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75th NSTA ANNIVERSARY

Learning About STEM Through BMX


SANDRA HAVELKA

Fourth graders at Liberty Elementary School in Tucson, Arizona, build a scale BMX track as part of the USA BMX Foundation's Track Modeling Program.

Teaching students science, technology, engineering, and math (STEM) by connecting it with bicycle motocross (BMX), closed-course bike racing over natural or simulated rough terrain, is possible with programs from the American Bicycle Association's USA BMX philanthropic arm, the USA BMX Foundation, located in Gilbert, Arizona. Marianne Landrith, gifted education teacher for the Sunnyside Unified School District in Tucson, Arizona, says she discovered the foundation's educational programs in 2017 when a student was working on "an inquiry project on helmet safety in extreme sports. We had to find resources for Daniel!"

Landrith contacted Mike Duvarney, executive director of the USA BMX Foundation. Through the foundation's Motivational Speaking program, Duvarney arranged for Olympic BMX racer Donny Robinson to visit Daniel's school. "Olympians can come to schools anywhere in the country [at no charge]. They talk about how much STEM is involved in the field and the tools used. Each Olympian talks about failure and staying motivated through the lens of cycling," Duvarney relates.

"We received lots of great information for Daniel," Landrith recalls. "Donny rode a bike into the classroom, talked about goals and perseverance, and [answered students' questions]. [The foundation] gave Daniel a BMX bike. [The school has] 92% [of its students receiving] free or reduced-price lunch, so it was very generous of them to do this."

With funding from the district's Jacob K. Javits Gifted and Talented Students Education Program grant, which Landrith coordinates, she was able to bring another USA BMX Foundation STEM program, the Track Modeling Program, to Tucson schools. "We started with classes with a high number of gifted students in them, and the program expanded from there [to include all students]," she explains.

Schools that don't have grant funding can receive help from USA BMX Foundation in finding funding sources, and may be matched with sponsors, Duvarney points out.

Designed for fourth graders, the weeklong/25-hour Track Modeling Program supports the *Next Generation Science Standards* (*NGSS*) and gives students an opportunity to conceptualize, design, and build a scale BMX track. "Students talk to a track builder and learn about which track features go well together [and] the engineering behind them. They are able to Skype with an Olympian. Then [students visit a local track] for themselves…They [get to] ride [bikes] on the track," says Duvarney. Back at their schools, they design their own tracks and work in groups to incorporate their individual designs "into one final track design," he adds.

"We spend an hour with teachers to help them teach it, an hour-long phone conversation," Duvarney reports. "All supplies [for the program], including dirt, are delivered to the school. It's truly a kit."

"Students are creating something from nothing, engaging their creativity," Landrith asserts. "They learn how to apply the information they heard [at the track] to their new creation. They gather information from their own experience riding on the track several times, which helps them make the track the right size." Making tracks

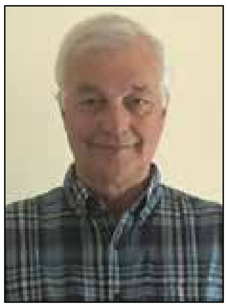
See BMX, pg 4

The Ultimate Review Game: Reviewing for Fun and Profit PG 3

COMMENTARY: **Wayne Snyder**

The Ultimate Review Game: Reviewing for Fun and Profit

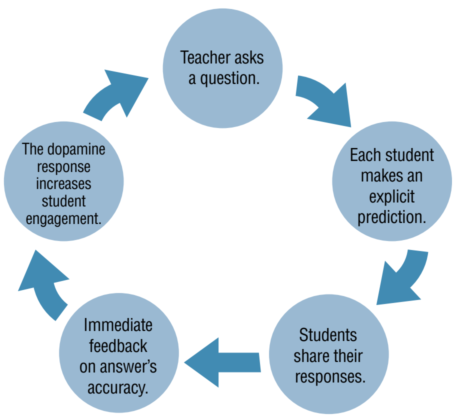
By Wayne Snyder



Wayne Snyder

Reviewing subject matter before a test is an important activity in every classroom, yet it is an area in which we often miss the mark with many students. Review strategies often don't meet their goals. Some ineffective review lessons include uninspiring individual drills; others rely on the fast answers (typically coming from a select few); and still more focus on the teacher talking even more. What makes for a successful review?

The foundation for effective review is the same as for any effective learning engagement: a cycle of prediction/performance/feedback. In *Learning to Love Math: Teaching Strategies That Change Student Attitudes and Get Results,* Judy Willis refers to this as Individualized Achievable Challenge. The brain functions on a chemical feedback system. When an individual's brain recognizes that it has made a successful "prediction, choice, or behavioral response," dopamine is released. When the brain realizes it missed this reward, it wants another chance to get that mental rush. Either way, the student's brain is engaged and primed for the next challenge. An effective review using the prediction/performance/feedback cycle would look like this:



As with planning any effective learning activity, the first step is to determine the goals of the review. Goals for review could include

- additional practice and help;
- increasing confidence and success;
- encouraging deeper thinking, reasoning, and risk-taking over guessing or giving up;
- engaging students and building self-efficacy skills;
- preparing students for the content and format of the assessment; and
- demonstrating students' understanding and misconceptions through informal assessment.

Achieving these goals requires that every student prepare an answer for every question, with the emphasis on accuracy and thinking, not speed. If successful, all students will experience self-efficacy as they prepare and share their thinking. The review must be enjoyable with individual achievable challenges to accomplish this.

Review can be approached in many ways. Taking the best from each, based on the purpose and traits of an effective review activity, yields what I call The Ultimate Review Game. This review uses the *Jeopardy!* format. (Kudos to *Jeopardy!* for allowing teachers to use their format as a fun and useful learning tool.) Focus the game on the content, removing confusing aspects such as the "question format," the Daily Doubles, and the speed factor.

1. Place students in teams of four. Each team member has a number from 1 to 4. Each student has a whiteboard, marker, and eraser.
2. The teacher randomly selects a student to choose the first question. Everyone has 30 or 60 seconds (depending on the difficulty of the question) to work on their whiteboards. They are encouraged to help their teammates as needed and to compare their work and answers to make sure that everyone is ready.
3. At the end of the time, the teacher selects a card. All of the students with that number hold up their whiteboards. Each correct answer scores a point for their team. If necessary, you can go over the problem, but usually the students will have helped one another since the randomly selected individual determines if the team gets the point.
4. Repeat the process.
5. For the final question, determine the range of scores, and pick a point value that gives any team the potential to win.

Keeping score can be chaotic, so have a trustworthy student totaling the scores on the board, switching halfway through so that each gets to be part of the review game. Using whiteboards allows for using open-ended and free-response questions, showing work, and writing justifications. My students even suggested I post the game online so they could play it at home to prepare for the test.

Each teacher has their own style and format for implementing review. But hopefully this Commentary has helped in evaluating the level of effectiveness for the process. Is every student answering every question? Is the emphasis on accuracy and not speed? Is every student actively engaged in thinking, learning, and sharing? Is the review a positive experience from the students' perspective? If the answer to these questions is "yes," then you are on the road to an effective review. ●

Wayne Snyder, PhD, taught biology, chemistry, and physics in upstate New York for many years before moving to California to lead the Caltech Precollege Science Initiative. He now trains teachers at California State Polytechnic University, Pomona. He is a frequent presenter at NSTA national conferences.

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

NSTA Reports

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

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

BMX, from pg 1

to scale "is challenging because fourth graders haven't been exposed to ratios and scale," she adds.

"They work in teams and learn to collaborate, how to have good discussions and compromise, how to divide tasks evenly. They get to play in dirt and be messy, which can bring science to life. And [Track Modeling] gets them outside and exercising. So many of our students have never ridden a bike, so they learn how to ride one," Landrith relates. The physical education teachers, she adds, "get the students on bikes three weeks before the trip and make sure the students are comfortable and know how [to use the hand brake]."

"People think of BMX as flips and tricks, but there are two types of BMX: freestyle (flips and tricks) and racing. We are BMX racing. We take safety very seriously and ensure that all precautions are followed. Students must wear a helmet, a long-sleeved shirt, and pants, along with closed-toe shoes," Duvarney explains.

Craycroft Elementary School in Tucson is in its second year of using the Track Modeling Program. Principal Jim Ridge says the program's "project-based, inquiry approach" supports "gifted students' strengths and supports all of our students [as well]…Our students took agency and created their tracks based on their learning and the resources [provided]. This was an engineering project [that taught students about concepts like] soil compaction, ratios, and elements of design that could be produced on a real track…Students learn about how water is important in track design; in the new Arizona standards, water is a big content piece."

Ridge adds, "None of the teachers are experts in track design and BMX, but the program doesn't require it…We had access to experts from the field: riders, engineers, and designers whose support helped move the project forward."

Cheryl Lane and Alison Scranton, fourth-grade teachers at Michael G. Wickman Elementary School in Chino Hills, California, taught the Track Modeling program with three of their fourth-grade colleagues. "The engineering project was clearly outlined and easy to follow. It was great! Alison was the only one who had experience with the BMX sport, but we all were able to do the project," asserts Lane.

"The only tweak [we made was] timing. The program was designed for one week; we spaced the activities out over a two-week time period. That worked perfectly," Scranton observes.

"We are in the beginning stages of *NGSS* implementation, but this gave us an opportunity to dive into the three dimensions of *NGSS*. We were able to design [lessons] through project-based learning and connect related curriculum. Track Modeling helped us design effective curriculum," say Lane and Scranton.

The program also increased students' environmental awareness. According to Lane and Scranton, students had to consider "where to build a track and the environmental impact. Is there enough space? How can we bring in natural elements? What is the impact of animals on a new track?"

"Students have to think about how to use recycled, reusable items in the track design," Ridge notes. "One award the judges present [when judging track designs] is for the greenest track."

"When students go to the track, they see the impacts of weather [on it, such as] erosion," says Duvarney. "So much maintenance is needed to keep these tracks in tip-top condition. Students learn it's all about safety and maintenance to preserve what you have built."

Students were assessed, says Scranton, "with the use of science journals. The kids kept record of all the stages of the project using the 5E lesson plan. The final track build was also used to assess overall understanding."

Read about USA BMX Foundation's STEM Program on NSTA's blog at *http://blog.nsta.org*. Learn more about USA BMX Foundation's youth education programs at *http://bit.ly/31zTsgH*. ●

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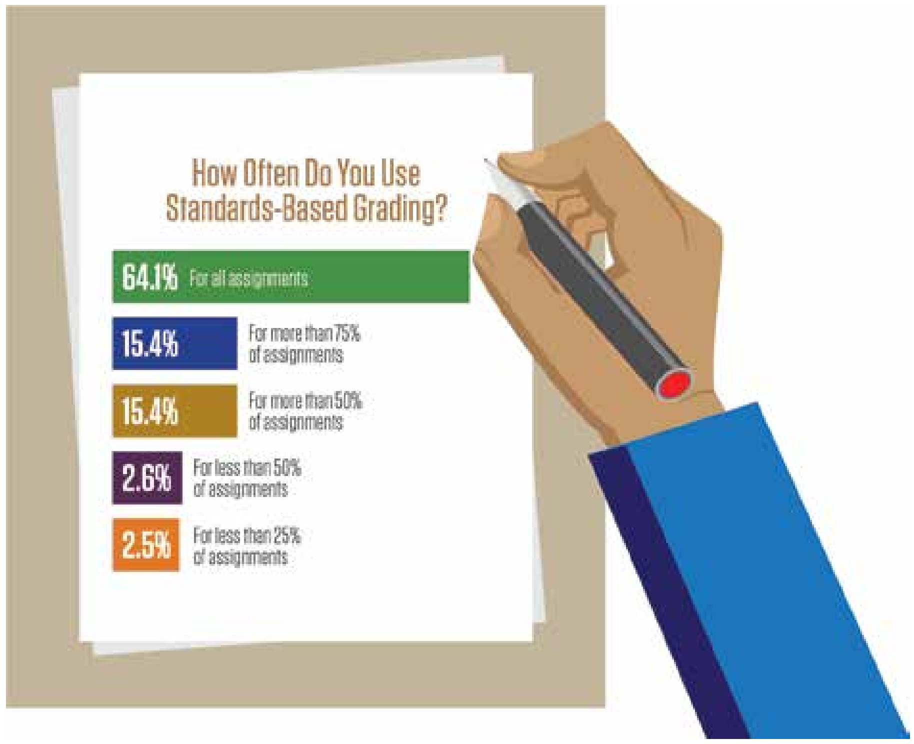
The Pros and Cons of Standards-Based Grading

In a recent informal poll, *NSTA Reports* asked science educators about their experience with standards-based grading (SBG). Fifty-five percent report using SBG in their classroom. Of them, 92.5% use it for tests or quizzes, 75% for performance tasks, 67.6% for labs or reports and projects, and 50% for essays (respondents could select multiple answers). About 64% report using SBG for all assignments, and 15.4% use it for more than 75% of assignments. Another 15.4% use it for more than 50% of assignments. Most (64%) say they use SBG by their own choice; 36% are mandated by their school districts.

Most (66%) reported creating their own assessments, although 28% said they used a mix of sources.

When asked in which subjects SBG works well, respondents indicated chemistry (78.9%), biology (81.5%), physics (78.9%), Earth science (76.3%), and computer science/technology (60.5%). Five percent said it does not work well for any of the listed subjects.



Here's what science educators are saying about the impact of SBG:

Impact on Students

They know where they are relative to other students across the state and country.—*Educator, High School, Nebraska*

Students are more motivated to do formative assessments because they know how much it impacts summatives. The stress level regarding grades has diminished substantially. It took a while, but students now understand what their scores really mean. —*Educator, High School, Iowa*

No impact.—*Educator, Institution of Higher Learning, Missouri*

It focuses more on skills. Less on content. Ensures future hard STEM [science, technology, engineering, and mathematics] students will be unprepared for competitive college programs.—*Educator, High School, Vermont*

It motivates them to keep trying and keep working at something. It becomes more transparent. It puts the owning on students.—*Educator, High School, California*

For many students, it allows them to relearn material without penalty. More students know more material. —*Educator, High School, Connecticut*

It makes them more accountable for the material.—*Educator, High School, New York*

I use the International Baccalaureate Middle Years Programme at my school. These standards unify the curriculum framework globally. In science, they incorporate "command terms"—basically Bloom's Taxonomy words that differentiate the levels that students reach. This helps students analyze what is required in questions.—*Educator, Administrator, Middle School, Norway*

Makes the focus of the class the standards—[Disciplinary Core Ideas, Science and Engineering Practices, Crosscutting Concepts]—which makes me explicitly teach and assess each of these.—*Educator, High School, Singapore*

Some have used it to really learn the material and retest. Others…just do the minimum and retest. I don't feel they really learn the material. —*Educator, High School, Iowa*

They are able to retake certain standards without having to retake a huge end-of-unit test. They know exactly what it is that they are expected to learn and what they haven't mastered yet.—*Educator, High School, Ohio*

When I polled my students about my grading system, the comments were overwhelmingly positive: "This grading system is amazing! It helps me have motivation toward my grade and has helped me become more of an independent learner." "This grading system is really helpful in understanding what a person is missing in assignments. It also helps understand what topics a person has difficulties with." "This grading system is super helpful and should be used in all the classes. It's helpful because when I can prove that I understand the content, I can fix my grade." "I think this grading system reflects my understanding of the subject because it's current and motivates me to try to do well because I'm not falling behind and getting weighed down by low-graded assignments." —*Educator, High School, Colorado*

It changes the focus from earning points to learning outcomes. Students are able to specify which skills and knowledge they need to work on developing in order to show improvement. It puts the responsibility back on the student for learning and fosters a growth mindset.—*Educator, High School, Iowa*

They are able to track their progress in class, and see what standards they need to remediate in and reassess.—*Educator, Middle School, Kentucky*

It takes students a while to get used to it and understand, but I am told it is better for them, and they like it better.—*Educator, High School, Idaho*

I think that the transition for students is challenging; however, I think that it gives them more of a purpose for the work they are doing. I also believe that it helps to build relationships, as you are having personalized conversations with students about what they understand and don't, and then being able to help them with those things they [don't]. I think it also gets them away from education being a game of collecting points in a class [in which] they can get through without learning anything.—*Educator, Middle School, Iowa*

Impact on Educators

I need to spend more of my own money and time to find non-free materials to teach from, and now assess toward. Of course, I could also compare myself to other teachers to confirm if I am covering the content appropriately. That assumes that all states are using the same standards, and that *every* state is the exact same.—*Educator, High School, Nebraska*

I've really had to focus on what's most important for my students. The newly-designed formative assessments that lead to the summatives have been so valuable in helping determine where my students really are academically. SBG has certainly decreased the amount of tedious grading that I do, and more time is devoted to lesson planning, formative assessments, etc. The four-point scale I use is meaningful to me and to my students: I can assess my students much more clearly now. I can't imagine going back to the old grading system! Unfortunately, our school still uses a 100-point scale for semester grades, so I have to do some creative conversions.—*Educator, High School, Iowa*

[SBG] made my job unsustainable. Added 20 hours of homework a week.—*Educator, High School, Vermont*

It has changed how I see students, growth, and remediation. It provides differentiation and requires me to be more on top of my game prior to giving a project/lab. It forces backwards planning. It's made me a better educator, and I wish I could do it in more classes.—*Educator, High School, California*

It's hard to come up with multiple assessments; that requires a lot more work. Also, it is a lot more information to keep track of.—*Educator, High School, Connecticut*

Standards-based has helped me significantly as an educator. We spend time telling students they should have a growth mindset, but a traditional grading system does not enforce a growth mindset. Content- and Standards-based grading must have the ability for students to redo work, which takes the pressure off of them and me. Once they can prove they understand a concept, their grade goes up to reflect that. It takes the pressure off of me, and puts it back onto the students to promote self-learning and self-responsibility. —*Educator, High School, Colorado*

It made me look at what is important to my courses and in our department. I'm less worried about what they know and more interested in how they can apply their knowledge.—*Educator, High School, Maine*

Students are not "let off the hook" for not knowing something. We don't just move on; they have to learn it until they master it. —*Educator, High School, New York*

[SBG] has really changed my ways of teaching and talking with students and parents, as well as lesson planning, assessment planning, etc., and my philosophy of education/teaching has changed…It brings purpose to everything we do in the classroom, as well as to the grade at the end of the reporting period. It also has made me really think about what my job as an educator really is, and that is to grow each child [who] is in my class and help to prepare them for not necessarily the content, but more the skills to be successful in the real world.—*Educator, Middle School, Iowa*

It has allowed me to implement clearly targeted tasks and assessments. I know exactly what students need more help with, not just if they do well on tests and homework in general. My grades now represent the most current evidence a student has shown for meeting standards, and they are not "penalized" for lower grades earlier in the term prior to their new learning.—*Educator, High School, Iowa*

New teacher at my school. Not new to teaching, just new to this method and the grading program they use. Difficult to learn and switch over to. Administration just gave a handbook and said, "Read it and figure it out." When I made mistakes, I got in trouble. The lack of support was astounding and made the learning stressful. —*Educator, High School, Idaho*

Our school has unfortunately been held back from making the change entirely to standards-based by our administration. I have used [SBG] for most assessments this year, but had to convert my grades to a 100-point scale to report in our grading system. —*Educator, Middle School, High School, New Hampshire*

[SBG] has been fine in most cases. It works fine for some assessments and projects. Assessments created by publishers are a nightmare to assess, as different standard areas are dispersed throughout a test in no apparent order, which makes gleaning the assessment areas and awarding scores incredibly time consuming. You definitely don't see the "bang" for the amount of time it takes. Teacher-made assessments are much more useful for standards-based assessing, but they take a lot of time to construct. This is especially true for *NGSS* practice-based assessments. It is just the sheer number of standard areas that I have to assess, which is rather insane. Our elementary report card has [more than] 50 standard areas from all subjects that we are required to assess. It confuses the heck out of parents, to be honest.—*Educator, Elementary, Oregon* ●

Encouraging Creativity in STEM Class

Creativity often may be overlooked in science, technology, engineering, and math (STEM), but STEM teachers are finding ways to make their lessons and courses innovative and encourage their students to be creative. For example, Emily Faulconer, assistant professor of math, physical, and life sciences at Embry-Riddle Aeronautical University in Daytona Beach, Florida, says, "I challenge my students to summarize a concept in the form of a haiku…It helps them with vocabulary and thinking through the process, and gets students thinking outside the box…Haiku is a literary device, and easy to infuse."

Faulconer cites "a recent interest in humanistic STEM at Embry-Riddle" that is supporting the infusion of the humanities into STEM courses. "It helps students view the sciences more broadly. They can look at science from other angles," she contends.

As an online instructor, Faulconer posts haikus—her students' and her own—in the discussion forum, and they're not assessed because "the rubric grades on how students engage; it doesn't have to be on the haiku. Students are assessed on one initial post and two reply posts [and giving] accurate responses," she points out. While not all students contribute haikus, "the students think haiku is fun, and they comment on them. I enjoy reading them and so do they," she relates.

"We've been doing infusions of other disciplines into science/STEM," Faulconer continues. As the result of a research project on students' perception of connections between the Introduction to General Chemistry 1 course and other STEM disciplines; the course and non-STEM disciplines; the course and their future careers; and the course and their academic degree, Faulconer and her science colleagues have changed the course's module titles, "[leaning] more on other disciplines to make the modules sound more engaging," she reports.

For instance, the course's Introduction to Chemistry module has become Bacon and Gunpowder. "Philosopher Roger Bacon was the first European to develop a formula for gunpowder. [The new title] shows how important math is, which is taught in introductory courses," Faulconer contends.

GIGI CARUNUNGAN

As part of Gigi Carunungan's module on germs, third graders create "germs" from modeling clay, store them in closed containers to prevent contamination, and label the containers. The result is a "Germs Museum" for their classroom.

Solubility and Intermolecular Forces in Oxidation is now Water, Water, Everywhere because understanding "solubility and intermolecular forces in the context of water [makes sense because] so many reactions occur in aqueous environments," she maintains.

And Solution Chemistry has become The Liquidation of Witches. "The phenomenon is from *The Wizard of Oz,* [when the Wicked Witch says,] 'I'm melting!' But she didn't melt; she might have dissolved, but not melted. In the movie, she smokes when 'melting.' Smoke is suspicious; it was a chemical reaction," Faulconer explains.

Last year, Faulconer and another Embry-Riddle professor created an interdisciplinary and multidisciplinary science course called Science of Flight. "Students are assessed on all subjects: biology, chemistry, environmental science, geology, and physics. It's a general education course, [created] to give non-science students more interesting options. It's a really popular class and is now running multiple sections online. Student feedback is positive," Faulconer reports.

"I enjoy finding the interdisciplinary connections," she relates. "The College of Arts and Sciences is so broad! It's easy to stay siloed and not reach out to colleagues. This has encouraged me to work more closely with instructors with whom I haven't worked before. Now they're asking me about the science slant to, for example, Edgar Allan Poe and his possible death by carbon monoxide poisoning."

Linking Robotics and Physics

"I am teaching Conceptual Physics and Robotics together [to first-year high school students] during the same class period. That has compelled me to be creative, searching for ways to link robotics and concepts in physics," says Kathy Snyder, science and math teacher at Mary Help of Christians Academy in North Haledon, New Jersey. "The current project students are working on takes a jigsaw approach (experts in physics and robotics), with each team comprised of one member from each class."

Snyder challenged student teams to "identify the key issues to enhancing ROV [remotely operated vehicle] design based on depth-pressure, kinematic, and dynamics to better gather scientific data in deep ocean trenches." She told students, "In addition to building a model to scale, [you] will identify financial issues, research and [develop], prototype, and market for [your] device. [You] will present [your] models and needs for financing to instructors at our school in a *Shark Tank*–style event."

Snyder says she developed the idea for the project when she read an article about Jason and Medea, ROVs designed and built by Woods Hole Oceanographic Institution's (WHOI) Deep Submergence Laboratory. She also was inspired by "research vessels that had gone to the bottom of the Mariana Trench" in the Pacific Ocean in record-breaking deep dives. Snyder cites WHOI's Dive and Discover website (*https://divediscover.whoi.edu*) as a resource in creating the project.

"Each team's underwater ROV must be better than…[Jason and Medea]," Snyder instructed students. To accomplish this, the robotics partner's primary job is to "assess the current weaknesses of Jason and Medea," she explains. Students' models also "must go deeper than any previous ROV," including the ones that traveled to the depths of the Mariana Trench, and students must "describe the way [their model] handles the pressure challenges of increasing depth," which is the physics partner's primary job, she relates.

"Some students are new to cooperative groups. It's interesting to see them move from the grumbling stage to beginning to understand," Snyder observes. "Both the [physics and robotics students] had a cursory knowledge of their own disciplines, but I encourage them to share their strengths…We do an engineering talk to share ideas."

While not all of the students "have been challenged to integrate knowledge from multiple disciplines in elementary and middle school, the *Next Generation Science Standards* (*NGSS*) encourage critical thinking and problem solving. This approach is new for many students, [but this] is the way I've always taught," Snyder relates. Her students "are getting comfortable with not knowing the answer" immediately, she adds. Along the way, she did "mini-lessons" on concepts students didn't know, such as "scale models, for example: 2-D to 3-D," she explains.

Part of her assessment of her students, she notes, includes whether "groups function effectively. Do they follow their agenda? What did they do when someone was absent, or when someone didn't do their work?" During their presentations, students were graded on things like "eye contact, enthusiasm, and answering questions that they weren't prepared to answer," she relates.

"Giving them choices [about how to design their models] made [the project] more fun," Snyder concludes. One team constructed their model from LEGO® toy building bricks, for example.

Using Play and the Arts

Gigi Carunungan, chief learning architect of Playnovate—an offline and online science, technology, engineering, art, and mathematics learning company for K–8—incorporates play and the arts in science teaching. She developed the Helical Model of Learning, which has five stages: Play, Explore, Connect, Imagine, and Remember. In a science module on germs, for example, third graders start by playing Tag with glitter of various colors attached to their hands with lotion. They spread "germs" by tagging their classmates and leaving glitter of mixed colors on their arms. (Alternatively, students could wear old clothing and aprons that could be tagged, Carunungan adds.)

"The game becomes a way to equalize the playing field because every student wants to play it, so everyone participates," Carunungan maintains. "The rules are really about creating a socially interactive and physical dynamic," she explains, because when students run around and tag one another, their arms now contain various colors, and the colors are blended. During the reflection time, "the teacher says, 'That is like transmitting germs to one another,'" and offers no further explanation because the teacher is using the game as the phenomenon, she points out.

"Students remember this because it's emotional. Emotional memory is more powerful than content memory in this case because the students have so much fun," Carunungan contends.

In the next game, groups of students shoot water pistols at targets at various distances from them and observe the results. During reflection time, says Carunungan, students reach the understanding that the closer they were, the easier it was to hit the target. "The teacher says, 'This is like [transmitting] germs. The closer you are, the more likely you'll get them.' The teacher is also showing students how to analyze data."

In the module's Connect phase, the teacher creates a graph of the length of students' absences due to illness and the symptoms they experienced. Students learn how symptoms can be both the same and different for various people. After discussion, the teacher then explains what the word *symptoms* means. "Students understand the concept before the word. The concept is based on what they say [during the discussion]," she reports.

This activity "helps students develop a scientific mindset because they look at evidence, patterns, and variables," Carunungan observes. The activity is done in the Connect phase because the graph "connects to real-world experiences from students' own lives…[They are also] using data to make conclusions."

Students then create their own graphs using data from students in other classes. Back in their classroom, they are assigned to small groups and present the data they gathered. Each group merges the data into one graph. "This is what scientists do: Collect samples from different places and compare and analyze and synthesize," says Carunungan. The teacher can then connect this phenomenon to the work of microbiologist Louis Pasteur.

In the Imagine stage, students use modeling clay to create their own "germs" for a Germs Museum. Then students create posters on avoiding germs and staying healthy and hang them around the school.

When this module has been taught, "there is a jovial atmosphere in the classroom," Carunungan recalls. "Creativity is cultivating an atmosphere in the classroom [in which] learning is about curiosity, connecting, and figuring out, and the students can get excited [about learning]."●

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SCIENCE TEACHERS' GRAB BAG

Inside this Convenient Pull-Out Section you will find:

Freebies for Science Teachers

Pathways. M H Developed by the National Institute of General Medical Sciences and Scholastic, these lessons, videos, and activities for grades 6–12 introduce basic science, its importance to human health, and careers in science research. Through four lessons and videos and an accompanying magazine, students learn about the science of living systems (Exploring the Science in Our World), the tool sets of research scientists (Exploring Research Tools), the benefits of studying research organisms (Small Cells, Big Findings), and the diversity of science careers (Exploring the Research Path). Visit *www.scholastic.com/pathways*.

***Waste Invaders* Mini-Unit.** E Think Earth Environmental Education Foundation's curriculum for grades 4–5 focuses on reducing solid and liquid waste. Designed in comic-book format to appeal to all students, including reluctant readers, struggling readers, special-needs learners, and English language learners, the mini-unit explores where trash and wastewater come from, where they go, and how to reduce the amount of solid waste and wastewater we produce. A Classroom Guide features discussion questions to deepen students' understanding, and follow-up activities to generate conservation awareness. Download the materials (registration required) at *http://bit.ly/2YYVNzy*.

My American Farm STEM app. E Students in grades 3–5 can play their way to understanding the roles of science, technology, engineering, and math (STEM) in agriculture with this app. Developed by the American Farm Bureau Foundation for Agriculture and available for iOS (*https://apple.co/2HVS9Re*) and Android (*http://bit.ly/2wDvdjm*) platforms, the app features four games, each focused on a different element of STEM.

In Keys to Stewardship, the science-focused game, students work to complete tangrams, learning about crop rotation and other farming practices. In the technology-focused game, the Great Seed Search, students pilot a plane around the world, collecting seeds and learning about agricultural products, geography, and other cultures along the way. In Thrive, the engineering-focused game, students identify healthy soil, develop strategies to improve soil quality, and enhance water quality to grasp how soil is a vital part of the natural environment. In Operation Peanut Butter, the math-focused game, students follow the path of peanuts from the field to the peanut butter jar, practicing fractions and other math concepts at each location.

ACROTERION

GLOBE Observer Toolkit. K12 GLOBE Observer, an app-based citizen science project, has a toolkit for informal educators at libraries, museums, parks and outdoor education centers, and after-school programs. The toolkit contains resources and activities for educators to integrate the citizen science initiative at their institution and involve participants, including K–12 students, in authentic science research. Organized by protocol (i.e., type of data collected), the resources help educators teach participants how to collect data using the app and explain why the observations are important.

For example, GLOBE Observer observations from students and other citizens can be used to help scientists track changes in clouds, water, plants, and other life in support of climate research and to verify data from NASA satellites. More specifically, reports of mosquitoes can be paired with satellite observations of vegetation and temperature to learn what conditions mosquitoes thrive in. Land cover observations can provide details about the landscape that satellites can't capture, such as urban parks. Participants who take cloud observations while a satellite is overhead are e-mailed matching satellite data for comparison.

The toolkit also has tips on data collection and a resource library with activities, books, videos, and presentations to provide background knowledge, as well as handouts and promotional materials to help educators generate interest in participation. Refer to *https://observer.globe.gov/toolkit*.

Infiniscope.org. M H Funded by NASA, this project specializes in browser-based digital learning and a teaching network for educators. At *https://infiniscope.org*, educators can access a collection of digital interactives on Earth- and space science–themed topics and accompanying lesson plans for middle and high school levels and informal science audiences. Developed by Arizona State University's School of Earth and Space Exploration, NASA's Science Mission Directorate, and Smart Sparrow digital content creators, the immersive interactives explore topics such as solar and lunar eclipses, asteroids, the search for

See Freebies, pg G2

Freebies, from pg G1

exoplanets, the Cretaceous–Paleogene (K–Pg) extinction event, Why Mars Is Red, and the search for life in the universe. Each interactive incorporates real NASA data and subject-matter experts and includes adaptive feedback to meet individual learners' needs. Teachers can also join the Infiniscope community to connect with colleagues interested in customizing interactives or collaborating to design new Earth and space digital technology resources for the classroom.

Project Hero. K12 A nationwide initiative from the Captain Planet Foundation teaches K–12 students about threatened and vulnerable animals and plants and where they live and empowers them to design and implement real-life solutions. Through the project's unique digital platform, students participate in hands-on environmental service-learning projects (quests) to learn about a topic and contribute biodiversity data to national and global conservation organizations. Currently, students can participate in two projects: Pollinator Quest (grades 3–5), which focuses on creating habitats for pollinators, and Minnesota Freshwater Quest (grades 5–8), which focuses on identifying threats to species and human health in community waterways.

Future projects will address topics like improving soil health and planting trees (Healthy Soil Quest, grades 5–8); helping the longleaf pine ecosystem (Longleaf Pine Quest, grades 3–5); reducing plastic pollution (Plastics-Free Oceans Quest, grades 3–8); and learning about the gray wolf (Rocky Mountain Wolf Quest, grades 8–12). Visit *https://herofortheplanet.org*.

Braincandy.org. K12 Teachers can design customized question sets at *www.braincandy.org* to uncover student preconceptions in K–12 STEM disciplines and support authentic discourse and argumentation in the classroom. The online question sets engage students in relevant science discussion and provide a safe place for them to share ideas without judgment. Teachers can create sets using the website's bank of curated questions, co-developed by scientists and educators, or devise their own.

The website's questions (and answer choices) incorporate student preconceptions common to K–12 STEM disciplines and are specifically designed to elicit differences of opinion. As students respond to the question sets, and differences inevitably emerge, students develop communication skills as they verbally reason with peers to reach consensus. The website also has tutorials for using the resource in the classroom.


ALUPUS

Kart Kingdom. E Use this game from PBS Kids to introduce K–3 students to the basics of systems thinking, strategy, and toolmaking. Players explore the Kart Kingdom world, crafting gadgets and customizing characters as they move through various game levels completing quests. The gadgets help (and change) how students move through each level. Sometimes more than one gadget can be used to complete a puzzle, and students must decide which gadget is the best.

The game can be played in the classroom or at home. An educator's guide has questions to reinforce student learning: What did you do to craft new gadgets? How did the gadgets help you complete the game quests? How was teamwork used to help solve problems? Later, discussions can expand to apply students' understandings to real-world systems, such as sprinkler systems, bicycles, or students' own bodies, and the idea that systems are component parts working together to make things happen/solve problems. Visit *http://pbskids.org/kartkingdom*.

STEAM Lessons @TeachRock. E M H TeachRock uses popular music to engage students in work that supports standards across disciplines, including science, technology, engineering, arts, and math (STEAM). TeachRock's STEAM lessons showcase connections among the STEM disciplines in popular music and introduce students to some of the music-related theories, practices, and methods regularly used in these fields. The lessons also incorporate an element of design—Art—hence their classification as STEAM.

Preview the lesson collection at *http://bit.ly/2IkTArn* (select STEAM under the Subjects heading). Highlights include Cleaning Up the Plastic Beach (elementary, middle, high school); Making Music Videos With a Homemade Projector (middle and high school); Designing an Electric Guitar With Shapes (elementary); and The Guitar: A Musical Transducer (middle and high school).

SageModeler. M H This easy-to-use software can engage middle level and high school students in systems thinking and model-building. Developed by the Concord Consortium and the CREATE for STEM Institute at Michigan State University, the software enables students to use a drag-and-drop method to build various customized phenomenon representations from the basic diagramming of a system structure to static equilibrium and dynamic time-based models. Teachers and students can access the software and supporting resources on how to use it at *https://sagemodeler.concord.org*.

PopED. K12 Explore human population issues with K–12 students with lessons and reading resources from Population Education. Search the resource database (see the website at *http://bit.ly/2ETMAkp*) to find interdisciplinary science activities. Downloadable lessons are indicated with a page icon and include a video demonstration of the activity along with the lesson plan.

Highlights include activities such as Crowding Can Be Seedy (K–2), a role play and gardening lesson that helps students understand the effects of population density, and Waste a-Weigh (K–2 and 3–5), in which students weigh and record their lunch waste for a week to understand how conservation efforts can reduce the total amount of trash generated. For the Common Good helps students in grades 6–8 determine consumption strategies that maximize resources for an entire group, while Carbon Crunch shows students in grades 9–12 how population growth and industrialization have impacted the environment.


JJ HARRISON

Beating Mosquitoes at Their Own Game. H This interdisciplinary lesson for high school learners fuses science, technology, mathematics, ethics, and language arts into a week-long experience exploring biotechnology. During the lesson—developed by the TGR Foundation as part of the TGR EDU: Explore curriculum—students not only learn how infectious diseases are spread, but also uncover specific concerns of the Zika virus and debate whether genetic modification of mosquitos is an appropriate method to stall or eliminate the spread of disease. Materials include a downloadable lesson plan and an accompanying PowerPoint presentation with guiding questions and embedded videos to help explain complex topics. Access this lesson and other lessons for middle and high school educators from the TGR EDU: Explore curriculum page at the website *www.tgreduexplore.org/curriculum*.

Physics Aviary. H You'll find hundreds of physics-related simulations, labs, homework problems, tools, and more—all designed to use on computers, tablets, phones, and other devices with HTML 5–capable browsers—at *www.thephysicsaviary.com*. The site was created by Pennsylvania educator Frank McCulley to support student learning in his high school physics courses. ●

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


"I enjoy taking courses that allow me to learn and use new information. My community benefits from the knowledge and skills I am able to bring back into my classroom. Plus, there is the benefit of going up on the pay scale."
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News Bits

- **With enough votes, a nuclear reactor LEGO® set designed by an Idaho research scientist will be sold in stores.** **A**

Catherine Riddle, a research scientist in aqueous separations and radiochemistry at Idaho National Laboratory in Idaho Falls, designed the Atomic Town Power set to inspire kids to learn more about science, technology, engineering, and math (STEM) fields. The design is based on an experiment that produced electricity using nuclear power for the first time in 1951. It uses a LEGO reactor to simulate the lighting and heating of a mini-town with nuclear energy. (The set doesn't actually use or produce nuclear energy.)

The set has 13 LEGO figurines: chemists, engineers, physicists, control room operators, technicians, a firefighter, a safety control rod axe person, and a receptionist. Two of the scientists are explicitly female and modeled after Riddle. The set needs 10,000 votes by May 2020. See *http://lego.build/2WBc6BE.*

- **In meta-analysis, researchers found that teachers play an important role in whether girls pursue science careers.** **K12**

After 50 years of "Draw-A-Scientist" studies, today more than half of girls draw a female scientist, a number that's been rising. Still, the meta-analysis findings showed that as students age, they increasingly draw male scientists.

David Miller and colleagues on the meta-analysis note that "girls may avoid activities that they consider appropriate for boys but not girls," and everything from the language teachers use to their classroom decorations may convey subtle messages about gender roles in science. To promote inclusion, teachers can hang diverse posters; promote books highlighting women; invite female guest speakers and role models to visit; and be mindful of gender bias and language. See *https://edut.to/2VH4sEQ.*

- **A high school after-school program developed by the U.S. Department of Energy's Brookhaven Laboratory is now part of the curriculum for a new scientific computing minor offered at Adelphi University in Garden City, New York.** **H HE**

Christopher Storm, associate provost for faculty advancement and research at Adelphi, says the minor will prepare undergraduates majoring in science and helps meet the demand for scientific computing in the workplace. According to the National Center for Education Statistics, the percentage of U.S. high schools offering scientific computing courses has declined, and averages less than 10% of all schools. The U.S. Bureau of Labor Statistics projects a growing demand for computing and mathematics jobs into the early 2020s.

David Biersach, a technology architect in Brookhaven Lab's Information Technology Department, said scientific computing is essentially applied computer science, with code speed and accuracy being essential—but high school computer science courses don't typically focus on those skills. According to Biersach, students who lack coding experience often spend the beginning of their internships determining how to instruct computers to perform basic data-processing tasks instead of learning domain knowledge from their mentors and conducting lab experiments.

To address this national problem, Biersach started scientific computing clubs at Long Island high schools to help students learn to translate scientific formulas into accurate and efficient code, store and analyze very large datasets, and effectively visualize complex data. See *https://bit.ly/2MwnvCm.* ●

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)

Science Education Partnership Award Teaching Resources K12

Excite students about careers in biomedical research and improve community health literacy with resources from the Science Education and Partnership Award (SEPA) program at *http://bit.ly/30IcWiJ*. Developed by NIH's National Institute of General Medical Sciences, this program funds innovative science, technology, engineering, and math and informal science education projects for K–12 audiences. The projects—which are created through partnerships between biomedical and clinical researchers and educators, schools, and other interested organizations—include an assortment of technology-based curriculum, games, apps, and other interactive resources for use in the classroom, community, or home.

For example, This Is How We Role (elementary), a curriculum developed with Purdue University College of Veterinary Medicine, explores careers in veterinary science and how to prevent health conditions that impact people and their pets. Online games like Monster Heart Medic and Space Chef (elementary and middle levels), developed with California's Lawrence Hall of Science, focus on the importance of maintaining a healthy lifestyle. Bibliotech CityHacks: In Search of Sleep and Bibliotech ReBound: Beating Concussions, multimedia resources developed with Duquesne University, build middle school students' literacy skills while addressing science content relevant to their lives. Resources for high school learners include lessons developed through Harvard University's Personal Genetics Education Project and the University of Nebraska's Biology of Human curriculum to teach students about biomedical research developments and their importance.

National Oceanic and Atmospheric Administration (NOAA)

Marine Debris Monitoring Toolkit K12

With the Marine Debris Monitoring Toolkit for Educators, K–12 students can study the issue firsthand as they collect and analyze marine debris data in their communities and contribute their findings to a national citizen science initiative, NOAA's Marine Debris Monitoring and Assessment Project (MDMAP). Produced jointly by NOAA's Marine Debris Program and Office of National Marine Sanctuaries, the guide has four sections. Teacher Resources includes an introductory PowerPoint presentation and links to lessons, articles, videos, and websites to build background knowledge on the topic. Guidelines for Data Collection presents survey protocols and data sheets to enable students to accurately collect and record marine debris data. In Guidelines for Data Analysis, the process of entering data in the MDMAP database is described and suggestions for creating visual displays from the data are provided. Community Engagement and Outreach offers activity ideas for generating awareness of marine debris. Visit the website at *http://bit.ly/2Msn2RF.*

National Aeronautics and Space Administration (NASA)

An Earth System View of Earthrise E M H

Targeted for grades 4–12, this lesson plan uses the Earthrise phenomenon—images of Earth as first viewed by the Apollo 8 astronauts as they orbited the Moon—as a central focus for exploring Earth's global systems and how they change over time. Students first make observations about two iconic images of the Earth as seen from the Moon. Next, students analyze data relating to one of four Earth science variables that NASA monitors (cloud cover, vegetation, surface temperature, and precipitation) and create a visualization documenting the changes they observe in their chosen variable over time. Students then pair with a classmate to compare their visualization with one on a different Earth science variable and make inferences about how the two variables may be related. Other accompanying materials, such as links to Earthrise images, Earth system poster cards, and student data sheets, can be found at the website *https://go.nasa.gov/2I3RRqn*.

NASA Kids' Club P E

Check out this website for games and other resources to inspire young scientists (preK–4) to learn about NASA and its missions. Share an image from NASA Kids' Club Picture show gallery to spark discussion and interest in science, or watch the Now in Space slideshow to get to know the astronauts on the International Space Station. The site also has space-themed games, puzzles, coloring pages, and mazes that support *Common Core* and *Next Generation Science Standards* and reinforce skills in core subjects.

For example, Roving on Mars lets students test their driving skills as they learn facts about the red planet, while another game, AstroMatic-3000, invites students to calculate their weight and age on different planets. Other resources include printable activity books such as *Forward to the Moon, Adventures in Aeronautics,* and the *International Space Station Activity Book*. Refer to *https://go.nasa.gov/2HJTSJm*.

U.S. Census Bureau

National Pet Day Challenge M H

Targeted for middle and high school levels, this Five-Minute Challenge offers hands-on practice in analyzing data and introduces careers in the veterinary industry. Students interpret an infographic with facts about various animal-related careers, then record positives and negatives about each career based on what they discover. Consult *http://bit.ly/2YW3vu6*.

U.S. Food and Drug Administration (FDA)

Using the Nutrition Facts Label to Make Healthy Choices M H

Make science and health relevant for students by exploring the impact of daily food and beverage choices on overall health. Through the activities in *Science and Our Food Supply: Using the Nutrition Facts Label to Make Healthy Food Choices,* FDA's inquiry-based nutrition education curriculum, students learn about healthy food habits and develop fundamental understandings about the Nutrition Facts Label; serving size and calories; sugar in beverages; sodium in snack foods; meal planning; and eating healthy when away from home. The standards-supported curriculum—versioned for both middle and high school levels—includes background information for teachers, five learning modules, student worksheets, glossary, and standards information. Access *http://bit.ly/2MiVv5b.*

U.S. General Services Administration (GSA)

Federal Crowdsourcing and Citizen Science Catalog K12

At CitizenScience.gov, K–12 educators and students can browse a database of more than 400 science research and crowdsourcing projects sponsored by federal agencies. The projects address various science disciplines (archaeology, biology, chemistry, environmental science, geology, health and medicine, physics, space science, and others) and offer opportunities for student participation and data-collection experiences.

For example, projects might involve tracking harmful algal blooms (Cyanoscope–Environmental Protection Agency Collaborative Project), documenting ladybugs in habitat (Lost Ladybug Project), verifying land cover type on satellite images (Adopt a Pixel), searching for exotic stars by analyzing radio data from the Green Bank Telescope (Pulsar Search Collaboratory), and measuring fossilized shark teeth (Students Discover). Users can filter searches by agency, status (active or completed), or science discipline. Visit *http://bit.ly/2XsuJs1*. ●

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

In Your Pocket

Editor's Note

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

July 31–August 31

Teachers Test Prep 'Pass the Torch' Scholarships for Educators HE

These awards go to future educators to help offset their living expenses so they can focus on preparing for their credentialing exams. Two $5,000 awards are available: one for an aspiring elementary teacher and one for a secondary teacher. Applicants must be enrolled in a teacher preparation program at a U.S. institution for the 2019–2020 school year and be receiving Federal Student Aid or be able to demonstrate financial need.

Recipients can use the funds for things most financial aid packages don't cover, including housing, transportation, books, and other living expenses. Five to 10 finalists will also receive $100 Amazon gift cards and free access to a Core Plus Online Prep Program for the PRAXIS, CSET, FTCE, or other credentialing exam.

To enter, record a short video about a teacher who made a difference in your life. Apply by **July 31.** See the website *http://bit.ly/2QxVBEq*.

American Honda Foundation Grants K12

The American Honda Foundation (AHF) awards grants of up to $75,000 to youth education programs focused on the environment and science, technology, engineering, and math (STEM). Public and private K–12 schools, public school districts, and nonprofit organizations that host such programs and have not previously received AHF funding can apply by **August 1** at *http://bit.ly/2EGCpiV*. AHF is especially interested in programs that are imaginative, creative, youthful, forward thinking, scientific, humanistic, or innovative.

Clarence E. Heller Charitable Foundation Grants K12

These grants go to programs providing environmental or arts education opportunities for youth (California-based programs are preferred). Grants of between $5,000 and $100,000 may be used to help 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. Submit a letter of inquiry by **August 1;** consult *www.cehcf.org/apply-for-a-grant*.

Bostitch Creativity in the Classroom Grant K12

These $250 grants go to two K–12 teachers with creative lesson plans. Lessons should be original and impactful, and exemplify creativity in the classroom. Submit a Google Doc with your lesson plan and an application by **August 20** to *http://bit.ly/2DWZ2jw*.

Bayer Fund Grants K12

These grants support communities within 30 miles of former Monsanto sites. Funds are available for K–12 general education and STEM programs that use innovative approaches to teaching or learning and foster student achievement; food and nutrition programs; and community development projects. Community gardens, after-school STEM and agriculture programs, and other projects that fall under the three focus areas are also eligible.

Applicants must first request an invitation code at *http://bit.ly/2s2sBJu* and be invited to apply. Applications are then due by **August 31.**

September 15–16

International Paper Company Foundation Grants P K12

These grants go to nonprofit organizations with children's education and literacy projects in communities where the company operates: in Alabama, Arizona, Arkansas, California, Colorado, Connecticut, Florida, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maine, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Nebraska, New Jersey, New York, North Carolina, Ohio, Oklahoma, Oregon, Pennsylvania, South Carolina, Tennessee, Texas, Utah, Virginia, Wisconsin, Washington, and Washington, D.C. Those focused on literacy from birth through third grade are of particular interest. Limited funding is also available for sustainability projects focused on forest, water, air, and responsible sourcing issues.

Submit a proposal to your nearest International Paper facility by **September 15.** For locations and details, visit *http://bit.ly/2WyjKjz*.

Bayer Fund's FIRST Robotics Program Grants K12

Bayer Fund supports FIRST Robotics teams in U.S. communities where its employees live and work. FIRST Robotics inspires youth to be science and technology leaders by engaging them in mentor-based programs that build necessary skills, inspire innovation, and foster life capabilities such as self-confidence, communication, and leadership. Bayer Fund supports FIRST Robotics Competition, FIRST Tech Challenge, FIRST Lego League, and FIRST Lego League Junior teams, prioritizing teams that demonstrate diversity, such as female-led teams, racially or gender diverse teams, and economically diverse teams. Bayer Fund accepts FIRST Robotics Grant applications from eligible U.S. communities by invitation only. To apply, applicants must obtain the invitation code from the Bayer site contact in the team's local community. All teams must be located within approximately 30 miles of an eligible site community. (If you do not have a contact at your local site location, submit a summary of your team and select your eligible site community on the Contact Us page at Bayer Fund's website, *http://bit.ly/2Mtiz1b*.) Applications will be accepted from August 15 to **September 15.**

Fulbright U.S. Scholar Program HE

This program provides teaching, research, or combination teaching and research grants to U.S. faculty and experienced professionals in a variety of disciplines. Grants are available in more than 125 countries worldwide for stints of between 2 and 12 months, though some flexible multi-country options are available. U.S. citizens with a PhD or equivalent professional or terminal degree (including a master's, depending on the field) may apply by **September 16.** Refer to the website *http://bit.ly/2QvWI7H*.

January 31, 2020

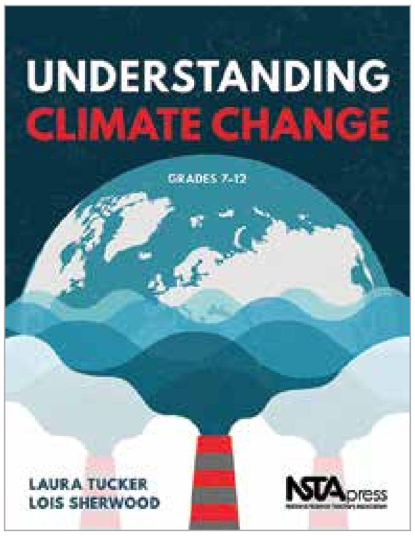
AAPG Foundation Teacher of the Year Award K12

The American Association of Petroleum Geologists (AAPG) presents this award to an outstanding K–12 geoscience teacher. The honoree receives $6,000: $3,000 for his or her school, to be used at the teacher's direction, and $3,000 for personal use. Applicants must have three years of full-time teaching experience, be currently teaching at a K–12 school, and teach one unit per year on natural resources.

Apply by **January 31** with the materials you taught during the academic year ending the previous spring or summer. Learn more at this website: *http://bit.ly/2WsXKGV*. ●

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

FRESH PICKS FOR SUMMER READING

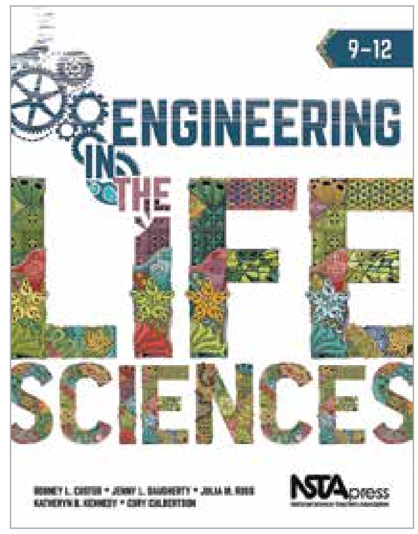


Grades 7–12

Book: Member Price: $25.96 | Nonmember Price: $31.95
E-book: Member Price: $19.17 | Nonmember Price: $23.96
Book/E-book Set: Member Price: $30.67 | Nonmember Price: $38.34

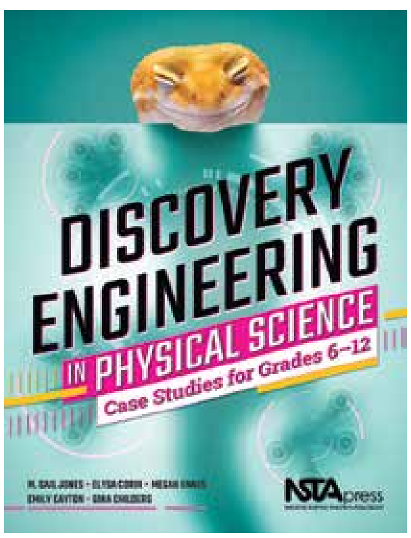
Grades PreK–5

Book: Member Price: $10.36 | Nonmember Price: $12.95
E-book: Member Price: $8.42 | Nonmember Price: $9.71
Book/E-book Set: Member Price: $13.47 | Nonmember Price: $16.84



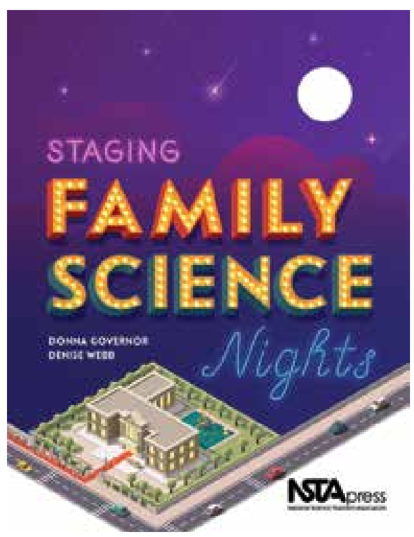
Grades 9–12

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



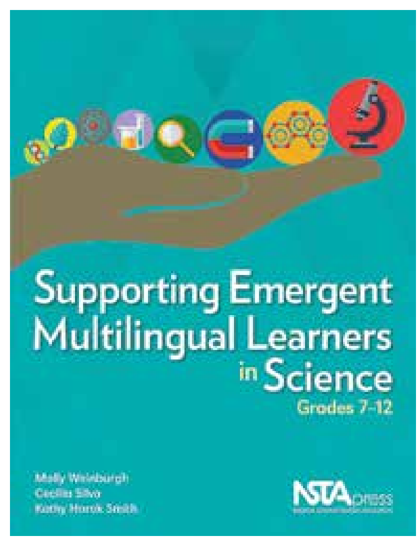
Grades 6–12

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



Grades PreK–12

Book: Member Price: $25.96 | Nonmember Price: $31.95
E-book: Member Price: $19.17 | Nonmember Price: $23.96
Book/E-book Set: Member Price: $30.67 | Nonmember Price: $38.34



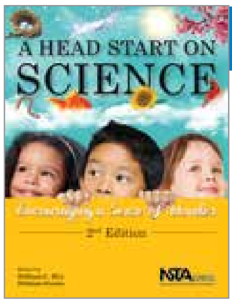
Grades 7–12

Book: Member Price: $25.96 | Nonmember Price: $31.95
E-book: Member Price: $19.17 | Nonmember Price: $23.96
Book/E-book Set: Member Price: $30.67 | Nonmember Price: $38.34

To place an order or download a free chapter, visit

WWW.NSTA.ORG/STORE

NSTA National Science Teachers Association



NSTA PRESS: *A Head Start on Science*

The Senses

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 A Head Start on Science, *edited by William C. Ritz and William Straits, edited for publication here. To download the full text of this chapter, go to* https://bit.ly/31A142K. *NSTA Press publications are available online through the NSTA Science Store at* www.nsta.org/store.

Young children learn about their world through their senses. Babies learn about objects by putting them in their mouths; banging them on the floor; and dropping, rolling, shaking, and throwing them. Preschool and primary-grade children continue to observe materials and objects to learn about them, although they can begin to be somewhat more systematic in their observations. These children also begin to organize information as they compare and classify objects by their attributes: Is this fruit sweet or sour? How does my skin look through a magnifying glass? Does it look different when I look through a prism? And they can communicate their discoveries in various ways, including sorting, drawing, graphing, and describing. All science activities involve the use of one or more of the senses. Focusing on each sense individually at the beginning of the year helps children become more aware of their senses and how they are used to learn about the world.

Selected Internet Resources

Senses in General

Ideas for Teaching the Five Senses (National Education Association), *https://bit.ly/2JMN4wH*
My Body, My Senses Unit (Head Start/Early Childhood Learning and Knowledge Center), *https://bit.ly/2Mt8bWW*

Shapes and Colors

Colors All Around (Resources for Early Learning), *https://bit.ly/2Mm983m*
Color and Shape Activity (Boston Children's Museum), *https://bit.ly/2WxAmrE*

Sound and Smell

PreK Unit on Sound (Resources for Early Learning), *https://bit.ly/2WwOeCp*
What Does Purple Smell Like? (The Free Library), *https://bit.ly/2VY4Df7*

Useful Magnifiers

Investigation: Using magnifiers to look closely at objects
Science practices and skills: Comparing, observing, using tools
Materials: Plastic magnifiers (also called magnifying glasses or hand lenses); a variety of objects to look at, including natural objects such as leaves, rocks, bugs, shells, and feathers
Safety: Caution against looking directly at the Sun or other bright lights.

Procedure

Getting Started

Put out a variety of magnifiers—one for each child, if possible. If you have a large magnifier, make that available as well. Put out a variety of interesting things for children to look at (see Materials, mentioned earlier). Let children try out their magnifiers. Watch what children do and listen to what they say before asking questions.

Questions to Guide Children

- What happens when you look through your magnifier?
- What can you see on the (object) that you couldn't see before?
- How does the magnifier help you see?
- What happens when you move the magnifier farther away from the (object)?

What Children and Adults Will Do

Children will want to look at everything through their magnifier, so be sure to have a large variety of objects available.

NGSS Connections and HSELOF Indicators

NGSS
PS4.B: Electromagnetic Radiation • Some materials allow light to pass through them, others allow only some light through, and others block all the light and create a dark shadow on any surface beyond them, where the light cannot reach. Mirrors can be used to redirect a light beam. (1-PS4-3) **Science and Engineering Practice: Planning and Carrying Out Investigations** • Make observations (firsthand or from media) and/or measurements to collect data that can be used to make comparisons.
HSELOF
P-SCI 1. Child observes and describes observable phenomena (objects, materials, organisms, and events). • Uses observational tools to extend the five senses, such as a magnifying glass, microscope, binoculars, or stethoscope. **P-SCI 2. Child engages in scientific talk.** • Uses scientific practice words or signs, such as observe, describe, compare, contrast, question, predict, experiment, reflect, cooperate, or measure.

What to Look For

Preparing	Child does not use magnifier; shows no interest.
Attempting	Child plays with or handles magnifier (not using it correctly); loses interest in activity and is not very curious or talkative.
Exploring	Child uses magnifier with adult's help and instruction; uses magnifier on some items and begins to respond to a few questions.
Connecting	Child uses magnifier correctly; looks at objects closely and eagerly responds to questions; independently uses magnifier at other times.

Encourage children to look at each object with and without the magnifier and to compare their observations.

Closure

Ask children why they think scientists use magnifiers and similar tools. During the discussion, help children to understand that scientists use magnifiers to help them look at an object carefully and to see small details they couldn't otherwise see.

Extending the Activity

Follow-Up Activity

On another day, do a "walk around" activity, either indoors or outdoors, with a magnifier for each child. Encourage children to look through the magnifier at objects they encounter. Remind children, "If you want to see it close up, look through your magnifier" and ask them, "What can you see now that you couldn't see before?"

Center Connection

Always keep magnifiers in your science center. Encourage children to use them in any part of the classroom or outdoors to help in their investigations. When children are interested in looking at something new, remind them that the magnifier is a tool that will help them to see the object more closely.

Literature Connection

What Is a Scientist? by Barbara Lehn, Millbrook Press, 1999
You Can Use a Magnifying Glass by Wiley Blevins, Children's Press, 2003
Ada Twist, Scientist by Andrea Beaty, Abrams Books, 2016

Family Science Connection

At home, see if family members have some kind of magnifying glass or lens. If not, many cell phones include a magnifier app. Find three objects to look at under the magnifier with your child, and encourage them to observe and describe the objects. Visit the library and search for books that include pictures of different objects magnified. With your child, compare the objects with the magnified pictures. How are they different? Do they look just like the real thing, but just enlarged?

Questions That May Add a Sense of Wonder to This Activity

- When you magnified the object, how did it look different?
- What can you see now that you could not see before? ●

BLICK ON FLICKS

A Trip to the Moon: *Apollo 11*

By Jacob Clark Blickenstaff

With the 50th anniversary of the Apollo 11 trip to the Moon upon us, this seemed to be a good time to watch the IMAX documentary *Apollo 11*, which arrived in theaters in March and is now available through various streaming services. The film consists almost entirely of footage taken during preparation for the mission and on the trip itself. It feels a bit like time traveling back to 1969, especially with the soundtrack of communications between Mission Control and the crew. Those audio recordings and the photographs of the crew as kids really help us connect with people who are now historical figures and may seem larger than life.

Since this documentary is about one of the most famous events of the 20th century, we don't have to worry about spoilers. All the same, the story of Armstrong's, Aldrin's, and Collins' four-day journey from the Earth to the Moon, the brief exploration of its surface, and the return is told here with drama and excitement. The countdown from 10 to zero is just the beginning.

After launch, but still far from the Moon, the lunar module has to separate from the command module, rotate, then re-connect. This is one of the scenes in which the filmmakers have included simple line animations to illustrate a step in the journey that could not be filmed. Touchdown on the Moon is a huge relief—for the astronauts, the controllers, and the viewers—because the *Eagle* was nearly out of fuel.

Finally, during re-entry to the Earth's atmosphere, there is a period when they are surrounded by very hot plasma, interrupting communications. Hearing Armstrong's voice again on the radio generates a huge cheer from Mission Control and might even do the same in your classroom. The film gives a good sense of the full eight-day mission from Earth to the Moon and back again. I suspect that students will be surprised at how long the trip actually took.

A physics class could do many calculations related to this film: figuring out the escape velocity from the Earth, calculating the acceleration of the Saturn V rocket during the first stage of the launch, or even verifying the difference in the astronauts' weight on the Moon compared to on Earth. The audio recordings used in the film provide some data about altitude, distance away from the launch site, and the rocket's speed shortly after launch. Unfortunately, they are all given in miles and feet per second, which are not units scientists use in 2019. The Wikipedia page on the Saturn V launches (*https://bit.ly/2WKP9Q2*) has a wealth of data that could be used for calculations.

This film is not just for physics teachers, though. Chemistry teachers could explore the reactions of the fuel systems (both solid and liquid fuels were used) or the air scrubbers that removed carbon dioxide from the crew spaces. Those scrubbers became a big issue during the infamous Apollo 13 mission, when the crew needed every tool at their disposal to return safely.

Biology and physiology teachers have several options to examine as well. Throughout the film, data on the astronauts' heart rates is reported by Mission Control. Heart rate was used as a measure of the crew's stress and exertion to monitor their physical health.

I found it interesting how different the three crew members' heart rates were at various moments. Armstrong was in charge of landing the *Eagle* on the Moon, and the landing was stressful because of the low fuel situation. His heart rate was much higher in that process than Aldrin's was, though both were certainly elevated. Another interesting biological moment occurred after their return to Earth. Since no one had ever been to the Moon, there was some concern about pathogens that could be brought back by the astronauts and contaminate the planet. To be sure they were not carrying a lunar virus, the astronauts were quarantined for 21 days after their return: They stayed in a portable trailer and communicated with the public and their families by telephone.

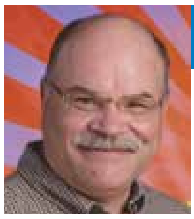
Students may wonder about the transitions between clear footage and the grainy television pictures as the movie progresses. It is probably worth noting that the high-quality images were made with film cameras, either still photographs or movies. In 1969, no high definition digital cameras existed, and color television was not even that widely adopted in the United States. The film from 1969 is really beautiful, though.

If I were to share this film with students, I would pair it with watching all or at least part of *Hidden Figures* (2016) to call students' attention to the underrepresentation of women and people of color in *Apollo 11*. Not only are all the astronauts white men, but also shots of the control room show dozens of white men all dressed in nearly identical shirts and ties. Even the crowds of spectators at the launch fail to represent the general population in the southeast United States. For more support for using *Hidden Figures* in your classroom, read my column at *https://bit.ly/2JPwRah*.

Finally, if you'd like an innovative way to explain the Saturn V rocket's anatomy, I highly recommend Randal Monroe's XKCD comic Up Goer Five at *https://xkcd.com/1133*. In it, Monroe labels and describes the rocket's parts using only the 1,000 most commonly used words in the English language. Since neither *Saturn* nor *rocket* are one of those common words, the vehicle is called "The Up Goer Five."

Teachers looking to mark the 50th anniversary of the *Apollo 11* mission should certainly check out the documentary and consider using it in class. ●

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.



ASK A MENTOR, **Advice Column**

Misconceptions, Management, and More

My kindergarten students believe that small objects are always light and big objects are always heavier. How can I address this misconception?

—L., Wyoming

Excellent question! This is a major misconception many *adults* have about density: the characteristic relationship between the mass and volume of materials.

I think the best way to tackle this is to have a hands-on activity. Buy or make identical-sized blocks, cylinders, or balls of different materials: plastic, wood, soap, iron, aluminum, plastic foam, plasticine, and so on. Although we are saying *size*, we are actually referring to *volume*.

Using the same series of materials, make shapes in larger sizes. The more sizes you can get, the better.

Have students hold the same-sized cube of iron and aluminum in their hands. They should observe a difference, albeit subjective. Use a double-pan balance or make a simple teeter-totter device to compare masses of objects objectively. Have them rank the different blocks from heaviest to lightest.

Can they balance a small, "heavy" object with a few "lighter" objects? At some point, the students should realize that many "light" things (or a single larger "light" item) can have the same weight (mass) as a smaller "heavy" object.

Now blow up a balloon! How does that compare to any of your other materials? It's bigger, but I bet it's lighter than almost everything else.

Hopefully this will lead to a better understanding of the *density* of different materials.

How do you maintain classroom management and control during active science lessons? I am curious about how to keep students under control when encouraging movement and active involvement in teaching.

— A., Texas

I have always liked an active class—provided the activity is focused on learning! Observing what is happening is important—so pick a spot in the room where the entire class is visible and set yourself up there. A corner is often the best. When helping someone, turn yourself to have as many students (or particularly sneaky ones) in front of you.

I think a key management strategy is having the class listen to you. Developing procedures to quiet the class is a good place to start. Use your teacher voice and be direct: "I need everyone back in their seats."

Don't talk over a class. Give one simple command, and wait until all students have complied. Insist that students put everything down and face you before talking. When needed, you may want to count to three out loud. Most students respond quickly to this—especially if you have been using it all year.

A last resort for a rambunctious class would be to look at the clock and write the time you asked them to settle down on the board. Remain quiet until the last student is seated and looking forward. Write down this time. Add the delay time to the end of the period (provided it didn't interfere with the next class or busing). You'll likely only need to do this once.

I am working on a lesson plan for the life cycle of a plant for kindergarten. Do you have any activity ideas?

— K., Oregon

SIMON GARBUTT

If you're teaching about life cycles of flowering plants, you should incorporate all the life stages.

Start by growing plants from seeds—particularly large, easily available seeds like peas or beans. I'm sure you're aware of the zip-top plastic bag and wet paper towel activity. (Soak the peas or beans overnight.) Students will see where plants come from, and you can discuss the different parts of an adult plant. Have students identify the same structures in the plants and trees they see on a nature walk.

Flowering plants create the next generation via their flowers. You can purchase inexpensive, fresh flowers and dissect the different parts. (Ask students and/or their parents about potential allergies.) Make sure to cut open the ovary, a harder, thicker section just below the petals. This contains tiny unfertilized ovules, waiting for pollen to develop into seeds. Use magnifiers to examine the ovules, and look closely at the other structures on the flowers.

Buy fresh pea pods, bean pods, and fruit. Open them to see the seeds. Where do the fruit and pods come from? Flowers! Photos of fruit trees in bloom or a nature walk during the blooming season will connect the two. You can have great discussions about the fruit we eat! Consider incorporating a talk about pollinators, particularly bees.

A search of NSTA's Learning Center (*https://learningcenter.nsta.org*) will give you ideas, lessons, and articles on this subject.

I was wondering how I could incorporate chemistry into my early elementary classes and what some good resources are to use.

— G., Montana

Chemistry activities for young children are some of the coolest and most engaging for students. Putting on goggles, using measuring utensils, and mixing substances are what most students think of when they hear the word *scientist*.

Elaborate equipment isn't required to teach chemistry. Stick with easy, inexpensive "bucket" or "kitchen" chemistry activities. Before you try any activity, practice it and follow all safety precautions. Insist students wear goggles—just like you are!

Demonstrations like elephant toothpaste are always a hit with students in all grades, but make sure to incorporate a lesson in the chemistry of what is happening. Ask students to observe carefully, attempt to explain what they see, and ask questions.

While demos are exciting, nothing beats hands-on activities. Slime or crystals are great. You can find many recipes that your students can experiment with. Inquiry activities like "What dissolves and what doesn't?" allow you to really give students a chance to follow their own paths, making observations all the way.

Search NSTA's Learning Center (*https://learningcenter.nsta.org*) and Freebies for Science Teachers web page (*https://bit.ly/2YrQ1qP*) for ideas, lessons, and activities.

The American Chemical Society has developed several free online and hands-on activities for elementary classrooms, including Adventures in Chemistry (*https://bit.ly/2eoKxcI*) and Science Activities for the Classroom (*https://bit.ly/2HPY8HM*).

And I particularly like the Janice VanCleave books for the multitudes of experiments! NSTA Recommends has reviews of several of her books at *www.nsta.org/recommends*.

Do you have any suggestions for using Chromebooks in middle school for more than just watching videos and reviewing material?

—A., Indiana

The real power of computer technology for a science classroom is in graphics, calculations, communication, interactivity, and creativity. Simulations (see *https://phet.colorado.edu*) allow you to augment lessons that would otherwise be impossible to perform in class. They differ from videos in that the students can actively participate by manipulating variables.

An excellent teaching tool is for students to script, record, and edit their own videos, which can take the form of mini-documentaries, animations, public service announcements, science shows, music videos, and so on. Many free video-editing options are available.

Communicate electronically or via print by creating presentations, wikis, blogs, brochures, posters, and comics. A very powerful way to learn something is to teach, so buddy up with students in a lower grade and have your students create picture books or graphic novels for them.

There are many citizen science initiatives in which your class can participate, and a wealth of online data that your class can download for their studies. You can access online telescopes and real-time webcams to bring astronomy, ecology, and biology right to your students' devices. You can make science investigations real and exciting by collaborating with classrooms almost anywhere in the world.

Chromebooks can also be used as scientific devices and data-loggers by attaching probes, digital microscopes, and cameras. ●

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

NSTA District Professional Learning Packages

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- **Making Sense of Three-Dimensional Teaching and Learning:** Give teachers a foundational understanding of the standards and shows them what three-dimensional instruction looks like in classrooms (modeled for each grade and discipline).
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- **Online Book Study and Discussion Forum:** This series of four web seminars combines asynchronous thought activities with discussions in private forums to give districts a flexible option for learning about three-dimensional instruction.
- **Or let us tailor a program for your needs.**

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

NSTA National Science Teachers Association

Mark Your Calendar

NSTA Dates to Remember

(All dates are deadlines unless otherwise specified.)

July 16—Register now to save on registration for the **Picture-Perfect Workshop in Anne Arundel County, Maryland**, August 6–7. Picture-Perfect authors Karen Ansberry and Emily Morgan will facilitate the workshop on using picture books to teach elementary STEM. Attendees also will receive *Even More Picture-Perfect Science Lessons; Picture-Perfect STEM Lessons, K–2;* and *Picture-Perfect STEM Lessons, 3–5.*

The workshop will take place at 9 a.m.–4 p.m. on both days at the Odenton Regional Library in Odenton. Early bird registration costs $449 for the basic workshop; with the train-the-trainer component and materials, the early bird price is $999. For more information or to register, visit *https://bit.ly/2zOlVTx*.

July 24—Celebrate the anniversary of the Apollo Moon landing and look to the future of space exploration during **NSTA Science Update: Apollo 11—50 Years Past and Future, a free web seminar.** The seminar will be held at 8–9 p.m. Eastern Time (ET). For more information on NSTA Web Seminars or to register, visit *http://bit.ly/2RGhr8N*.

July 24—The **Eighth Annual STEM Forum & Expo** hosted by NSTA runs today through July 26 in San Francisco, California. Conference strands focus on Lower Elementary/Early Childhood; Upper Elementary; Middle Level; High School; Building STEM Ecosystems: Community Partnerships; and Postsecondary. Registration costs $250 for NSTA members. For more information and to register, visit *www.nsta.org/stemforum*.

July 24—Don't miss the **Assessing Three-Dimensional Learning Workshop** in San Francisco, California. The workshop will be held at 8 a.m.–4 p.m. Learn how to leverage student artifacts as part of a formative assessment cycle using a student work analysis protocol as you employ science assessment tasks screening tools. Participants receive *The NSTA Quick-Reference Guide to the* NGSS, *K–12*. Registration for the workshop costs $275 for members; combined member registration for the workshop and STEM Forum costs $375. For more information or to register, visit *https://bit.ly/2I9wEwq*.

September 13—Take advantage of the **early bird deadline** and register now for the **NSTA Area Conference on Science Education in Salt Lake City, Utah**. The conference will be held October 24–26 at the Salt Palace Convention Center and features keynote speaker Mireya Mayor, primatologist and National Geographic Explorer. Early bird registration costs $195 for members of NSTA, Utah 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/saltlakecity*.

September 17—Discover how you can join **Leaders for Science Education: Preparing an Application for the NSTA Board and Council, a free NSTA Web Seminar**. Rene Corrales, a member of the NSTA Nominations Committee, will discuss the application process for the NSTA Board and Council and the important role members play in shaping the association. The seminar 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*.

September 17—Join the **Shifting to the *NGSS*: Professional Book Study for Secondary School Teachers,** a series of four live web seminars for teachers of grades 6–12. The book study supports educators interested in using the *Discover the* NGSS: *Primer and Unit Planner* enhanced e-book as they implement the *Next Generation Science Standards.* The program includes asynchronous discussions with other participants and with the web seminar presenters, Tricia Shelton and Jessica Holman. The remaining seminars will take place on September 24, and October 1 and 8. The seminars will be held at 7:15–8:45 p.m. ET. Registration costs $63 for NSTA members. For more information on NSTA Web Seminars or to register, visit *http://bit.ly/2RGhr8N*. ●

Celebrating 75 Years at NSTA

2008 NSTA's Learning Center debuted at the NSTA National Conference in Boston. It currently houses more than 12,000 resources.

#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*.

"Shell Science Lab Challenge Announces 2019 Grand-Prize Winner" (June 4, *NSTA Express*)

Congratulations to Betty Lewis, a science teacher at N.H. Pilate Middle School in Newton, Mississippi, who won the grand prize—a school science lab makeover support package valued at $20,000—in the 2019 Shell Science Lab Challenge. (Learn more about the awards at *www.nsta.org/shellsciencelab*.) Four national finalists also received a lab makeover package valued at $8,500. (*https://bit.ly/2K9R5M0*)

"How Arts-Based Lessons Improve Science Performance" (June, *The STEM Classroom,* Elementary and Middle Level versions)

Integrating the arts into science lessons helps the lowest-performing students retain more content, according to a recent study published in the journal *Trends in Neuroscience and Education*. (*https://bit.ly/2wQnNZW*)●

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Dive Into STEM at Forum & Expo

NSTA's Eighth Annual STEM Forum & Expo opens July 24 in San Francisco, California. Focused on science, technology, engineering, and mathematics (STEM), the forum offers professional learning opportunities and resources to formal and informal educators, with workshops and panel discussions aligned to six strands: lower elementary/early childhood, upper elementary, middle level, high school, postsecondary education, and community partnerships.

Keynote speaker Bernard Harris, a former astronaut and current CEO of the National Math + Science Initiative, will share his pursuit of his own goals of becoming an astronaut and doctor and his efforts to increase access to STEM education so other students can reach their greatest potential.

The program also contains a number of panel discussions, including The Power of STEM Education, featuring students who participated in the Army Education Outreach Program (AEOP); Connecting the STEM Pipeline From K to Career; English Language Learners in STEM Subjects; and Designing Inspiring, Resilient Settings for STEM/STEAM/STREAM. The Elementary STEM Showcase highlights resources targeted for elementary students. Attendees can visit the Exhibit Hall to learn about the latest resources from more than 80 vendors.

Taking place at Moscone Center West, the conference will run through July 26. Registration costs $250 for members of NSTA, American Association of Chemistry Teachers, American Association of Physics Teachers, American Institute of Architects, American Society for Engineering Education, International Technology and Engineering Educators Association, National Association of Biology Teachers, National Council of Teachers of Mathematics, and STEMx. Dominican University of California is offering graduate-level credit in professional development for an additional fee. For more information and to register, visit *www.nsta.org/stemforum*. ●