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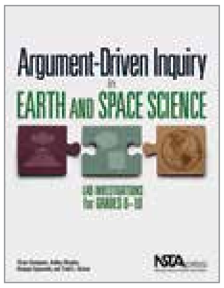

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Redesigning the Science Fair

Schools and teachers are transforming traditional science fairs into events incorporating science, technology, engineering, and math (STEM) or STEAM (STEM plus Arts). At Lake Washington Girls Middle School in Seattle, Washington, for example, "we have transitioned [to] a Public Health STEAM Fair [in which seventh graders] identify a public health issue in our community, research the issue, develop a question and design a research procedure, then conduct statistical analysis to help them explain their data. Lastly, students present their research to [public health]...experts in the style of a conference," says Christine Zarker Primomo, STEAM teacher.

"The curriculum in seventh-grade science is biology, so public health works great. But the bigger piece is that it [connects more] to citizen science. Public health is super broad and has a lot of connection to students' lives," Primomo observes. In addition, "[s]cience and social justice come together [for students] because their research can impact their community."

She works closely with the math department because "they teach statistical analysis. [For their project,] students have to collect 30 data points... Students are more motivated to learn about standard deviation when it's their own data," she maintains. Local public health department staff provide data sets.

Students collect data via surveys and activities like collecting cigarette butts from nearby water bodies to study their effects on water, for a project exploring the effects of air quality on water quality, Primomo explains. For a project focusing on human sugar consumption, "students had test subjects and created a form requesting permission to collect data from them," she recalls.

JACK NEWMAN, DIRECTOR OF COMMUNICATIONS, DOANE ACADEMY

For the STEAM Fair at Doane Academy in Burlington, New Jersey, upper-school students "complete projects in any field as long as they [relate] in some way to science concepts," says Michael Russell, STEAM coordinator and mathematics and science department chair.

During the fair, students present a slideshow about their research to their families and judges from the public health community. Primomo grades students on their questions, procedures, data analysis, graphs, and presentations.

Doane Academy in Burlington, New Jersey, transitioned to a STEAM Fair because "we [decided] to celebrate student innovation and collaboration across all grade levels with a fair that permitted them to complete projects in any field as long as they related in some way to science concepts," says Michael Russell, STEAM coordinator and mathematics and science department chair. "We wanted to motivate [students] to use the engineering design process more organically, [with the] idea that the science department isn't the only anchor for that," he adds.

Doane now holds a STEAM Fair because the science department found "students who thrive in science do elaborate, cohesive projects, while mid-tier students and students struggling in science find shortcuts and don't do original work…We wanted to not just apply standards, but also have students do purposeful tinkering, driven by their passions and struggles," Russell

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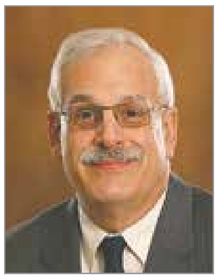
Staging Classroom Climate Summits PG 14

COMMENTARY: **Jim McDonald**

Active Formative Assessment

By Jim McDonald



ROBERT BARCLAY AT CENTRAL MICHIGAN UNIVERSITY

Jim McDonald

When you teach, one goal is to have students understand the science concepts after the unit of instruction. But before you can know what to teach and how to teach, you have to know what your students know. So your units of accountability are all of those individual students and *what they know at the beginning of instruction*.

Formative assessment should be one of the tools you consider when planning instruction. Why formative assessment? An assessment activity can help learning if it provides information to be used as feedback by teachers, and by students in assessing themselves and one another, to modify the teaching and learning activities in which they are engaged, according to "Inside the Black Box: Raising Standards Through Classroom Assessment" (Black and William 1998). Such assessment becomes formative assessment when the evidence is actually used to adapt teaching to meet learning needs.

In "The Characteristics of Formative Assessment in Science Education," Beverley Bell and Bronwen Cowie maintain that formative assessment is the process used by teachers and students to recognize and respond to student learning to enhance that learning, during the learning. Margaret Heritage asserted in "Formative Assessment: What Do Teachers Need to Know and Do?" that formative assessment is a process that occurs continuously during the course of teaching and learning to provide teachers and students with feedback to close the gap between current learning and desired goals.

Since your students are the focus of your teaching, shouldn't they be involved in the assessment process? Students become frustrated and annoyed with passive assessment that does not seem to have a purpose. Active formative assessment (AFA) involves students in thinking about what they already know and how they can improve their understanding. In the age of three-dimensional learning and the *Next Generation Science Standards* (*NGSS*), we seek to impart a deeper understanding to students of how the parts of science connect.

How does AFA work? It takes place in a classroom environment where students feel safe sharing ideas, listening and learning from their peers' ideas, and with a teacher who uses assessment tools to improve learning. The teacher involves students in the assessment process by telling them what the assessment is for and how it will be used. The teacher tells students the assessment will guide instruction and that the students will receive feedback from the formative assessments on how they can grow as a science learner.

AFA also promotes a classroom atmosphere where ideas can be shared. Models of this include the Talk Moves strategies from TERC's Inquiry Project and the Claims-Evidence-Reasoning framework by Carla Zembal-Saul. Students need to know they are not the only ones with a particular science idea. When students hear others' ideas, their own science knowledge increases.

What are some tools to help with AFA?

Thought Swap. Have students work in pairs, ideally in two rows facing one another, and have an A line and a B line. Pose a question, and the A line students have 30 seconds to answer the question, then students in the B line respond to their partners. Students in one line then move a space to a new partner. The new partners then share their answers to the question. Repeat this process three times. Debrief the answers with the entire class. This lets students hear the ideas of others quickly, in a personal manner and in the debrief.

Formative Assessment Probes. These assessments allow students to share their current science understanding with the teacher and other students. The probes in Page Keeley's Uncovering Students' Ideas series align with *NGSS* and include teacher background knowledge, common misconceptions, how to administer the probe, and how to make sense of student answers.

Concept Cartoons. Concept cartoons introduce science concepts in everyday settings. Each character has a different opinion about the topic being discussed. All of the possible answers are plausible and highlight common misconceptions. Learners extend the discussion from the concept cartoon. This can be in the form of a vote, group discussion, or class debate. Concept cartoons often include ideas for finding out about the science concept in question.

Pre-/Post-Unit Questionnaires. Give students a two–page pre-unit questionnaire that includes choosing among pictures showing different aspects of the science concept and multiple-choice questions. Randomize the questions and give them to the students again as a post-unit questionnaire. This shows student growth and provides data for teacher evaluations. When shared with the students, it allows them to know how they have progressed in their science understanding.

When teachers establish the proper classroom environment and students actively participate in their own learning and assessment, science understanding can be a dynamic process. Students benefit from understanding what they know as opposed to not knowing where they stand. Teachers benefit from discovering what a particular group of students knows and how they can adjust their science teaching—and even where to begin. ●

Jim McDonald is a professor of science education at Central Michigan University, president of the Council for Elementary Science International, and chair of the NSTA Alliance of Affiliates.

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Science Fairs, from pg 1

explains. "We made the fair a core part of our curriculum" because when students worked on projects at home, they tended to receive either "too much help from parents or none," he contends.

Upper-school students can work with any teacher or community member to develop a product of their choice. One student wrote a book of science-related poetry that informed readers about mental health issues. Another wrote short stories about bug anatomy and behavior and illustrated them with photos. "A really cool thing is that our science kids haven't lost the opportunity to do hard-science projects," Russell emphasizes.

Introducing Engineering

Seventh- and eighth-grade science teacher Samantha Rudick of Northvale Public School in Northvale, New Jersey, was asked to redesign the seventh-grade science fair to include the engineering design process (EDP). "I [also] came up with [the idea of having] a theme," she notes. Last year, students were told they were stranded on an island and had to create things to help them survive. This year, she told students they were living in a town with a polluted environment and had to use recycled or reusable materials to create games for a carnival that would raise funds for their town's new recycling center.

"We did a unit on reusable versus nonrenewable materials…[Students] had to distinguish between [reusable and nonrenewable materials] to create their games," she explains.

Students developed game prototypes and continued testing and improving them before the fair. They also created an interactive button apparatus that fair attendees could push to begin a presentation. "Some groups' buttons were electric, [while others] used a sound-making device," Rudick relates.

In addition, students had to make videos of their games and create a poster board showing every step of the EDP, illustrated with photos. "In their presentations, they had to explain their [EDP] without looking at their poster board," she points out.

"The [school's] administrators said this was the best science fair they'd ever seen," Rudick reports.

Virtual Fairs

"We now participate in a Science/Engineering Fair, and everything is virtual," says Laura Mackay, science coach and STEM liaison at Ed White Elementary E-STEM Magnet School in El Lago, Texas. "Students complete either a science fair investigation or engineer a design to solve a problem" and create a PowerPoint presentation, she explains.

Science fair participation had declined because "it wasn't required, so more parents opted out. We decided to take the parents out of the process, and technology allowed this," she relates.

Science fair boards were no longer needed, "which was really hard for some parents and teachers," she reports. "The boards were flashy, but they didn't emphasize the data."

Using PowerPoint "meets the tech part of STEM," Mackay contends, because students become highly proficient in it. "We're modeling what the world is like now [and teaching] lifelong skills," she adds.

"Science is still in there because students are analyzing data to see if their design will work," Mackay points out. Past projects have explored solutions to problems like how to go fishing with minimal equipment and how to keep a soda cold using a wet towel in the freezer.

"Sometimes the finished project isn't as amazing, but it's all student-driven. It equaled the playing field on the judging part" because not all students have access to technology, "so we provide it to everyone," she observes.

The judges appreciate that the judging is done virtually because "they don't have to come here [to do it]," she reports. Students are only graded on participation because "[h]arsh grading killed the love of science fair [in the past]," she asserts.

"[Now we can] see what kids are really capable of doing," instead of what parents do, Mackay concludes. ●


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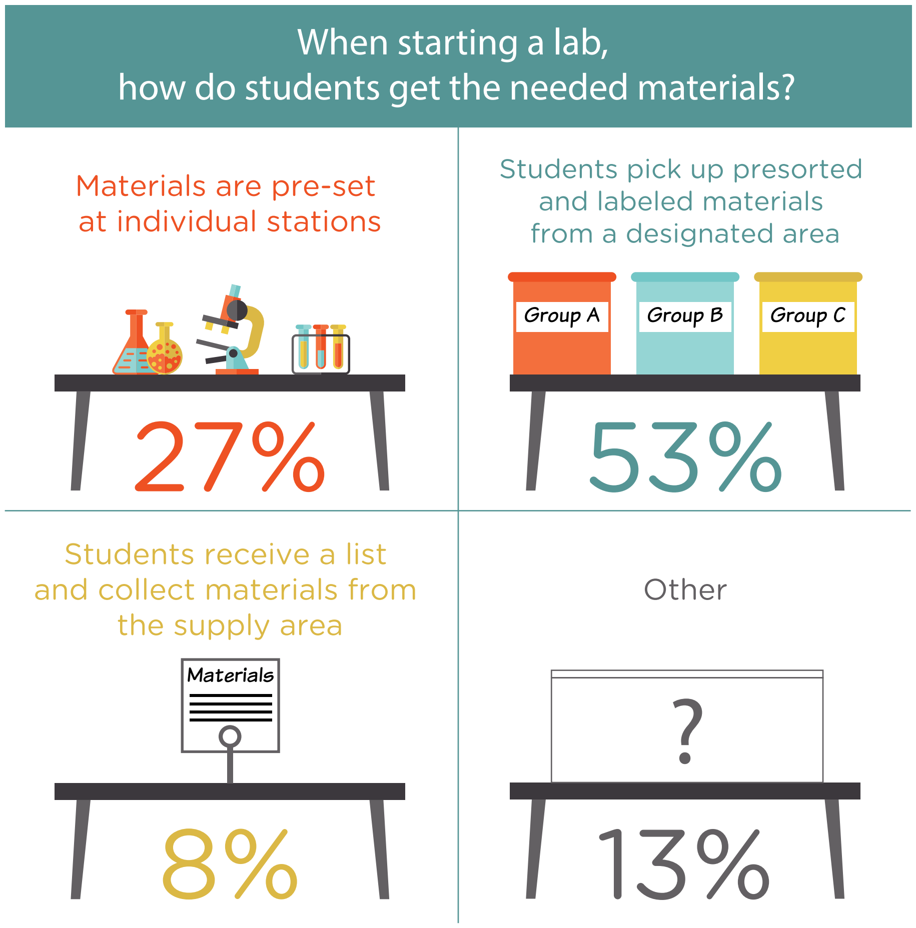
Looking at Lab Spaces, Equipment, and Practices

As educators strive to engage students in hands-on scientific inquiry, they must find time and space to not only conduct labs, but also store and distribute materials, tools, and equipment. In a recent informal poll, *NSTA Reports* asked science educators about their classroom and lab environment and practices. The survey found most science teachers (82%) do not have separate classrooms and labs, and less than half of those (45%) have a designated lab space within their classrooms. Of those who have a lab room, a third share it with more than two other teachers, another third do not share the space, 27% share it with one other teacher, and 7% share with two others. The majority (81%) report their schools do not have a designated lab assistant or coordinator.

When starting a new lab, more than half (53%) said they have students pick up presorted and labeled materials from a designated area, while 27% report setting up individual stations in advance.

When labs are completed, 54% have students return materials to a labeled, designated area; 23% have materials remain at the lab station; and only 9% have students return materials to the instructor or lab assistant/coordinator to be checked in. Sixty-nine percent indicated they reserve time at the end of the lab to ensure everything has been returned and is undamaged.



*Numbers have been rounded to the nearest whole number.

Here's what science teachers say about how they deal with students/student teams who don't return materials/equipment on time or return broken/damaged items:

If damage was deliberate or caused by recklessness, I have consequences for the individual students.—*Educator, Middle School, New Mexico*

I usually find the materials later, shoved in a drawer or sink. If they broke something, I talk to them and determine how it was broken. —*Educator, High School, Maine*

Take points off. Reprimand.—*Educator, High School, Georgia*

Not allowed to charge students for damaged or broken items. Usually other students will help me clean up and set up for the next class.—*Educator, High School, Florida*

I generally address it with the entire class, unless it becomes a consistent problem. At that point, I would address it individually with the student and document it with my supervisor. —*Educator, Institution of Higher Learning, South Carolina*

There is a range of things. Honest accidents when safety protocols were followed have no penalty. [Penalties for b]roken [equipment]/late [return] for other reasons range from lower grades, detentions, or alternate assignments on [the] next lab.—*Educator, Middle School, Oregon*

[It] depends on what and who. —*Educator, Middle School, California*

Lost items are charged to the student when [he or she requests] a replacement.—*Administrator, Middle School, High School, Texas*

We review protocol. Perhaps they will not participate in the next experiment and complete an online simulation instead. They identify what was the error and what they should have done. A signed lab contract was collected from all students [initially].—*Educator, Middle School, California*

Because I have small classes, I can tell if students break things due to negligence or simply being human. I haven't had to deal with someone breaking something on purpose yet.—*Educator, High School, Kansas*

It depends on the type of equipment. If there was deliberate destruction or theft, it warrants a phone call home, a trip to the principal, or doing an alternate activity in class (no lab). Otherwise, I generally let it go and assume there will be some level of material lost/damaged from year to year. —*Educator, Middle School, California*

[The student] will not be able to do the next lab.—*Educator, High School, California*

They will work separately or with me during the next lab.—*Educator, High School, New York*

I give a lot of reminders about appropriate use before and during the experiments. I circulate a lot during that time to ensure proper use. Over 18 years, I've only had a couple of damaged items.—*Educator, High School, Georgia*

They have to pay for it.—*Educator, High School, Georgia*

Classes are not allowed to leave the room until everything is accounted for and put away. Students who do not use the materials responsibly are not allowed to participate in future labs until they have met with administration and parents.—*Educator, Middle School, DoDEA Pacific South District*

Students are held after dismissal bell to complete lab cleanup and be checked on lab assignment rubric. The rubric has four observed checkpoints: 1) data recorded; 2) safety precautions followed; 3) shared effort to complete lab tasks; 4) station clean [and] materials returned, which are evaluated before student groups are released from their station to return to class desks to continue analysis and [conclude] work...Damage caused by abuse or failure to follow instructions rather than by accident may result in a lab fine if expense is significant ([more than] $25), similar to a library fine for replacement of equipment, but current state laws make collection of such student fees difficult.—*Educator, High School, Tennessee*

[I] hunt them down and get items; e-mail parents.—*Educator, High School, Florida*

If it is intentional, a discipline report is done. If it is by accident, a life lesson is learned.—*Educator, High School, New Hampshire*

For broken/damaged equipment, students are fined to repair or replace the item. Students who do not return items can also be fined.—*Educator, High School, Wisconsin*

It depends on the item; generally a conversation with student or student teams. Sometimes I call home to talk to parent.—*Educator, Middle School, Nebraska*

I tell students to let me know if anything is broken or damaged so that it will be ready for the next group. It is normally due to an accident, not playing around, so no consequences. —*Educator, Middle School, Virginia*

On lab days, students are expected to have the signed contract in the room, and it is checked by the teacher before students can participate. No lab contract, no completing the lab. We also add the rule of *no* restroom use or leaving class during a lab. Students do not get another copy of the contract if they lose it; it is like a driver's license, and there is a cost if they are in need of another copy.—*Educator, Middle School, Oregon*

I start counting down the time at the end of the lab to remind students to start to clean up the lab. I ask them to return materials [to] where they got them. I walk around the room checking the cleanup process. [At a]ny lab bench that is not cleaned up, I ask the students who worked at it to clean up. —*Educator, High School, Pennsylvania*

I inspect lab tables and release students only when they have completed cleanup. As students are always ready to leave class, they comply quickly when something is awry.—*Educator, Middle School, Maine*

Students do not seem to care about putting things back.—*Educator, High School, Alaska*

It depends on what it is, but it may involve the student buying a new package of something; students may stay after school to wash dishes or help with general lab/classroom cleaning. If at all possible, I think restitution is key.—*Educator, Middle School, Iowa*

Our school has a science lab fee. Small things like broken glassware [are] taken from that budget.—*Educator, High School, New York*

No, they are fourth graders learning how to use equipment. Our school has accepted [the fact that] some materials may break. —*Educator, Elementary, Colorado* ●

Quotable

Never be limited by other people's imaginations.

—Mae Jemison, U.S. physician and astronaut

Videoconferencing Expands Classrooms

The increasing availability of low- or no-cost videoconferencing technology offers teachers ways to connect their students with the broader world around them.

"We're a Title 1 school; many of our kids don't get a chance to explore beyond their own neighborhood," says Betty Jo Moore, a sixth-grade science teacher at Wiley Magnet Middle School in Winston-Salem, North Carolina. "I try to help them see beyond the neighborhood, our community. If I can help them see beyond the neighborhood,…then I find that spark that will really help them see beyond. The cool thing about videoconferencing is it doesn't cost anything."

"It's a really good way to bring in technology," asserts Nancy Fitzgerald, environmental science teacher at the Academy for Environmental Science and the middle school gifted and talented teacher in Jefferson Township, New Jersey. "They see not only real scientists, but I can go further and use that scientist's data in the classroom… It's different [from] watching YouTube videos; there's a real person standing in front of you, interacting with you."

Fitzgerald's first videoconferences with her students were with a friend working for Conservation International in Hawaii. Later, she learned about videoconferencing opportunities with Polar-ICE (Interdisciplinary Coordinated Education) during a workshop presented by staff from New Jersey's Rutgers University.

Working with Polar-Ice "has changed the way I teach. I bring in their data, use it in the classroom. When we've done a teleconference, so many kids say 'I want to be that scientist,' 'I want to live in Antarctica someday,'" she relates. "The Polar-ICE website has a host of resources… They're very good at supporting [teachers] pre- and post-conference. The lead-up and follow-up lessons make it really impactful."

The Polar-ICE videoconferences (*https://polar-ice.org*) are an integral part of sharing work being done at the Palmer Long-Term Ecological Research (LTER) area in Antarctica, according to Janice McDonnell, science agent in the Department of Youth Development at Rutgers University. With funding from the National Science Foundation, Polar-ICE coordinates approximately seven half-hour videoconference calls each year.

"Each call includes three schools, one classroom from each school. They do it round-robin [style]: A student asks a question, gets a response, and it moves to the next school. As a side benefit, the schools enjoy hearing other schools' questions. It's neat to build that internal community," McDonnell explains. "We do fewer [schools], but in a more in-depth way. Our evaluation data shows that both teachers and students benefit from the experience. We are trying to make the LTER research accessible to people other than scientists.

"We try to follow the [*Next Generation Science Standards*] and help teachers meet those goals. We try to focus on that as much as possible. Kids are interested; they want to know how things change over time. They ask really good questions. Scientists have called their questions thesis-like," she notes. "That wouldn't happen without teachers. We're 100% partners in this. They prepare the students [to ask good questions]….it's lots of fun. Kids get a kick out of seeing glaciers behind the researchers, thinking about what it's like to be at the end of the Earth."

Moore has arranged videoconferences between her classroom and classrooms as far away as South Africa and Australia. She developed her network of teleconference partners through the NSTA member e-mail listservers and attending professional development events.

"Before the different conferences I go to, I ask online for people to bring me a soil sample," she says. "I have the kids analyze the samples, and then we do mystery calls with [a teacher and class from the region]." Moore's students pose questions about the local geography and climate to determine where the sample originated. "The kids [we're videoconferencing with] look like us, but their soil is very different. It gets [my students] to understand soil is not the same everywhere,…and it ties back to geography as well… They need to understand everything is not the same as it is here. I really want them thinking out of their own neighborhood."

Scheduling across time zones can be a challenge whether educators are working with a project like Polar-ICE or just one-on-one.

"Most challenging is obviously the logistics, finding the right time of day," acknowledges McDonnell, who often works with schools in differing time zones as well as the Antarctic researchers. "We get a lot of folks who deal with time [restrictions]. We get around that by recording them. All our videoconferences are recorded and put on the website."

Trying to work the videoconference into a high school schedule requires planning, acknowledges Fitzgerald. If the conference and her class time don't align, "I have to get permission for students to miss other classes… Hopefully teachers would have support from administration to do that."

Professor of Education Hani Morgan incorporated videoconferencing this year into his elementary methods class at the University of Southern Mississippi when he had two online students register for what had been a face-to-face class.

"In order for my online students to have the same experience, I started using this technology so they could listen to what went on in class," as well as see any visuals he shared in the classroom, he explains. He was also interested in setting up a videoconference with three teachers in Nepal to connect with all his students. "One of my goals for doing this was to introduce the idea of working with people in developing countries. The other goals included helping students in developing countries…and promoting cross-cultural understanding."

To that end, he coordinated a videoconference between his students and a group of teachers in Nepal. Both groups described what it was like to live in their respective countries and regions during the exchange. "There's potential for both [connecting with other countries and replacing field trips]," Morgan observes. Videoconferencing has the potential to connect classrooms "with educators overseas and with experts in the [United States]." ●

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Submit Your Nominations for the NSTA Board of Directors and Council

The annual NSTA Nominations for Board of Directors and Council engages science educators in leadership positions. The NSTA Board of Directors and Council work together to promote excellence and innovation in science teaching and learning for all.

This year's offices that are open for entries are President, Coordination and Supervision, High School Level Science Teaching, College Level Science Teaching, and District Directors for NSTA Districts III, V, IX, XI, XV, and XVII.

Submit all applications for nomination by October 19, 2018

Learn more about eligibility and requirements at
www.nsta.org/about/governance/nominations

NSTA National Science Teachers Association

Supplementing STEM's Palette

Incorporating art into science, technology, engineering, and mathematics (STEM) has been a natural consequence for many teachers; for others, a more deliberate process. Art has been intrinsic to the STEAM Lab in the Millstone Township (New Jersey) School District since its inception.

"From very start of our program, it's been called STEAM. Good design incorporates art. Every good design has to be aesthetically appealing," asserts STEAM Lab teacher Beth Topinka. "It makes the lab happier having the A in STEAM."

For instance, one STEAM Lab project challenges Topinka's fourth-grade students to design "mountainside mouse motels" after studying erosion and natural hazards. "Students did real angle measurements of the hillside, then designed a motel for a mouse," she explains. After making risk assessment maps, students received differing material budgets based on their locations' erosion risks. The assignment also called for students to come up with ways to promote their motels. Topinka monitored the weather forecast, and when rain was expected, had students install their motels, with a container inside to catch and measure water, on the hillside.

Topinka also has coordinated with colleagues to apply what students learn in her lab to other classes. After noting that "these little motels take a pounding," the language arts teacher created a natural disaster reporting assignment. Topinka also works with the art teacher to make sure students develop the sketching skills they need.

"With my third graders, it was teaching them about sketching for scientific accuracy," she recalls. The students reviewed the journals of the Lewis and Clark expedition as well as *Notable Notebooks: Scientists and Their Writings* by Jessica Fries-Gaither to "emphasize the importance of sketching by hand. If you snap a pic, you're not looking, analyzing, observing" as closely, Topinka contends. "Those artistic sensibilities and detailed observational skills come more into play when sketching than by taking photos."

When she adds art to a lesson, "kids who don't feel like they're science and math kids really like it. It feels a little bit more accessible," explains Melissa Wilson, math and science teacher at The Learning Community, a K–8 experiential learning school in Black Mountain, North Carolina. When her seventh- and eighth-grade students were learning about scale, "the math curricula had a lot of taking an object and scaling it down. I thought, 'Where do we use scale?'…I realized we could study da Vinci's work as an artist and scientist and incorporate scale. Students looked at Vitruvian Man in art [class], then took those ratios and proportions and applied them to themselves. We used those ratios to do scatterplots in math. In science, we went outside and looked for ratios and proportions in leaves, sunflowers."

Wilson's fifth- and sixth-grade students studied Rube Goldberg comics before sketching and building their own devices. She says the experience was a lesson for her as well. "I was hoping they'd learn engineering, force and energy, a lot of math," she recalls. "I learned, though, that I needed to put grit and resilience on the rubric. Because the machines had an end task, there were so many trials" as students learned why they shouldn't manipulate multiple variables at one time.

She adds, "By starting with art, I hooked the artist students. It's a way to get a higher level of engagement as well."

At San Francisco's Town School for Boys, Lower School STEM teacher Jessica Boualavong meets before the school year starts with colleagues to discuss the main themes they will each cover during the school year. "We try to find one unit of collaboration in each grade…Our units are not STEAM in one classroom; they're more STEAM-collaboration," she says. When the fourth graders were studying ecosystems in STEM, they learned about the anatomy and life cycle of coral, knowing they would be using what they learned to make coral models in art class. In art class, they also learned about clay—from how pigments change when the clay is fired to techniques to add texture to a clay surface.

Boualavong and the art teachers assess the models separately. "On my side, it's about scientific accuracy. Are they including accurate representations of different types of coral? Is the design appropriate to scale? In some activities, there is a labeling component," she explains. She also aligned her assessments with the science and engineering practices of the *Next Generation Science Standards*. "It's one way to vary my projects from year to year, and to keep skills consistent as they move through the grades."

MELISSA WILSON

At The Learning Community in Black Mountain, North Carolina, students collected, sorted, and measured leaves as they learned about patterns, graphing, proportions, and analyzing and interpreting data.

Timing is one of the "trickiest things," she observes. "I'm moving at a pace based on student progress…and I'm trying to sync my schedule with the art department's schedule. We have to decide if they're learning the science first or the art first. I like to pop into the art studio when they're starting a STEAM project to answer questions. The art teachers also visit the STEM lab."

Boualavong appreciates the support of the art teachers as they also hold students accountable for developing skills. "Kids understand they're building skills and those skills overlap in different areas." she says.

Seth Hodges, a physical science teacher at Adna Middle / High School in Chehalis, Washington, began incorporating engineering into physical science lessons more than 10 years ago. Inspired by his own physics teacher years earlier, he began assigning his ninth-grade students to design Goldberg-type devices, which naturally led to discussions of perspective and scale.

"I tell them perspective is about looking at it in two dimensions and how to get it looking like three dimensions," he explains. "I want students to learn how to evaluate things. I have juniors and seniors, who did the drawings themselves in ninth grade, evaluate [anonymously] the [ninth graders'] drawings for perspective and scale."

Hodges likes to "surreptitiously slide" art into his lessons. "Kids have preconceived notions about what science class is like," he says. He tries to disrupt those ideas by having students create skits about rules and sharing illustrations from *Grey's Anatomy* as examples of "all the kinds of different things they can do here…Kids [come to appreciate] that there's a lot more to my class than 'just' science."

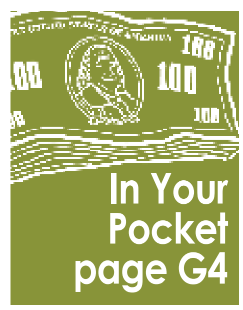
This year, Hodges started teaching a course on the physics of sound. "One of the main projects is kids have to build a musical instrument…We're incorporating art and the visual process in designs of musical instrument process," he explains, adding the instruments will not only have to produce sound, but they also will have to resemble something someone would want to play.

"I find that when we do incorporate artistic things into the classroom, I get a very good response from students. It's not always art; sometimes things from [physical education] class. I'm always trying to find what else I can bring into my classroom to maybe reach the students," Hodges concludes. ●

P U L L - O U T S E C T I O N

SCIENCE TEACHERS' GRAB BAG

Inside this Convenient Pull-Out Section you will find:



Freebies for Science Teachers

Neuroscience Is...Cool. P K12 The American Academy of Neurology's web page at *https://goo.gl/F3Vq2a* offers a wealth of preK–12 activities, experiments, and science fair topics for learning about the brain while having fun. Introduce neuroscience vocabulary and relax with brain coloring pages (all ages); learn about the functions of different areas of the brain through the "Anatomy of the Brain" poster (middle and high school levels); or play a neuroscience virtual reality (VR) game on Google Cardboard, using a set of inexpensive VR goggles you build yourself (middle and high school levels). The site also has classroom lessons ranging from simple sensory activities for grades preK–2 to deeper investigations for grades 3–5 examining how the brain learns. Lessons for older students include Brain Interactive Notebook Activities (grades 6–8) and the Psychology or Health—Neurological and Brain Diseases webquest (grades 9–12).

***NGSS* Infographics from NSTA. K12 HE** NSTA's infographics summarize the essential tenets of the *Next Generation Science Standards* (*NGSS*) and three-dimensional teaching. Three posters—"Why It's Time for New Science Education Standards," "How Today's Students Learn Science," and "A Teacher's Journey to Transition From Scientific Inquiry to 3-D Teaching and Learning"—are the first in a series exploring all aspects of the *NGSS*. Of interest to K–college teachers and administrators alike, the colorful posters include links for more information and can be printed, shared, and sent among friends and colleagues. Download the posters at *https://goo.gl/KdgqNq*.

The Frogs of Panama. K12 HE Engage K–12 and college students in authentic science research or explore biodiversity and conservation issues in the classroom with outreach materials developed by scientists/educators studying frogs at the Smithsonian Tropical Research Institute in Panama. Mate Choice Activity (for advanced high school and introductory college levels) has students collect data (from videos) to study frog acoustic communication about mate choice in female frogs and guides them through a statistical analysis of the results. The Fabulous Frogs of Panama (for elementary through middle levels) teaches about the diversity of Panamanian amphibians as students identify amphibians using a dichotomous key, examine similarities and differences between frogs and toads, study the frog life cycle, and discover strategies frogs use to avoid predation. Access both resources at *https://goo.gl/Mqyymc*.


DIRK VAN DER MADE

ISS and Project WET. K12 NASA declared September 2017 to September 2018 as a Year of Education on Station, and to celebrate, they are featuring fun, education-related activities aboard the International Space Station (ISS), including several from Project WET. Students ages eight and up can participate in The Water Use Challenge, a digital trivia interactive. In the challenge, students answer questions about personal water use, learning facts about water use and conservation along the way and comparing their water-use data to the amount of water an astronaut uses in a day. (Hint: Astronauts use a lot less!)

Teachers can download the *Out of This World Lesson Plan,* a 22-page guide featuring suggestions to help teachers relate Project WET activities to the ISS. The guide addresses activities for K–12, and includes standards correlations, NASA videos and resources, and digital games to review learning. Visit *https://goo.gl/Mk1ZuS* (registration is required to download the guide).

Explore Science Digital Kits. K12 The National Informal STEM Education (NISE) Network and partners have produced hands-on activity kits on science, technology, engineering, and math (STEM) topics, including Earth and Space Science, Nano Science, and Chemistry (coming in September 2018). Available in both Spanish and English, the kits offer digital materials on each topic, including hands-on STEM activities, planning and promotional materials, and "teacher training" videos. Although the kits are designed for use in informal education settings (e.g., museums, camps, and university outreach programs), K–12 teachers can do the activities in the classroom.

The Earth and Space 2018 kit, for example, features more than a dozen activities suitable for elementary to adult audiences, covering topics as diverse how the shape of the land and the pull of gravity influence the movement of water over Earth (e.g., Exploring Earth: Paper Mountains) to helping students design and build their own space telescope models (e.g., Exploring the Universe: Pack a Space Telescope).

See Freebies, pg G2

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

Freebies, from pg G1

Download these and other resources at *www.nisenet.org*.

Understanding Food and Climate Change. M H Two digital publications developed by the Center for Ecoliteracy in Berkeley, California, explore the relationships between our changing climate and what we grow, eat, and discard. Suitable for grades 6–12 and general audiences—and supporting the *NGSS* and National Curriculum Standards for Social Studies themes—*Understanding Food and Climate Change: An Interactive Guide* (*https://goo.gl/HBDozG*) uses text, video, photography, and interactive experiences to teach climate science and help readers see how food and climate interact and how personal choices can make a difference. A companion publication, *Understanding Food and Climate Change: A Systems Perspective* (*https://goo.gl/r8Eagq*), takes a broader approach to the topic, presenting a collection of essays demonstrating how seemingly disconnected phenomena are often dynamically linked and can be understood best when viewed in a larger context.

GigaPan in the Garden. K12 HE Since 2013, educators at West Virginia University have collaborated with the Create Lab at Carnegie Mellon University to use gigapan technology—i.e., panoramic digital images with billions of pixels combined into a single, zoomable image—for garden-based learning linked to the *NGSS*. The technology has been used with both inservice and preservice teachers and elementary students. The April 2018 issue of *GigaPan Magazine* showcases examples of some of the gigapan images that have been created, along with stories and descriptions of how the images link to *NGSS*. Like what you see/read? The issue's Background Section includes a link to register for GigaPan membership (basic level is free) that affords additional capabilities for instruction. Consult *https://goo.gl/AbPwwJ*.

NASA AND THE HUBBLE HERITAGE TEAM (AURA/STSCI)

New Astronomy Resource Guides. K12 HE Visit the Exploring the Universe website (*https://goo.gl/UgXzxm*) to view or download a collection of new or updated astronomy resource guides for K–college teachers and students. Compiled by astronomer/educator Andrew Fraknoi, the online guides present annotated lists of the best books, articles, and websites on several space and astronomy topics, including women in astronomy, Pluto and the Kuiper Belt, sources for astronomical images, free online lab exercises, plays about astronomers, the Messier Catalog, and debunking astronomical pseudoscience. The lists are hyperlinked, providing quick access to many of the suggested resources, and are downloadable as either PDFs or Word files.

Smithsonian Life Science Resources. E M Ditch the lecture and spice up your K–8 biology instruction with engaging resources from the Smithsonian Science Education Center. Students can play games like Showbiz Safari (grades 1–3) and Habitats (grades 3–5) to learn about the diversity of plants and animals in different habitats; watch videos such as *How Do Orchids Attract Pollinators?*, *What Can We Learn from Lion Poop?*, and *How Do Scientists Use Electricity to Study Fish Populations?* (all for grades 3–8) to study plant and animal behaviors; or travel the world to observe six insects in their natural habitats in the animated e-book *Expedition: Insects* (grades 3–5), complete with accompanying coloring pages. Access these and other life science resources at *https://goo.gl/SugHNT*. ●

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

What's New

FROM U.S. GOVERNMENT SOURCES

National Institutes of Health (NIH)

NIH Scientist Launch Game M

Jump-start middle level students' interest in science, health, and research careers with this clever app from the NIH. The app lets students experience the challenges and excitement of learning science, getting a grant, and navigating real-life obstacles that researchers often face. Along the way, players learn about various diseases, experimental design, and the life of a successful scientist. Learn more and download the app, which is available for both Apple and Android devices, at *https://goo.gl/s8jRLL.*

National Aeronautics and Space Administration (NASA)

InSight Mars K12

Get the lowdown on NASA's InSight Mars mission and learn about the special lander designed to study "marsquakes" (i.e., seismic activity on Mars). Unlike other missions to the Red Planet, which have yielded data about surface of the planet, this mission aims to examine Mars' inner workings—its crust, mantle, and core—and provide insight into how rocky planets, including Earth, formed. At *https://goo.gl/G9roq7,* K–12 teachers can watch an introductory video about the mission and the suite of instruments on the lander that will be used to collect data.

Educators can also find activities to bring the excitement of Mars exploration into the classroom. For example, Mission to Mars, a 19-lesson unit for grades 3–8, encourages students as they learn about Mars, design a mission to explore the planet, build and test model spacecraft and components, and engage in scientific exploration. Stomp Rockets, a video lesson for grades 4–9, showcases the engineering design process as students design, build, and launch paper rockets, calculating how high they fly and using the data to improve rocket designs. Quake Quandary: A Pi in the Sky Math Challenge lets learners in grades 11–12 model the practices of NASA scientists and engineers as they use the mathematical constant pi to identify the timing and location of a seismic event on Mars.

***Mission Possible: Women of the Hubble Space Telescope* M H**

When they were growing up, the six women in this eight-minute video from NASA's Goddard Space Center never imagined that they would work for NASA on the Hubble Space Telescope. From astronaut to social media lead, scientists to engineers, the "Women of Hubble" overcame obstacles and persevered to achieve success and make Hubble one of the greatest exploration machines in human history. Show the video in middle and high school classrooms to remind students that anyone can succeed if they stay curious, never quit, and don't let anything keep them from reaching their goals. Watch the video at *https://goo.gl/GwN5Ws,* then click the "supporting visualizations" link for more information about these women, including a series of video interviews with Nancy Grace Roman, "The Mother of Hubble" and NASA's first Chief of Astronomy.

National Oceanic and Atmospheric Association (NOAA)

How Reliable Are Weather Forecasts? M H

This article from SciJinks—NOAA's weather education program for middle level and high school students—discusses how meteorologists predict the weather, which tools (e.g., satellites) they use, and how accurate forecasts can or cannot be. The article includes links to web pages with more in-depth information about several topics mentioned in the text, such as NOAA's Geostationary Environmental Operational Satellite-R , NOAA's Joint Polar Satellite System, and space weather. Visit *https://goo.gl/6kNXL2.*

U.S. Department of Energy (DOE)

Nuclear Energy: Seven Things *The Simpsons* Got Wrong M H

The Simpsons is a popular animated TV series—except among those working with nuclear technology. The comedic depiction of the fictitious Springfield nuclear power plant—and its negligent safety operator Homer Simpson—is far from "excellent." To set the record straight, staff from DOE's Office of Nuclear Energy wrote an article, "Seven Things *The Simpsons* Got Wrong About Nuclear," which addresses several obvious "wrongs" in the series.

One misrepresentation "righted" in the article, for example, is the idea that control room operators work alone. In actuality, the Nuclear Regulatory Commission requires that a supervisor, along with a second supervisor or reactor operator, be present at all times during reactor operation. Other misrepresentations identified in the article include the ideas that radioactive waste is a green oozy liquid, nuclear power plants are poorly maintained, fuel rods can be used as paperweights, and nuclear power plants cause mutations.

Although *The Simpsons* is a parody intended to entertain, it's important to correct its misrepresentations. Sharing the article in middle and high school science classrooms is a fun way to engage learners and start a discussion about real careers in nuclear technology. Read the article at *https://goo.gl/17aKBd.*

Coloring Book: *Women in the Manhattan Project* M H

Use this coloring book to bring the stories of women who helped end World War II to life. Appropriate for all ages, but especially inspiring for middle and high school girls interested in STEM careers, the booklet features project scientists such as Lilli S. Hornig (chemist), Blanche Lawrence (biochemist), Irene Joliot-Curie (chemist and physicist), Floy Agnes Lee (biologist), and the Calutron Girls (equipment technicians). The book concludes with short biographical summaries highlighting each scientist's noteworthy achievements. Download the book at this website: *https://goo.gl/xv7qKp.*

ORISE Resources K12

Educators will discover a wealth of K–12 STEM curricula and other materials to foster students' thinking, reasoning, teamwork, investigative, and creative skills at the DOE's Oak Ridge Institute for Science and Education (ORISE) website. Highlights include The Harnessed Atom, a middle level curriculum featuring lessons, games, and teacher presentations covering the essential principles of energy and matter, and STEM Topic videos (for teachers), which explore topics from *Using Fairy Tales to Teach Math and Engineering in Lower Elementary School* to an *Introduction to Probeware in the Classroom* (Vernier). Another notable resource at *https://goo.gl/Zdxh5C* is the Bioenergy Workforce Development curriculum, a collection of interdisciplinary lessons and activities developed by the DOE's Bioenergy Technologies Office for exploring bioenergy topics in middle and high school classrooms.

U.S. Geological Survey (USGS)

Volcano Resources M H

With the recent volcanic activity in Hawaii, students may be interested in understanding more about volcanic eruptions. At *https://goo.gl/4L7aPB,* the USGS provides resources for middle and high school educators to teach students about different types of volcanoes, how they erupt, and how many exist in the United States. In addition to providing near-real-time volcano-monitoring data, the site presents information and lessons about plate tectonics; posters explaining geologic hazards at volcanoes (e.g., lava flow, lahar, debris avalanches) and other topics; references such as a USGS Photo Glossary of Volcanic Terms and a Frequently Asked Questions and Answers page; and interactive scenarios that show students how scientists can predict volcanic eruptions from data. ●

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

In Your Pocket

Editor's Note

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

July 1

Breakthrough Junior Challenge M H

To enter this competition, students ages 13–18 create an original video that brings a life sciences, physics, or math concept to life. Videos should be no more than three minutes long and inspire creative thinking about science. Students who create videos that communicate complex ideas in engaging and imaginative ways may be awarded a $250,000 college scholarship, a $50,000 prize for their teachers, and a $100,000 Breakthrough Science Lab for their schools. Winners will receive their prizes at a live, televised ceremony in November.

Students must complete a short questionnaire and submit their videos by 11:59 p.m. Pacific Time on **July 1.** For more details, see the website *https://goo.gl/NRqhyT.*

July 27

Eileen Fisher Community Partnerships Grants A

These grants go to local nonprofits that focus on their communities' needs. Grants of up to $2,500 or $250 gift certificates are awarded to organizations doing local work in these areas: the Environment, Women and Girls, Diversity and Inclusion, and Human Rights. Organizations must be located within 25 miles of an Eileen Fisher office, showroom, or retail store. Funds can be used for programming, operating expenses, or event sponsorship.

Submit applications online by noon Eastern Time on **July 27** at *https://goo.gl/SDcZ7o.*

August 1–10

American Honda Foundation Grants K12

The American Honda Foundation (AHF) awards grants to youth education programs focused on science, technology, engineering, and math (STEM) and the environment. Grants of between $20,000 and $75,000 are available. Programs should be imaginative, creative, youthful, forward thinking, scientific, humanistic, or innovative. Public and private K–12 schools, public school districts, and nonprofit organizations that have not previously received AHF grants can apply by **August 1** at the website *https://goo.gl/9IckUp.*

Chichester duPont Foundation Grants A

These grants of up to $50,000 support nonprofit organizations with programs focused on the environment, education, health care, social services, or the arts. Preference is given to those with new initiatives, special projects, or expansions of current programs in which the foundation's funding will play a pivotal role. Programs must be located in Delaware, serve underprivileged children in the state, or have an established relationship with one of the foundation's trustees.

Interested organizations should submit a letter of inquiry by **August 1.** Consult *www.chichesterdupont.org.*

Clarence E. Heller Charitable Foundation Grants A

These grants go to California-based programs providing environmental or arts education opportunities for youth. Grants of between $5,000 and $200,000 may be used to help artists and educators improve their teaching skills or enhance environmental or arts education programs. Those that support environmental health and encourage regional planning, prevent harm from environmental hazards, or improve sustainability in agriculture and food systems in local communities are also encouraged to apply. Visit *https://goo.gl/cmQUpG* to submit a letter of inquiry by **August 1.**

AVS Science Educators Workshop H

This American Vacuum Society (AVS) workshop for high school science teachers provides two days of instruction on low-pressure experiments and modeling. Participants get to take home a vacuum system for their school that is identical to the one they use in the workshop, in addition to a certificate and 1.5 nationally certified continuing education units.

This year's workshop takes place October 22–23 in Long Beach, California. Regional AVS chapters sponsor local teachers and typically cover their travel and lodging expenses. Apply online at *https://goo.gl/rTpAmR* by **August 10.**

August 24–31

Lowe's Community Partners Grants K12

These grants focus on K–12 public/charter education and community improvement projects. Lowe's aims to help build stronger communities by providing funds for nonprofits and municipalities with high-need projects, such as grounds or safety improvements, technology upgrades, or building renovations. Grants range from $2,001 to $100,000. Visit the website *https://goo.gl/ze8uAx* to apply for a grant by **August 24.**

Monsanto Fund Grants K12

These grants support communities within 30 miles of Monsanto sites. Funds are available for K–12 schools, libraries, farmer training programs, or academic enrichment programs focusing on STEM or aiming to improve basic science, math, or reading skills. Programs using evidence-based methodologies are preferred.

Applicants must first request an invitation code at *https://goo.gl/CZPbnY.* Apply by 11:59 p.m. Central Time on **August 31.**

Patagonia Environmental Grants A

These grants go to small, grassroots activist organizations aimed at preserving and protecting the environment. The company funds work that is action-oriented, builds public involvement and support, and protects local habitat. Grants of between $10,000 and $20,000 are available. Apply online by **August 31** at *https://goo.gl/EW8KqJ.*

September 1–10

NiSource Charitable Foundation Grants A

These grants support communities where NiSource employees and customers work and live: in Indiana, Kentucky, Maryland, Massachusetts, Ohio, Pennsylvania, and Virginia. Nonprofit organizations with programming in these areas are eligible: learning and science education, environmental and energy sustainability, community vitality and development, and public safety and human services. Apply by **September 1;** consult the website *https://goo.gl/sDXHcn.*

Kinder Morgan Foundation Education Grants K12

These grants of between $1,000 and $5,000 go to education programs for K–12 youth in communities where Kinder Morgan operates. Public and private schools and nonprofit organizations with arts education or academic programs, including tutoring, in the United States and Canada are eligible. Learn more at *https://goo.gl/SEblfF.* Apply by **September 10.** ●

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

Staging Classroom Climate Summits

Holding a classroom climate summit allows students to learn about climate change "in a new way, to understand the needs of developing countries and politics,...why [climate change] is such a contested topic, and why it's difficult to get countries to participate and act," says Harry Dittrich, grades 7–8 science teacher at Pathway School of Discovery in Dayton, Ohio. The summit shows students that "science isn't just people working in a lab; it's communicating, debating, and defending the information you found."

Dittrich conducted the summit based on the Model United Nations (UN) Mini-Simulation on climate change (*https://goo.gl/ysCWm4*) and on a version Ohio State University's Byrd Polar and Climate Research Center does with children. "It's like the Model UN, but they added economic differences among nations," he explains.

Students first researched the economic, political, and social aspects of their countries and any scientific developments there. "They looked at crop yields and food production,...imports and exports, per capita income," whether a natural disaster or a war had occurred there recently, he relates.

Next Dittrich set "the ground rules: how to do the discussions, draft proposals, barter with other countries, and the legal side, because all parties have to agree to a binding contract... [We discussed] how UN policies and procedures work...[T]hey learned the proper way to debate a topic without yelling," he recalls.

The summit took place over two class periods. Dittrich had 10 groups of students, each representing one country. "Students led the discussions. My role was to make sure they were following procedures, " he notes, adding that students "were eager to participate."

Dittrich says he graded students on the depth of their research, and "how well they did during the discussions with other groups—understanding policy issues, bartering to have a positive impact on the environment, and successful relations with other countries." Their overall grade was based on "a formative and summative combined assessment to see if they... [understood] the global perspective and the full impact of climate change."

Previously, Dittrich simply taught a two-week climate change unit. "The summit took a little less time, and students retained the information longer," he contends.

Jeanette Thomas and Laura Barry, biology teachers at Langston Hughes Middle School in Reston, Virginia, teach Addressing Potential Impacts of Climate Change on World Biomes, a problem-based learning unit featuring "a [senate] hearing in which [seventh graders] participate as expert witnesses, senators, and journalists. The expert witnesses represent different biomes (rather than countries), while the senators and journalists represent a range of special interests: fossil fuels, automobiles, mass transit, etc.," says Thomas, who authored the unit. "Climate change isn't specifically mentioned as a topic in our curriculum, but we felt the issue was too critical not to specifically address," she points out.

"We run the activity concurrently with our biomes and adaptations unit; it is a good jumping-off point because it gives students the background information they need" for the senate hearing, says Barry.

The unit is designed for general education students in grades 6–12, with scaffolds for honors and advanced students, English language learners, and students with disabilities. "In some cases, this required filling in gaps in background knowledge related to civics, specifically how Congress uses incentives (such as grants and tax rebates) and consequences (such as fines) to influence the decision-making of private citizens, organizations, and companies," say the teachers.

Thomas says the unit "inspires the students to take action." She recalls one student with a learning disability "was so determined to make a difference [that] she wrote letters to [legislators] to defend [the science around] climate change. The process of writing was incredibly challenging for her, but she felt that passionate about making a difference."

"We've had VIPs from the community come to watch the testimony," Barry reports. "Students feel very proud of themselves at the end and empowered to take action to address climate change."

The unit and the teachers' presentation about it at the 2018 NSTA National Conference in Atlanta can be downloaded at *https://goo.gl/fNfwQi*.

Interdisciplinary Approach

Jenna Totz, climate change education manager for Climate Generation, a nonprofit climate change education organization in Minneapolis, Minnesota, has used the World Climate Simulation (*https://goo.gl/czLY1x*) from Climate Interactive, a not-for-profit Washington, D.C.–based organization that creates climate change models and tools. Totz used World Climate—a role-playing exercise of the UN climate change negotiations—with teachers from Lowell School in Washington, D.C., who are working to revamp "their humanities curriculum to become climate change–centric," she explains. "We use [World Climate] because it connects deeply to climate change and uses a lot of science background."

Totz and her colleagues "like that [the simulation] is constantly updated…It provides the temperature increase data," she reports. And "the debrief goes a lot deeper…, [asking participants to discuss] their emotions," she notes. "It can make a really lasting impression on students."

Natalie Stapert, Lowell School's social studies/English language arts coordinator, and her colleagues recently did the simulation with sixth graders, scheduling it at the end of the year so students would have enough science background to participate. She says the simulation helped students understand "the long-range need for coordinated, collaborative action" to mitigate climate change's effects. A survey also showed that "[Lowell] students with a sibling in sixth grade had [gained] more knowledge and understanding of the topic. There was an impact on families as well as the sixth graders," she relates.

Totz says Climate Generation will have new curriculum in the fall that will include the World Climate Simulation. It will be available free on Climate Generation's website (*www.climategen.org*).

Supporting Standards

Laura Tucker, climate educator and member of the Port Townsend/Jefferson County (Washington) Climate Action Committee, used Climate Interactive's Climate Rapid Overview and Decision Support (C-ROADS) simulator (*https://goo.gl/PMdXU1*) last year with 10th graders in three of Lois Sherwood's science classes at Port Townsend High School. Tucker practiced C-ROADS with the students before doing it with adults, and noted how successfully it worked with both age groups.

"C-ROADS is really structured well," she contends. "Some students had to work to understand the negotiation piece, but after that, they were amazing! [Two classes reduced] their emissions to 2 degrees Celsius of warming, and one class was close," she reports.

C-ROADS benefits science classes because "several [*Next Generation Science Standards*] Disciplinary Core Ideas discuss using modeling, and teaching climate change covers six of the seven Crosscutting Concepts," Tucker asserts.

"My sense is that students enjoy simulations, but…[C-ROADS] had more impact because [they] could watch the graph change as…[groups added data]. They experienced how individuals can cause change," says Sherwood. ●

BLICK ON TV

Lost in Space

Earlier this year, Netflix rebooted the 1960s science fiction classic, *Lost in Space*. The original television series ran for more than 80 episodes between 1965 and 1968, and featured a robot that raised alarms by blaring "Danger, danger!" and at least once, "Danger, Will Robinson!"

The main characters' names have been preserved in the new series, although some roles have changed, upending much of the sexism of the original. John and Maureen Robinson; their children, Judy, Penny, and Will; and Dr. Smith all remain. Maureen, a talented engineer, leads the family. The original Dr. Smith (known for alliterative insults of the robot like "cackling cacophony") was a man; the new Dr. Smith is played by Parker Posey. Both of the Robinson daughters are talented as well, with Judy serving as the ship's doctor even though she is only 18 years old.

As in the original, an accident disrupts the journey from Earth to Alpha Centauri, sending the Robinsons into uncharted space, where they crash on an unknown planet. Surviving in an alien world provides many opportunities for adventure and problem solving.

Science teachers could use ideas from the new series to talk about exoplanets, properties of water, and the scale of the universe.

One of the most amazing discoveries in astronomy during my lifetime was the confirmation that planets orbit other stars. Astronomers long suspected our solar system is not unique, and therefore many—if not most—stars are likely to be orbited by planets. Only in the last 30 years has the existence of exoplanets been confirmed; as of this writing, more than 3,500 planets in about 2,800 systems have been discovered.

Planets are very, very dim compared to the stars they orbit, so direct observation is extremely difficult, though some planets have been found this way. More often, astronomers look for regular variations in a star's brightness (due to a planet passing between the star and our vantage point), or periodic motion of the star caused by the gravitational pull of the planet(s) orbiting it. With thousands of planets now confirmed to exist outside our solar system, at least a few are likely to be the right distance from their stars for liquid water to exist.

If a planet orbits too close to its star, it will be too hot for water to remain as a liquid (like Mercury and Venus). If a planet is too far from its star, any water on it will be permanently frozen (Jupiter and Saturn). A planet in between, where water can exist in all three forms—solid, liquid, and gas—is said to be in the "Goldilocks Zone," where it is "just right" for life like ours to be possible.

The Robinsons crash on a planet that is clearly in the Goldilocks Zone: They immediately find liquid, solid, and gaseous water, and a breathable atmosphere. A breathable atmosphere means oxygen, and oxygen is a fairly reactive element. It tends to combine with other elements either rapidly (in fire) or slowly (in rusting). For oxygen to exist in abundance in the atmosphere, something must be generating a constant supply, and I suspect it is the plants. Plants do that on Earth, and most of the plants we see in *Lost in Space* look familiar.

The planet has water in all three phases, and life is abundant under those conditions. However, the writers don't seem to understand the properties of water. In the first episode, Judy is trapped in a solid block of ice after a huge volume of water freezes solid in a matter of seconds. This scenario has a few problems.

First, the episode shows the water behaving like supercooled water we see in videos like this one from the European Synchrotron Radiation Facility (*https://goo.gl/Z3KtXz*). Supercooled water is liquid water below 0 degrees C, which can happen if you have very pure water and you cool it slowly without disturbing it. An impact will cause a tiny ice crystal to form, and then the rest of the water quickly freezes solid.

A swimming pool–sized body of water with many impurities cannot be supercooled, so we must assume that the water Judy is in is above 0 degrees C, and would be cooled, then frozen in the normal, time-consuming way, as a huge amount of energy has to leave the water. Also, the ice would freeze from the top down, not from the bottom up, so Judy should have been be able to break through a thin layer of ice.

Finally, ice is less dense than water, which means it expands when it freezes. The scene makes it clear that Judy is surrounded by ice and completely immobile: There isn't even room for her chest to expand and contract with normal breathing. Even if Judy's suit was able to keep her warm and produce fresh air, she would have suffocated in just a few minutes.

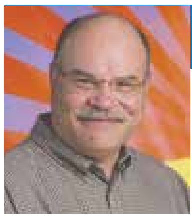
In the second episode, we learn a bit more about how the Robinsons came to crash on this unknown planet. Maureen says a collision sent them "trillions of light-years" in an unknown direction. We've heard how big the universe is, so it might seem okay to say "trillions of light-years." Unfortunately, that's not true.

Our best estimates of the age of the universe put it between 13 and 14 billion years old. That means the farthest away anything can be in our universe is 13–14 billion light-years. Trillions of light-years would be about a thousand times bigger than the universe.

It's not really necessary to send their ship so far, in any event. Alpha Centauri is less than 5 light-years away from Earth, so why not fling the Robinsons across our galaxy, say 75,000 light-years off course?

Science teachers interested in exoplanets and astronomical scale could use aspects of the new *Lost in Space* to get students hooked. Chemistry teachers could use the misconceptions about water to motivate student calculations of heat capacity, and help them understand the phase change from water to ice. ●

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



ASK A MENTOR, **Advice Column**

Strategizing for Success

I have applied to multiple teaching programs for my time after college, but I'm worried that I look too young to be taken seriously as a teacher. How do you gain the respect of students who may not be much younger than you?

—*D., California*

If you are considering teaching at the elementary or middle levels, don't worry: You will look old to them!

I have seen young-looking, diminutive teachers manage classes with no problems. I think it comes down to leadership ability and presence in the classroom. How do you become the leader? Envision what your "perfect" class would look like: What are the students doing? How are they interacting? What are you doing?

With that vision firmly in mind, you now have a basis to make all your decisions. You will know what big things to worry about and what little things to let slide, and don't let students try to make those decisions for you! In no time at all, students will see you as their educational leader.

I strongly discourage teachers from trying to get all students to like you or to become friends with them. That is counter-productive in my opinion, and a big mistake. NSTA Learning Center online advisor Pamela Dupree adds: Don't text or connect on social media with students…or parents!

Maintain your classroom with consistency and develop a caring attitude toward the students, and you will not have any problems. Well, maybe a few, but we all do!

I am about to graduate and become a new teacher. Is it a good idea to use lesson plans that are handed down to me and maybe need to be tweaked, or is it better to write brand-new lesson plans each year?

—*G., Florida*

Since I never had an entire class comprehend 100% of what I taught, I always made changes to my courses. The most important thing, in my opinion, is to reflect on everything you do! You need to have a real willingness to learn and change to make things work in your classroom.

You don't need to create everything from scratch! Many bright and intelligent people are producing great resources you could use. You should make decisions about resources in this order:

- If you find or are given a resource that, after thorough review, fits perfectly with what you want to accomplish in your classroom, then use it unmodified.
- If you find a great-looking resource that doesn't quite fit, then modify it.
- If you can't find a great resource, create your own.

Most of your lessons, obviously, will revolve around modifying something out there.

After your lesson, reflect and re-evaluate everything you used and the impact it had on your students. Make modifications as necessary. Don't beat yourself up if a lesson bombs: Just figure out why it did, and do something about it.

I've read about inviting guests into the classroom for a day. Would you recommend that for a new teacher, or would it be best for students to see me as the expert initially? Also, how can we get experts into the classroom?

—A., North Carolina

I loved bringing guests into my classrooms! I think it is perfectly fine for a teacher to act as facilitator and guide to help students learn rather than be seen as the expert in everything. This approach is very conducive to inquiry and questioning.

Professional organizations in many fields often have outreach programs and volunteers who visit classrooms. Agricultural groups may offer speakers and demonstrations. Zoos, animal hospitals, animal shelters, and conservation organizations might have an educational "roadshow." Don't be too shy to ask friends, acquaintances, and your former professors to share their expertise with your class! Videoconferencing can open up amazing opportunities to connect with scientists in the field.

Check with your administration on the protocol for inviting guests. Talk with your guests about what they will bring (literally and figuratively) into the classroom. Help them modify anything that might not fit with your curriculum and your students. Also, have students submit written questions to you the day before so you can vet them and avoid the awkward silences when you ask, "Does anyone have any questions?"

I always had some kind of gift for guests. Ask the principal if there is some school-related bling you can hand out.

What can we do to better support our teachers in ways such as development to help decrease the burnout rate?

—I., Connecticut

Teacher burnout is a worldwide phenomenon. My predecessor, Mary Bigelow, addressed this issue in 2015 (*https://goo.gl/PS4HWJ*), but it merits continued discussion. I've maintained that strategies for avoiding or mitigating burnout should be part of teacher education, but most educators don't receive any formal training in these strategies.

I tried to focus on the things in my control and kept my highest priority—the happiness of my family and myself—in mind. I wouldn't have been any good to my family, or my students, had I burnt out.

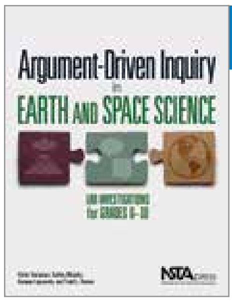
You are not alone.
Confide in friends, family, and colleagues about what you're facing. Teachers associations will likely have phone lines and counselors you can contact. Also watch your colleagues for signs of burnout.

Work hard, but not stupid.
Look at how you work, and set some realistic goals. Modify your assessment strategies to reduce grading. Drop some voluntary committees, coaching, or supervision no matter how much you like them. Try arriving a little earlier or staying later on some days to prepare and grade while preserving other evenings and weekends for you and your family.

Incorporate wellness into your life.
Is your diet (reasonably) healthy? Do you have any exercise routines? Don't dwell on things you can't control, and look at positive things you are accomplishing. Take up or revisit a hobby. You are no good to anyone if you are sick, so take time off to address your health.

Take care of yourselves, people! ●

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



NSTA PRESS: *Argument-Driven Inquiry in Earth and Space Science*

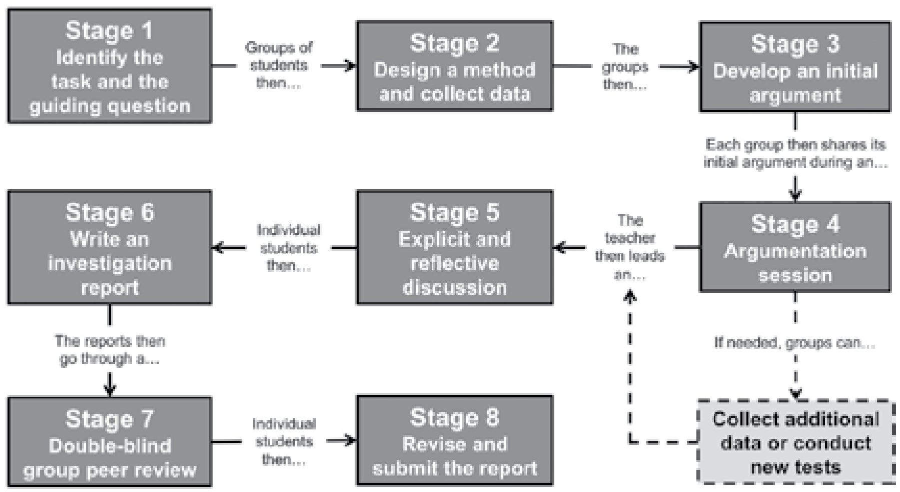
Stages of Argument-Driven Inquiry

Editor's Note

NSTA Press publishes high-quality resources for science educators. This series features a few of the books recently released. The following excerpt is from Argument-Driven Inquiry in Earth and Space Science *by Victor Sampson, Ashley Murphy, Kemper Lipscomb, and Todd L. Hutner, edited for publication here. To download more, go to* https://goo.gl/XpKws2. *NSTA Press publications are available online through the NSTA Science Store at* www.nsta.org/store.

FIGURE 2

Stages of the argument-driven inquiry instructional model



Stages of Argument-Driven Inquiry

The argument-driven inquiry (ADI) instructional model was designed to change the focus and nature of labs so that they are consistent with three-dimensional science instruction. ADI therefore gives students an opportunity to learn how to use disciplinary core ideas (DCIs), crosscutting concepts (CCs), and science and engineering practices (SEPs) (*NGSS* Lead States 2013; NRC 2012) to figure out how things work or why things happen. This instructional approach also places scientific argumentation as the central feature of all lab activities. ADI lab investigations, as a result, make lab activities more authentic (students have an opportunity to use the three dimensions of science) and educative (students receive the feedback and explicit guidance that they need to improve on each aspect of science proficiency).

In this chapter, we will explain what happens during each of the eight stages of ADI. These eight stages are the same for every ADI lab experience. Students, as a result, quickly learn what is expected of them during each stage of an ADI lab and can focus on learning how to use DCIs, CCs, and SEPs to develop explanations or solve problems. Figure 2 summarizes the eight stages of the ADI instructional model.

Stage 1: Identify the Task and the Guiding Question

An ADI lab activity begins with the teacher identifying a phenomenon to investigate and offering a guiding question for the students to answer. The goal of the teacher at this stage of the model is to capture the students' interest and provide them with a reason to complete the investigation. To aid in this, teachers should provide each student with a copy of the Lab Handout. This handout includes a brief introduction that provides a description of a puzzling phenomenon or a problem to solve, the DCIs and CCs that students can use during the investigation, a reason to investigate, and the task the students will need to complete. This handout also includes information about the nature of the argument they will need to produce, some helpful tips on how to get started, and criteria that will be used to judge argument quality (e.g., the sufficiency of the claim and the quality of the evidence).

Teachers often begin an ADI investigation by selecting a different student to read each section of the Lab Handout out loud while the other students follow along. As the students read, they can annotate the text to identify important or useful ideas and information or terms that may be unfamiliar or confusing. After each section is read, the teacher can pause to clarify expectations, answer questions, and provide additional information as needed. Teachers can also spark student interest by giving a demonstration or showing a video of the phenomenon.

It is also important for the teacher to hold a "tool talk" during this stage, taking a few minutes to explain how to use the available lab equipment, how to use a computer simulation, or even how to use software to analyze data. Teachers need to hold a tool talk because students are often unfamiliar with specialized lab equipment, simulations, or software. Even if the students are familiar with the available tools, they will often use them incorrectly or in an unsafe manner unless they are reminded about how the tools work and the proper way to use them. The teacher should therefore review specific safety protocols and precautions as part of the tool talk.

Including a tool talk during this stage is useful because students often find it difficult to design a method to collect the data needed to answer the guiding question (the task of stage 2) when they do not understand how to use the available materials. We also recommend that teachers give students a few minutes to tinker with the equipment, simulation, or software they will be using to collect data as part of the tool talk. We have found that students can quickly figure out how the equipment, simulation, or software works and what they can and cannot do with it simply by tinkering with the available materials for 5–10 minutes. When students are given this opportunity to tinker with the equipment, simulation, or software as part of the tool talk, they end up designing much better investigations (the task of stage 2) because they understand what they can and cannot do with the tools they will use to collect data.

Once all the students understand the goal of the activity and how to use the available materials, the teacher should divide the students into small groups (we recommend three or four students per group) and move on to the second stage of the instructional model. ●

Mark Your Calendar

NSTA Dates to Remember

(All dates are deadlines unless otherwise specified.)

July 1—How do you teach your middle school students about **"Stability and Change"**? Share your best practices with your fellow educators in the February 2019 issue of ***Science Scope,*** NSTA's middle level journal. Manuscripts focused on making, technology, practical research, and more, as well as general-interest manuscripts, are accepted at any time. Read the call for papers at *https://goo.gl/l6bNbz*.

July 11—NSTA's **Seventh Annual STEM Forum & Expo** opens today in Philadelphia, Pennsylvania. The forum features strands targeting concerns specific to lower-elementary/early childhood, upper-elementary, middle level, and high school education, as well as administration and partnerships. For more information or to register, visit *www.nsta.org/stem2018*.

July 28—Take an in-depth look at **Using Phenomena to Drive Student Learning** during this virtual conference from NSTA. The four-hour event will focus on the effective use and assessment of phenomena as part of science instruction, with breakout sessions for elementary, middle, and high school teachers. Okhee Lee and Sara Cooper will be featured presenters. Registration costs $63 for NSTA members. Participants can receive a certificate verifying their attendance for an additional fee. The conference will run from 10 a.m. to 2 p.m. Eastern Time (ET). For more information or to register, visit *https://goo.gl/PRmPR2*.

August 1—***Science Scope's*** March 2019 issue will explore how middle level educators are incorporating **"Performance Tasks and Test Prep."** Submit your manuscript on your experience with designing, scaffolding, and organizing performance tasks, as well as how you prepare students for traditional tests. General-interest manuscripts, as well as manuscripts focused on making, technology, practical research, and more, are accepted at any time. Read the call for papers at *https://goo.gl/l6bNbz*.

August 1—Have you developed ways to modify how to use materials from kits to teach the *Next Generation Science Standards* (*NGSS*)? The April/May 2019 issue of ***Science and Children*** (***S&C*****),** NSTA's peer-reviewed journal for elementary science education, will focus on teachers **"Shifting From a Kit to *NGSS* Strategies."** Tell your story of modifying and refining lessons with fellow elementary educators! General-interest manuscripts may be submitted at any time. Read the call for papers at *https://goo.gl/UXBmlh*.

September 1—The focus will be on **"Biological Evolution: Unity and Diversity"** in ***Science Scope's*** April/May 2019 issue**.** Manuscripts discussing how to help students understand evolution and correct misconceptions are being accepted for this issue. Manuscripts focused on making, technology, practical research, and more, as well as general-interest manuscripts, are accepted at any time. Read the call for papers at *https://goo.gl/l6bNbz*.

September 1—Informative assessments can help clarify student understanding and guide instruction, but developing and implementing them can be challenging. Share your innovations with your fellow teachers by submitting a manuscript on **"Using Formative Assessment in Designing Lessons"** for ***S&C's*** July 2019 issue. General-interest manuscripts may be submitted at any time. Read the call for papers at *https://goo.gl/UXBmlh*.

September 12—Find out how you can take a leadership position with NSTA and help shape the future of science education during **Leaders for Science Education: Preparing an Application for the NSTA Board and Council**, a free NSTA Web Seminar. Learn about the criteria for each position and strategies for completing an effective application. The session will run from 6:30 to 8 p.m. ET. For more information on NSTA Web Seminars or to register, visit *https://goo.gl/PRmPR2*.

October 2—Don't miss the first meeting of **Shifting to the *NGSS*: Professional Book Study!** This online book study features live web seminars and asynchronous discussions focused on NSTA's enhanced e-book, *Discover the* NGSS*: Primer and Unit Planner*. Additional live events will be held on October 9, 16, and 23. Each event will run from 7:15 to 8:45 p.m. ET. Registration for NSTA members costs $63. Participants will receive a certificate of participation from NSTA after each live web seminar (1.5 hours each). For more information or to register, visit *https://goo.gl/PRmPR2*.

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

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

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Don't Miss July's STEM Forum!

Want to meet the first person to tweet from space, Mike Massimino? Come to Philadelphia for the seventh annual STEM Forum & Expo, hosted by NSTA, taking place July 11–13. In his keynote speech, Lessons From Space, Massimino—a former NASA astronaut, a professor of mechanical engineering at Columbia University, and senior advisor for space programs at New York City's Intrepid Sea, Air, & Space Museum—will describe his adventures in space, focusing on persistence, teamwork, and other skills important for STEM success in space and on Earth. Fans of TV's *The Big Bang Theory* will recognize Massimino, who has a recurring role as himself.

The STEM Forum will have strands for teachers of all grade levels and for administrators, as well as a strand on forming partnerships among community, business/industry, and education-focused groups that connect preK–16 schools and universities to valuable resources. Whether you're teaching English Language Learners, combining STEM and the arts (STEAM), seeking games for your classroom, or hoping to integrate literature and STEM, the STEM Forum will have sessions to help you accomplish your goals.

Featured panels will discuss topics such as Recruiting and Retaining Minorities and Women in Engineering; Design for Success: Engaging Diverse Learners in STEM; The STEM Influence on Autonomous Vehicles; and Leading for STEM Success: Leadership Practices for a Successful STEM Learning Environment. The Exhibit Hall will feature more than 100 exhibitors ready to show you the latest STEM teaching tools, programs, kits, curricula, and equipment.

Learn more and register at this website: *www.nsta.org/stem2018*. ●