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NSTA Reports
National Science Teaching Association

DENISE KUEHNER

Learning How to
Teach Science 25

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75th NSTA ANNIVERSARY

Science Education in Prison

SHONA SIMPSON CCC STAFF

Students at Chillicothe Women's Correctional Center in Chillicothe, Missouri, examine lunar rocks from NASA in Mary Haskins' environmental science course.

When Rockhurst University in Kansas City, Missouri, started an education program last spring at the Chillicothe Women's Correctional Center, biology professor Mary Haskins says she "jumped" at the chance to teach a semester of environmental science there. "The work is incredibly rewarding and truly life changing for all involved, especially the offenders," she maintains.

"We provide courses…to both the offenders and to the [Chillicothe] staff" in a separate class because "most staff don't have college degrees, and no colleges are nearby….It's an opportunity for both groups to earn college credit," Haskins explains.

Only 20 prisoners were permitted to take Haskins' course. Chillicothe is a mixed security prison, so Haskins taught both violent and nonviolent offenders ranging in age from 20 to 50. She says it is standard procedure for all volunteers to wear "a body alarm for protection…and there was a camera in the room so our activities could be monitored."

One challenge Haskins faced was equipment approval. For her spring 2019 course, she had to have a November "'show and describe' session with the warden to identify 'types' of equipment that might be used." In December she submitted "a complete equipment list for all of the January 2019 labs (types of equipment and numbers of all items)." She had to submit equipment lists each month for the next month's labs thereafter.

"I was also allowed to show environmental DVDs, but the lights had to stay on, so image contrast was a challenge," Haskins reports. And after clearing security to enter the prison, "I didn't want to forget anything because I couldn't run back to the university to pick it up.

"In May, I wanted to bring in lunar rocks and meteorites from NASA, a hammer, 40 pounds of flour, a laptop, a projector, and [many] other items. I made that request in March, thus allowing my long list of equipment ample time for analysis and approval, since laptops were not traditionally allowed. All of the items, including the hammer, were approved (it may have helped that I also had five assistants that day, so they could be assured the activities and equipment would be monitored). All items were counted each week by the guard at the front desk and checked against the memorandum of agreement for entry/exit," Haskins relates.

"The limitations are restrictive and require creativity [and] a willingness to substitute some alternative labs for traditional ones," she observes. One successful project was a benthic research project. "I placed leaf packs in a river in November, retrieved them in January, and hauled the leaf packs to the prison for analysis. Students then sorted and analyzed the data, and wrote research papers on their results."

Sometimes Haskins' students surprised her. "Several offenders wanted additional information and used their telephone time to ask family

See Science Ed in Prison, pg 4

MONEY 101: WIDENING ASSET GAP HIGHLIGHTS NEED FOR FINANCIAL PLANNING PG 12


This program is definitely worth the time, money and effort. This program was very useful in the knowledge and skills that I was able to use in my own classroom. Plus, there is the benefit of going up on the pay scale.
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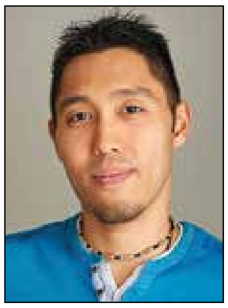
COMMENTARY: **Bryan Henderson and Earl Aguilera**

On the Screen, Beneath the Screen, Beyond the Screen: Using Educational Technology to Support Argumentation

By Bryan Henderson and Earl Aguilera

Bryan Henderson



PERRINE PHOTOGRAPHY, LLC

Earl Aguilera

You pose a question to push students' thinking, and wait for their responses. Without fail, your most diligent student quickly raises her hand. She responds with eloquent words; a few students nod; some jot down notes. No one shares follow-up questions or other ideas. You wonder, "What is the rest of the class thinking?"

Hoping that smaller groups might make it less intimidating for students to talk to one another, you frame a new question and invite students to discuss it. But even in these groupings, it seems like a small handful of students drive the discussions.

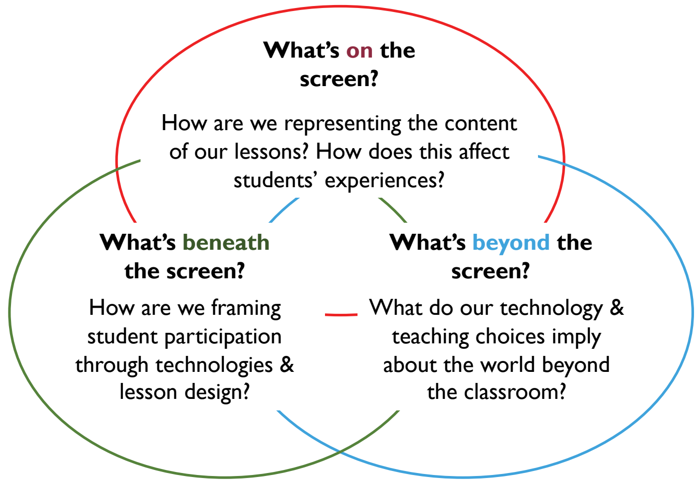
These are familiar scenarios in many science classrooms. Fortunately, educational technology developments can support a less intimidating, more interactive classroom experience. These technologies make it possible for students to accept that differences of opinion exist and the resulting uncertainty is not a bad thing. Mounting evidence indicates that learning how to navigate these uncertainties is a more effective way of learning science than receiving science as a monolith of uncontested facts.

Instead of immediately asserting what scientists think about a phenomenon, placing the onus on students to work through uncertainty makes it more likely that students will attempt to argue differing positions. When students do this, they are more likely to consider others' perspectives, as well as revisit their original position when differences arise. The result is a science classroom that better resembles the messiness of science in real life.

The myriad technologies and countless ways to use them can be overwhelming. We have found considering three simple questions helps guide our decisions on how and which educational technology to use to support argumentation in the classroom.

1. What's *on* the screen? How is content rendered on the screen by the technology, and how does this affect the students' learning experience? This includes factors such as whether or not students can access the content through visual and audio-based representations, in addition to textual descriptions. The graphical interface helps determine whether or not student contributions are anonymous, which can influence participation. Identify technologies that include multiple means of representing scientific content—again modeling how science is done in real life.

Three "Lenses" for Looking at Digital-Age Literacies



2. What's *beneath* the screen? What processes are happening beneath the digital screen—the "rules" that guide and shape how we experience the content? Reflect on your intentions for what is ultimately presented digitally to students—as well as the way the technology itself is designed. Technologies offering multiple options for student response can provide different insights into the way students think and respond to ideas.

3. What's *beyond* the screen? What are the implications of using the technology for learning goals that extend beyond the specific lesson? Using technology to support learning science through argumentation can enculturate students into a more appreciative view of argumentation. When a technology gives students repeated opportunities to argue though uncertainty, they may increasingly view engaging in genuine, respectful arguments as a way to sharpen their own thinking while acquiring new insights. This provides a model for argumentation in science and beyond!

Choosing among the many educational technology tools available can feel overwhelming. These three simple, yet important questions—**What's *on* the screen? What's *beneath* the screen? What's *beyond* the screen?**—can inform decisions about how to best match tools to curriculum, content, and classroom contexts. Setting explicit intentions for how you teach your students and understanding the corresponding implications for students both within and beyond the walls of your classroom are part and parcel of reflective practice as an educator. Such reflection is even more important when planning curriculum at the intersection of two relative newcomers to the science education conversation: evidence-based argumentation and digital technology. ●

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Earl Aguilera, PhD, is a former high school teacher and currently assistant professor of education at California State University, Fresno.

Are you interested in submitting a Commentary for consideration for *NSTA Reports?* E-mail Lynn Petrinjak at *lpetrinjak@nsta.org* for more information.

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Science Ed in Prison, from pg 1

and friends to look up [information online]. So although the offenders couldn't directly access the internet, they did manage to find far more information than I had expected."

Afterward, "we prepared two posters from that work, which I presented at different scientific meetings on their behalf," Haskins relates. "I was very proud of them, and they felt very accomplished."

The same could be said of some male prisoners at Tomoka Correctional Institution in Daytona Beach, Florida—even ones serving life sentences—who "cried [tears of joy] when they earned their GEDs," recalls Pam Walker, who taught "biology, physics, and chemistry to prepare them for their GEDs." She says she would do "demonstrations for them," such as "showing surface tension using water droplets on a penny….[In physics, they had to] use one piece of paper to create a tall or strong structure. [I gave them] toothpicks and water-based glue to build things with and test them with weights. I limited how much glue everyone had."

In another lab, Walker says she taught prisoners "about scientific [methods] of approaching a problem" by having them weigh a piece of gum, "chew it for 10 minutes, and weigh it again to see where the weight went." In addition to science, "I tried to teach them life skills, how to read a phone bill and balance a checkbook, to give them a basic education," she notes.

When Andrea d'Aquino, a graduate student in the Department of Chemistry at Northwestern University in Evanston, Illinois, taught incarcerated males at Stateville Correctional Center in Crest Hill, Illinois, as part of Northwestern's Prison Education Program (NPEP), she made sure her general chemistry course "would teach students about how the world works, through the lens of a chemist. I focus on topics students can relate to and care about. I want to ensure they can use what they learn."

NPEP courses are credit-bearing and taught with content and expectations equivalent to those at Northwestern. To comply with Stateville's equipment limitations, d'Aquino and her co-teacher "make videos of all of the labs to show in class. [In the videos,] we do everything an undergraduate would do, [including] pre-labs and post-labs," she explains.

"Trying to tailor your teaching to different learning styles and backgrounds [is challenging]. Some students have no or little chemistry experience, while others are quite proficient at it," d'Aquino acknowledges.

Differentiation was also arduous for Kristen Lee, now a physics teacher at Avondale High School in Auburn Hills, Michigan. When she taught science for Spectrum Juvenile Justice Services at the Calumet and Lincoln Centers in Highland Park, Michigan, her students were male youth ages 12 to 21 who were separated into eight "pods" by criminal offense, "so there was a substance abuse pod, a sex offender pod, [for example]," she explains.

Each pod could have both middle level and high school students. "Each grade level did [its] own thing. I had only one group doing a lab each day; the other students [in the pod] did a worksheet," Lee recalls. She taught physical science to the middle level students and biology, chemistry, and Earth science to the older students, so she taught different subjects in the same classroom. And "everything had to be portable; the teachers moved from classroom to classroom," she notes.

"The IT [information technology] people made websites for virtual dissections available. I had to sit next to [students] to make sure they stayed on the pages they were supposed to stay on," Lee relates. "I did a lot of modeling with paper or other safe materials." And for a thermodynamics lesson, "we made ice cream, which the kids really liked. There's nothing like eating ice cream at 9 a.m. in science class," Lee asserts. ●

Educating Students About Civil Engineering

Students may not have known what a civil engineer does, but were often intrigued when guest speakers would discuss their careers with his classes, recalls retired Winnipeg, Manitoba, educator Gabe Kraljevic.

"I really spent a lot of time explaining what engineering is and how to become an engineer—particularly in grades 10 through 12," says Kraljevic, who serves as NSTA's District XVIII Director. "One speaker fascinated the classroom with his work on runways made with ice (and his travels to the Arctic and Antarctic)."

"States' Department of Transportation [DOT] need civil engineers," declares Linda Clifton, Transportation and Civil Engineering (TRAC) and Roadways Into Developing Elementary Students (RIDES) manager at the American Association of State Highway and Transportation Officials. "If we introduce [civil engineering careers] at an early age, students are more receptive, more interested in those fields."

RIDES was developed in Mississippi with the state's DOT to target female and minority students in elementary school, demographics often underrepresented in science, technology, engineering, and mathematics (STEM) fields, Clifton notes.

"In Mississippi alone, we've trained [more than] 2,500 teachers since 2004," she says. "Once we train teachers, they can use the program every year…Our training is aligned with math and science standards, as well as *Common Core Standards*. It's a win-win for schools.

"These programs are especially good for new teachers who may need help with lesson plans and activities," Clifton maintains. "All our trainers are classroom teachers. They can relate to teachers; they've been where they are."

She says 25 states across the United States use the program; some using just one, others using both. According to Clifton, TRAC and RIDES (see *http://bit.ly/2OVStDr*) typically partner with a state's DOT, which in turn partners with schools, often paying for the training and providing the modules, which include a variety of hands-on activities. The DOTs often send engineers to participating teachers' classrooms to discuss their careers.

"The modules are designed for 30 students in a class. The program offers several different ones that represent different specialities within civil engineering. The main items can be used every year, although they may have to replace consumables," she says.

"We're seeing a lot of positive comments about the program. Kids in RIDES and TRAC—once they see what engineers do—they're more inclined to pursue those careers," Clifton says. "We are seeing more students, especially females, going into engineering. We're seeing a lot of students going into engineering- or transportation-related careers" including some who have gone on to intern with state DOTs.

Cindy Steven-Pheal, a teacher at Oak Grove Middle School in Hattiesburg, Mississippi, has been using RIDES in her classroom since 2012 and training other teachers in the program since 2013. She says her students have greatly benefitted from the program, particularly since other teachers in her district also participate. "When asked about some of their favorite classroom activities, many will refer to one of the RIDES activities. They recall when they were building or designing something and it went well, and also recall with great laughter or frustration when it didn't. And the beauty of the activities, if they repeat them in a later grade, their experience is different because their background knowledge has increased.

Often, knowing what not to do is just as powerful as knowing what to do.

"I am seeing an interest in engineering in my sixth graders. Through using the RIDES activities, we are introducing engineering concepts earlier and in a more fun, engaging way. The activities are removing the fear of engineering being 'hard' or 'only for smart people,' which hopefully will translate into a new career path my students may not have originally considered. They are learning that engineering is about thinking about finding solutions to real-world problems," she continues.

Exploring Careers

"Students engage as citizens in the built environment through fun activities that expose them to built environment careers," shares Linda Keane, professor of architecture and environmental design at the School of the Art Institute of Chicago, and co-creator of the NEXT.cc website's (*www.next.cc*), "STEAM [science, technology, arts, and mathematics] by design e-learning journeys." She works with college art, design, environment, and science students to research, annotate, compile, and share "journeys" such as designing different sizes of streets, bike lanes, bus stops, structural systems, and bridges. These journeys vetted by "multi-generation college and educator teams offer place-based activities aligned to the *Next Generation Science Standards*," with links to additional resources.

She equates each journey to a lesson plan, noting that "teachers use them as 'priming' and 'extending' for students. They look at NEXT.cc journeys and links before in-class sessions and afterward share thoughts about possible careers. Some even create and present NEXT.cc projects. A free learning resource for teachers, vetted by teachers, educators, and practitioners, NEXT.cc journeys are used in 50 states, helping students to see the broader application of the concepts they're learning in school out in their communities. They realize someone made those decisions [of what and how to build] at some point," Keane adds. "Engineering introduces design practices into K–12—the iterative process of research, conceptualizing ideas, testing them, and evaluating them." ●

Quotable

Our senses enable us to perceive only a minute portion of the outside world.

—Nikola Tesla, Serbian-American inventor and engineer (1856–1943)

Educators Favor Online Communication

In a recent informal *NSTA Reports* poll, 92.7% of science educators find communications websites and apps to be beneficial overall in communicating with students and/or parents, although they have some downsides. According to 88.4% of science educators, their school or district requires them to communicate with students and/or parents via websites or apps or post grades in an online gradebook. Sixty percent of those not required to do so choose to use websites or apps. More than half of respondents (56.4%) reported using three to five apps or websites; 43.6% reported using one or two. Most (82.1%) said their school colleagues use the same websites or apps, while 17.9% said they don't know if colleagues use the same ones.

The websites or apps most science educators reported using were Remind (59%) and Google Classroom (51.3%). More than 84% selected "Other;" with Canvas, PowerSchool, and eSchool as the most frequently noted. Most educators report that using communications portals does increase their workload, with 53.8% reporting an increase of less than two hours per week; 15.4%, an increase of two to three hours a week; and 7.7%, more than three hours a week. Twenty-three percent reported no required extra time. Only 40% reported equity concerns at their school over the use of communication apps/websites.

Here's what science educators are saying about the use of communication apps/websites:

It increases accountability for students, and makes parents more aware of students' performance.—*Educator, High School, New York*

Parents don't check them. Or parents check them and "bulldoze."—*Educator, Middle School, Illinois*

[I] **can** reach a larger audience in a shorter amount of time.—*Educator, High School, Texas*

Quick and easy way to communicate on the occasions you do not see them face to face. Students can check online for any communications.—*Educator, High School, Australia*

It limits access to my private e-mail and cell phone.—*Educator, High School, Missouri*

Increases communication on grades, gives another view into what happens in the classroom.—*Educator, High School, California.*

I don't have to go hunting for parent information. It makes it easier to include colleagues on messages. I have a record of communication.—*Educator, High School, Arizona*

Allows everyone to see/hear the same message; offers a place to refer to.—*Educator, High School, Illinois*

The more parents know about what is going on in class, the more secure they will feel. I mainly use Remind sparingly to update students about class changes and upcoming due dates.—*Educator, High School, Michigan*

It saves time.—*Educator, Middle School, Pennsylvania*

It is another form of communication that busy parents can access, generally from anywhere and anytime they can. On the negative side: There has been an increase in unreasonable parents who chose to argue every grade and blame teachers for their child's performance.—*Educator, High School, Manitoba*

In my case, everything uploaded is just a copy of what they have received in class (both in terms of printables and assignments), so there is no equity concern, but it's a nice way to keep parents in the loop [and] help kids with executive function challenges, and Remind is really just for the science team vs. the classes.—*Educator, Administrator, Middle School, High School, Informal Education Setting, Illinois*

If parents are able to receive communication with their cell phone, they're more likely to respond.—*Educator, Middle School, New York*

I use Talking Points for the language barrier. Discipline problems decrease when I use Talking Points. Parents are more likely to read a text than pick up the phone for a voice call.—*Educator, High School, North Carolina*

The more communication options you give to parents, the more they are in the loop [about] their teenager's education. If you want to build a support system, you need informed parents.—*Educator, Middle School, Arkansas*

[**They are a**] great way to share information with parents and students so that kids have the info they need to take responsibility for their own learning, and so that parents are kept in the loop. Vidigami has been a great *easy* way to post student photos and sample science notebook pages.—*Educator, Elementary, Middle School, Washington, D.C.*

They are beneficial overall in that students can have an electronic record of anything we do in class...The downside is that sometimes students expect me to serve as their personal assistant, *always* sending a reminder for every homework assignment.—*Educator, High School, Georgia*

On Google Classroom, I can post PDFs from the SmartBoard-type device I have so students who are absent or who just want to review something they may have missed can look at the PDF. My students all have internet at home. Even if that weren't true, I still think it is overall beneficial. I can find an alternative for contacting students and parents that have no internet. On the other hand, a parent who cannot easily get to school will have access if they do have internet, which is a plus for families of working parents who find it hard to take time off to come in during a weekday.—*Educator, High School, North Carolina*

Any channels of communication are beneficial if [they help] connect students and parents with the material and their progress. An online presence for the classroom also adds legitimacy in the student's eyes, since most of their world is online.—*Educator, High School, Ohio*

It is another [way] for students to communicate with teachers, especially at the high school level.—*Educator, High School, Ohio*

Extends the classroom, like a peek inside the classroom.—*Educator, Middle School, Hawaii*

Remind lets you send messages to parents on their phones, so they do not have to go to a website or have internet access to be contacted: [I]t keeps parents in the loop in a way that is very easy for them.—*Educator, Middle School, Tennessee*

In the middle school, [the apps] allow the parents the gradual release to independence when they are used correctly.—*Educator, Middle School, New York*

Parents can more easily keep tabs on their child(ren).—*Educator, High School, New York*

It allows us to reach students where they *live*: their electronic world. It also gives us a place to show that we *have* communicated.—*Educator, High School, Indiana* ●

What Do We Know About Developing Lifelong Interests in Science?

By Dennis Schatz, NSTA President 2019–2020

"I did fine on the science exam. I'm just glad I never have to take another science class."
—10th-grade student after taking the Washington State high school test

This quote not only saddens me, but it also reinforces my belief that the number-one responsibility we have as science educators is to instill a lifelong interest in science.

A "typical" person living to be 80 years old spends only 3% of their life in K–12 classrooms. If their only engagement with science is during school, then they are disconnected from science for most of their life.

Reviewing what we know about developing a lifelong interest in science is the first step in deciding how to approach this problem. Adam Maltese, Christina Melki, and Heidi Wiebke asked 8,000 adults—some working in science, technology, engineering, and mathematics (STEM) fields and some not—what inspired their lifelong interest in science (*Science Education*, Vol. 98, No. 6, pp. 937–962). They offer wonderful insight into what we need to do to develop a love of science that our students will carry into adulthood.

- Early engagement with science is critical.

Maltese, Melki, and Wiebke found that more than 50% of those interviewed developed their interest before sixth grade, and more than 70% did so by the time they entered high school, regardless of whether they pursued a STEM career or not.

- Parents are a major influence in the early years.

According to the study, parents are the dominant influence on developing an interest in science for the first 10 years of a child's life. Teachers become a bigger influence in middle and high school, but never at the level of being majority influencers.

- Out-of-school STEM experiences are a major influence.

The researchers also found that the *type* of experience that sparked students' interest in science is the most important. Before sixth grade, out-of-school or intrinsic interest (i.e. when the person could not identify a specific reason for what sparked the interest) are the dominant motivators for an enthusiasm for science, including building and tinkering, visiting a museum, playing in nature, and experiencing different media.

Two comments from these studies underscore the importance of these insights:

> *"I liked toys like Tinkertoys® and building blocks, and taking [things] apart and seeing how they worked from early on."* —Female, professor, chemistry

> *"I remember one time after dinner, my dad had a bunch of balls in his hand, and he showed me the solar system, how things moved around the Sun. And from there, I was fascinated with space."* —Male, professor, physics

Key Points

1. Both in-school and out-of-school science learning experiences are important to developing a lifelong interest in science. The lack of science learning in the elementary classroom is evident in teachers not becoming a significant influence until middle school. A critical priority needs to be enhancing the amount, and quality, of science instruction at the elementary level, especially since most people develop their interest in science during these early years.
2. Parents and other family members are critical influencers of science interest, especially in the early years. Parents need to become more comfortable engaging with science, and educators should make more connections with what happens at home. The Reading Is Fundamental initiative advocates "Read Aloud 15 Minutes. Every Child. Every Parent. Every Day." We need a similar campaign encouraging "Parents and Children: Enjoy Doing Science Together Every Week." As part of this effort, teachers could send family-science activities home each week.
3. Out-of-school science learning experiences are important to developing interest in science. We need to find ways for youth to experience more tinkering activities, visiting science museums and nature centers, watching more science-based videos, attending science summer camps, and participating in science competitions.

This may seem like a daunting task, but it aligns with NSTA's commitment to a high-quality and engaging science learning experience for all youth, and to provide effective resources for everyone teaching science, including parents.

If you're interested in learning more about research in this area, please join me and other in-school and out-of-school science educators in a NSTA Virtual Conference, Connecting In-School and Out-of-School STEM Learning and Teaching, on December 7. Visit *https://bit.ly/2mTX8Kk* for details and to register. ●

MONEY 101

Widening Asset Gap Highlights Need for Financial Planning

In recent weeks, several reports have resounded the alarm bell on the financial instability of the U.S. workforce.

New data from the U.S. Census Bureau (*https://n.pr/2pGfIqF*) revealed a widening gap between high earners and typical Americans despite historic economic growth. That gap is the greatest it has been since the agency began tracking such trends more than 50 years ago. According to the data, income inequality from 2017–2018 was significantly higher in five states: California, Connecticut, Florida, Louisiana, and New York. Other states with significant gaps include Alabama, Arkansas, Kansas, Nebraska, New Hampshire, and New Mexico.

Similarly, the National Institute on Retirement Security found that financial asset inequality among Americans continues to increase, the inequality is consistent across generations, and the gap is harming retirement readiness (*http://bit.ly/2lGCY63*). Their analysis indicates that from 2004 to 2016, the share of financial assets owned by the top 25% of Baby Boomer households grew from 86% to 91%. Meanwhile, the share of assets owned by the bottom 50% of Baby Boomer households shrank from 3% in 2004 to less than 2% in 2016.

Among GenX households, the wealthiest 25% owned 87% of financial assets in 2016. Millennials in 2016 reached a comparable degree of financial asset concentration, with 85% of financial assets owned by the wealthiest 25%.

The bottom line: Financial assets have been and increasingly continue to be highly concentrated among the wealthiest people.

This is especially worrisome for education professionals. Educators already earn less than their non-teaching peers after accounting for education and experience, with weekly wages 21% lower in 2018. In addition, more teachers took on additional work to supplement their wages during the 2015–2016 school year: 59% compared to 56% in the 2011–2012 school year (*http://bit.ly/2o89fEk*).

Given this economic environment, educators can take steps to build a stronger financial foundation for the future.

Make Savings Part of Your Normal Lifestyle

According to Bankrate, more than half of U.S. adults don't have enough money to cover their bills for three months; 28% have no emergency savings at all (*http://bit.ly/2o9M6Bx*). This precarious situation could spell a financial disaster that's hard to recover from if a big expense hits or in the event of a lost job or wages.

The most important step is to make savings part of your normal routine. Just as you pay your rent or mortgage and other bills, pay yourself. This means setting up a savings account for emergencies, and being disciplined about contributing from every single check—even if it is a low amount. Small amounts add up over time. You'll sleep better and won't have to turn to family, friends, or high-interest debt if you need cash for an unexpected medical costs or automobile/home repairs.

Then apply that same discipline to saving for retirement. The sooner you start saving, the less you have to save for your "golden years" because you'll realize the benefits of compounded interest over time.

Most public school teachers have one big advantage: Automatic retirement savings via a defined benefit pension plan. However, many jurisdictions are changing or reducing their pension benefits. Not all states offer cost-of-living adjustments for pensions. That means if you retire at age 60 and live to 90, your pension benefit, in practice, will be lower each year due to inflation. If you work for a private or charter school or in higher education, your primary retirement plan might be a defined contribution plan. In these plans, you may or may not have automatic enrollment and contributions, and you likely have more responsibility for managing your contributions and investments.

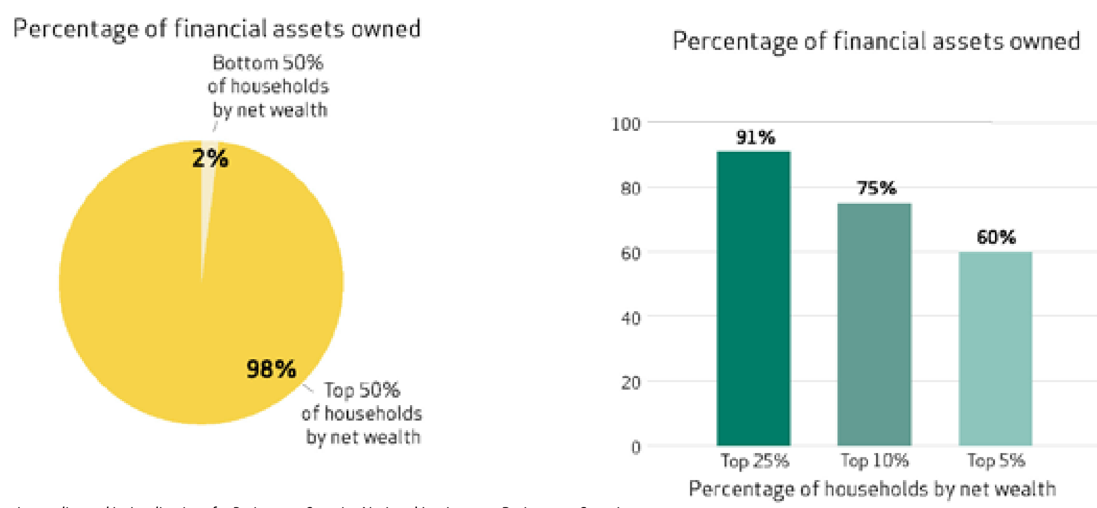
Regardless of your employer or retirement plan, it's crucial to maximize your retirement savings throughout your career. Make an appointment with your benefits office to get educated on your retirement benefits and to learn what options are available to you to maximize what you save and your employer's contributions. For example, public school educators with pensions can save more through Supplemental Retirement Savings plans (SRPs) offered in most states. However, only a few states offer SRP auto-enrollment, so you have to know about the benefit and proactively sign up.

Consider Delaying Social Security

Most educators contribute to Social Security, and this is a growing source of retirement income for Americans given alarmingly low retirement savings levels. One key strategy to make the most of this income source is to delay the benefit as long as possible. The longer you wait to tap into Social Security, the larger your monthly checks will be.

According to the Social Security Administration, you can retire at any time between age 62 and your full retirement age. Keep in mind, though, that Social Security's full-benefit retirement age is increasing gradually (see the website *http://bit.ly/2LI52QL*). Currently, the full benefit age is 66 years and two months for those born

Distribution of Baby Boomer Financial Assets, by Wealth Percentiles - 2016



Financial Asset Inequality and Its Implications for Retirement Security, National Institute on Retirement Security in 1955, and rises to 67 for those born in 1960 or later.

If you start receiving benefits before your full retirement age, the amount of your benefits goes down. Alternatively, delaying retirement offers a financial bonus.

Investopia (*http://bit.ly/2AFtLiA*) provides an insightful example for someone with a full retirement age of 66. If they claim benefits at age 66 and their full monthly benefit is $2,000, each monthly check will be $2,000. Claiming at age 62, however, will result in 25% less per month, with a check of $1,500 for the rest of their life. The only increases will be slight cost-of-living adjustments.

But if they wait until age 70 to claim Social Security, there will be an extra 8% annually, or a monthly check of $2,640. Waiting to begin claiming Social Security after age 70 offers no advantage, though, as your benefits won't increase further.

Obviously, the contrast between $1,500 and $2,640 each month in this example is substantial, and a consideration to be carefully weighed. For example, cash needs in retirement will be an important factor in decision making. If you retire early and have adequate resources, you can be flexible about when to take Social Security benefits. But if you need Social Security benefits to make ends meet, delaying retirement until the full retirement age or age 70 to maximize benefits may make sense. Another consideration is at what age will you "break even" and begin to come out ahead if you delay Social Security.

The Social Security Administration provides calculators to estimate your benefits and break-even age. Use the agency's Early or Late Retirement Calculator (*http://bit.ly/2V6UrlE*) to assess your specific situation. In doing so, you will have a fuller understanding now of your future Social Security income options, and you can factor that into a long-term budget so you're best positioned to maintain your standard of living in retirement.

Keep in mind, this column shouldn't be considered financial advice, but instead a motivator to think strategically about your financial goals. The growing wealth gap facing the U.S. workforce highlights the importance of early, strategic planning. ●

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.

PULL-OUT SECTION

SCIENCE TEACHERS' GRAB BAG

Inside this Convenient Pull-Out Section you will find:

Freebies for Science Teachers

Audits and Inspections. **K12** **HE** Produced by the Laboratory Safety Institute (LSI; *www.labsafety.org*), a nonprofit organization providing safety education for government, industry, and K–college educational laboratories worldwide, this report summarizes recommendations from safety consultations and inspections the LSI has conducted and offers additional general lab safety guidance. The report can give teachers, scientists, and lab professionals a deeper understanding of the types of issues and concerns raised during laboratory safety consultations and inspections.

For a free copy in PDF format, e-mail *molly@labsafety.org* and mention this announcement in the Freebies for Science Teachers column of the November 2019 issue of *NSTA Reports*. This freebie will only be available until **December 15.**

Amazon in Your Classroom. **M** **H** Explore sustainability and conservation in the Amazon with these education resources from the Morpho Institute. Targeted for middle and high school levels, the materials include six interdisciplinary lessons (e.g., Examining Landscape Change; Treasuring the Amazon; Investigating Ecosystem Services; Aiming for Sustainability, in the Amazon and at Home; Calculating Ecological Footprints; and Exploring Food Choices) and an online bulletin, Amazon In Your Classroom, which has links and teaching resources relating to current news stories about burning of the rainforest. All of the resources are designed to engage students in grappling with complex real-world issues related to resource use, human rights, and conservation needs. Access the materials at *http://bit.ly/35fiWBL.*

STEFAN WERNLI

Teaching With i-Tree. **M** **H** Available in Spanish and English, this curriculum from Project Learning Tree teaches middle and high school students about the many ecosystem services trees provide. Through three hands-on activities—Tree Benefits and Identification, Tree Value, and Land Manager Role Play—students learn to identify, measure, and assess a tree's health and understand the role of trees in mitigating greenhouse gases by improving air quality, intercepting stormwater, or lowering a building's energy use. The lessons also teach students how to calculate the dollar value of the benefits provided by a tree (or a set of trees) and offers valuable practice in analyzing and interpreting data. The curriculum, which includes video tutorials and downloadable student pages, can be used in both formal and informal settings, as well as in urban, suburban, and rural environments. Consult *http://bit.ly/31W3b0s.*

2020 Students Rebuild Hunger Project. **K12** Sponsored by the Bezos Family Foundation, this project engages K–12 students and teachers worldwide in a common effort to make a difference while giving students opportunities to learn about other cultures and create art as a means of change. In the project, which runs through June 5, 2020, students research hunger and malnutrition issues in their community and around the world. Students then collaborate to develop potential solutions and create artwork to showcase their ideas. For every piece of artwork submitted on the project website, the Bezos Family Foundation will donate $3 (up to $700,000) to youth-focused nutrition programs nationwide and worldwide.

To guide participation, teachers can download The Hunger Project: A PBL Unit, a framework developed collaboratively by nonprofits Students Rebuild and PBLWorks. The framework can be used with all grade levels and provides specific pathways students can follow to design a successful project-based learning experience on the topic. See *http://bit.ly/2VmszKh.*

MOSAiC in the Classroom. **K12** **HE** Follow along with scientists on the Multidisciplinary drifting Observatory for the Study of Arctic Climate (MOSAiC) research expedition. This year-long international expedition is exploring the physical, chemical, and biological processes connecting the Arctic atmosphere, sea ice, ocean, and ecosystem. Scientists hope to use the mission's collected data and analyses to improve models and forecasts of local, regional, and global weather and climate. Outreach materials produced by the Cooperative Institute for Research in Environmental Sciences (CIRES) at the University of Colorado Boulder—including K–college lesson plans, videos, and a weekly newsletter—are available at *http://bit.ly/31VCtoM.*

See Freebies, pg G2

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

Freebies, from pg G1

While many activities are more appropriate for middle to college levels, some lessons are suitable for younger audiences. Design and Build a Sea Ice Drifter, for example, is an engineering design challenge for grades 3–5, and EcoChains: Arctic Life Game can be played with upper-elementary to high school learners. These and other activities can help students better understand the complex relationships among Earth's ecosystems, human activity, and weather and climate.

Stanford *NGSS* Integrated Science Curriculum. **M** With a tagline of "An Exploration of a Multidimensional World," this curriculum for the middle level (grades 6–8) aptly reflects an interdisciplinary, phenomena- and project-based approach reflective of the *Next Generation Science Standards* (*NGSS*). Developed by educators at Stanford Center for Assessment, Learning, and Equity (SCALE), the curriculum aligns with California's integrated model and embeds Earth and space science, life science, physical science, and/or engineering within each curriculum unit.

Each grade level has four project-based units and one groupwork-themed unit. Titles include Setting Things in Motion, Extreme Living, Nature via Nurture, and A Warmer World for sixth grade; A Balanced Biosphere, Matter Matters, Mimicking Nature's Design, and Save the Andes! for seventh grade; and Colossal Collisions, Traveling Through Space, Using Engineering and Technology to Sustain Our World, and Adapt or Die? for eighth grade. Visit *https://stanford.io/2LPcSZ0*.

What to Recycle? **A** Students and teachers of all ages and levels generally support recycling trash and other products. However, it can sometimes be difficult to determine which items are recyclable and which aren't. An online interactive produced by National Public Radio, Plastics: What's recyclable, what becomes trash—and why, can help. Featuring images, videos, and text, the interactive describes many common plastics the recycling system is designed to handle and explains why other plastic packaging shouldn't go in the bin. Students can also see what happens to the items as they move through the recycling facility. View this resource at *https://n.pr/2ItSmex*.

KAREN MARDAHL

Bone ID Chart. **E** **M** Thinking of dissecting owl pellets with students? Make it easier with a Bone Identification Chart from The Cornell Lab of Ornithology. Most appropriate for grades 4–8, the detailed chart enables students to compare the bones of six prey types commonly found in owl pellets (e.g., rat, vole, mouse, shrew, mole, bird). After downloading the chart (free registration required), teachers gain access to videos, images, and other fun facts to share with students. See *http://bit.ly/2pSKUmN*.

Tami's Tower: Let's Think About Engineering. **E** Designed for emergent readers, this online game from the Smithsonian Science Education Center challenges K–2 students to solve problems using basic engineering design principles. To play, students build towers from blocks to help Tami the golden lion tamarin reach the fruit. As students experiment with different shape arrangements, they discover how pieces can be used to create various structures and which shape arrangements are the sturdiest. The game can be played on computers, tablets, or smartphones in the classroom or at home. Play the game and access an accompanying teacher's guide at *https://s.si.edu/2Os74q3*.

ACT Academy. **K12** Check out a collection of learning videos, games, and interactives from publishers of K–12 education content online, including Flocabulary, NASA, Crash Course, GeoGebra, and PBS. In addition to content review/practice material for students, the site also has classroom assessments, homework, and lesson plans. Visit *http://bit.ly/2It9FfG* to search the resource database by *NGSS* and other parameters (e.g., grade, resource type, subject, or publisher).

Nobel Prizes Lessons. **M** **H** Nobel Prizes are awarded yearly in the categories of Physiology or Medicine, Physics, Chemistry, Literature, Peace, and Economic Sciences. At the Nobel Prize website, middle and high school educators can access games, lesson plans, and other resources inspired by innovations and discoveries by Nobel Prize winners. For example, students can play the game Pavlov's Dog, based on the work of Ivan Pavlov, who received the Nobel Prize in Physiology or Medicine in 1904 for his research on the digestive system. Classroom lessons typically contain four parts: a slideshow, a student worksheet, two short videos, and a teacher's guide. Refer to *http://bit.ly/2LS5KLl*.

NISE Net Resources. **A** The National Informal STEM Education Network (NISE Net) is a community of informal educators and scientists dedicated to supporting learning about science, technology, engineering, and math (STEM) nationwide. At NISE Net's website (*www.nisenet.org*), informal educators and others can access digital resource kits and other materials (e.g., fact sheets, training presentations) to successfully explore and promote science topics in museums and community outreach settings. Each kit contains lesson plans for exhibit activities, facilitator training videos, a planning and promotional guide, and promotional and marketing materials. Available kits include Earth and Space, Zoom Into Nano, Frankenstein 200, NanoDays, sustainABLE, and Building With Biology.

Spatial Vis Classroom. **M** Students with strong spatial visualization skills can envision 2-D and 3-D shapes from any view and in relation to other shapes. These skills are necessary for many STEM careers and can be improved through practice. Using this app, middle level students can develop these skills and learn to sketch in 2-D and 3-D through a series of 10 lessons. As students complete each drawing, they receive immediate, personalized feedback about their performance. The app makes practice fun for students and measurable for instructors. Consult *https://apple.co/35cIcZh*.

GOLDWAR1

Ocean Literacy Framework for K–12. **K12** The National Marine Education Association's Ocean Literacy Framework outlines the essential knowledge K–12 students and teachers need to be considered ocean literate. The three-part framework contains the Ocean Literacy Guide, the Ocean Literacy Scope and Sequence for Grades K–12, and the Alignment of Ocean Literacy to *NGSS*. The Ocean Literacy Guide presents a rationale for using the ocean as a teaching tool and describes in detail each of the Seven Essential Principles of Ocean Sciences: (1) The Earth has one big ocean with many features; (2) The ocean and life in the ocean shape features of the Earth; (3) The ocean is a major influence on weather and climate; (4) The ocean made Earth habitable; (5) The ocean supports a great diversity of life; (6) The ocean and humans are inextricably interconnected; and (7) The ocean is largely unexplored.

The Ocean Literacy Scope and Sequence contains conceptual flow diagrams for educators to address each principle in four grade bands: K–2, 3–5, 6–8, and 9–12. The Alignment of Ocean Literacy to *NGSS* provides information about how the concepts included in the Ocean Literacy Guide and the Ocean Literacy Scope and Sequence support the *NGSS* Disciplinary Core Ideas and Performance Expectations. See *http://bit.ly/2K5GT7g*. ●

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

News Bits

- **The Utah Computer Science Grant Act has earmarked $3.15 million for the governor's Computer Science Master Plan, following a state school board clash over updated science standards. K12**

Utah Governor Gary Herbert unveiled a plan to bring computer science courses to each Utah school by 2020, but he couldn't have done it without help from five corporations: Pluralsight, InsideSales, DOMO, Vivint SmartHome, and Qualitrics. Leaders from these companies each donated $1 million and challenged state lawmakers to increase funding for computer science education.

Only 16% of Utah high schools currently have intermediate or advanced computer science courses, and the state lags behind others in science, technology, engineering, and math (STEM) education for women and girls. Only 21% of women in Utah have completed STEM education degrees and programs. That's why InsideSales launched its first Girls Code Camp, then began encouraging other tech leaders to get involved in other ways, such as teaching coding classes. Pluralsight's nonprofit, Pluralsight One, funded the state's Computer Science Master Plan, which will focus on reaching rural and underserved communities by using inclusive language and diverse ideas, such as how STEM plays a role in agriculture. Read more at *https://bit.ly/2OhCuPH.*

- **With no current standards for teaching climate change in Pennsylvania, Governor Tom Wolfe says the state will modernize its science curriculum, with one option being the *Next Generation Science Standards* (*NGSS*). K12**

Without standards, Pennsylvania schools aren't formally required to teach climate change. The current environment and ecology standards—written in 1996 and adopted 17 years ago—don't address climate change specifically. Besides lacking the resources to teach climate change, teachers may have avoided the topic due to its polarizing political nature.

The *NGSS* have comprehensive K–12 climate change lessons; 20 states and the District of Columbia have already adopted them. A press secretary for Pennsylvania's Department of Education says the governor supports adding accurate information about climate change. However, with possible pushback from lawmakers and a long review process, implementation of any new science standards may take several years. Still, an April 2019 National Public Radio poll shows that four out of five parents want their children to learn about climate change in the classroom. See *https://n.pr/2ARM9F3*.

- **Barbie dolls encouraging girls to consider careers in aviation have been produced by Mattel in partnership with Virgin Atlantic. P E**

The dolls wear real Virgin Atlantic uniforms and resemble a pilot, an engineer, and a cabin crew member. They will be sold in stores and on Virgin Atlantic flights. Phil Maher, Virgin Atlantic's executive vice president of operations, says the dolls play a role in encouraging girls to pursue STEM) careers.

The dolls are part of the Barbie Dream Gap Project, which began in 2018 to provide resources and support for girls to achieve success. The latest three dolls join others—such as Frida Kahlo and Amelia Earhart—in the project's Inspiring Women Series. Learn more at *https://bit.ly/2LGZlCE.* ●

In Your Pocket

Editor's Note

Visit https://bit.ly/2ZlRIp5 to learn about more grants, awards, fellowships, and competitions.

November 30–December 1

Weighing Dinosaurs Experiment: Science Classroom Kit Sweepstakes M H HE

How much did dinosaurs weigh? By submerging dinosaur models in a bucket of water, students measure the mass of the displaced water, then calculate the mass of the actual dinosaurs. The kit helps teach Archimedes' Principle, volume, mass, and density, and how to record data and make simple calculations. It's appropriate for the upper–middle school, high school, and first-year college levels.

Only science teachers may enter by **November 30;** see the website at *http://bit.ly/2nsLCWL*. Entries also will be accepted at the Weighing Dinosaurs Experiment booth at NSTA's Cincinnati Area Conference, November 14–16.

2020 Knowles Teaching Fellowship H

These five-year fellowships help early-career high school science and math teachers become master teachers and leaders. Fellows receive stipends, funds for professional development, grants for teaching materials, and leadership and mentoring opportunities during all five years of the program. New teachers with leadership skills, the potential to develop innovative teaching methods, and the capacity to commit to teaching as their primary career will qualify.

Applicants must be entering their first or second year as the teacher of record during the 2020–2021 school year. They must have a degree related to the science or math discipline they intend to teach and a valid state teaching credential, certificate, or license by September 1, 2020. Apply by **December 1;** see *http://bit.ly/2poPEAf*.

AAPT's Barbara Lotze Scholarships for Future Teachers H HE

The American Association of Physics Teachers (AAPT) offers grants of $2,000 and a one-year student membership to aspiring high school physics teachers. Undergraduate students in physics teacher preparation programs at accredited two- or four-year universities, or high school seniors admitted to such programs, may apply. Students can receive this scholarship annually for up to four years.

Applicants should show academic promise and be U.S. citizens. Apply online by **December 1** at the website *https://bit.ly/2cuMyzz*.

AAUW Community Action Grants A

The American Association of University Women (AAUW) provides grants for innovative programs or non-degree research projects that promote education and equality for women and girls. Grants go to individuals, AAUW branches and state organizations, and community-based nonprofit programs.

One-year grants of $2,000–$7,000 and two-year grants of $5,000–$10,000 are available. Projects focusing on K–12 and community college women's achievements in science, technology, engineering, and math (STEM) receive special consideration. Women who are U.S. residents or permanent citizens may apply by **December 1** at the website *http://bit.ly/2n0uwPY*.

Partners in Science Program H

In this program, high school science teachers work with a mentor to conduct cutting-edge research over the course of two summers. The goal is to bring the knowledge gained from these research experiences to the classroom to promote hands-on learning.

About 25 grants are awarded annually to teachers in the Pacific Northwest. Participants must arrange their own partnerships, though the program provides a list of research projects submitted by scientists who want to serve as mentors. Apply by **December 1.** Consult *http://bit.ly/2nSc4cx*.

December 15–27

Air Force Association Educator Grants K12

The Air Force Association provides 40 $500 grants each year to promote aerospace education in K–12 classrooms. Projects should include innovative aerospace activities within the prescribed curriculum that significantly influence student learning. One grant per teacher is available, and up to two per school are permitted. Apply by **December 15** at *http://bit.ly/2piEJYB*.

CSX Community Service Grants A

These grants go to organizations that make a quantifiable impact on communities in which CSX employees live and work. PreK–12 schools, charter schools, community colleges, and colleges or universities in Alabama, Connecticut, Delaware, Florida, Georgia, Illinois, Indiana, Kentucky, Louisiana, Maryland, Massachusetts, Michigan, Mississippi, New Jersey, New York, North Carolina, Ohio, Ontario, Pennsylvania, Quebec, South Carolina, Tennessee, Virginia, West Virginia, and Washington, D.C., are eligible. Apply by **December 15;** visit *http://bit.ly/2mYvFaL*.

National Gardening Association's Youth Garden Grant P K12

These grants go to schools and nonprofits with planned or existing garden programs that enhance the lives of young people and their communities. Garden programs must include at least 15 youth between the ages of 3 and 18. Twenty winning gardens will receive an award package worth $775, and five will get packages worth $2,360, all of which include a $250 cash prize and gardening tools and supplies.

Apply by **December 16.** See the website *http://bit.ly/2McMaIG*.

Katie's Krops Start a Garden Grants E M H

These grants help youth ages 9–16 start a community vegetable garden and donate their harvest to people in need. All types of gardens are eligible, from those in urban containers to those for schools or neighborhoods. Grantees decide what kind of garden to grow and where to donate their harvest.

Those chosen receive gardening supplies, a gift card for a local garden center, growing manuals, and support from Katie's Krops, but must commit to maintaining their garden to be sustainable long term. Postmark applications by **December 27.** Visit the website *http://bit.ly/2IlwBgL*.

February 27–March 31, 2020

Population Education's World of 7 Billion Student Video Contest M H

This contest is part of Population Connection's World of 7 Billion campaign to promote understanding of the ways our world population affects our neighborhoods and global communities. Middle and high school students can enter 60-second videos that highlight one of these global challenges: sustaining water systems, ensuring economic opportunities, or improving climate resiliency. Videos should include content on how population growth affects the selected issue and at least one idea for a sustainable solution.

Free curriculum resources for participating teachers are available, and student winners receive cash prizes of up to $1,000. Apply by **February 27, 2020,** at *http://bit.ly/1QL6u1M*.

AAPG Foundation's Inspirational Geoscience Educator Award HE

The American Association of Petroleum Geologists (AAPG) presents this $6,000 award to a college or university professor who has shown outstanding leadership in geoscience education. Nominees must have a PhD in geoscience, taught at least three years full-time at a higher education institution, taught at least one course that includes content applicable to the formation and geological history of Earth resources, and be within 10 years of their initial tenure-track appointment.

Apply by **March 31, 2020.** Consult *http://bit.ly/2OhD14r*. ●

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

What's New

FROM U.S. GOVERNMENT SOURCES

Library of Congress (LOC)

Science, Civics, and Primary Sources M H

Analyzing historic newspaper articles can give students unique insights into the relationship between scientific literacy and civic behavior. Read Science, Civics, and Primary Sources: A Measles Debate One Hundred Years Ago, a post from the Teaching With the Library of Congress blog, for ideas for exploring this topic using a newspaper article from 1913, written to discourage the popular practice of "measles parties" during which parents would intentionally expose their children to measles as a sort of "immunization." Most appropriate for middle and high school levels, the activity provides useful focus questions for teachers and guides students through the process of analyzing passages from primary source documents. Refer to *http://bit.ly/35cDtXF*.

National Aeronautics and Space Administration (NASA)

Artemis Program Activity Guide E M

Did you know we're sending the first woman and next man to land on the Moon? NASA's Artemis program will take them there! Students in grades K–8 can learn more about the mission from the activity guide *Forward to the Moon With Artemis Explorer Activities,* which contains puzzles, games, and other activities that introduce the features of new rockets and spacecraft that will make the mission possible. Learn more and access the guide at *https://go.nasa.gov/2MdXFiY*.

U.S. Department of Energy (DOE)

Technology Transfers Poster Set M H

Celebrate science successes at U.S. National Laboratories with Advancing America Through Technology Transfer, a series of 17 posters developed by the DOE's Office of Technology Transitions. The poster series highlights some of the significant work done at each site and represents it as an illustration that captures the spirit of the lab and its surrounding area. The downloadable posters showcase the impact that lab-derived technologies have on everyday life, including advancements in electric car technologies, brain imaging and cancer diagnosis, transforming secure communication, and improving public health. Access the posters at *http://bit.ly/2OqnnDR*.

"Your AI (Artificial Intelligence) Career: April's Story" M H

Share this article from the DOE's Energy.gov to show middle and high school students how a passion for math and the support of encouraging mentorships can lead to a fulfilling science, technology, engineering, and math (STEM) career in AI. The article describes the type of research work in the AI field and has information about which degrees are best suited to careers in the field. Read the article at *http://bit.ly/2oXPNu7*.

Federal Reserve Board

U.S. Currency Education Resources E

How well do you know the dollar? At the Federal Reserve's Currency Education Program website (see *http://bit.ly/2LT5iwB*), teachers can access animations, vocabulary sets, and lesson plans to help students in grades 2–5 better understand the money in their pockets. The animations—You'd Be Surprised: The Journey and You'd Be Surprised: Special Features—explain currency concepts using animal-themed metaphors. For example, You'd Be Surprised: The Journey likens the process of developing U.S. currency to the life cycle of the monarch butterfly, while You'd Be Surprised: Special Features relates the unique features of U.S. bills (e.g., raised texture, color-changing ink, patterns, and appearance under the ultraviolet light) to the characteristics of various animals. In addition, Currency Academy, an online interactive for students, expands on the animations' ideas and includes accompanying worksheets for grades 2–3 and 4–5.

National Oceanic and Atmospheric Administration (NOAA)

Oysters in the Chesapeake Bay K12

This curriculum for K–12 learners was developed by NOAA Education to support the shift to three-dimensional learning as indicated by the *Next Generation Science Standards.* The curriculum features the Eastern Oyster in Chesapeake Bay as its central focus. It contains six elementary lessons, two middle level modules, and four high school modules in a coordinated learning sequence at each level.

- Elementary lessons begin with a water pollution study and build to knowledge about oyster shells, oyster reefs, and oyster internal anatomy. By fifth grade, students consolidate their learning, examine other perspectives, and demonstrate their mastery of ecological principles.
- Middle level lessons begin with a historical look at Eastern oyster populations and the Chesapeake Bay watershed, then move to examining water-quality parameters and the effect of land use on water quality and oyster populations and reef ecosystems. The lessons conclude by studying how healthy oyster reef systems can be used to increase the health of the Chesapeake Bay ecosystem and its water supply.
- The high school module sequence focuses on developing issue-analysis skills as students complete lessons based on this question: How do we increase Chesapeake Bay oyster populations while providing economic, cultural, and ecological benefits?

Learn more and access the modules at *http://bit.ly/2Mi230E*.

"Why Do Leaves Change Color?" M

Use this article from NOAA's SciJinks website to spark science investigation with middle level students on a favorite fall topic, Why Do Leaves Change Color? Featuring photographs, hyperlinks, and chunkable text, the article briefly explains the reasons why leaves change color and the role of weather in this process. Read the article at the website *https://scijinks.gov/leaves-color*.

U.S. Geological Survey (USGS)

Project E-Trout A

This citizen science program engages students and teachers of all ages and levels in studying fish ecology and participating in scientific research at the USGS. In the project, students use virtual reality technology to count the numbers of adult trout observed in video footage of trout streams in West Virginia's Shenandoah National Park. The collected data, which is submitted on the project website, helps scientists identify areas of high and low numbers of fish, learn how fish habitat varies from place to place, and study how fish feed and interact. An introductory video about the project includes information about how to identify the various fish species observed in the footage, as well as additional details on how to participate.

Visit *https://on.doi.gov/2VdSkMK*.

Centers for Disease Control and Prevention (CDC)

E-Cigarettes and Their Risks M H

A website from the CDC features fact sheets, infographics, multimedia presentations, and other materials to educate students and consumers about electronic cigarettes and their risks. Most appropriate for middle and high school audiences, and available in both English and Spanish, the primer straightforwardly addresses e-cigarettes and their various types, the science of how e-cigarettes work, and their negative health effects.

The site also includes news updates and data pertaining to the CDC's recently identified Outbreak of Lung Injury Associated With E-Cigarette Use, or Vaping, as well as information for teachers and parents about prevention campaigns. Refer to the website at *http://bit.ly/33gjbLd*. ●

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

Summer Programs

Editor's Note

Visit https://bit.ly/2ZlRIp5 to learn about other summer professional development opportunities.

National Center for Case Study Teaching in Science Workshop H HE

This workshop trains science educators to develop and use case studies in their classes. Participants spend three days learning the case study method and preparing their own case study. During the last two days, participants teach the case studies they've developed to a student audience. They then have six months to develop one for the center's national peer-reviewed case collection.

The workshop takes place May 18–22 at the University of Buffalo in Buffalo, New York. Anyone interested in science education, including high school and international teachers, may attend. See *http://bit.ly/2ouPcju.*

Morpho Institute's Educator Academy in the Amazon K12

Thirty educators spend 10 days (July 1–11) in the Peruvian Amazon learning about this crucial ecosystem and about teaching inquiry-based science. Participants do field research, participate in citizen science, and explore the area's natural history by boat, trail, and canopy walkway. Agendas for the grade-level bands are as follows:

- Elementary educators will explore the Amazon through the lens of place-based learning and inquiry. They'll visit Amazon schools, conduct service projects, and learn from villagers in remote communities.
- Middle level educators will do research and citizen science, learning techniques directly applicable to their teaching while exploring the Amazon rainforest and connecting with local communities.
- High school and Advanced Placement educators will explore tropic ecology, community-based conservation, and sustainable development. They'll learn from indigenous villagers and make connections to their teaching.

Ten teachers can participate at each grade level, and scholarships are available. Visit *http://bit.ly/2LI7lU6.*

Field Course in Measuring, Monitoring Biodiversity A

This course will take place July 28–August 4 at Nuevo Durango Maya Community in Quintana Roo, Mexico, an area recognized for its biological diversity. It is only open to field researchers and has more than 400 bird species, as well as stable populations of jaguar, ocelot, and spider monkeys.

Participants study tropical botany while learning field-method protocols in conducting biological diversity research. Invertebrate and vertebrate field surveys introduce participants to sampling methods and the varied wildlife found at the reserve. Evenings include night hikes and seminars discussing issues in conservation biology. Lodging will be in traditional Maya cabins.

Other activities include exploring the marine ecology of the barrier reef and snorkeling. E-mail Dan Bisaccio (*Daniel_Bisaccio@Brown.edu*) to learn more and register. ●

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

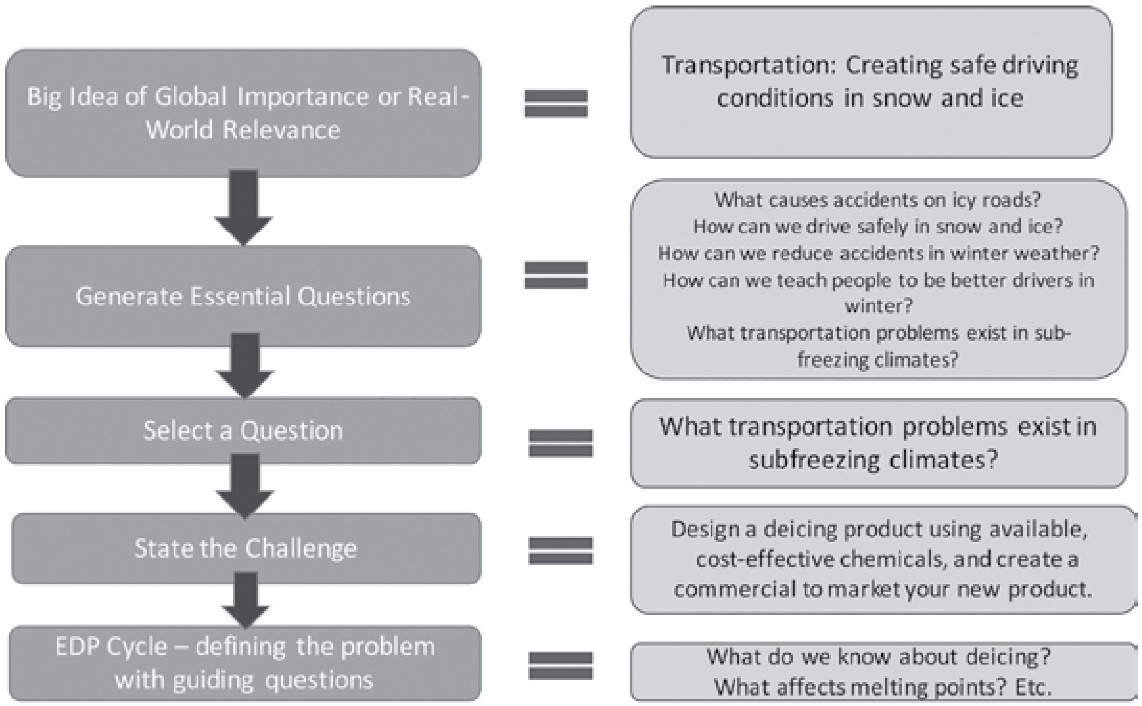
NSTA PRESS: *Creating Engineering Design Challenges*

Challenge-Based Learning and Engineering Design

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 Creating Engineering Design Challenges: Success Stories From Teachers, *edited by Helen Meyer, Anant R. Kukreti, Debora Liberi, and Julie Steimle, edited for publication here. To download this excerpt, go to* https://bit.ly/2IFzHMD. *NSTA Press publications are available online through the NSTA Science Store at* www.nsta.org/store.

Figure 1.4. Challenge-Based Learning Leading to Engineering Design



Challenge-Based Learning (CBL) is similar to both project-based learning and problem-based learning in many of its instructional practices, and the way we use CBL combines practices from these other two methods. A typical project-based learning activity begins with students working to meet a result, with specifications for the end product presented to the students by the teacher at the start of the activity. For instance, a teacher leading a project-based activity might tell students to design and construct a water filter that removes a dangerous chemical, such as lead. In problem-based learning, the problem—and thus the product—is ill-defined, and students set the parameters themselves (Morrison 2006). Problem-based learning is frequently used in medical education, when medical students not only have to identify the treatment for a health issue, but also use multiple information sources to define the health issue. CBL brings together both of these strategies by presenting students with an ill-defined "big idea" tied to a global issue that the teacher and students work to narrow into a related, actionable design product.

CBL provides students with the opportunity to define the questions they want to answer and provide input on the challenge to be solved. Student choice has been shown to be highly motivating and increase student learning (NASEM 2018). Pragmatically, however, giving students control over the shape of the problem, the questions to be answered, and the methods to be used can be frightening and impractical. Curt Blimline's design challenge, described in the story on page 17, shows how one teacher worked through the processes of CBL and the engineering design process (EDP) while still meeting his chemistry curriculum dictates. Figure 1.4 details Blimline's process of combining CBL with the EDP to develop a design challenge for his students.

After identifying the essential question, students are able to provide input to shape the design challenge in order to address the essential question. It should be the teacher's goal to promote as much student-centered learning and choice as possible; however, teachers must also ensure that required academic content is incorporated. It is critical that teachers take an active role to guide the process of moving from big idea to design challenge in a way that allows for student input and choice, but also sets goals and parameters to ensure the challenge can be accomplished in a classroom setting. To do this, teachers need to have a challenge in mind from the start. In other instances, teachers can have students submit ideas in writing, read all the ideas after class, and select or modify a popular, doable option that also satisfies the academic goals of the unit.

After the essential question is transformed into a design challenge, the class can form guiding questions. Guiding questions for the design challenge detail the content students will need in order to learn the necessary science behind the challenge; they also explain the materials and resources students will need to design, test, revise, and redesign their product ideas. Guiding questions start the EDP cycle and focus the content learning goals.

Curt's Story

Curt, a chemistry teacher, wanted a creative way to teach the content of intermolecular bonding and stoichiometry. He also needed to incorporate several key science and engineering practices. Curt knew what his standards required and where he wanted his students to end up, and he had a starting idea in mind; this was how he moved from a big idea to a design challenge.

Curt taught in a rural school where snow days were a frequent occurrence due to icy roads; this could make educational access an issue for his students. Equal access to education, Curt's big idea, is a global problem, although it looks different in different places. Curt introduced the big idea of equitable educational access to his students. He then showed YouTube videos of car accidents resulting from snowy or icy roads. The class discussed how icy conditions affected their access to education.

To get to the next stage, Curt shared ideas about what makes a good essential question to understand and solve problems. An essential question does not have one correct answer; it can't be answered by a simple "yes" or "no." Rather, essential questions are broad in scope, they involve information and actions to resolve, they are not limited to factual answers, and they require students to make judgments and use predictive skills (Global Digital Citizen Foundation 2016). Curt then had the class work in teams to brainstorm essential questions related to their real-world problem of icy roads affecting their educational access. At the end of brainstorming, Curt had each student team share their essential questions, which he listed on a whiteboard. He then skillfully led the class to settle on one essential question, a question that approximated his original idea for a challenge: What transportation problems exist in subfreezing climates?

Once the class had settled on their challenge question, Curt needed to help the students shape it into an engineering design challenge. To do this, he was able to prompt the students to focus on ice and deicing by asking, "How could we use chemistry to solve transportation problems in subfreezing climates? Do you have similar issues at home? Do you have icy walkways at home?"

In one day, Curt led his students from the global issue of equitable educational access and transportation to road safety in freezing temperatures. From here, Curt and the class negotiated a final challenge: to design a deicing product using available, cost-effective chemicals and create a commercial to market the new product.

With the design challenge defined, Curt and the class brainstormed guiding questions, which connected more directly to the required chemistry content and focused the students on what they needed to learn to design the deicer. The guiding questions, the starting point of the EDP, clarified the constraints of the challenge. Some examples of guiding questions for this unit are as follows:

- What is a deicer?
- How do deicers melt ice?
- What chemical compounds are used as deicers?
- What chemicals will we have access to when we design our deicers?
- What environmental risks are associated with the use of deicers?
- What impact will the product have on the surfaces it is placed on?

Curt used these questions to refine his chemistry instruction and establish the resources the students needed to complete their design challenge and his design challenge unit. ●

BLICK ON FLICKS

Ad Astra, Per Aspera

By Jacob Clark Blickenstaff, PhD

I was excited about a new “hard” science fiction movie coming out after all the Marvel Cinematic Universe and other fanciful space movies I’ve seen recently. *Ad Astra* portrays a possible near future with commercial rockets to the Moon and a permanent, inhabited base on Mars. The story centers around Roy McBride (Brad Pitt) and his trip to Neptune to try to find his father, Clifford McBride (Tommy Lee Jones), who has been missing for nearly 30 years.

Roy is an experienced astronaut, known for his famous father and for remaining calm even in extreme situations. The opening scene establishes this when a mysterious power surge causes an accident on the International Space Antenna (the antenna appears to reach from Earth all the way to low-Earth orbit). Roy falls off the structure, but his parachute saves him, and he lands back on the ground with his heart rate only slightly elevated.

We learn that the power surge was caused by a cosmic ray burst from Neptune, which scientists think can be attributed to the matter/antimatter reactor that powered the Lima Project, Clifford McBride’s mission to seek intelligent life outside our solar system. Roy undertakes a secret mission to find out what is happening at Neptune and prevent a runaway matter/antimatter reaction that could destroy the whole solar system. Roy travels on a commercial rocket from the Earth to the Moon, then a military rocket from the Moon to the Mars base. Getting from Mars to Neptune will depend on Roy’s ability to communicate with his father from the Mars base. *Ad Astra* has a lot of cool science to unpack, from cosmic rays and radiation to scale and the speed of light.

Solar System Scale

In middle school, I worked on an independent project to build a scale model of the solar system. When I started doing the math, I quickly realized that the scale for the planets and the scale for the distance between them could not be the same. Either the planets would be invisibly small, or the spaces between them would be much too large to fit on my school campus. I ended up with a scale in which the Earth was a glass marble, Saturn was beach-ball sized, and on a different scale, the whole solar system would fit in the gym.

Teachers could use this movie along with a solar system scaling project to check if the relative travel times in the film make sense. It is a bit hard to tell how long the Earth-Moon journey lasts, but it looks like a long airplane trip (given no sleeping quarters, and the hot towel presented at the end). Students could calculate how fast the rocket would have to go to cover the Earth-Moon distance in 12 hours, for example. (The Apollo missions took three days to reach the Moon.) Roy’s trip from the Moon to Mars seems to be six weeks long, even with a detour to investigate a distress call. (More on that later.) Finally, the journey from Mars to Neptune is 79 days long.

I'm going to really oversimplify how real spacecraft get from one place to another in the solar system, and suggest here that the travel time should be proportional to the distance traveled. (In reality, to save fuel, we use the gravity of the Sun and inner planets to speed up our spacecraft, so they don't take a "direct" route from the Earth to their final destination.) Using round numbers and averages, the distance from Mars to Neptune is about 20 times longer than the distance from the Earth to Mars. It seems likely, therefore, that it would take Roy a lot more than double the time shown in the movie to make the final leg of his journey.

Radiation Effects

The reason the Lima Project needs to be investigated is that large cosmic ray bursts are coming from Neptune, likely caused by the matter/antimatter reactor. Energy bursts like this are a real threat to our astronauts on the International Space Station (ISS), but those come from solar storms or solar flares on the Sun. Solar storms can release high-energy charged particles (radiation) that would harm people on the ISS.

NASA constantly monitors solar activity so that if a dangerous flare occurs, astronauts can shelter in the station's most resistant area. Extravehicular activities can be cancelled or rescheduled if solar activity is higher than normal. For long trips in space, astronauts will have to be protected from both acute events like solar flares, and the constant background radiation present in deep space. NASA shared a video about preparing for a future Mars mission at *https://bit.ly/2osalee*.

A three-year-long mission to Mars is about one-tenth the duration of Clifford McBride's time near Neptune. Unless his spacecraft is very well shielded, he would likely have significant health effects from all that radiation.

For teachers interested in a whole lesson about space radiation, check out this high school lesson, available from Microsoft Education and NASA at *https://bit.ly/2MlIhBu*.

Basic Physics

Though overall *Ad Astra* does a nice job depicting space travel in a realistic light, I need to touch briefly on two scenes. On the trip from the Moon to Mars, Roy's ship receives a distress call, and he stops to investigate. While that may seem trivial, a rocket moves very fast, and has a limited fuel supply. Stopping takes just as much energy as getting started does, and after they stop, they have to speed up again. By pausing in the trip, they have at least doubled the amount of fuel they would need for the journey, and that would only work if they have an essentially infinite energy supply.

Near the movie's end, Roy has to coast through the rings of Neptune (it really does have rings, so that's cool) wearing just a spacesuit. We see dozens of small rocks bounce off a shield he is carrying, and the shield becomes battered and dented, but Roy does not slow down. Each of those collisions should have slowed him a bit and changed his trajectory; the total effect should have been to bring him to a stop somewhere off course.

Ad Astra is certainly a good way to start a conversation about the scale of the solar system, and could connect to NASA's plans for a Mars mission in the coming decades. The film has some questionable physics, but overall it presents a realistic vision for future space travel. ●

Rated PG-13 for some violence and bloody images, and for brief strong language.

Jacob Clark Blickenstaff is an independent science education consultant in Seattle, Washington. Read more Blick at http://bit.ly/2S2wH2L, *or e-mail him at* jclarkblickenstaff@outlook.com.

Science Festivals Focus on Community, Diversity

According to Marc Schulman, executive director of the USA Science and Engineering Festival (USASEF), "the modern era of science festivals…was kicked into gear" when the National Science Foundation (NSF) awarded a grant to four institutions in 2009 to support the creation of three science festivals modeled on the Cambridge Science Festival: one each in the San Francisco Bay area and San Diego, California; and Philadelphia, Pennsylvania.

"Science festivals are really about having a spot for science on the cultural calendar, the cultural stage," asserts Ben Wiehe, manager of the Science Festival Alliance (SFA) at MIT. "They're about bringing people together around science and technology and a shared identity of how science makes us who we are." Because the best science festivals are "extremely responsive to cultural geography," Wiehe describes his role at SFA as helping members consider what's important to their communities and form goals around that, rather than focusing on an institution's own outreach goals. He advises organizers to reflect on "what will give [attendees] new memorable, fresh experiences.… This is ultimately about trying to create a community-wide event. You have to see how people come together in your community, what gives them a sense of pride, how they come together for work or play." He asks them, "What's a good inside joke for your area?"

SFA, which grew out of the original NSF grant, now includes 63 member festivals. Many of SFA's members started with grants from the alliance's Science Festival Accelerator, which provides professional development and up to $10,000 in matching funds to "new or significantly expanded festival initiatives that focus on areas or communities with relatively small resource space," Wiehe explains, noting that 2019 Accelerator applications are being accepted through December 2.

Director Jonathan Frederick says he considers the North Carolina Science Festival as erecting "a science circus tent over the state," with events at more than 250 K–12 schools, and 150 public event partners producing more than 400 events statewide.

MOREHEAD PLANETARIUM AND SCIENCE CENTER

Students participate in hands-on activities at the 2018 University of North Carolina, Chapel Hill, Science Expo, part of the North Carolina Science Festival.

"We're trying to connect science to everyday life," he says. "Our audience is the 10+ million people of North Carolina." Public events range from urban geology hikes to skywatching at rooftop restaurants to art conservation programs focused on chemistry and biochemistry at museums.

"We have a science night program, with the ambition to be in every elementary school in the state. Each year we send out boxes of supplies [from a library of 40 activities]," Frederick says. Each school receives supplies for 10 different stations and 200 participants. "Some schools in more rural areas may only have 60 people show up; they use the rest of the supplies at the schools. Others have 600 people show up; they use our kits as a 'starter pack' and go from there."

In addition, the festival includes events at university campuses and science centers, such as a science street fair at University of North Carolina, Chapel Hill, and the Gravity Games sponsored by Google and Appalachian State University.

The ninth Wisconsin Science Festival (WSF) was held in October. "We have seen tremendous growth in organic interest, the number of communities interested in participating," says Laura Heisler, cofounder and director. "The very first year, we kept it within Madison;…the expansion became organic with different organizations. Communities across Wisconsin have embraced it…We share resources, advice, and contacts."

Rather than planning events for various communities, Heisler says her group invites organizers at the community level to share what they're doing and the science connection, and WSF shares the events on their website and social media and provides T-shirts, a banner, and other promotional items. When they "hit a critical mass" in an area, WSF will buy local advertising to support the events.

WSF also participates in EvalFest, a five-year study of 25 science festivals to develop evaluation tools. "We've learned there is great value when people interact with scientists. People don't realize how much science is in their state," says Heisler, who is excited to see the results of the study, expected to be completed this year.

A National Stage

"There are different styles of festivals," says USASEF's Schulman. Many are connected to specific institutions or last for two weeks or longer with events spread across a large area, attracting local or regional audiences. "Our model is a little different…Ours attracts people from across the country…We're trying to be like a lightning bolt. Everything you see at [the USASEF] is what you could see at others if you were go to all their events," he contends. The sixth USASEF will be held April 23–26, 2020, in Washington, D.C.

Held every other year, the four-day USASEF features "650 organizations including nonprofits, [130] government agencies, colleges and universities, professional societies, and corporations," many of which bring chemists, engineers, and other STEM professionals from facilities around the country. Exhibitors are arranged in "topical pavilions" such as national security, health and medical, and exploration. "We try to showcase the diversity in [science, technology, engineering, and mathematics] STEM jobs and STEM careers. We're trying to cover the gamut of what STEM jobs look like—including skilled trades/advanced manufacturing," says Schulman. "We're constantly trying to push boundaries of what we would consider a STEM career."

On the first day, USASEF hosts X-STEM, which Schulman describes as "a TED talk" for about 4,000 middle and high school students. "Sneak Peek Friday" is reserved for K–12 school groups, with the final two days open to the public. The 2018 festival drew 375,000 attendees on the final three days, leading Schulman to conclude "we're at capacity…Booths have 30,000–40,000 people come through."

After witnessing attendees struggling to reach various exhibitors due to the large crowd, USASEF will add a registration system for the 2020 festival. "It's not good for attendees when it's too crowded. They can't get to what they want to see. It's not good for organizations; they can't talk to everyone when they're jammed up," Schulman says. A nominal fee will be charged for attendees older than 18; registration for attendees younger than 18 will be free.

While the impact is hard to measure, Schulman is confident science festivals are an important "response to the lack of STEM education in American public schools." He explains, "I have a science event that gets 300,000 people...Some debate if a festival is a good investment. I tell people, if [festivals] are not working, why are 300,000 people here; 50,000 people [at other science festivals]? It does work; I just can't give metrics as to how it works." ●

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Science teachers come to NSTA conferences to learn new ways to teach science, meet mentors, and find new teaching tools. But we won't tell anyone if you want to come to Boston to go museum hopping, run the Freedom Trail, or whale watch.

What better place for science teachers to gather together to be inspired, to learn, and to innovate themselves! Start your conference by making new friends at the First Timer's session, then take in a few sites after your sessions and a visit to the exhibit hall. Here are five things you may want to add to your schedule:

1. Bundle up and head to the New England Aquarium for a whale-watching tour.
2. Experience the Museum of Science.
3. Check out Ether Dome at Mass General Hospital, where Paddy the Mummy was once used as a fund-raising attraction.
4. Get up close and personal with nature at the Franklin Park Zoo.
5. Tour Fenway Park and see the Green Monster for yourself.

NSTA 75th ANNIVERSARY

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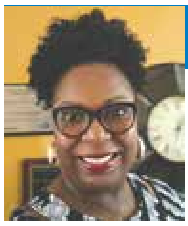


ASK A MENTOR, **Advice Column**

Building Trust, Assessing Rigor, and Collaboration Among Colleagues and Students

By Sharon Delesbore

Editor's note: Beginning this month, Sharon Delesbore joins Gabe Kraljevic in writing NSTA's Ask a Mentor column in NSTA Reports *and on the NSTA Blog. Delesbore is an assistant principal in Texas who loves and advocates for science instruction. She has trained educators teaching science at all levels from preschool through higher education in effective instructional strategies as well as cultural and environmental awareness as it relates to our science community. She also serves as the president of the Association for Multicultural Science Education.*

Why must we meet so much as a physics team when I need time alone to prepare for my classes?

—M., Indiana

Regularly meeting as a collaborative team, department, or content area is extremely beneficial to teachers, and most importantly, essential to student success. When science teachers collaborate, it allows for what I call the 3Ds: Design, Dig, and Discuss.

Collaborating allows science teachers to *design* lessons together. It is much easier to create and assess assignments, projects, and laboratory activities that engage and evaluate the learning of students as you ensure that your group meets the performance expectations of the curriculum. Common planning and common assignments create opportunities to *dig* through data together to determine which instructional strategies effectively enhance the student experience. This helps you and your team understand your students' processing and thinking and discover patterns and trends in student learning. You can clarify misconceptions. Coming together as a team enriches our practice as we *discuss* student work.

Analyzing student work helps the team identify where students are in their learning. You may notice something that your colleagues don't, and vice versa; the feedback can guide your instruction. When we take these conversations into the classroom with our students, our learners get the opportunity to see exemplars and understand what "meet performance expectations" actually does or does not look like. As our ultimate goal of teaching is student ownership of learning, we must start with the fundamentals of collaboration. The more teachers plan, the more they learn how to best serve their students.

I am a first-year teacher at a high school listed as a priority to the district (i.e., school improvement needed). I like the school and the students, but it seems like the administration is in my classroom all the time. I'm concerned that they do not trust my capabilities to teach my students.

—C., Texas

Yes, you are being "watched," for lack of a better term. In any organization, administrators monitor the activity taking place. For schools, this monitoring happens during classroom walkthroughs. They help administrators connect to students' learning. As a first-year teacher, it is even more important that your administration sees what is occurring in your classroom: not in an "I caught you!" way, but to better assist you as you develop your instructional identity.

A 2013 article, "How Do Principals Really Improve Schools?" (*Educational Leadership, https://bit.ly/2mha6BK*), asserts that classroom walkthroughs allow for "a new pair of eyes in the classroom, where we are able to help a teacher become aware of unintended instructional or classroom management patterns. We could express appreciation for the wonderful work a teacher was doing because we had witnessed it firsthand. We observed powerful instructional strategies that we were able to share with other teachers."

Administrators' walkthroughs are opportunities for them to provide instructional leadership and coaching with specific feedback. Don't be discouraged by the visits! Embrace the attention, demonstrate your abilities, and be open to the feedback as you strengthen your instructional identity.

My third-grade class created models of plant and animal cells with various items that they found around the house. Many of the kids did a great job, and their projects were very colorful. I brought samples to my Professional Learning Community. As we discussed the students' work, I could not understand why my colleagues thought the work was not rigorous enough.

—D., Kentucky

The essence of the *Next Generation Science Standards* (*NGSS*) is increasing the rigor of student work, in part through performance expectations that deepen student thinking. Models are no longer considered 2-D or 3-D representations for identification, but as representations with a purpose. The performance expectation at the upper-elementary level is for students to not only identify a model's parts or demonstrate its functions, but also to apply their content knowledge by predicting limitations or the results of manipulations. If your students created plant and animal cells missing an organelle of their choice, would they be able to predict how the missing organelle affects the entire cell? The students would demonstrate their ability to identify parts of the cell and their understanding of the organelle's functions and importance to the cell.

Using analogies with models can bring a concept to life. What if your students created an analogy for each organelle to help describe its function? For instance, "The cell membrane is like a sandwich bag, and cytoplasm is like gelatin." Students could collaboratively discuss their analogies to determine how to construct a model with items that best represent the organelles' functions.

NSTA provides many resources to help understand the progression of thinking students are expected to demonstrate as we facilitate their comprehension and help them understand how they are learning in a progressive manner. Developing and Using Models from the *NGSS*@NSTA Hub (*https://bit.ly/2nS5XVm*) could be particularly useful here.

How can I keep my students more engaged in their science cooperative learning groups?

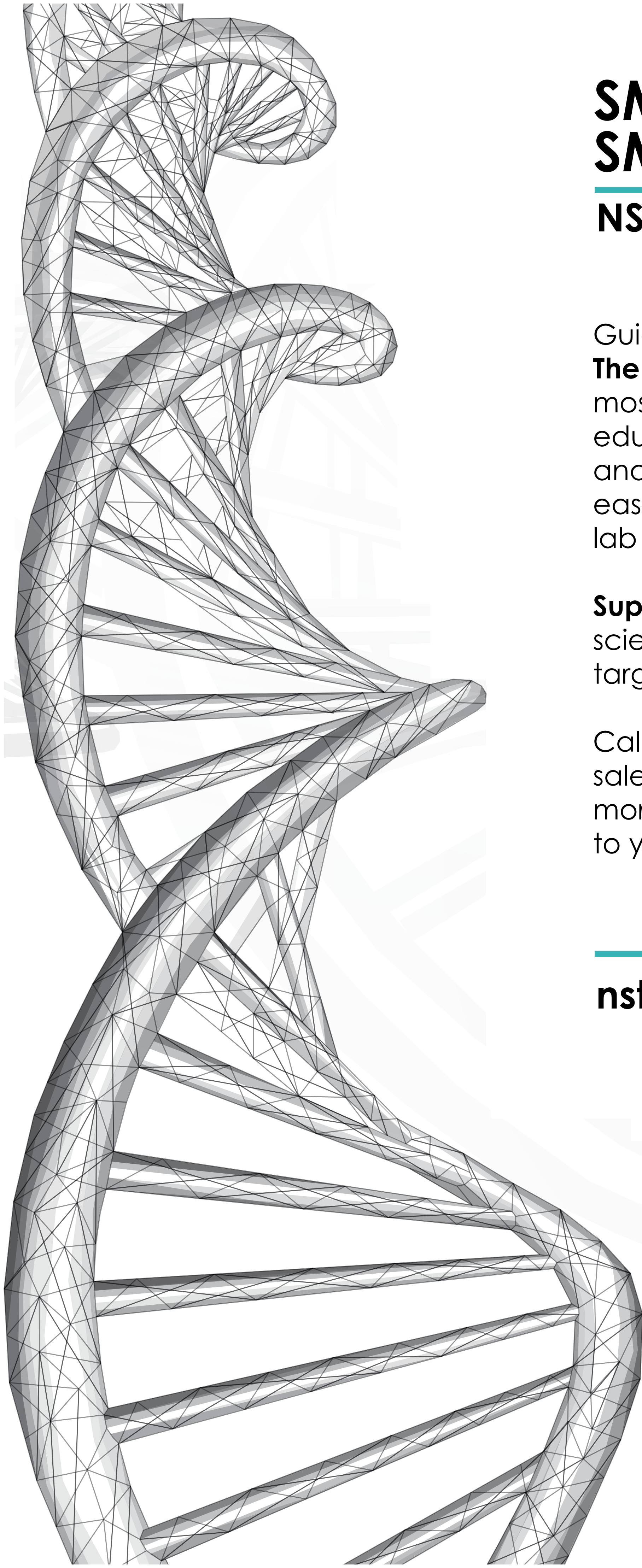
—A., California

Group work must be intentional. Defined roles help students keep one another accountable. They have to see and care that if they do not do their parts, the group will not reach its full potential. One way I helped increase engagement was by using props for the designated roles. For example, group leaders or "principal scientists" wore lab coats, enhancing the role's appeal. Because group leaders need to speak in positive and encouraging ways, this also helped teach soft skills such as positive verbal communication. We practiced sentence stems to help guide the group.

Students also liked the "observer" role. This student documented how well the group worked together. We discussed what a good functioning group looked and sounded like. Along with the checklist, observers received a pair of oversized party glasses. The "safety manager" wore a hard hat and safety vest.

These props kept safety on everyone's mind at all times. At the end of a group activity, students rated how well each task was performed, with the focus on the role, not who held the role. This helped them understand that group work is not personal. Group accountability determines the group's success.

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



Learning How to Teach Science

Internship programs around the country are bringing high school students to classrooms to learn about teaching, and some interns are discovering what it's like to teach science. "For the past few years, I've hosted high school interns from the Bergen County Academies (BCA), a nearby magnet school," for their Senior Experience internship, says Denise Kuehner, K–6 science lab specialist at Oradell Public School in Oradell, New Jersey. During Senior Experience, BCA seniors "spend one day a week at an internship of their choosing, for their entire senior year," and receive academic credit and preparation for the workforce, she explains. "It's a great program, and I think it has encouraged students to consider teaching science."

Science labs "take a bit of setup and cleanup time. With the *Next Generation Science Standards,* I've had to develop new labs and lessons. I thought it would be great to have an intern to help," Kuehner explains. For the interns, "it's a unique position because they can see the teaching profession from both sides, so they can understand it better….We make it fun in science lab; they can see teaching can be a lot of fun," she adds.

Jacob Raghoobar, now majoring in computer science in college, was Kuehner's first intern. "I had been searching for a software development internship since I was studying computer science,…but I had been struggling to secure one. When I saw that Ms. Kuehner wanted an assistant in her science lab, it seemed totally [different] from what I initially wanted…, but it also seemed very interesting because I was very interested in the topic of education….I had never really worked with kids before, or been in a school environment where I wasn't a student, ...but I decided to try it out," he recalls.

Working with Kuehner, Raghoobar could "focus on aspects such as lesson planning and student performance….I personally had never thought about how intricate lesson planning was, or how much thought goes into lessons to make sure most, if not all, students can benefit from a lesson/activity….I was able to learn the differences between what it was like to work with kindergartners versus working with sixth graders. It was a very good introduction to working in a school environment," he contends.

"I volunteer [in] the Newark Public School system [now], working with a computer science teacher at American History High School. I use *a lot* of what I learned in Senior Experience," Raghoobar reports.

Jocelyn Greer, a former student at the Bergen County Academies in Hackensack, New Jersey, worked with Denise Kuehner's science lab students at Oradell Public School in Oradell, New Jersey.

DENISE KUEHNER

Kuehner says she has also benefitted. "I have learned more about how to be a better teacher because I have to explain my lessons to others….[and] I learned how to teach someone to be a teacher." She concludes, "It's very rewarding to encourage youth to go into teaching."

Teacher Cadets

Originating in South Carolina, and now active in 40 states, the Teacher Cadet Program (*http://bit.ly/2VQXYEV*) aims to encourage "dynamic, compassionate, and smart" high school students "who want to help change the world by educating future generations" to enter the teaching profession, says Todd Scholl, Teacher Cadets' coordinator of communications and program development. More than 70,000 students have participated over the past 35 years, and "a significant percentage are headed" to the classroom, he notes, adding, "We don't need them to be committed [to a teaching career], just to have an open mind."

The elective course allows students to earn both high school credit and college credit from Teacher Cadets' College Partners, and its curriculum "aligns with best practices and current research," observes Scholl. Even if Teacher Cadets "don't go into education, they're developed into education advocates," Scholl asserts. "Most students will be parents of students, so it's important for them to understand the value of teachers and why our country should invest in them."

Isaac Russell, second-grade teacher at Richfield Elementary School in Richfield, North Carolina, worked with a Cadet for two years when he taught fourth-grade science and social studies. "She was another arm: Most teachers only have so many arms," he observes. "She helped set up and organize stations, helped students organize their binders, helped with getting supplies ready for Lab Day on Fridays, and worked with small groups of students on labs and experiments. "

In addition to helping students stay focused and teaching a two-lesson unit once she became more experienced, "she built relationships [with students]," he contends. "I'm a veteran teacher. We worry about getting through objectives. [But students also] need the soft skills. Teacher Cadets remind us that we need these skills."

Earning a Credential

Hazelwood School District in St. Louis, Missouri, has a Teaching Profession Internship for high school seniors. To qualify, students take the Exploring Teaching Profession course and apply what they learn during an internship in Hazelwood elementary and middle schools. The course prepares students to earn the Educational Fundamentals credential offered by the American Association of Family and Consumer Sciences, which enables them to work in an educational setting while attending a postsecondary institution to earn full certification.

The internship was established "to alleviate the teacher shortage," says Christina Hughes, the district's K–12 science curriculum coordinator. "University of Missouri St. Louis (UMSL) is a partner and offers credit" to the interns, she notes. The Exploring Teaching Profession course lasts for three hours, and during their second semester, interns spend half of their school day on-site, working in small groups with the teacher and students, she explains. Interns "observe and facilitate lessons, help the teacher plan lessons, and interact with and observe the students."

"Internship placements depend on students' interests," says Matt McClellan, Hazelwood's Career and Technical Education coordinator. "If they're interested in science, then they are placed [with a teacher of science]," he explains. "This year, we're working with UMSL so that [interns] will get dual credit, high school and college, for courses at the high school."

Last spring, in addition to working in classrooms, interns worked at the St. Louis Zoo, which has "an Early Childhood program….The zoo is not a traditional prekindergarten facility, [so the interns] got to experience a different environment to teach in," he relates.

Hughes' daughter Alisha is one of those interns. "I had been a part of the Zoo ALIVE volunteer program and found that I enjoyed helping out with their camps," says Alisha. "I am currently employed as an assistant educator at the [zoo]. The Teacher Profession Internship/Exploring Teaching [course] seemed like a great way to get more experience. It helps give me a closer look into the teaching career and gives me a chance to get some experience I wouldn't normally get." ●

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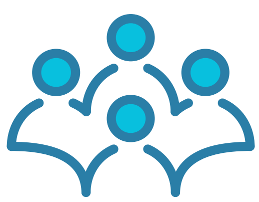
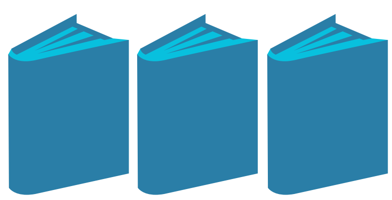
- **One print journal** for the school building and e-journals for every teacher/member in the school
- **One hard copy of *NSTA Reports*** (newspaper) with e-Reports for every teacher/member in the school
- **Access to Learning Center Forums**, including collections of *NGSS* and STEM resources differentiated by grades
- **An initial one-on-one conversation** with NSTA to determine which products and services can best support school-wide professional learning goals
- **Participation in three virtual conferences** per year, exploring critical topics for STEM and *NGSS* integration
- **Access** to a national *NGSS* and STEM listserv and 16 other listservs

In addition, each teacher gets discounts on



NSTA conferences and workshops



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75th NSTA ANNIVERSARY

National Science Teaching Association

Mark Your Calendar
NSTA Dates to Remember

(All dates are deadlines unless otherwise specified.)

November 14—The **NSTA Area Conference on Science Education in Cincinnati, Ohio,** opens today and continues through November 16. Luke Dollar, National Geographic Explorer and Bashore Distinguished Professor and chair of the Department of Environment and Sustainability, Catawba College, North Carolina, and Adjunct Professor of the Environment, Duke University, will present the keynote session. For more information or to register, visit *www.nsta.org/cincinnati.*

November 16—Don't miss the **Three-Dimensional Teaching and Learning Powered by STEM Workshop** in Cincinnati, Ohio, and learn how to bring STEM together with three-dimensional instruction to enhance your students' learning. Early bird registration (by **October 4**) for the workshop costs $200 for NSTA members; combined early bird member registration for the workshop and the **NSTA Area Conference on Science Education in Cincinnati** costs $300. For more information or to register, visit *https://bit.ly/2MfZWvK.*

November 21—Middle and high school teachers, would you like to win a $20,000 lab makeover for your school? Apply for the Shell Science Lab Challenge! Join the **Developing a Competitive Application for the Shell Science Lab Challenge free web seminar** to learn about the application process and the keys to a strong application. The event will be held at 6:30 p.m. Eastern Time (ET). For more information on NSTA Web Seminars or to register, visit *http://bit.ly/2RGhr8N.* For more information on the NSTA Awards and Recognitions Program, visit *www.nsta.org/awards.*

December 4—K–12 teachers working near Shell assets in six states can apply for the Shell Science Lab Regional Challenge to win a science classroom makeover. Don't miss the **free web seminar, Developing a Competitive Application for the Shell Science Lab Regional Challenge,** to learn how to best showcase your efforts! The event will be held at 6:30–8 p.m. ET. For more information on NSTA Web Seminars or to register, visit *http://bit.ly/2RGhr8N*. For more information on the NSTA Awards and Recognition Program and specific qualifying districts for the regional challenge, visit *www.nsta.org/awards.*

December 12—The **NSTA Area Conference on Science Education in Seattle, Washington**, opens today and continues through December 14. Nalini M. Nadkarni, STEM (science, technology, engineering, math) Ambassador Program (STEMAP) Director at the University of Utah, will present the keynote session. Early bird registration costs $195 for members of NSTA, Washington Science Teachers Association, American Association of Chemistry Teachers (AACT), American Association of Physics Teachers (AAPT), American Chemical Society (ACS), American Society for Engineering Education (ASEE), and National Association of Biology Teachers (NABT). One-day registration options are also available. For more information or to register, visit *www.nsta.org/seattle.*

December 14—The **Assessing Three-Dimensional Learning Workshop** in Seattle, Washington, will empower you with a set of tools that can be used to evaluate and improve existing assessment tasks, as well as analyze student artifacts using a student work analysis protocol. Registration includes *The NSTA Quick Reference Guide to the* NGSS, *K–12*. Early bird registration (by **November 4**) for the workshop costs $200 for NSTA members; combined early bird member registration for the workshop and the **NSTA Area Conference on Science Education in Seattle** costs $300. For more information or to register, visit *https://bit.ly/2JSIZWw.*

February 21, 2020—Register today to maximize your savings on registration for the **NSTA National Conference on Science Education**, 20/20 Science: Expanding the Vision, happening April 2–5 in Boston, Massachusetts. Visit *www.nsta.org/boston* for more information and to register. ●

#ICYMI

In case you missed it, check out a few highlights from NSTA's e-newsletters. Catch up on all the latest e-newsletters at *https://bit.ly/2X5iuEQ.*

"Pairing Literacy and Science to Effectively Teach Argumentation"

English Language Arts Curriculum Specialist Judine Keplar and Science Curriculum Specialist Carrie Launius work together in the St. Louis Public School District, training elementary teachers to effectively use trade books to engage students in the science and engineering practices of argumentation from evidence.

—*Next Gen Navigator* (September 2019, *https://bit.ly/2Yr2PAD*)

"Now Available: Free Downloadable Full-Color Poster Highlighting Where Food Comes From"

Check out the new food and agriculture website—unveiled last month by NSTA and Corteva—that features science-based lesson plans and resources for elementary teachers. And don't forget to download and display the free poster that shows the path from farm to grocery store in your classroom! For more information, including access to the new resources, visit *www.nsta.org/corteva.*

—*NSTA Express* (October 8, 2019, *https://bit.ly/2K9R5M0*)

Celebrating 75 Years at NSTA

1949 NSTA purchases *The Science Teacher,* which becomes the association's first teacher journal. First issue appears in October 1950.

2019 NSTA changes its name from the National Science Teachers Association to the National Science Teaching Association to better connect with all members of the science teaching community.

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Join an NSTA Committee!

Interested in shaping the future of science education? Step up to serve on one of NSTA's standing committees, advisory boards, or panels! NSTA needs our members—regardless of the grade levels they work with or the setting they work in—to provide their insight and experience to help guide the association's activities and initiatives.

Advisory board and committee members serve three-year terms, beginning on June 1, 2020. Committees are divided by grade levels, tasks, and function, such as Preschool-Elementary Science Teaching, High School Science Teaching, Postsecondary Science Teaching, Coordination and Supervision of Science Teaching, Informal Science, Multicultural/Equity in Science Education, Preservice Teacher Preparation, Professional Learning in Science Education, Research in Science Teaching, and Budget and Finance.

NSTA's advisory boards include Publication Advisory Boards, Aerospace Programs Advisory Board, Conference Advisory Board, Development Advisory Board, Retired Members Advisory Board, Rural Science Education Advisory Board, Science Safety Advisory Board, and Special Education Advisory Board. In addition, NSTA members can also serve on three panels: the Outstanding Science Trade Books Panel, Best STEM Books Panel, and the Shell Science Teaching Award Panel.

A full list of NSTA's committees and advisory boards is available at *https://bit.ly/2pYnE6B*. Apply to join a committee, advisory board, or panel at *https://bit.ly/35oBijO*. ●