams have included middle level, community college, and informal educators. Teachers can involve their students in NITARP throughout the project. Teachers, students, and scientists collaborate remotely via conference calls and online.

NITARP is unusual because the program funds three trips. Participants attend two January meetings of the American Astronomical Society (AAS), the first in conjunction with an initial NITARP workshop and the other a year later to present their research findings in a science poster session. Educators produce two posters: a scientific poster that educators defend along with the scientists, and an education poster "to jump start their reflection on what they learned and how it will affect their teaching," Rebull explains.

Teachers also visit Caltech in Pasadena, California, in the summer to work on the data with their team. NITARP funds the attendance of teachers and two of their students at the Caltech meeting and the second AAS meeting.

Often teacher alumni raise their own funds to attend additional AAS meetings after their project ends "because it's so much fun that they want to come back and keep learning," Rebull reports.

"NITARP helps teachers tackle a seemingly impossible project," she maintains. "We help them feel comfortable with not knowing everything [at the start]. Scientists are used to [this, so we tell teachers], 'It's okay to [not know everything]: It's part of being a scientist.'" ●

"This online master's in biology program has opened up opportunities for me as a teacher. It has helped me develop skills to talk with students and get them interested in science."

Curtis Reese, Graduate
University of Nebraska at Kearney
Biology, MS

Online Biology, MS
University of Nebraska at Kearney

- Non-Thesis Online Option
- Master's of Science Program
- Low Student to Faculty Ratio

Develop the skills to make an even greater impact in your classroom.

Learn more:

online.nebraska.edu

University of Nebraska Online

KEARNEY | LINCOLN | OMAHA | MEDICAL CENTER

MONEY 101

The Value of a Good Retirement Plan

By Kelly Kenneally

We've all seen the headlines about teacher pay. The issue has reached a boiling point in jurisdictions from coast to coast. Already in 2019, protests have occurred in Virginia and California, following walkouts in multiple states last year.

Furthermore, a new *Washington Post* analysis (*https://wapo.st/2Tt04bZ*) found public school salaries fall short compared to industry pay averages in nearly every state. The article reports that "other comparable industries in terms of employment and salaries to see similar pay slides include delivery drivers, printers, electronics retailers, and warehouse workers—industries which were reshaped by the rise of the internet."

If you teach in a private school, the situation likely is worse. Most private school teachers are paid less than their public school counterparts, according to data from the National Center on Education Statistics (see the website *http://bit.ly/2DUAtDB*).

Factoring Retirement Benefits

Given the salary issue, it's all the more important for educators to pay close attention to another key aspect of compensation: their retirement benefits. Historically, employers have offered retirement benefits to recruit and retain workers. Retirement benefits are particularly important for retention in the public sector because state and local employers often offer lower salaries, yet require employees with high levels of education, skills, and experience.

Often, public workers like educators sacrifice salary for long-term financial security (retirement benefits). A national poll found that public workers place a significantly higher value on retirement benefits than salary. This is a different picture for private sector workers with higher pay and the potential for other types of compensation like performance bonuses or stock options.

Strong retirement benefits can make a real and substantial financial difference. Workers with inadequate benefits risk slipping into poverty, a growing concern due to longer life spans and the rising costs of medical and long-term care. On the other hand, those with strong benefits can expect to maintain their standard of living as they age and not risk running out of money when returning to work is impossible.

Retirement benefits for public school teachers typically are provided as defined benefit (DB) pension plans that provide guaranteed monthly retirement income based on salary and years of service. Alternatively, educators can receive retirement plans in the form of retirement savings accounts, also known as defined contribution (DC) plans. Teachers who receive DB pensions can supplement their savings with individual DC retirement savings accounts similar to 401(k) accounts.

The DB to DC switch has been undermining workers' financial security according to a wide body of research, including a key report from the U.S. Government Accountability Office (*http://bit.ly/2GnVZm0*).

The Changing Retirement Landscape

It's important to note that many states are changing educator retirement benefits. Some states, like Colorado and Minnesota, have adjusted their existing pension benefit structure. Other states like Michigan have completely restructured benefits, now enrolling new teachers by default into a "hybrid plan" that combines a DC-style account with a less generous pension. In Alaska, new teachers do not have pensions *and* do not participate in Social Security.

Just how important is the type of retirement benefit to the bigger goal of financial security in retirement? When you dig into the data, the type of benefit is quite important.

Take, for example, a National Institute on Retirement Security report that focuses on the retirement security of women, who coincidentally dominate the education profession. *Short-Changed in Retirement* (see the website *http://bit.ly/2SpJkoV*) finds that women are far more likely than men to face financial hardship in retirement because they live longer, earn less, and often take time out of their career for caregiving. As a result, women age 65 and older are 80% more likely than men to be impoverished.

This report also looks at women's retirement income by profession. One would think women working in higher-salary private sector fields—like finance or the sciences—would have the highest retirement income. But they don't.

Women working in education have the highest retirement income. Yes, the same women who earn lower salaries than their private sector counterparts have the best retirement income outcomes.

Looking closely at the numbers, it's the DB pension income that makes the difference in better retirement income for these women. In 2013, women aged 65 and older working in education had an average retirement income of more than $66,000, with 37% of that income from a pension. In contrast, the private sector industry that came closest had a lower average retirement income for women of about $57,000, with only about 17% of that coming from a pension. This means that higher private sector wages don't necessarily translate into higher retirement income. It's clear that wages aren't the driving force, but instead a retirement benefit like a pension with mandatory participation, regular contributions throughout an entire career, lower fees, and professional asset management.

To further illustrate the comparison of retirement outcomes in DB pension versus individual DC retirement accounts, a new study published earlier this year by University of California, Berkeley, (*http://bit.ly/2UGbedA*) considered six states. The analysis revealed 8 out of 10 educators in those states can expect to collect DB pension benefits greater than what they could receive from an idealized DC retirement account. Compared to DC plans, "pensions are better for 81% of teachers," the report indicates.

The bottom line—pay as much attention to your retirement benefits as you do to your salary. Know what benefits you have (keeping in mind 40% of teachers do not participate in Social Security), what changes may occur, and if your benefits offer cost-of-living adjustments. Remember, good retirement benefits ultimately can help mitigate some of the shortcomings of education salaries. ●

Kelly Kenneally has 25 years of public policy experience including serving in the White House. She has worked for more than 10 years with nonprofit organizations to help improve Americans' financial security.

Supporting All Who Inspire the Future

Christine Anne Royce, Ed.D., NSTA President (2018–2019)

NSTA membership offers benefits such as a choice of grade-level journals, this newspaper, discounts, and opportunities to participate in online forums. However, NSTA has many additional ways it supports science education and educators. Sometimes we do so through broad initiatives that make national news, while other times we do so in connection with a particular event or purpose. Regardless, these efforts support *you* the science educator and impact people and policy while advancing our mission.

NSTA's mission statement calls for us "to promote excellence and innovation in science teaching and learning for all." One of the ways we strive to accomplish our mission statement is to "raise the status of science education and science teaching as a profession by advocating for high-quality science education within national, state, and local contexts."

Nationally, NSTA played a leading role in developing a federal five-year strategic plan for STEM education, *Charting a Course for Success: America's Strategy for STEM Education,* which offers guidance to the science, technology, engineering, and mathematics (STEM) education community and shapes commitments from the federal government. To quote the plan, "Now more than ever, the innovation capacity of the United States—and its prosperity and security—depends on an effective and inclusive STEM education ecosystem. Individual success in the 21st-century economy is also increasingly dependent on STEM literacy; simply to function as an informed consumer and citizen in a world of increasingly sophisticated technology requires the ability to use digital devices and STEM skills such as evidence-based reasoning," which means science education and science educators are key to meeting the demands of this future.

NSTA has been on the leading edge of supporting science and science education for the past 75 years. In 2017, we partnered with many other groups in the March for Science, an event with international connections. More than a million people participated in excess of 600 marches around the world. Science was in the news, on television, and definitely part of the conversation. Nearly 7%—more than 70,000 of those marchers!—identified themselves as science teachers. At the Washington, D.C., march, I stood side by side with other NSTA members as we used our teacher voices to proclaim the need for evidence-based science and support for science education in our schools. It was a moving experience to join with friends, colleagues, and mentors; hear the chants; engage in conversation; and help spread the #VoteforScience message. NSTA continues to support this effort, and you are encouraged to participate in whatever way possible.

We influenced the Every Student Succeeds Act by working with key decision makers who crafted the new federal education law to ensure that STEM education was included as an area of support for professional development, thus allowing educators to gain the assistance and encouragement needed to create and share new and innovative teaching strategies and program implementation. NSTA worked collaboratively with other organizations through initiatives such as the STEM Education Coalition to contribute to Capitol Hill briefings and events.

To support classroom educators, we developed two new position statements on the teaching of climate science and the importance of elementary science, which included feedback and input from our membership. When groups shared misinformation to challenge the validity of climate science research, NSTA responded with science-based materials. We continue to update and add position statements to support science educators into the future.

At the state level, NSTA provided assistance to science educators in Arizona, New Mexico, and Idaho as they advocated for adoption of the *Next Generation Science Standards* and *The Framework for K–12 Science Education*; challenged proposed anti-science changes in the Virginia Standards of Learning; and advocated for the adoption of standards founded on research–based best practices in Colorado.

Locally we enter educators' classrooms through the quality science materials available on our website and in our publications. We offer chances to connect in person at conferences and events and virtual opportunities through web seminars, and we provide information via weekly e-mail updates from NSTA, member e-mail lists, and e-newsletters.

We promoted the need for all of these and other important areas in science and STEM education through participation in more than 150 media interviews at national, state, and local levels.

Individual members are educators who strive to meet students' needs every day and give them a solid foundation for understanding science so they may contribute to society. Science educators have great enthusiasm and dedication. During my term as NSTA President, I have been fortunate to have many educators and advocates communicate their enthusiasm to me over the past nine months.

NSTA is a community of educators who unite on behalf of science education. We bring our talents, our expertise, our questions, and our concerns to a collaborative arena where we endeavor to improve science education, support one another, and teach about critical science issues facing our nation and the world. Our ultimate goal is to promote the importance of science and science education for our students, for science, for society, and for our future!

The need persists for collective advocacy, and we as a community of science educators must continue to call attention to the accomplishments and needs of our students, the significance of science education as a pathway to future scientific discoveries, and the importance of teaching that enables students to use real-world strategies. By advocating together, we can express a clear message. I ask each of you to continue to advocate for the importance of science education. We are NSTA! ●

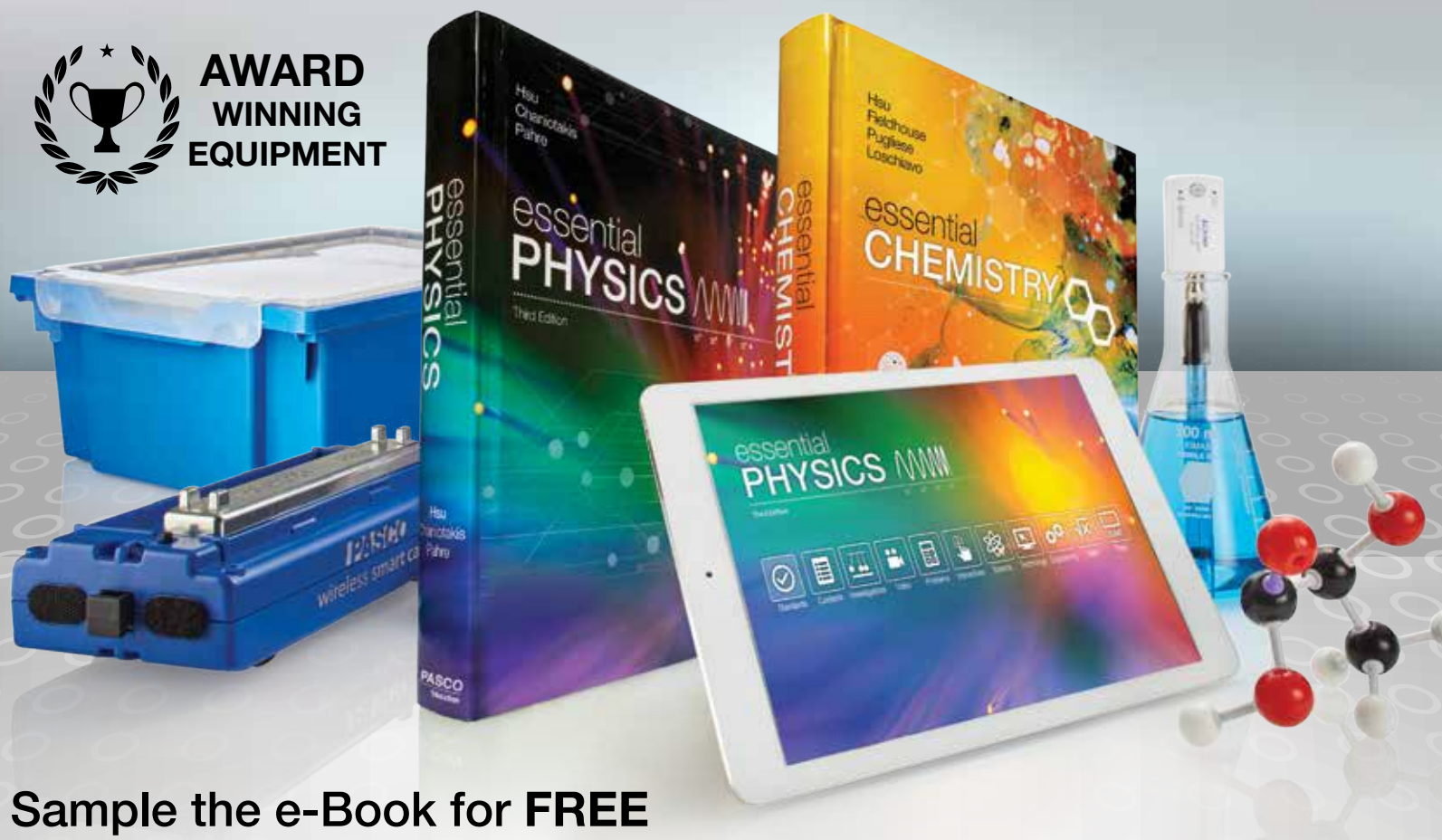
essential
CHEMISTRY & PHYSICS

The *only* curriculum that includes lab equipment and probeware!

PASCO Education offers complete and affordable chemistry and physics solutions that include textbooks, e-books, digital teacher editions, and hands-on activities featuring PASCO's award-winning equipment. **Already have curriculum?** You can also easily integrate our labs and equipment into your existing curriculum.

- NGSS & state standards correlations
- Innovative interactive media
- Flexible assessment options
- Award-winning PASCO equipment
- Digital Teacher Edition

AWARD WINNING EQUIPMENT



Sample the e-Book for **FREE**

For more information about our curriculum solutions or to sample the e-Books, visit **pasco.com/essentialchemistry** or **pasco.com/essentialphysics**

Visit PASCO at the NSTA National Conference in St. Louis.

See live demos in **Booth #1060** • Get hands-on in one of **24 FREE workshops!**

Learn more at **pasco.com** • **877-373-0300**

PASCO

Making Connections to Local Manufacturing

Introducing students to manufacturing career opportunities in their community can "really help students understand what we're studying has applications, a real purpose," says Vic Chamness, Ed.D., director of science and health, Evansville Vanderburgh School Corporation in Evansville, Indiana.

To help Evansville teachers make the connections between content and careers, the district joined a "boot camp" for educators and school counselors in 2015, during which they visited local businesses, including manufacturing facilities. "It's predominately science and math teachers going to the manufacturers," he says. "One of their goals is to develop lesson plans [that] help to emphasize science and tech skills [students will need] and soft skills like showing up on time, working on a team."

Megan Wright, sixth-grade teacher at Helfrich Park STEM (Science, Technology, Engineering, and Math) Academy in Evansville, participated in the first boot camp, noting she "was curious how we were going to connect manufacturing and education." Her tour of plastic manufacturer Berry Global led to an ongoing relationship. Berry engineers visit her classroom to discuss their work and the types of jobs available with the company, and share a challenge the company has had.

"The first year, all my student groups worked on the same project," Wright recalls. "This year, we have five different topics…It's a large amount of time from my end…We're working on Berry Global about half the time every week." She is able to include science content, math (such as calculating surface area and volume), and English, as students design products, conduct market research, and prepare presentations for Berry Global.

"The Berry people said they've been floored [by the students' work] and have gone back to original teams to incorporate [a few] of their solutions," says Chamness. "These are sixth graders. It's very impressive what our students are able to do."

"Developing the talent pipeline is very important," Patti Andresen-Shew, director of education and talent development at Oshkosh Chamber of Commerce in Oshkosh, Wisconsin, asserts. "A big component of our work with the Oshkosh Area School District is showing…what career options are here." During Manufacturing Month in October, Andresen-Shew coordinates tours of manufacturing facilities for area high school students and eighth graders. The chamber also organizes a Career Cluster Showcase featuring actual and 3-D training simulations for hands-on learning experiences and includes a variety of fields, such as medicine and public safety.

Jason Jischke, a technology and engineering instructor at South Park Middle School, has taken his eighth-grade students on several field trips to manufacturing companies. He extends the experience with an assignment, explaining, "Students need to write an essay, in an attempt to convince their readers that the manufacturing company they visited is the best in Oshkosh." He says the Career Exploration Fair "is an excellent opportunity for students to meet, interact [with], and ask questions of many different local employers."

The Chamber of Commerce also works with schools on Career Pathway Days (for eighth graders), a structured career job shadow experience. Students learn about possible careers and what kind of education various careers require. Andresen-Shew says

high school students have reported selecting a school-to-work experience (youth apprenticeship) and job shadow experience based on what they learned during the career exploration field trips.

In Ohio, Kurtz Miller, science teacher at Wayne High School in Huber Heights, says the Dayton Region Manufacturers Association (DRMA) and City of Dayton Office of Economic Development were pivotal in connecting area schools, community colleges, and the community with local manufacturers. While companies struggled to find employees with both technical and soft skills, many in the community were unaware of these opportunities. DRMA also began organizing Manufacturing Day tours for the schools and general community. "[More than] 1,000 students every year go into various types of manufacturing facilities, see how science, how STEM is being used every day in those facilities," says Miller. "The shock and the awe students have, to be able to see the types of things being built in their community, is great."

When he taught chemistry in New Haven, Connecticut, Peter Dimoulas noticed the local manufacturing community "had a track record" with the vocational high schools and decided to find ways to include it in his lessons. He began by adapting his reactivity labs.

"We had a good-sized aerospace and medical device [manufacturing community], so I posed the question, 'What materials would you use for a medical staple?' to my students," Dimoulas says. The labs then revolved around testing for the properties of a good medical staple.

His students also had job-shadowing opportunities through an agreement with the New Haven Manufacturing Association. "Job shadowing gives managers a chance to meet potential future employees and to understand what schools need" to know to prepare students for the workforce, he adds. "With the expected job turnover with an aging workforce, there's plenty of opportunity to be had.

"If we give students a better sense of what the labor market needs, develop that awareness in middle and high school, help students develop requisite skills and attributes, then they (students) stand a better chance once done with high school," observes Dimoulas, now teaching in Bethel, Connecticut. ●

Quotable

The core skill of innovators is error recovery, not failure avoidance.

—Randy Nelson, director, Apple University, Cupertino, California

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 specific 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 Master's 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

Take online graduate credit and non-credit courses for professional development, or work toward one of five 12-credit online graduate certificates (Life Science, Physics, Chemistry, Elementary Science and Earth Science) or an online Master's 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

PULL-OUT SECTION

SCIENCE TEACHERS' GRAB BAG

Inside this Convenient Pull-Out Section you will find:

Freebies for Science Teachers

STEM Mystery of the Month. M Every month, Science, Naturally!—an independent publisher of science- and math-focused materials—releases an online science, technology, engineering, and math (STEM) mystery from their popular series for middle level students, One-Minute Mysteries. Available in both English and Spanish, the one-page, literature-based, math- and science-themed brainteasers help students learn how to extract the important data needed to solve science, math, and logic problems while also strengthening reading skills. The mysteries can be used as independent reading assignments, bell ringers, and assessment tools for math and science knowledge and literacy. Visit *https://bit.ly/2DWGZKb* to read sample mysteries and register for the monthly e-mail.

The Energy Teacher Resource. K12 Created by the Association of Science-Technology Centers and BP America—with input from educators, museum professionals, and scientists—the website found at *http://energyteacher.org* offers a vetted collection of energy literacy activities, videos, websites, and other resources for professional developers, K–12 teachers, and parents. Educators can filter the database (e.g., by audience, resource type, learning time, modality, energy topic, material needed, and age range) to find resources ranging from five-minute demonstrations to multi-hour units.

Of particular interest is the Argumentation Toolkit: How It Works, a simple exercise from the Denver Museum of Nature and Science that provides hands-on practice in evaluating pieces of evidence to support a claim and teaches middle level students how to discuss and argue with one another in a meaningful way. Other notable resources include engineering design challenges for all ages, such as Sun Powered Cars and Designing and Testing Turbines, and hands-on activities to inspire creative thinking in elementary and middle level students, such as Zip Lines, Electric Scribbles, and LED Creations.


MICHAELISSCIENTISTS

EarthEcho Expedition: PlasticSeas. M Excite middle level students about science, and involve them in the search for solutions to the problem of plastics pollution in the oceans with these resources from Earth Echo International. Through videos, lesson plans, and design challenges—developed by the teacher-participants on a recent EarthEcho educational expedition to Australia, sponsored by the Northrop Grumman Foundation—students explore the impact of plastics pollution on marine life and coastal communities and "meet" scientists, experts, and young environmental leaders working to address the issue. The classroom lessons focus on helping students explore solutions such as developing alternatives to single-use plastics and engineering solutions to waste in schools, while the videos introduce students to careers in science fields and promote environmental stewardship. Visit *https://bit.ly/2SeE08o.*

The Green Room. K12 These K–12 conservation lessons for the classroom were produced by the National Wildlife Federation and distributed through the *Los Angeles Times* in Education program and Newspapers in Education Online. The lessons are organized by themes such as habitat, ecosystems, and wildlife. In Habitat for Sale (grades K–2, 3–8), for example, students write imaginative classified ads about habitats, then play a game to match specific animals with the animal's native habitat or home. In Go With the Flow (grades 6–8), students learn about watersheds, then map their own local watershed. In Massive Migration, students in grades 9–12 map and calculate the migration routes of Arctic species to learn about animals that spend part of their lives in the Arctic and how they are connected to other parts of the world for food and shelter. See *https://bit.ly/2GoyfOA.*

Green Ninja Show. M Interested in engaging middle level students in climate change issues and caring for the environment? Grab students' attention with Green Ninja, a fictional climate-action superhero! Developed at San Jose State University with funding from a National Science Foundation (NSF) grant, the Green Ninja Show is a series of short (1- to 3-minute) humorous videos that inspire environmental awareness and teach students about the factors impacting climate change and what can be done about them. Refer to *https://bit.ly/2RH7tmF.*

"How Exposure to Innovation Closes the Gender Gap in STEM Fields." H HE This article from the National Inventors Hall of Fame (refer to the website at

See Freebies, pg G2

Freebies, from pg G1

https://bit.ly/2Gkzdva) discusses how women in STEM fields can influence students interested in similar career paths. The article, which includes links to several studies, addresses some of the reasons for limited female representation in the STEM industry and presents research demonstrating female STEM mentors' influence on young women and their role in combating gender stereotyping. The article also includes advice for young scientists from women recently inducted into the National Inventors Hall of Fame for their innovations in STEM fields such as bioengineering (Frances Ligler), computer programming (Radia Perlman), and chemistry (Carolyn Bertozzi).

Compass to Nature web seminar. **K12** Watch this web seminar to learn about the benefits of and best practices for teaching in an outdoor classroom. The 45-minute presentation highlights the Compass to Nature program, a universally applicable (adaptable for any location, season, and age group) outdoor education program developed by the U.S. Fish and Wildlife Service and the Prairie Science Class at the Prairie Wetlands Learning Center in Fergus Falls, Minnesota. The program centers on building relationships with nature through four components: place, journals, phenology, and naturalists. The seminar discusses each component of the place-based program and provides suggestions to spark ideas for adapting it to a specific site. See *https://bit.ly/2Tv968H*.

LALOBIOZAR

Teaching Gardens Network and Recognition Program. P E Sponsored by the American Heart Association (AHA), this garden education initiative celebrates schools and organizations involved in implementing instructional gardens for preK–5 audiences. Teachers who join the Teaching Gardens Network at *https://bit.ly/2S4U8tg* receive a curriculum guide, naming recognition on the AHA website, and a certificate. The guide, *Whole Kids Foundation and AHA's School Gardens Lesson Plans,* features more than 30 lessons to engage students in gardening, agriculture history, and nutrition topics, from plant- and botany-based activities (e.g., Sprouting Seeds—A Seed Has a Coat, grades preK–4) and lessons in agricultural history (e.g., What Went Wrong?, grade 5) to lessons promoting consumer education (e.g., Know Your Labels, grades 2–5) and heathy eating habits (e.g., Eat Your Greens, grades preK–5).

STEM Resources @ReadWriteThink.org. **K12** Looking for resources to support goals in K–12 reading and science literacy? Then check out the website *www.readwritethink.org.* The literacy-themed website has resources like lesson plans, calendar activities, and videos to enhance STEM instruction. To access them, choose a theme (e.g., Nonfiction, Science, STEM, Careers), then add parameters (e.g., grade level, resource type, learning objective) to narrow the selections to meet specific needs.

Resources include lesson plans such as How Does My Garden Grow? Writing in Science Field Journals (grades K–2) and Create a Great Future: STEM Career Research Using Close Reading (grades 6–12); calendar activities, such as It's Winter in the Northern Hemisphere! (grades K–6); and a three-part video series, STEM Poetry (K–12 educators).

***NGSS* Crosscutting Concepts (CCC) Training Materials.** **K12** The California Academy of Sciences has created a professional development toolkit to help K–12 teachers demystify the *Next Generation Science Standards* (*NGSS*) and facilitate professional development workshops for colleagues. Available at *https://bit.ly/2Tp64Tf,* the toolkit contains PowerPoint presentations, activities, and scripts that can be modified to meet your group's specific needs. The activities can stand alone or be used in progression to give educators a complete picture of the CCCs. Titles include Introducing the Crosscutting Concepts: The Chess Metaphor; CCC Speed Dating and Station Rotation; and Vertical Alignment and CCC Lenses.

Aquation: The Freshwater Access Game. **M** Parts of the planet struggle to get enough water. Teach students how to manage the world's water with this interactive educational game from the Smithsonian Institution. Students can use the game to build pipes, desalinate water, and conduct research based on different regions of the world. Most appropriate for the middle level, Aquation supports the *NGSS* for Earth Science and includes supplementary information about the benefits of using digital games in educational settings to build critical-thinking, systems thinking, problem-solving, and creativity skills. Access a game tutorial and play at *https://s.si.edu/2S9o2N5*.

High Adventure Science Curriculum Models. **M H** Developed by the Concord Consortium with NSF funding, these online curriculum modules for middle and high school levels explore issues facing scientists today, including climate change, the availability of fresh water, land management, air quality, space science, and energy choices. Each module contains six guided activities (with embedded assessments) that examine various sides of the topic and provide opportunities for students to work with data while learning to construct an argument based on evidence. In addition, standalone interactives introduce students to the Factors Affecting Air Quality, Movement of Pollutants, Hydraulic Fracturing, Groundwater Movement, Managing an Agricultural System, Planet Hunting, and other topics. Consult *http://has.concord.org.*

Night Sky app. **A** Imagine having a personal planetarium at your fingertips! With the recently updated Night Sky, an augmented reality–enabled app for iOS platforms, stargazing and science enthusiasts of all ages can study the stars,

STEVE RUNFELDT

planets, constellations, and satellites above by simply aiming an iPhone, iPad, or Apple Watch skyward. Day or night, the app provides users with a live 3-D map of the sky, complete with illustrated constellation overlays, stars, planets, and satellites. An Object Exploration screen allows users to "pull" a celestial object out of the sky, read detailed data about the object, and "throw" the object back when done. Access the app at *https://apple.co/2sT8MTW.*

CTE Online. **K12** At the website *www.cteonline.org,* registered educators can access standards-supported resources relating to career and technical education (CTE) and academic core instruction, including K–12 lesson plans; Project-Based Learning and STEM Integrated projects; curriculum models; shared communities of practice; and professional development tools that enable teachers to create (and share) their own curriculum and collaborate in groups. Visit the CTE Online Help Pages to watch introductory videos explaining how to navigate the site and maximize its capabilities.

Research and Practice Collaboratory Task Formats. **K12** The Research and Practice Collaboratory has developed a series of "task format" tables—i.e., templates—to help K–12 teachers design student assessments that integrate real-world science and engineering practices with disciplinary core ideas as envisioned by the *NGSS.* The series includes several possible task formats for each of the *NGSS* science and engineering practices. Teachers can also use the templates as a guide when brainstorming new student activities or adapting existing lessons to reflect three-dimensional science learning. Visit *https://bit.ly/2bGy0eL.* ●

News Bits

- **Addressing low-income students' anxiety can help them succeed in science, technology, engineering, and math (STEM) courses.** H

High school students from disadvantaged backgrounds are less likely than their peers to pursue or excel in STEM subjects. Researchers theorized that low-income students are particularly affected by anxiety. To test that, they divided more than 1,000 ninth-grade biology students at a Midwestern high school into four groups and asked them to write about their concerns to help regulate their emotions and dispel their worries, allowing students to focus on academic performance. A reappraisal exercise asked students to reinterpret the emotions they were feeling as a beneficial force rather than anxiety or failure.

In their study, published in the *Proceedings of the National Academy of Sciences,* researchers concluded that students who had participated in the intervention tasks performed better on an examination than those who had not. They found that the "intervention significantly reduced the raw examination achievement gap between higher- and lower-income students by 29%." Read more at *https://bit.ly/2SpdcBQ.*

- **A National Academy of Sciences report offers recommendations for improving STEM teaching for English learners (ELs).** K12

In *English Learners in STEM Subjects,* researchers reported that some schools operate under the assumption that English proficiency is required for STEM learners. However, opportunities for STEM learning exist through alternate routes such as experimentation, demonstration, and science practice. One major obstacle for teachers is that they're not prepared to teach ELs in ways that they will benefit from.

Recommendations include policy changes at the federal level to allocate funding to research and development; higher expectations for EL learners; more training and tools for teachers; formative assessments of progress; and a review of state, district, and school policies about accommodations to offer ELs those that best meet their needs. Read more at *https://bit.ly/2GqSdrK.*

- **The success of an inclement weather program featuring digital learning days has prompted a Georgia school district to add school-based digital learning days regardless of the weather.** K12

In the 2017–2018 school year, Gwinnett County School District instituted six digital learning days to keep students from losing instruction during inclement weather. Tricia Kennedy, the district's executive director for Instructional Development and Support, said some lessons learned were ensuring assignments weren't too long, creating a mix of offline assignments, and standardizing assignments. The program's success has led to an increase in digital learning on early release days for the 2018–2019 school year.

Still, Tom Murray, director of innovation for Future Ready Schools at the Alliance for Excellent Education, a Washington, D.C.–based national nonprofit, said digital learning can create a homework gap, and schools must make sure all students can participate and have connectivity before making digital learning mandatory. "The students most likely to be without internet are probably those most at-risk," he asserted. Read more at *https://on-ajc.com/2Bt1gp5.* ●

In Your Pocket

Editor's Note

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

March 31

EJK Mini-Grants P K12

The Ezra Jack Keats (EJK) Foundation, named for the children's book author and illustrator, provides $500 grants for public schools and libraries with innovative programs that support or extend the *Common Core*. Projects should foster creative expression, collaboration, and community for preK–12 students and be informed by Keats' books, life, and vision.

Public schools, libraries, and preschool programs, such as Head Start, in the United States and its territories can apply by **March 31.** Learn more at *http://bit.ly/1ZzqINI.*

April 1

ACS-Hach Post-Baccalaureate Teacher Scholarship HE

This American Chemical Society (ACS) award goes to recent graduates and professionals with limited work experience who want to become high school chemistry teachers. Recipients must

- have an undergraduate degree in chemistry or a chemistry-related area;
- have less than one year of work experience;
- be pursuing a master's degree in education or certification as a chemistry or science teacher; and
- be a U.S. citizen or permanent resident.

The award provides $6,000 for full-time study or $3,000 for part-time, which can be renewed for up to three years. Funds can be used for tuition, room and board, and other education-related expenses.

Apply by **April 1** at the website *http://bit.ly/1ZYOroR.*

ACS-Hach Second Career Teacher Scholarship HE

This ACS scholarship goes to working chemists who are pursuing a master's degree in education or certification as a chemistry or science teacher. Up to $6,000 is awarded for full-time study and $3,000 for part-time study. Funds can be used for tuition, books, room and board, and other education-related expenses and may be renewed for up to three years. Applicants must

- have a bachelor's degree or higher in chemistry or a chemistry-related field and at least one year of work experience in a chemistry-related profession;
- be accepted into a master's or teacher-certification program; and
- be a U.S. citizen or permanent resident.

However, applicants cannot have more than one year of experience as a high school chemistry teacher.

Apply by **April 1** at the website *http://bit.ly/2GamFXX.*

ACS's Dorothy and Moses Passer Education Fund HE

This $1,000 award supports continuing education activities for teachers at two- and four-year colleges and universities that do not have graduate programs in the chemical sciences. Such activities should directly relate to the recipient's teaching and take him or her off campus.

Applicants must be full-time faculty and registered ACS Division of Chemical Education members 60 days prior to applying. Funds can be used for transportation, housing, and meals. Apply by **April 1;** consult the website *http://bit.ly/XFpNZT.*

Frances R. Dewing Foundation Grants P E M

These grants fund projects or programs focused on early childhood education. Of particular interest are new, untried, or unusual educational organizations or institutions that want to introduce new methods for children ages 2 to sixth grade. Grants range from $1,000 to $20,000, though the average is $5,000.

Programs must be located in the United States and have tax-exempt status. Submit proposals by **April 1;** see *www.frd-foundation.org/apply05.html.*

NiSource Charitable Foundation Grants A

These grants support communities where NiSource employees and customers work and live: in Indiana, Kentucky, Maryland, Massachusetts, Ohio, Pennsylvania, and Virginia. Nonprofit organizations with programming in the following areas are eligible:

- learning and science education,
- environmental and energy sustainability,
- community vitality and development, and
- public safety and human services.

Apply by **April 1;** see the website *http://bit.ly/2GnKHhu.*

April 12–15

AFCEA STEM Teacher Graduate Scholarships HE

The Armed Forces Communications and Electronics Association (AFCEA)—in partnership with NSTA and the International Technology and Engineering Educators Association—awards these $2,500 scholarships to those pursuing a graduate degree, credential, or licensure to teach STEM in grades K–12. Graduate-level applicants should be in their second semester and majoring in secondary education at an accredited U.S. college or university; have a minimum grade-point average of 3.5; and be enrolled in at least two semester-equivalent classes per term. Credential or licensure applicants must have a bachelor's or master's degree in a STEM field. All applicants must be U.S. citizens.

Apply by **April 12** at the website *http://bit.ly/2Strmlj.*

ACS-Hach High School Chemistry Classroom Grant H

The ACS provides grants of up to $1,500 to high school chemistry teachers who want to enhance learning in their classrooms, foster student development, and reveal the wonders of chemistry. Funds can be used for professional development, instructional materials, lab equipment and supplies, field studies, or science outreach events. Apply by **April 14;** see the website *http://bit.ly/2BkD8VE.*

Dorothy Stout Professional Development Grants K12 HE

The National Association of Geoscience Teachers (NAGT) provides these grants for K–12 teachers and faculty and students at two-year colleges who want to

- take an Earth science class or workshop;
- attend a professional scientific or science education meeting;
- plan an Earth science field trip; or
- purchase Earth science materials for classroom use.

A $750 grant and one-year NAGT membership will be awarded annually to one community college faculty member, one community college student, and a K–12 teacher. Educators who teach one or more Earth science courses or students actively pursuing a career in the Earth sciences are eligible.

Submit applications at the website *http://bit.ly/2DUwNSp* by **April 15.**

Apply Year-Round

Brinker International Grants A

Brinker International supports communities in which employees of its Chili's and Maggiano's Little Italy franchises work and live. Grants go to nonprofit organizations with programming in education, diversity, arts, social services, and health. Requests are reviewed on an ongoing basis, and it may take four to six weeks to review a request.

Visit *http://bit.ly/2A2riiE* for more information. ●

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

67TH ANNUAL
NSTA NATIONAL CONFERENCE ON SCIENCE EDUCATION

ST. LOUIS
MISSOURI
APRIL 11-14, 2019

Come as a group!

Register 4 attendees and get the 5th registration free!

Use code 5FOR4 to get the discount when you register at *www.nsta.org/stlouis*.

NSTA's Keynote Speaker will be former NASA Astronaut Scott Kelly. Kelly was mission commander on several expeditions to the International Space Station, including the 11-month space mission, during which he set records for the single longest space mission by an American astronaut. The goal of the mission was to better understand how the human body is affected by long-term spaceflight.

Don't miss his keynote presentation:
The Sky Is Not the Limit:
Lessons from a Year in Space.

Keynote Speaker

Courtesy of NASA/BillIngalls

Learn more at *www.nsta.org/stlouis*

#NSTA19

National Science Teachers Association

What's New

FROM U.S. GOVERNMENT SOURCES

U.S. Geological Survey (USGS)

Water Cycle Diagram for Kids E

Teach young elementary students about the water cycle with this printable, placemat-style diagram at the website *https://on.doi.gov/2SxTjZm*. It features simple illustrations and age-appropriate explanations, covering terms such as water vapor, precipitation, and evaporation and addressing each phase of the water cycle to help students understand the idea that the same water continuously moves around the Earth.

Women in STEM Report M H HE

Share this report in middle school, high school, and undergraduate college classrooms to expand horizons and introduce students to the diversity and potential of science, technology, engineering, and math (STEM) careers supported by the USGS. The report—*A Snapshot of Women of the USGS in STEM and Related Careers*—presents profiles of more than 70 women, past and present, engaged in STEM roles at the agency, including biologist, biological science technician, cartographer, chemist, ecologist, geographer, geologist, hydrologist, hydrologist technician, and physical scientist. The report also offers information about internships and other opportunities for high school and college students interested in pursuing careers at the agency, as well as links to information about the criteria needed for various USGS-related STEM careers. Access the report at *https://bit.ly/2RopXfx*.

National Aeronautics and Space Administration (NASA)

X-57 Electric Airplane: STEM Learning Module M

This STEM Learning Guide designed for grades 6–8 uses NASA's X-57 Maxwell electric airplane project as a phenomenon for learning about alternative energy, physics, engineering, and teamwork. The X-57 uses alternative energy and innovative design to fly without aviation fuel, with wings that provide five times as much lift as expected. The module has animations, hands-on activities, and digital challenges to teach students about the experimental electric aircraft and its unique capabilities. The activities address topics such as how batteries work and what causes them to fail; what the four principles of flight are; and how to collaborate as an expeditionary team of scientists. Download the module, which includes an Educator's Guide, at *https://go.nasa.gov/2F3MgB9*.

U.S. Department of Agriculture (USDA)

Wildfire Tracker M H

With the USDA Forest Service's Wildfire Tracker tool—available at *https://bit.ly/2CIRu37*—middle and high school educators can access maps and real data to teach students about current fire activity and conditions in the continental United States, Alaska, Hawaii, and Canada. It is estimated that 4 to 5 million acres of land are affected annually by wildfires, most of which occur in wildlands and forests. Working with the tracker data can help students study the impacts of the fires and learn about the factors involved in balancing the allocation of resources to reduce land damage and prevent future wildfires.

U.S. Mint Education Outreach

Celebrating Space and Coins K12

To commemorate the 50th anniversary of Apollo 11's Moon landing, the U.S. Mint Education Outreach department has released a collection of resources—including lesson plans, commemorative coins, games, and videos—to generate interest in space exploration and coins among K–12 audiences. For example, Sunny Symbols, a lesson for grades 4–6, teaches students the meaning of the Zia Sun symbol on the quarter, then provides opportunities to investigate relationships among the Earth, Moon, and Sun. Similarly, Amazing Auroras, a lesson for grades 7–8, uses the Voyageurs National Park Quarter as a starting point to learn how the Northern Lights are formed. Space Supply, an arcade-inspired game for all ages, challenges players to race the clock to deliver supplies to space colonies from a space shuttle, while dodging asteroids, space debris, laser beams, and UFOs.

Access these and other space/coin–themed resources at the website *https://bit.ly/2GeYO9M*.

National Oceanic and Atmospheric Administration (NOAA)

SOS Explorer Lite E M H

SOS Explorer Lite—a flat-screen version of Science On a Sphere (SOS), NOAA's large-scale Earth system science visualization tool used in museums and science centers—is now available for the classroom. Most appropriate for grades 5–12, the program features three preprogrammed, computer-based presentations (educational tours) for students: Earth System, which explores how heat and sunlight are connected to life, atmosphere, ice, rock, and water; Plate Tectonics, which focuses on understanding how earthquakes and volcanoes are related, and how the age of the seafloor can be explained by movement of Earth's

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

tectonic plates over time; and Wind and Weather, which examines basic concepts relating to the causes of weather, wind, and ocean currents.

The scripted tours incorporate the use of provided SOS datasets and feature text, guiding questions, pop-up web content, videos, and pictures/diagrams throughout. Lessons and extension materials accompany each tour. Learn more and download the program at *https://bit.ly/2Sj8TZs.*

Planet Stewards Education Project (PSEP) K12 HE

At *https://bit.ly/2RMpvnr,* K–college teachers can access a collection of environmental education resources for increasing students' (and their own) science literacy. The resources—curriculum, videos, games, websites, and other materials—were developed through various NOAA initiatives and affiliated groups, including National Ocean Service Education, Ocean Today, NOAA Citizen Science, NOAA Climate Portal, Data in the Classroom, National Marine Sanctuaries, and NOAA Coral Reef Conservation Program.

Teachers can also join the PSEP Education Community to participate in monthly webinars and stewardship–themed book club discussions. Past webinars (archived online) addressed topics such as Spanning Time and Spatial Scales: Modeling Our Planet's Climate; Connectedness in the Climate System; and Using Simple Models in Climate Change Education. The book club selections, which span literary genres and feature guided questions for each book, have included a nonfiction memoir, *A Hole in the Wind: A Climate Scientist's Bicycle Journey Across the United States* (Goodrich 2017); a climate-fiction thriller, *The Water Knife* (Bacigalupi 2015); and a children's science trade book, *The Magic School Bus and the Climate Challenge* (Cole 2010).

U.S. Bureau of Labor Statistics (BLS)

Interactive Periodic Table of STEM Occupations M H

Get details on STEM careers with this interactive periodic table highlighting STEM occupations instead of elements! Created as an accessible and engaging way for middle and high school students (and others) to learn about STEM occupations, the table features information (e.g., job duties, work environment, education, pay, job outlook, state and area data, similar occupations, and links) and short videos highlighting 24 STEM occupations, including chemist, computer information analyst, mechanical engineer, microbiologist, soil and plant scientist, geological petroleum technician, astronomer, physicist, and statistician. See *https://bit.ly/2TAPHmL.*

Peace Corps

Global Connections in the Classroom K12

Broaden K–12 students' understanding of other cultures and global issues by connecting with a Peace Corps volunteer in the field. Once matched, teacher and volunteer collaborate to decide how to share experiences with each other, such as through pictures, letters, or webchats or by co-authoring a blog. As the teacher's class communicates directly with the volunteer, students discover firsthand knowledge of a culture rather than secondhand knowledge as depicted in textbooks and other media. To learn more and register, visit *https://bit.ly/2DiZTJx.* ●

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.

CEDAM's Lloyd Bridges Scholarship K12

Through this program, one educator will join CEDAM International's Reef Environmental Education Foundation's Fish Survey Trip to Bonaire, an island that is a municipality of the Netherlands, to scuba dive, collect data, and participate in daily talks during July 27–August 3. Afterward, the educator will return home to share the experience with others and continue working to help protect one of Earth's most fragile ecosystems.

This scholarship is open to certified scuba divers who teach at the elementary or secondary level or work in education programs at aquariums, science centers, or other sites of informal or environmental education. The award is based on both merit and financial need, and covers the full cost of the trip, including a meals allowance and up to $1,200 reimbursement for air travel.

Apply by **April 1;** learn more at *http://bit.ly/2GDmILe.*

NASA's Texas Space Grant Consortium LiftOff Summer Institute E M H

This six-day (June 23–28) institute at NASA's Johnson Space Center in Houston features inquiry-based, hands-on science, technology, engineering, and math (STEM) activities and opportunities to work with NASA scientists and engineers. Teachers of grades 5–12 with one year of teaching experience, a willingness to share information with others, and U.S. citizenship are eligible. The program is free for Texas teachers.

To apply online, visit the website *www.tsgc.utexas.edu/liftoff.* Applications are due by **April 1.**

Penn State Interdisciplinary Materials Research Experience for Teachers Program K12

This six-week program provides hands-on research experience for STEM teachers, who are paired with faculty mentors in materials chemistry, physics, and nanotechnology. From June 24 to August 2, teachers engage in demonstrations, seminars, workshops, and activities, and do research that has applications to bioengineering, chemistry, electronics, materials science, optics, optoelectronics, physics, and the life sciences. Fellows present their research at a mini-symposium afterward.

K–12 preservice and inservice teachers are eligible to apply. Participants receive housing and travel expenses; preservice teachers are awarded a $6,000 stipend and inservice teachers get a $5,000 stipend. Apply by **April 15** at *http://sites.psu.edu/materialsret.*

Genetic Technology for All Classrooms National Academy H

The HudsonAlpha Institute for Biotechnology sponsors this five-day professional development academy for high school teachers, who learn how to incorporate genetics, genomics, and biotech content; common complex disease; and agricultural genomics in the classroom. Participants receive 40 hours of training, $800 worth of kits and materials, and experience using some of HudsonAlpha's digital resources.

This year's academy takes place July 22–26 in Huntsville, Alabama. Register online by **April 30** at the website *https://hudsonalpha.org/gtacnational.*

American Radio Relay League's Teachers Institute E M H

This expenses-paid professional development seminar is offered at two levels: Introduction to Wireless Technology (TI-1) and Wireless Technology Remote Sensing and Data Gathering (TI-2).

- TI-1 provides tools and strategies for teachers who want to learn more about wireless. The seminar covers basic electronics, understanding signals, radio applications in the classroom, microcontrollers, and robotics. It also has options for those who want to start radio clubs and find career and scholarship opportunities for students and grants for their own programs.
- TI-2 is the advanced institute. It provides hands-on instructional resources and equipment and covers sensor basics, various deployment methods, and an introduction to satellite communications.

Applicants must teach in a school, college, or educational organization serving students in grades 4–12 or lead a school-affiliated enrichment program in an official capacity. Apply by **May 1;** see *http://bit.ly/2DyyDa1.*

University of Cambridge's Science Summer Programme H HE

Located in the United Kingdom, the university's Science Summer School offers courses for teachers, other professionals, and undergraduate and graduate students. One-, two-, and four-week options are available. Term 1 (July 7–20) features courses in microbiology, physics, genetics, and more. Term II (July 21–August 3) has courses on nanobiotechnology, cryptography, and sustainability, among others.

Those with a strong interest in science but little formal training may apply, though some courses require knowledge of differential calculus, some integral calculus, and fluency in high school level algebra and geometry. Visit *http://bit.ly/2SepNbG* for details and requirements for each course. Register by **June 24** for Term 1 and by **July 8** for Term II.

Modeling Workshops M H

The American Modeling Teachers Association sponsors these yearly workshops for middle school science and high school physics, chemistry, biology, and physical science teachers. Over two to three weeks, participants receive course materials and work through activities as they practice guided inquiry and cooperative learning.

Workshops are currently scheduled in Alabama, Arizona, California, Florida, Illinois, Indiana, Kansas, Kentucky, Maine, Massachusetts, New York, North Carolina, Ohio, and Texas. At most workshop sites, first-time participants qualify for a free one-year AMTA membership. Program dates vary by location. See *http://bit.ly/2DV1Ddm.*

Teaching the Genome Generation Summer Course and Program H

This residential short course for high school teachers will take place June 23–28 at Bowdoin College in Brunswick, Maine. Preference will be given to teachers from Connecticut, Massachusetts, Maine, New Hampshire, Rhode Island, and Vermont because the primary goal of this National Institutes of Health–funded program is to enhance genetics education in New England. Teachers from these states can attend at no charge.

Participants will receive the content knowledge; hands-on, inquiry-based teaching strategies; and resources needed to teach genetics and personalized medicine. Teachers will perform experiments in a research lab and receive ongoing support from the program throughout the following school year.

Participants receive a certificate for 40 contact hours, and teachers from New England also will earn a $500 stipend. Apply at *https://bit.ly/2IG2PCu.*

Crow Canyon Archaeology Research Program A

In this program, teachers learn excavation techniques while digging alongside archaeologists at the Haynie site, an ancestral Pueblo village located just northeast of Cortez, Colorado. Participants also work in the archaeology lab, washing, identifying, and analyzing artifacts; explore nearby Mesa Verde National Park; and hear talks on current topics in Southwestern archaeology. Sessions will take place during June 2–8 and June 9–15. Register online at *https://bit.ly/2BvU5MG.* ●

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

BLICK ON TV

It's the End of the World, Yet Again

By Jacob Clark Blickenstaff

Netflix has been producing more and more original content, and a significant portion of it has been science fiction. (Check out my past review of the Netflix reboot of *Lost in Space* from 2018.) A recent addition is the film *Io* (2019), which brings some real star power to a post-environmental apocalypse storyline. Only three actors have significant screen time, and two of them are quite well known: Margaret Qualley has the lead as Sam, a scientist; Danny Huston plays her father, who is also a scientist; and Anthony Mackie plays Micah.

It isn't clear exactly when the film is set, but the technology appears present-day, so my guess is the not-too-distant future. Some sort of toxicity in the air has rendered most of the Earth uninhabitable. The lethal element stays at relatively low elevations and causes flames to burn purple. To escape the deadly air, 100 rockets left the planet for a space colony near Jupiter's moon, Io. The colony is there because scientists have developed a way to harvest geothermal energy from other planetary bodies. (Io is very geologically active, so the science makes some sense.)

Sam stayed on Earth because she was trying to find species that could adapt to the new atmosphere and perhaps make the planet more habitable in the future. She has a romantic e-mail relationship with Io colonist Elon (played by Tom Payne). We see much of how Sam survives by herself in a mountaintop observatory with a greenhouse, a lab, and beehives. She occasionally travels down to an abandoned, increasingly overgrown city, wearing an oxygen mask to survive in the toxic atmosphere.

Every day, Sam broadcasts a message her father recorded asking other survivors to make contact. About halfway through the film, Micah arrives by helium balloon. One more rocket will launch to the Io colony in just a few days, and Micah wants Sam to accompany him on that rocket.

Io has a lot of questionable science, and since its release, viewers have been posting their observations on the Internet Movie Database. I'll note a couple of pet peeves of mine, but I also will mention some scenes in which science teachers can take positive messages away from the film.

Space Is Big

I mentioned this in my review of *Lost in Space,* but it bears repeating. It is hard for the human brain to grasp just how big space is, and that leads screenwriters to give characters some wacky lines to say.

In *Io,* Elon writes to Sam that leaving Earth gives humanity a chance to eventually colonize "…a whole new galaxy." What I'm sure the writers

---

National Earth Science Teachers Association

2019 St. Louis NSTA Conference

We have a number of exciting sessions! To find our sessions, enter ***NESTA*** *as the keyword when searching events online at NSTA's session browser for the conference. On* ***Friday, April 12*** *and* ***Saturday, April 13,*** *we have a series of sessions all in* ***Annex*** *of the* ***America's Center convention complex.*** *Don't miss out on our Share-a-Thons and the events below!*

Friday, April 12

- 2:00 – 3:00 pm **AGU-NESTA Sponsored Lecture**

Finding Our Way: The Science Behind Today's GPS Revolution

Speaker: Dr. Theresa Damiani. Getting from place to place is a daily activity for most people. Now, many of us use the U.S. Global Positioning System (GPS) through our smartphone, car, or other navigation device to do that. This talk explores the science of GPS and mapping, how it allows us to quickly and easily find our way through the world, and the sometimes, unexpected ways in which it is revolutionizing our society.

Location: **Ferrara Theatre, America's Center convention complex**

Saturday, April 13

- 3:30 – 4:30 pm **NESTA's exciting Rock, Mineral, and Fossil Raffel!**
  Location: **Annex, America's Center convention complex**

Saturday, April 13

- 6:30 – 8:00 pm **Friends of Earth Science Reception**
  Location: **Crystal Ballroom, Marriott St. Louis Grand**

Visit NESTA at **nestanet.org**

meant was "…a whole new solar system," because that would mean traveling to another star with a habitable planet orbiting it. That's difficult enough, since stars are at least tens of light years away from Earth. (A light year is the distance light travels in one year, more than 9 trillion kilometers.)

Humans probably won't have the technology to travel to another solar system for at least 100 years, and that is "only" traveling to a nearby star. Galaxies that are "close" to us are 100,000 to 2 million light years away.

At other moments in the movie, the writers imagine that a relatively small Earth-based telescope can get a super-clear, close-up image of Jupiter. Sam looks through her telescope and is able to see the space colony orbiting Io. Although Io is one of the four moons of Jupiter that can be seen from Earth with binoculars or a small telescope, it is not possible to get a close-up of it from Earth. One of the best images of Jupiter taken by the Hubble Space Telescope (HST) is available at *https://bit.ly/2t7Lnj5*. While it is beautiful and very detailed, not even the HST could take a close-up of Io.

Science Notebooks

Though the writers had difficulties with the scale of the solar system, scenes of Sam collecting samples and working in her laboratory are good for showing a couple of science practices. First, Sam keeps a detailed laboratory record—a handwritten notebook of her procedures and the results of her experiments. Second, she seems methodical about identifying samples and labeling them carefully. For many field scientists, careful notation of when and where specimens were collected is essential to their work. Cross-referencing samples with the pages in the laboratory record is also key to documenting every experiment.

Science and Humanities

During Sam's first trip into the abandoned city, we learn that she is interested in mythology. She regrets not seeing an art exhibit titled Modern Mythology that was on display just before the exodus from Earth. She asks Micah to tell her about the story that inspired a particular painting, and in the end, she sees herself as a modern version of a mythological character (but no spoiler here to tell you which one). This scene gives science teachers an opportunity to collaborate with language arts teachers who cover the Greek myths. It is perhaps worth noting that Io means "moon" in Greek, and the moon of Jupiter was named in the 17th century.

Though *Io* has some very nonscientific moments, it offers opportunities for teachers to discuss good scientific practices and the scale of the solar system, and make connections to the humanities. ●

This film is rated TV-14.

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

ASK A MENTOR, **Advice Column**

Coping With Challenges

Have you ever been challenged by student teachers and the methods they bring to the classroom that differed from yours? Have students ever favored your student teacher over you? How did you react?

— R., Ohio

On a few occasions, I did learn some new activities or labs which I would gladly discuss with the student teacher and look at employing myself. I think because I dedicated myself to keeping current on new ways of teaching and tried many different techniques throughout my career, there weren't many times when a student teacher presented a completely new way to teach something. In fact, even though I and many other teachers have switched to student-centered approaches, some preservice teachers still start in a teacher-centered manner, much in the way they themselves had been taught in school!

My ego took quite a blow whenever students preferred my student teacher and moaned when I took over the class again! I would brush it off, justifying it as their attraction to someone younger (and better looking). If I only had to teach for five weeks with a reduced workload, I could be a rock star, too, I told myself. However, I also had to acknowledge that some were better than me and some will always be better than me. And that's a good thing for everyone. If teachers don't improve, then our education doesn't move forward. And that means that we stop progressing.

Better said by John Dewey: *"If we teach today's students as we taught yesterday's, we rob them of tomorrow."*

I am currently reading a book about childhood trauma in the classroom. How do we as teachers help students who have had a traumatic experience?

— A., Iowa

I discovered the biggest hole in my teacher preparation when after 25 years of teaching, a tragedy outside of school deeply affected students in my classroom. I had no idea how I was supposed to respond. I did the only thing I could: I asked for help. Guidance counselors and school psychologists are better trained to help with tragic situations. I sought out their advice and kept them apprised of what I observed in my classroom.

My other students didn't know if they should talk to the traumatized students, if they could laugh or joke around, or if they could just go about their lives as usual. A classroom is a micro-community that we cultivate as teachers. This community was hurting, and I asked if one of the specialists could talk to my classroom.

This event greatly affected me, too. Thankfully, my wife helped me cope.

Learning doesn't mean much to someone when they are dealing with a horrible situation. Give all the support you can by easing off and allowing them space and time. When it comes to class and homework, grading, and testing, remember your gradebook is *your* gradebook. Be a caring adult.

So, my advice to you is this:

- Seek the help and advice of specialists.
- Remember that other students may be affected indirectly.
- Observe and report what you are seeing to the appropriate counselors.
- Take care of yourself. Find a confidant or seek out personal help. Almost all teacher organizations have helplines.
- Be compassionate and flexible in teaching and grading.

When they can, traumatized students may be able to pick up the pieces, and you should be there to hand those pieces to them with compassion and understanding.

I hope you never need this advice.

I hope that 20 years from now, I can still get excited about being a part of kids' lives. I am looking for suggestions on how to enjoy teaching for a long time.

— J., Missouri

One of the best compliments I ever received was in my last year of teaching: "I walked past your classroom this morning, and I just hope I have the same passion when it's my time to retire!" I really don't know how to address your question without talking about my approach to my career.

I always expected that some students in every class would pose difficulties, and planned accordingly. Similarly, I could only expect a few students to actually be enthused about my course. This led me to focus on developing lifelong learners, not scientists or engineers. I shared my passion for learning and tried to make learning fun to accomplish this. I dedicated myself to creating fun environments, being a bit zany, and always being passionate about what I taught, which incidentally made it fun for me.

I embraced change and kept current in my subjects and teaching approaches (lifelong learning). I also tried to distance myself from colleagues who were generally negative and frequently complained. Sure, we all have bad times and need to vent, but to live in a negative funk all the time is not good for anyone.

And I had a lot of hobbies.

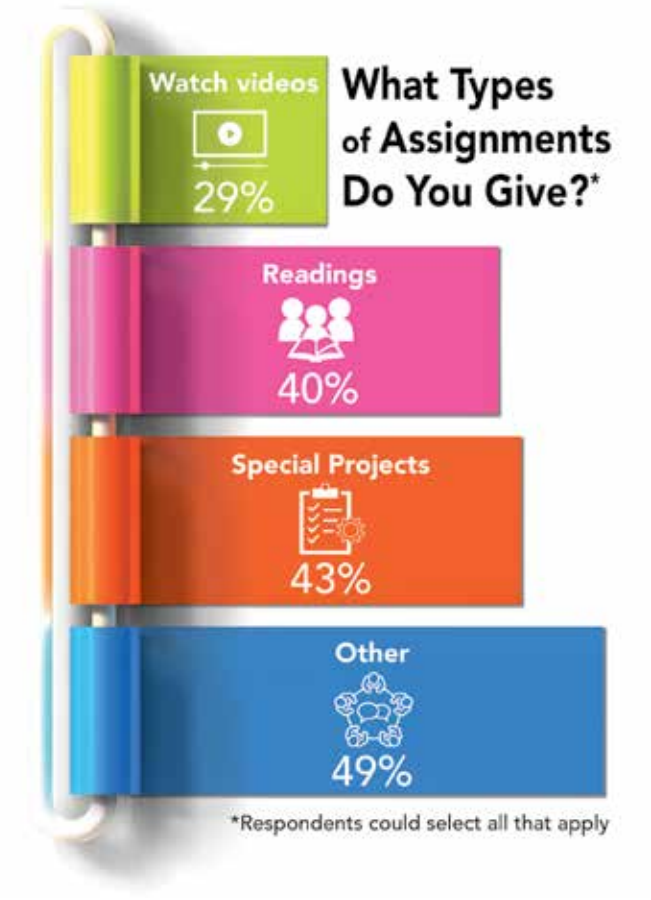
Hope this helps!

Check out more advice on diverse topics or ask a question of Gabe Kraljevic from Ask a Mentor at http://bit.ly/2FpGb1u, *or e-mail* mentor@nsta.org.

Should Work Be Assigned During School Breaks?

Just ahead of Spring Break across most of the United States, *NSTA Reports* asked educators to share their thoughts on assigning students work over long breaks. The concept was not popular, with 72% reporting they don't assign students work during these breaks. Of those who do, less than half (48%) require it, 28% offer it as an extra credit assignment, and 24% give it as an opportunity to extend learning without credit.

The idea does not appear to be popular with students, either. Only 19% of teachers who assign work over breaks reported more than 90% of their students complete it; 54% say fewer than half do. Forty-three percent said they assign special projects over a break; 40%, readings; and 29%, videos to watch. Other assignments include creating models, making up work, keeping diaries with photos of the geology of places visited, taking practice exams, or doing experiential assignments such as watching an eclipse.



Here's what educators are saying about assignments over breaks:

The advantage is that it gets kids outdoors and often into nature, off of video games and social media, and provides an opportunity to think more deeply about one subject. The disadvantage is that some students are not self-motivated or who have parents who do not support or do not understand the value of deep learning over time.—*Educator, Elementary, Middle School, California*

I don't give work over a break, unless the student has a lot of make-up work due to illness or absences, because I work them pretty hard all year. —*Educator, Middle School, Arkansas*

Projects over break give a good home-to-school connection.—*Educator, Middle School, Oregon*

It allows students to work on their own schedule, which is good, but it puts students who have commitments at a disadvantage.—*Educator, High School, New York*

Advantage: [S]tudents [are] more aware of the geology of the places [they] visited.—*Educator, High School, Washington*

There are three schools of thought: 1) Most kids are bored over vacations, and parents want something for them to do; 2) Some kids are completely busy during vacations and have little time or need a break from school, so [they] don't welcome work; and 3) It keeps them intellectually active, and they don't lose ground during this break from school. I like the latter and use the time as an extension to add to their curiosity and engagement. —*Educator, Middle School, Connecticut*

If students are doing work over a break, this is an opportunity, as they either missed it and they are buying time to make it up when they are not doing other schoolwork, or they are having an opportunity to revise that which was unsatisfactory.—*Educator, Middle School, New Jersey*

Advantage: [It] keeps the topic covered just before break fresh in students' minds. Disadvantage: [It is] rarely done, often last-minute or copied just before class. Disrupts the whole idea of "break" and interferes with family plans.—*Educator, High School, Manitoba, Canada*

Students need breaks to synthesize information and just relax. Research shows that kids do better when they have unplugged rests from learning that fosters family and community relationships.—*Educator, Elementary, Middle School, Informal Education Setting, Arizona*

While I appreciate that it's a long time to spread out the work, few students work that way; they wait until the last night and try to pull it together. —*Educator, High School, Virgin Islands*

I think that it is a detriment to students to assign work over break. Students need time to decompress. They can do other activities such as getting outside time, which are also needed for brain development. —*Educator, Middle School, High School, New Hampshire*

I only see disadvantages. Students already spend *too* much time in school, and doing homework, to consider giving them work over holidays. —*Educator, High School, Nuevo Leon, Mexico*

Advantage is preparing students to keep concepts fresh. Disadvantage is that we know they don't complete it.—*Educator, High School, Indiana*

Advantages: [It r]einforces and refreshes content from class. Disadvantages: [It] takes away from leisure time, competes with other classes, frustrates families.—*Educator, Middle School, High School, Minnesota*

Advantages include they are less rushed at the end of the semester; they can spend more quality time focusing. Disadvantages only occur when they cannot find access to the internet, but then accommodations are made for them.—*Educator, Institution of Higher Learning, Illinois*

I think it takes away from family time. I do encourage students to visit museums or [do] outdoor activities. —*Educator, Middle School, Ohio*

Some parents expect students to have homework. It's odd that these parents don't also require the student to *do* the homework, but some parents are disappointed when none is assigned. Other parents are *very* upset when homework is assigned over break, but those same parents want me to give the student all their homework when the *parent* decides to take a vacation during school. I can't get parents (or students) to understand that most of the learning we do occurs *in the classroom*, not on homework or other outside-the-classroom assignments. —*Educator, High School, Michigan*

Assigning work over a break defies the purpose of a break. I don't do it, and I tell my students to forget about school for the duration of the break. Humans need breaks.—*Educator, Middle School, Illinois*

It's a needless imposition that ignores the need for balance between school and life.—E*ducator, Middle School, Washington* ●

#onlyatNSTA

Remember: Your NSTA membership includes the valuable benefit of deep discounts on conference registration.

Only at NSTA can you get these savings and top-notch professional development.

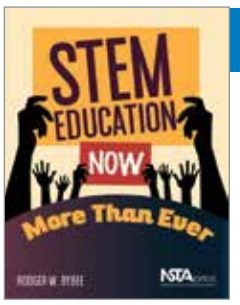
Visit *www.nsta.org/conferences*

to register for one of our upcoming 2019 conferences.

St. Louis	San Francisco	Salt Lake City	Cincinnati	Seattle
April 11-14	July 24-26	October 24-26	November 14-16	December 12-14

Learn about all your membership benefits at *www.nsta.org/membership*

NSTA National Science Teachers Association



NSTA PRESS: *STEM Education Now More Than Ever*

STEM Education Now More Than Ever

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 STEM Education Now More Than Ever, *by Rodger Bybee, edited for publication here. To download the full text of this chapter, go to* https://bit.ly/2Uyr4XX. *NSTA Press publications are available online through the NSTA Science Store at* www.nsta.org/store.

Why Do We Need an Integrated Approach for STEM Units?

Perhaps the most fundamental reason for introducing an integrated approach in school curricula is that it can provide students some opportunities to learn to apply knowledge, skills, and abilities from science, technology, engineering, and mathematics (STEM) disciplines in contexts close to what they will experience in the future. This reason alone should be enough to give integrated STEM units a fair and thorough consideration for inclusion in school programs. From an education point of view, an integrated approach presents the opportunity to introduce students to a broader range of subject matter in all grades. An integrated approach softens disciplinary boundaries without sacrificing the basic crosscutting concepts and practices and presents an entry into STEM disciplines without requiring a student to understand one discipline before learning another. In an integrated approach, we avoid statements such as, "You have to understand physics before Earth science makes sense," or "You may have to take chemistry before biology."

What Are the Implications of Integrated STEM for Schools and Teachers?

Introducing integrated STEM units into the school curriculum will not be easy. An integrated STEM unit is different from typical units and requires a considerable amount of forethought, planning, and support. By definition, an integrated approach suggests that there could be a range of learning outcomes and instructional strategies. By design, the learning outcomes of integrated STEM units may include understanding content of science, technology, engineering, mathematics, and social issues. Instructional strategies may incorporate project-based learning, investigations, historical case studies, reading, internet research, and educational technologies.

Implementing integrated STEM instructional materials is not as simple as replacing the current biology course with a new biology course. The challenges of implementing an integrated STEM unit may parallel those experienced by the Earth Science Curriculum Project (ESCP) in the late 1960s and early 1970s. With ESCP, the science education community introduced a new subject into school science programs. This challenge was complicated by the fact that few teachers were actually prepared to teach Earth science at all, much less use an activity-based program. Similarly, with integrated STEM units, there will be a need to identify a place for the units in school programs. Teachers in all grades are the best people to identify locations for the STEM units. Elementary teachers should consider coordinating units across the elementary grades, and middle and high school teachers might consider capstone units for their courses.

Before engaging in further discussions of integrated STEM units, it is important to address teaching and learning. Too often, educators go right from issues to content and curricular emphasis without reviewing what, it seems to me, is basic to our profession: how students learn and what we can do to enhance learning through the design of curriculum materials and use of instructional strategies.

Addressing Learning and Teaching of STEM

How Students Learn

Enhancing student achievement will rely on developing units based on research that has advanced our understanding of how students learn. The National Research Council (NRC) reports *How People Learn: Brain, Mind, Experience, and School* (Bransford, Brown, and Cocking 1999), *How People Learn: Bridging Research and Practice* (Donovan, Bransford, and Pellegrino 2000), and *How Students Learn: Science in the Classroom* (Donovan and Bransford

2005) presented a major synthesis of research on human learning. I also will note a volume I edited for the National Science Teachers Association that had the intention of presenting these findings for science teachers (Bybee 2002). Three findings from the NRC reports have both a solid research base and clear implications for developing integrated STEM units. The following statements come from *How People Learn: Bridging Research and Practice:*

> *Students come to the classroom with preconceptions about how the world works. If their initial understanding is not engaged, they may fail to grasp the new concepts and information that are taught, or they may learn them for purposes of a test but revert to their preconceptions outside the classroom.* (Donovan, Bransford, and Pellegrino 2000, p. 10)

The curricular implications of the first finding are related to the structure of experiences that draw out students' current understandings, bring about some sense of the inadequacy of their ideas, and provide opportunities and time for them to reconstruct their ideas so they are consistent with basic STEM concepts.

A second finding refers to the conceptual foundation of a curriculum:

> *To develop competence in an area of inquiry, students must (a) have a deep foundation of factual knowledge, (b) understand facts and ideas in the context of a conceptual framework, and (c) organize knowledge in ways that facilitate retrieval and application.* (Donovan, Bransford, and Pellegrino 2000, p. 12).

Integrated STEM units should incorporate fundamental knowledge and be based on, and contribute to, students' development of a strong conceptual framework. Research comparing performance of novices and experts, as well as research on learning and transfer, shows that experts draw on a richly structured information base. Although factual information is necessary, it is not sufficient on its own. A mastery of concepts that allow for deep understanding and a framework that organizes facts and information are essential to developing expertise. Finally, there is a finding related to students' abilities involving reflective thinking:

> *Students can be taught strategies that help them monitor their progress in problem solving.* (Donovan, Bransford, and Pellegrino 2000, p. 13)

Research on experts' performance suggests that they reflect on and monitor their understanding of a science investigation or design problem. They note any requirement for additional information, the alignment of new information with what is known, and the use of analogies that may provide insights and advance their understanding. For experts, there are often internal conversations grounded in the processes of inquiry or design. This finding has clear implications when teaching STEM using an integrated approach.

Developing an integrated STEM unit should acknowledge the fact that students already have ideas about objects, organisms, and phenomena in the natural world and materials, structures, and problems in the designed world. Many of the ideas that students express do not align with discipline-based or crosscutting concepts. The challenge for teachers is not so much the fact that students have these misconceptions, but how to change those current conceptions to an understanding grounded in STEM disciplines. In contrast to many contemporary programs, research on learning indicates that curriculum and instruction should include a clear conceptual framework as well as facts and information. Finally, students can enhance their own learning through encouragement and opportunities for self-reflection and monitoring; these skills can be taught in the context of the proposed STEM units. ●

Between now and March 31, 2019, get free shipping when you order $75 or more of NSTA Press and NSTA Kids books. Use promo code BOOK19 when you checkout in the online Science Store.*

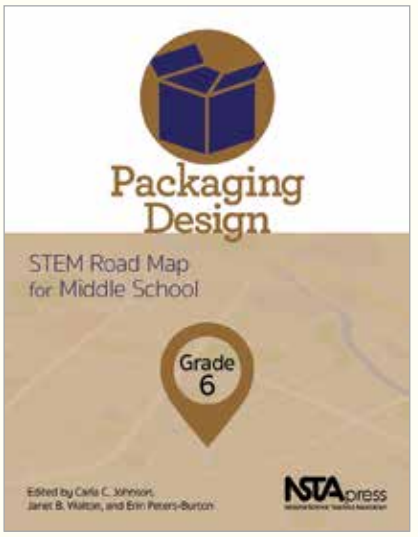
*Offer valid only on orders for NSTA Press and NSTA Kids books or e-books purchased in the online NSTA Science Store and shipped to U.S. addresses. May not be combined with any other offer.

Here at NSTA, we are having our own MARCH MADNESS

WITH A SWEET CATALOG OFFER

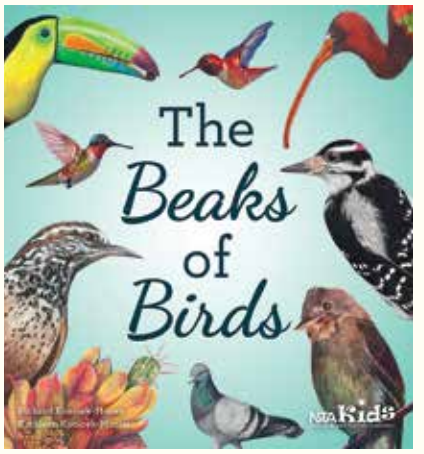
I GET SO MANY GREAT IDEAS FROM NSTA BOOKS!

—BRANDI W.



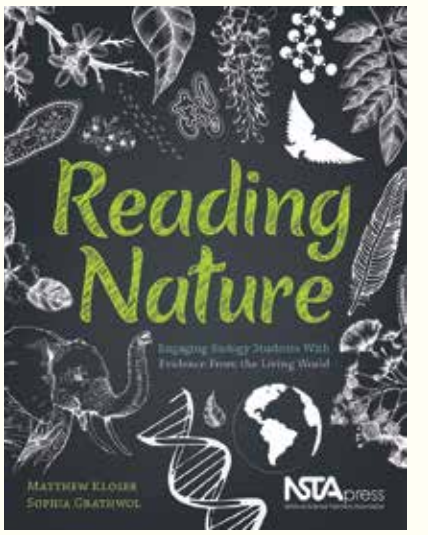
Grade 6

Book: Member Price: $19.96 | Nonmember Price: $24.95
E-book: Member Price: $14.97 | Nonmember Price: $18.71
Book/E-book Set: Member Price: $23.95 | Nonmember Price: $29.94



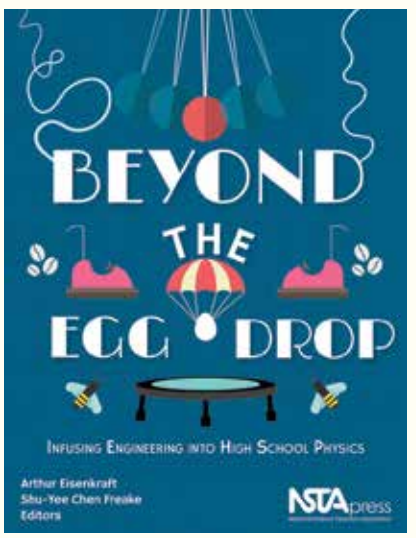
Grades 3–5

Book: Member Price: $10.36 | Nonmember Price: $12.95
E-book: Member Price: $7.77 | Nonmember Price: $9.71
Book/E-book Set: Member Price: $12.43 | Nonmember Price: $15.54



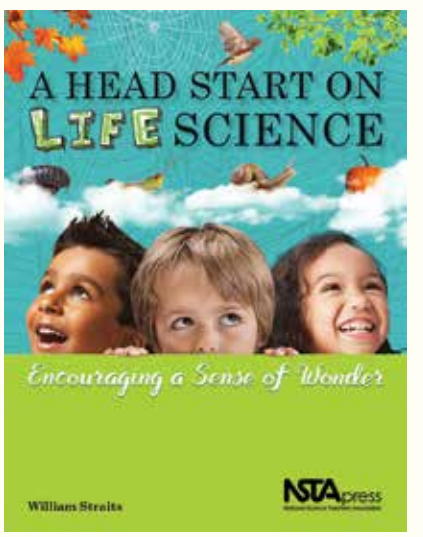
Grades 6–12

Book: Member Price: $19.96 | Nonmember Price: $24.95
E-book: Member Price: $14.97 | Nonmember Price: $18.71
Book/E-book Set: Member Price: $23.95 | Nonmember Price: $29.94



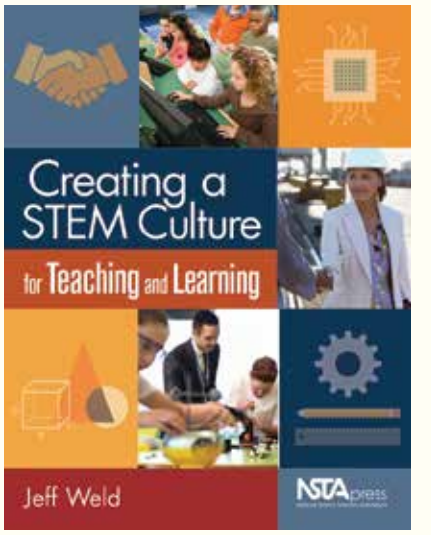
Grades 9–12

Book: Member Price: $35.96 | Nonmember Price: $44.95
E-book: Member Price: $26.97 | Nonmember Price: $33.71
Book/E-book Set: Member Price: $43.15 | Nonmember Price: $53.96



Grades PreK–2

Book: Member Price: $27.96 | Nonmember Price: $34.95
E-book: Member Price: $20.97 | Nonmember Price: $26.21
Book/E-book Set: Member Price: $33.55 | Nonmember Price: $41.94



Grades K–12

Book: Member Price: $30.36 | Nonmember Price: $37.95
E-book: Member Price: $22.77 | Nonmember Price: $28.46
Book/E-book Set: Member Price: $36.43 | Nonmember Price: $45.54

To place an order or download a free chapter, visit

WWW.NSTA.ORG/STORE

National Science Teachers Association

(All dates are deadlines unless otherwise specified.)

April 1—***Science and Children* (*S&C*),** NSTA's peer-reviewed journal for elementary science education, is looking for creative, effective strategies for having students take science home and extend their learning. **Submit your manuscript on "Take-Home Science"** for consideration for the January 2020 issue by today. General-interest manuscripts may be submitted at any time. Read the call for papers at *http://bit.ly/2StzkHq*.

April 1—Share how you're **"Using Technology for Instruction and Assessment"** with your middle level colleagues by submitting an article on that theme to ***Science Scope,*** NSTA's middle level journal, by today. What are your favorite apps for students to use? What online programs have challenged your students to develop their critical-thinking skills? General-interest manuscripts, as well as manuscripts focused on making, technology, practical research, and more, are accepted anytime. Read the call for papers at *http://bit.ly/2zOZUUA*.

April 3—Don't miss the first session of the **Picture-Perfect STEM Online Course** with the award-winning authors Karen Ansberry and Emily Morgan. The online course features 10 hours of live training; participants' choice of *Picture-Perfect Science STEM Lessons K–2* or *Picture-Perfect Science STEM Lessons 3–5* e-Book; and a digital learning packet. Graduate credit is available. Registration costs $175. For more information, visit *https://bit.ly/2zOlVTx*.

April 11—**NSTA's National Conference on Science Education** opens today in St. Louis, Missouri, and runs through April 14! NSTA members and members of the Science Teachers of Missouri can register for the conference for $350. Don't miss keynote speaker and retired astronaut Scott Kelly, hundreds of sessions on three-dimensional science education, cross-curricular connections, and more. To register or for more information, visit *www.nsta.org/stlouis*.

May 1—Do your students "tinker" in science? Is it different from hands-on engineering? *S&C* will explore these and related topics in the February 2020 issue. Share **your manuscript on "Tinkering vs. Engineering" with elementary students** by today for consideration. General-interest manuscripts may be submitted at any time. Read the call for papers at *http://bit.ly/2StzkHq*.

May 13—Register for the **Eighth Annual STEM Forum & Expo** hosted by NSTA now to maximize your savings. The STEM Forum will be held July 24–26 in San Francisco, California. Conference strands focus on Lower Elementary/Early Childhood; Upper-Elementary; Middle Level; High School; Building STEM Ecosystems: Community Partnerships; and Post-Secondary. Members of NSTA and our STEM Partners who register by this earlybird deadline pay $205. For more information and to register, visit *https://bit.ly/2GeGvke*.

May 28—Don't miss today's earlybird deadline for the **Picture-Perfect Workshop** June 18–19 at the **University of Tennessee**, Knoxville. Karen Ansberry and Emily Morgan, the award-winning authors of the Picture-Perfect book series, will guide participants as they explore the use of picture books in elementary science, technology, engineering, and mathematics (STEM) education and model lessons. Attendees also will receive *Even More Picture-Perfect Science Lessons; Picture-Perfect STEM Lessons, K–2;* and *Picture-Perfect STEM Lessons, 3–5*. The workshop will take place at 8 a.m.–3 p.m. both days. Earlybird registration costs $449 for the basic workshop; with the train-the-trainer component and materials, the earlybird price is $999. For more information or to register, visit *https://bit.ly/2zOlVTx*.

June 4—It's your last chance to save on registration for the **Picture-Perfect Workshop in Winston-Salem**, North Carolina, June 25–26. Picture-Perfect authors Karen Ansberry and Emily Morgan will facilitate the workshop on using picture books to teach elementary STEM. Attendees also will receive *Even More Picture-Perfect Science Lessons; Picture-Perfect STEM Lessons, K–2;* and *Picture-Perfect STEM Lessons, 3–5*. The workshop will take place at 8 a.m.–3 p.m. both days. Earlybird registration costs $449 for the basic workshop; with the train-the-trainer component and materials, the earlybird price is $999. For more information or to register, visit *https://bit.ly/2zOlVTx*. ●

Celebrating 75 Years at NSTA

2003 NSTA established members-only e-mail lists, allowing educators to share challenges, advice, and resources with colleagues around the country 24 hours a day, seven days a week.

Index of Advertisers

National Science Teachers Association
1840 Wilson Boulevard
Arlington, Virginia 22201

NON-PROFIT ORG.
U.S. Postage Paid
CAPITOL HEIGHTS, MD
PERMIT NO. 953

Allan Elected NSTA President

NSTA members elected Elizabeth Allan, a professor in the Department of Biology at the University of Central Oklahoma, as the association's 2020–2021 president.

"NSTA should and can be the unifying force bringing together multiple groups supporting teachers as we work to fulfill the vision of science for all. Through cooperation, we will magnify the impact of our individual endeavors," Allan says. "If we all work together—preK–12, higher, and informal education—high-quality science for all is attainable. As president, I hope to foster collaborations that will provide the most scientifically accurate, developmentally appropriate resources for high-quality science instruction."

Also elected to NSTA's Board of Directors are Sharla Dowding, science coordinator with the Wyoming Department of Education, as the Coordination and Supervision Division Director; Brenda Walsh, chemistry teacher at Eden Prairie High School in Eden Prairie, Minnesota, as High School Level Division Director; and Lisa Kenyon, associate professor in the Departments of Biological Sciences and Teacher Education at Wright State University in Dayton, Ohio, as College Level Division Director.

In addition, NSTA members in six districts elected new district directors. They are Florentia Spires, District III (Delaware; Washington, D.C.; Maryland); Brian Butler, District V (Alabama, Florida, Georgia, Puerto Rico, the Virgin Islands); Scott Johnson, District IX (Minnesota, North Dakota, South Dakota); Jodi Bahr, District XI (Kansas, Missouri, Nebraska); Lesley Urasky, District XV (Idaho, Montana, Wyoming); and Jeanne Chowning, District XVII (Alaska, Oregon, Washington). ●