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NSTA Reports
National Science Teachers Association


CARRIE QUINNEY/BOISE STATE UNIVERSITY

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Off to the STEM Races

When students build race cars and compete in races, they can learn science, technology, engineering, and math (STEM) concepts, are more likely to retain what they learned, and have fun in the process, educators have found. Building and racing CO_2-powered dragsters—miniature race cars propelled by a carbon dioxide cartridge—"creates a lot of excitement and anticipation in students. When I tell students that [there] is going to be a competition, that sparks a lot of students to want to try and make the best car possible," says Matt Hall, a fifth-grade teacher at Manchester Middle School in Manchester, Michigan.

The project began two years ago when Amcor, a global supplier of plastic packaging that has a local office, gave the school a $2,500 grant to fund a science project. Hall and the other fifth-grade teachers "decided to do CO_2 cars. It lined up with what I was teaching in fifth-grade science, in a forces and motion unit," Hall explains. "When I was in high school, we built CO_2-powered dragsters, and it was a memorable project for me. I liked designing something and building it and seeing it in 3D."

The grant paid for "consumables, car parts, a starting gate and finish line with a sensor, equipment, and paint," Hall relates. The following year, another Amcor grant of "$800 or $900" funded paint and other consumables, he notes.

During the design phase, "we looked at car designs: what made cars faster and more aerodynamic," he reports. "There was a relationship between what we discussed and building the cars. It was force and motion principles in action." Before designing the cars, he says many students had trouble understanding the effects of mass on acceleration. Afterward, "I was very surprised to see some students who were special education or not the best academically come up with some interesting designs," he observes.


MID-AMERICA TRANSPORTATION CENTER

Building race cars made of food and powered by potential energy stored in a rubber band is one of the hands-on, inquiry-based activities in the Roads, Rails, and Race Cars after-school program, held in schools around Nebraska.

Next, Hall and co-teacher Cindy Karapas "set up different stations [for activities like] prototyping, cutting [car bodies from balsa wood], drilling, sanding, and painting," he explains. They ensured safety by having students wear eye protection and aprons to protect their clothes, roll up long sleeves, and tie back long hair. In addition, "I spent most of the time supervising [the cutting and drilling stations]," he asserts. Parent volunteers also staffed the stations to prevent injuries.

Students then raced their cars in the tournament. About 100 fifth graders participated in the race each year, Hall recalls. Excitement about the event has made students "more likely to talk about the project and the science," he contends.

"Some students do worry that if their car loses in the first round of racing, is that going to affect their grade? I tell [them] their grade on their car project is not dependent on how well they do in the race. They are graded on thoughtful design of their car, taking into consideration all that we have learned about forces and motion," he points out.

For 10 years, Kara Gelinas—grades 5–6 science teacher at Edgartown School in Edgartown, Massachusetts—has run annual solar car races for fifth and sixth graders at schools on Martha's Vineyard. Energy services organization

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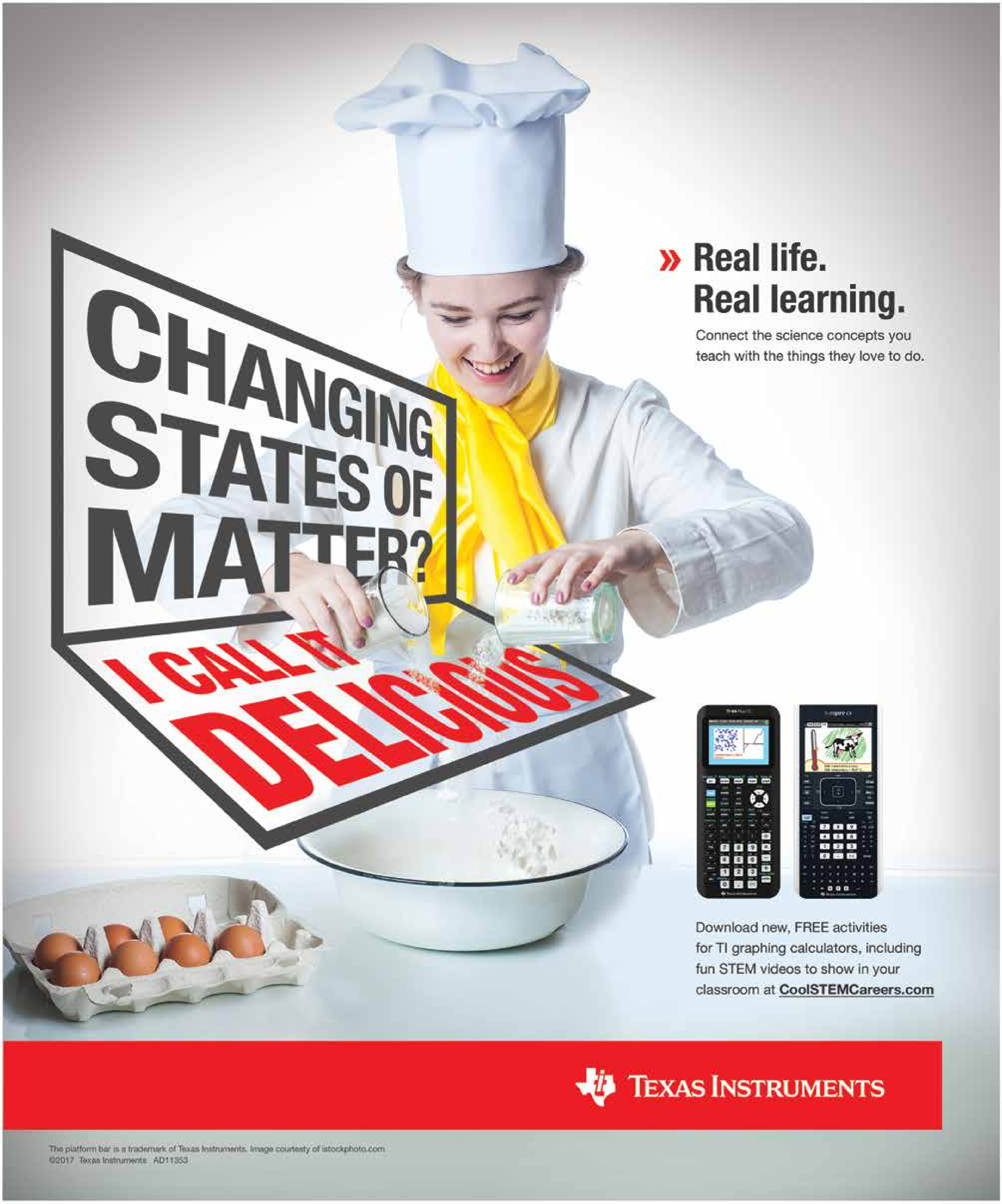
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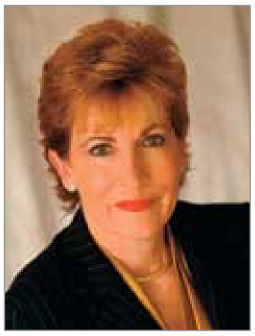
COMMENTARY: **Jo Anne Vasquez**

A STEM Approach to Transform Teacher Education

by Jo Anne Vasquez



Jo Anne Vasquez

True science, technology, engineering, and mathematics (STEM) integration across a school or district is harder to find than one would think. As a STEM education consultant, I am lucky to work with many innovative schools, teachers, and projects. Schools around the world are rushing to provide STEM education opportunities for their students and providing professional learning experiences for their teachers. STEM teaching and learning is no "flash in the pan" education movement. It is here to stay and having an immense impact on how all students are learning.

It is not surprising that STEM education has become recognized as a meta-discipline that integrates formerly separate subjects into a new and coherent field of study. As we learned from the 2007 National Science Board Report, *A National Action Plan for Addressing the Critical Needs of the U.S. Science, Technology, Engineering, and Mathematics Education System*, an effective 21st-century economy for our nation requires a constantly evolving mix of new and improved competencies with strong foundation in STEM that emphasize critical thinking, problem solving, collaboration, and creativity.

Knowing research supports multidisciplinary, interdisciplinary, and transdisciplinary STEM teaching, it begs the question: Why don't colleges and universities provide elementary teachers with the skills and knowledge needed to become effective STEM educators during their preservice education courses? Is this possible, and if so, how do they begin to implement this change?

The first step is to radically redesign elementary education teacher education programs. We must recognize that change is not always easy or swift, and it takes deliberate conviction to accomplish this reorganization from isolated classes and coursework. There is the faculty to enlist, a design team to organize, and K–6 school partners to recruit. There needs to be research on 21st-century schools and STEM practices, and interviews and surveys with principals, award-winning teacher leaders, current elementary education candidates, and graduates in the field. No simple task, and not one to be rushed into quickly. Planning, strategizing, and communication are required to bring about lasting change.

Moving toward an integrated STEM approach will help preservice elementary teachers recognize their science and math courses are not just a jumbled collection of random facts—if they are provided with an integrated sequence of courses that create opportunities to explore connections among all the STEM disciplines. How can we expect future teachers to implement STEM teaching and learning in their own elementary classrooms without giving them in their preservice courses the very experiences we want them to use?

One solution to the challenge of offering courses in a cross-curricular model as recommended by NSTA and the *Next Generation Science Standards* (*NGSS*) would be to completely redesign science and math courses into integrated blocks that include technology and engineering. The University of Indianapolis' School of Education will move in this direction in August 2018. According to Interim Dean Colleen Mulholland, the university designed an elementary education program with extensive collaboration among campus faculty, local K–6 partners, and national education consultants. She says the program "threads 21st-century skills (critical thinking, collaboration, communication, creativity) with a STEM focus; follows the K–6 calendar (August through May), providing rich immersion in 'clinical' settings, thus enabling candidates to compact 4 years into 3.5 years to graduate one semester early; commingles university content and pedagogy courses with field experiences synergistically, in every semester of the program; aligns with current K–6 Indiana Generalist and Developmental Standards along with [*NGSS*]; [and] aims to meet the increased demand for elementary teachers with strong content knowledge, most notably the demand for highly qualified elementary teachers in STEM."

(To learn more about UIndy's Elementary Education "Teach Today, Transform Tomorrow" STEM program, e-mail *education@uindy.edu*, or visit *https://goo.gl/cTfnVq*.)

If STEM education is to become a greater priority in our schools, we need to change the system preparing our teachers. Many of them will have had these types of experiences during their own education, but let's give them a clear path to developing the skills and knowledge to be successful STEM teachers. My hope is that universities and colleges everywhere will recognize it is time to make STEM education meaningful and relevant for all preservice teachers. ●

With thanks to Colleen Mulholland, John Somers, Stephen Spicklemire, Nancy Steffel, and Elizabeth Turner from the University of Indianapolis, School of Education.

Jo Anne Vasquez is a STEM education consultant, author, speaker, and professional learning provider. She is a past president of NSTA and was the first K–12 teacher educator to be appointed to the National Science Board.

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STEM Races, from pg 1

Cape Light Compact sponsors the races, providing materials and race day volunteers. The main challenge with this event is the weather: "We need the sun. If it rains, we have to hold the race in the gym with battery packs," Gelinas explains.

Teachers "realize how [the race] ties in with STEM and STEAM [STEM plus art] and meets standards. The push for STEAM is great because it's about figuring things out, not just doing activities," she maintains.

"Students have to use only one particular solar panel and motor, the cars have to have at least three wheels and carry an empty can, and they have to use the same track," Gelinas explains. When building them, students learn about energy transfer, gears, torque, electricity, engineering, and sustainable energy. "Students' choices of design have tangible results on the racetrack… The engineering design process—evaluating, sharing, and retooling—makes it really clear what is wrong with their cars. For example, lots of students gear [their cars] for speed, but don't have enough torque. They [learn that they] have to gear for torque for the car to work," Gelinas notes.

While some teachers don't count building the car as part of students' grades, Gelinas says she has a rubric for group work: "teamwork, collaboration, being careful with materials… Students also have classroom assessments of the content—solar panel operation, gear ratios, energy transfer, kinetic and potential energy, conservation of energy—and technology and engineering standards, including use of tools and materials."

She recruits 25 community volunteers to judge the race, which typically has about 200 student contestants. Students answer judges' questions about how their cars work, why they chose their design, and how they had to modify their design. Judges award prizes for design, technical merit, and knowledge.

"I don't grade the outcome of the [race] because some of the cars don't even move on the track. We run 12 heats, but some cars don't make every heat," she notes. Students learn "when they make mistakes, it's not a failure, not a crisis. It's just a mistake."

Building race cars from food and powering them with the potential energy stored in a rubber band is just one of the hands-on, inquiry-based activities in the Roads, Rails and Race Cars (RRRC) after-school program in Nebraska, which features a transportation-based curriculum for grades 4–12 and is funded by the U.S. Department of Transportation, State Farm Insurance, and Union Pacific Railroad Company. Students from groups historically underrepresented in STEM-related fields are especially encouraged to join a weekly RRRC club. "Our focus is on middle school,…[when] some students begin to lose interest in math and science," says Laurence Rilett, Keith W. Klaasmeyer Chair in Engineering and Technology at the University of Nebraska–Lincoln (UNL) and director of the Nebraska Transportation Center and the Mid-America Transportation Center (MATC). MATC has offered RRRC since 2010.

Professional and industry partners inform students about careers in engineering and transportation, while showing them "you need math and science to do these jobs," Rilett relates. University student mentors majoring in STEM subjects also lead activities related to transportation engineering. "[A]ny mentoring helps reinforce what students learn in class," he asserts.

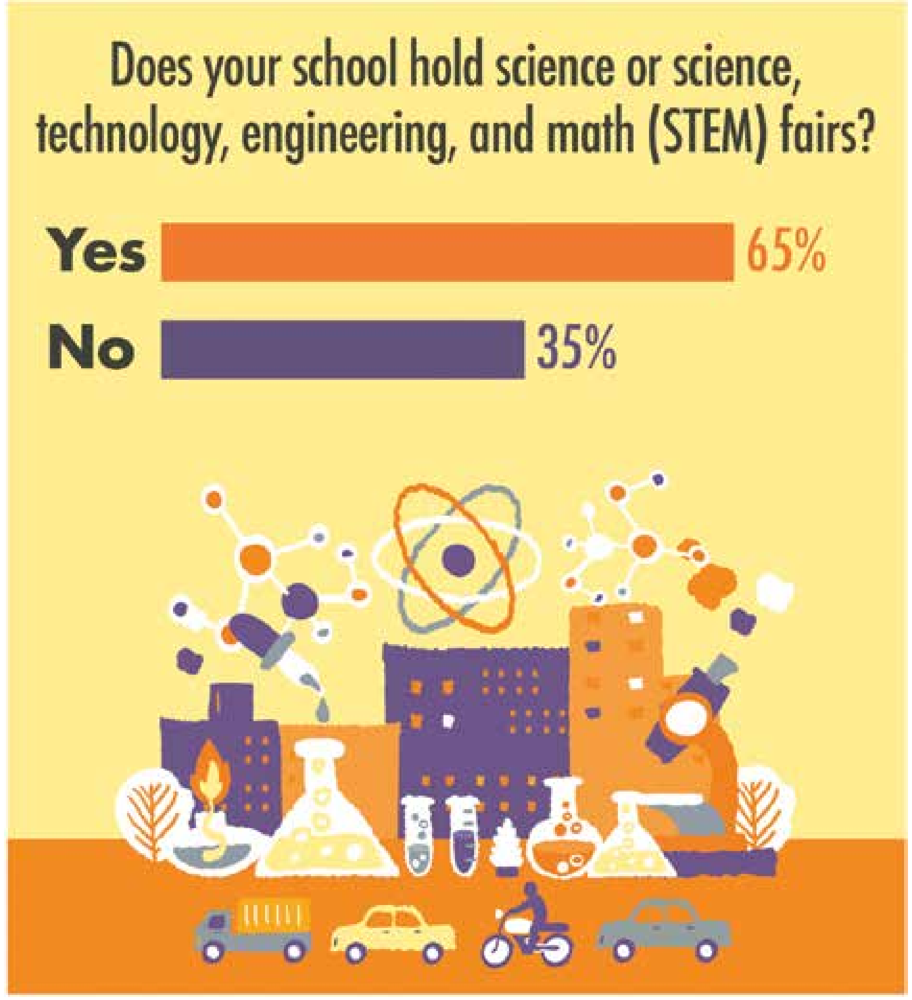
Building the cars teaches students about "friction, force, resistance, and gravity," Rilett explains, and they learn about impact and momentum in a lesson about what happens when race car drivers crash into a barrier. UNL engineers developed the Steel and Foam Energy Reduction Barrier system, which has saved drivers' lives, he notes.

For STEM lesson plans developed by teachers who attended RRRC's Summer Institute, see *http://goo.gl/gAECsW*. ●

Some Schools Replacing Science, STEM Fairs

In a recent informal *NSTA Reports* survey, 65% of science educators say their schools continue to hold science or science, technology, engineering, and math (STEM) fairs. However, 36% say science/STEM fairs are being replaced by different STEM-related events, including STEM competitions (42%), family STEM nights (21%), or other events (25%). More than two-thirds (68%) report the *Next Generation Science Standards* has not affected expectations of students' projects. Those reporting an impact say the changes include "more student-led activities" and "more creative, local problem-driven projects [are] encouraged."

Nearly three-quarters (71%) report that science fair participation is required at certain grade levels. Only 12% say they and their students participate in online science fairs.



Some of the resources science educators say they use to prepare students for the science fair are these:

Anything that they would need for the experience.—*Educator, Elementary, Middle School, Alabama*

We have a dedicate[d] class at our high school for students enrolling in science fair.—*Educator, High School, Florida*

My fourth-grade students use the Kid's Inquiry Conference style of science fair. My students begin in January and work on their projects once a week for 14 weeks and present to local college professors and/or former science teachers one-on-one. They defend their ideas in a closed room presentation, talking to the judges and sharing their ideas to modify their project outcome as needed.—*Educator, Elementary, Texas*

Research help, set up mentorships, practice presentations.—*Educator, Middle School, Ontario*

Science lab teacher at our school, interact[ive] science fair simulation, and science fair night for parents and students to learn expectations and see examples of projects.—*Educator, Elementary, Florida*

We devote three weeks of class time to conduct the physical project and prepare the displays. This year, their core teachers will help edit the writing component. Eventually we would like to include their math class for working on displaying data.—*Educator, Middle School, California*

The Science and Engineering Fair is optional. We hold before/after-school extra help from science teachers and PTA mentors...The [Science and Engineering] Fair is very popular with sixth graders, but participation dwindles in seventh and eighth [grades].—*Educator, Middle School, Connecticut*

We help students with the writing in class, with managing the project, and often with materials that we loan or can arrange to borrow.—*Educator, High School, New Mexico*

We use [S]cience [B]uddies, science fair books, and other online resources. —*Educator, Middle School, Iowa*

Students in my classes are required to complete a one-semester original research project even if they do not present it at the science fair. A lot of them [use projects from] Science Buddies, but they must adapt the project listed.—*Educator, High School, Indiana*

University of Wyoming; natural resource agencies; professional science sites; doctors; veterinarians.—*Educator, Middle School, Wyoming*

Parents/scientists in the community, if we can get them. Google Classroom to collect all written information and data, so it doesn't get "lost." NoodleTools is available to keep track of research, prepare an outline of written material, and to evaluate research sources. This year, we are switching from a traditional Science Fair format to a STEM fair with varied presentation modes. Don't know how that will be different, but it is in the works.—*Educator, Middle School, Virginia*

We get them to think about what interests them and then scaffold up from "genius hour" on Fridays to researching science discovery projects. We don't call ours a science fair, but rather a night of science demonstrations. They must demonstrate original knowledge and not repeat a... science fair project from the internet. —*Educator, High School, Ohio*

A good outline of steps and a timeline.—*Educator, Elementary, Alabama*

Most of our guidance materials come from the county. Our fair winners move on to compete at the county level, so we have all our students organize their projects such that they're ready to move on to the county level if they win at the school level.—*Educator, High School, Informal Education Setting, Pennsylvania*

Books, online ideas, several meetings with teachers and science fair participants to answer questions.—*Educator, Elementary, Minnesota*

DVSF.org [Delaware Valley Science Fairs website], [S]cience [B]uddies. —*Educator, High School, New Jersey*

Everything: Guidance, supplies, time, space.—*Educator, Middle School, California*

I confer with [students] to help them choose a question to investigate, and check back in to be sure they are making progress and have solid data. Also, in years past, they could do work at home; I now require it as class projects.—*Educator, Elementary, Washington*

Local scientists serve as mentors and judges. Teachers [also] mentor students. Students research project ideas and do literature searches online. —*Administrator, Middle School, High School, Massachusetts*

Student guide packets that include guides for each category, as well as general templates.—*Educator, High School, California*

Students' and research competitions' handbooks.—*Educator, Middle School, High School, Oregon*

Students have access to computers for research, are given the boards, and are taught how to do an experiment. —*Educator, Elementary, California*

We created a handbook and have classroom examples to share. Students use Science Buddies, Science Spot, and our school's [web]site of suggested topics for ideas.—*Educator, Middle School, Florida* ●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Taking STEM Home in a Backpack

Educators are filling backpacks with materials and resources for exploring science, technology, engineering, and math (STEM) and loaning them to students and their families. Backpacks for Science Learning—a partnership among University of Washington (UW) Bothell's OpenSTEM Research Collaborative, UW College of Education's Institute for Science + Math Education, Pacific Science Center, the Seattle Public Library, and organizations serving Native American youth—received a $2.4 million, three-year National Science Foundation grant last year to hold workshops and create STEM-related backpacks targeted to families who are underrepresented in STEM, says UW Bothell Associate Professor Carrie Tzou, principal investigator and director of OpenSTEM Research Collaborative.

The backpacks contain resources for engaging with robotics—robotics kit components such as motors and lights, a laptop computer, and a WiFi hotspot—and books with diverse representations of families, such as *Thunder Boy Jr.* by Sherman Alexie, about a boy who is named after his dad but wants his own unique name. Before taking the backpack home, families attend Tech Tales, workshops held at libraries and community facilities that engage families in engineering education and give them "challenges about things to build and program based on the story," Tzou explains. For example, after reading *Thunder Boy Jr.*, a family could "build a robot that says, 'I hate my name,'" which is a refrain in the book, she notes.

"We have the potential to decentralize informal education [by spreading it into] libraries and communities," Tzou contends. The project offers "meaningful professional development for librarians and community educators who may not have seen themselves as

CARRIE QUINNEY/BOISE STATE UNIVERSITY

Students at Garfield Elementary School in Boise, Idaho, can take home backpacks filled with supplies to do STEM activities with their families.

STEM educators" and who must learn how "to work with multi-age groups."

With funding from the NASA Idaho Space Grant Consortium, Julianne Wenner, assistant education professor at Boise State University in Boise, Idaho, and colleagues Sarah Anderson, lecturer at Boise State, and Soñia Galaviz, fifth-grade teacher at Boise's Garfield Elementary School, "created a 'library' of three different backpack activities for each grade level (K–6), for a total of 21 different activities," says Wenner. "We asked ourselves, 'What can we do to sustain STEM all year and include families?' We wanted students to work with data [in activities that support] *NGSS* [*Next Generation Science Standards*] and make the scientific explanation accessible to families." She adds that Garfield Elementary has many students from families who are underserved and could benefit from the backpacks' supplies and activities.

"We provided pictures of all the supplies so [teachers] know what needs to be returned to school," Wenner notes. In addition, the principal requires parents to sign permission slips "so students would be safe and things would be returned," she reports.

"We tried to have authentic activities involving recording data and/or [following] the engineering design cycle," observes Wenner. Family activities range from making bubble wands and blowing bubbles at the kindergarten level to creating a terrarium and growing plants at the fifth-grade level.

In surveys, "we ask the parents [questions such as], 'Did you enjoy it? How much time did it take?' and [want the] students to tell what they did," explains Wenner. "Parents are spending about a half-hour on STEM…Sixty to 70% respond, 'My child learned something new.'"

While Seattle-area and Garfield Elementary students aren't required to use Tzou's and Wenner's backpacks, fifth graders at Westwood Elementary School in Greenwood, Indiana, take home materials for science experiments every other week as part of the Science in a Bag program. "We wanted to squeeze in more science and get families involved," explains fifth-grade teacher Teresa Gross. "In fifth grade, science is not tested; it's tested in grade four. So we try to get science into English language arts," for example.

With $500 in initial funding in 2010 from an Eli Lilly Teacher Creativity Fellowship Grant, the fifth-grade teachers created "30 experiments that cover Indiana science standards," says Gross, and each class has a set of 30 bags. Activities include bouncing balls of different sizes and composed of different materials to see how high they bounce "and using a balance scale to find their mass," she relates. Slingshot cars teach students about Newton's Second Law, and rocket balloons enlighten them about Newton's Third Law.

"We encourage parents to supervise" the activities, but students without parental support can do their experiments with a teacher during recess, she points out.

The bags contain simple equipment with no sharp objects or flame involved. "Some bags may only have a lab sheet," says Gross. "Some labs take 15 minutes to do; others, [like the water cycle lab], take one week," she contends. For all activities, "students have to give supporting evidence from the data they collected about how they got their conclusion.

"Each lab has a 'Science Behind' [page] that explains the science, with questions that lead back to the scientific basis of the experiment," she emphasizes. Teachers track students' results to make sure they understand the concepts. "Sometimes we re-do the activities if lots of students didn't get [the concept]," she adds.

Exploring Outdoors

"I do a program that provides books and backpacks to all of the first graders in Darke County, Ohio. The L.I.G.H.T Project has grown from 85 [students during the first year] to [more than] 600…[three years later]. Even better, I am now receiving funding from Matt Light of the Light Foundation (not a connection to [my] original project). He is a former [National Football League] player…with the New England Patriots," says Angela McMurry, K–12 science curriculum specialist with the Darke County, Ohio, Educational Service Center.

Though the Darke County schools are located in agricultural areas, "the students aren't spending much time outside simply playing," McMurry observes. Inspired by Richard Louv's book *Last Child in the Woods* and encouraged by Matt Light's belief that youth should have opportunities to explore nature, she says she created the L.I.G.H.T Project to provide students with "activities that fit these rural communities and give [them] things to do outside with their families."

The backpacks contain tools like hand lenses, specimen jars, forceps, a ruler, and plastic bags for collecting leaves, water, and insects. They feature "state-aligned science and math activities" that can be done for "10 to 15 minutes outside," McMurry explains. The backpacks correlate with 72 nature- and science-related books children can check out. Journal writing and drawing what they observe are key elements of the activities, she notes.

Students earn prizes for reading the books, doing activities, and writing in their journals. The top prize, "if they read 50 books and do their journal and activities," is "an overnight at Matt's property, Chenoweth Trails" in Greenville, Ohio, where they and a parent can have outdoor adventures such as learning to fish, McMurry relates.

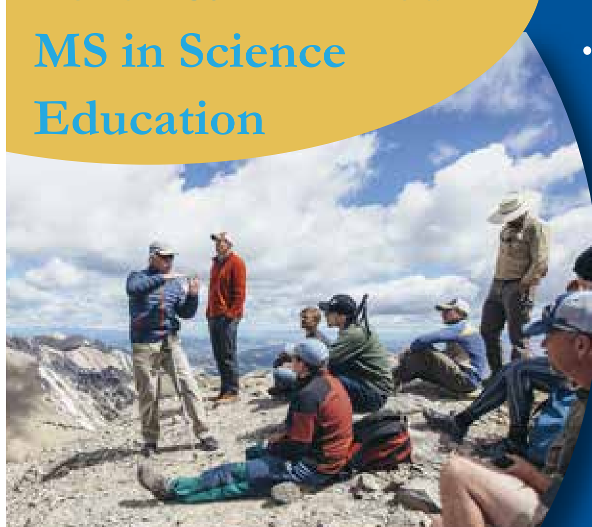
Most students average 10 books a year. "One teacher said her participating students collectively wrote [more than] 600 journal entries beyond the writing they do in class," McMurry reports.

Keeping It Safe

"With [doing STEM activities outside school] comes the responsibility for parental/guardian supervision," says Ken Roy, NSTA's Chief Science Safety Compliance Adviser. Classroom teachers expect "parents/guardians [to] supervise and take part in these learning activities. No matter how simple or harmless an activity may seem, accidents can happen. [Parents should a]lways help [their] child follow the teacher's instructions for each activity," he maintains.

Before having students explore outdoors, teachers should "visit the site without the students first, to check for any hazards," Roy urges. Teachers should inform parents "in writing in case there are medical issues [and] check with the school nurse for potential student health issues. Don't forget [a] means of communications, like a cell phone," he advises.

"Students should use appropriate personal protective equipment, including safety glasses or goggles, gloves, close-toed shoes, hat, long-sleeved shirt, pants, sunglasses, and sunscreen. [Teachers should] use caution relative to poisonous plants like poison ivy, and animals, especially ticks and mosquitoes, which can carry diseases. Watch for litter, broken glass, wood splinters, and tripping hazards when walking. Lastly, have students wash hands with soap and water after returning from the field," he recommends. ●



PULL-OUT SECTION

SCIENCE TEACHERS' GRAB BAG

Freebies for Science Teachers

CalAcademy's Science Video Vault. **K12** Engaging topics highlighted in these video resources from the California Academy of Sciences include *How Hummingbirds Hover, Why Protect Pollinators, Photosynthesis Seen From Space, Live Penguin Webcams,* and *The Living Soil Beneath Our Feet.* The vault at *http://goo.gl/8aA1NS* contains hundreds of short videos and data visualizations drawn from CalAcademy programs, such as Flipside Science, Habitat Earth, and Biodiversity Course. The videos explore topics in Earth, Energy, Ecosystems, Engineering, Human Impacts, Ocean, Space, and Weather and Climate, with content available for use with every grade level, K–12. The website also presents ideas for using the videos in the classroom.

What Can an Entomologist Do for You? **M H** An infographic produced by the Entomological Society of America highlights some of the many roles of insect scientists and their impact on our daily lives. Career opportunities range from working with farmers to reduce pest impact on the food supply to researching insect behaviors that help conserve our forests. Share the infographic as an introductory resource in middle and high school classrooms. Consult *http://goo.gl/AvR92K.*

Exploring* NGSS *in the Classroom: Red-Winged Blackbird Unit Overview. **E** In this video, teachers Alice Severson and Dom Lark teach the three dimensions from the *Next Generation Science Standards* (*NGSS*) to their elementary students. They engage students in a problem-based learning unit, using driving question and final artifact to explore competition for resources and how traits influence the social behavior of the red-winged blackbird. This video presents an overview of the unit; subsequent videos spotlight the progress of three individual students, and the series concludes with the teachers discussing and demonstrating how the unit influenced their ideas about teaching.

This video is first of five that introduce elementary science educators to important strategies based on the *Framework for K–12 Science Education* and the *NGSS.* NSTA led the project with funding from Disney. Watch the video at *http://goo.gl/MiaQ5p.* Learn more about the *NGSS* at this website: *http://ngss.nsta.org.*

MAGNUS MANSKE

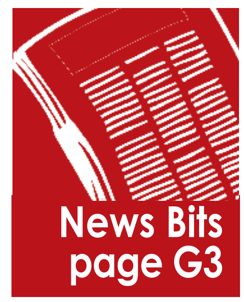
Principles of Curiosity. **H** Produced by science writer Brian Dunning and Skeptoid Media, a nonprofit science, technology, engineering, and math (STEM) media producer, this short film and lesson guide can be used to teach high school students the fundamentals of critical thinking, deductive reasoning, and scientific skepticism. The guide provides both pre- and post-viewing activities to develop a deeper understanding of critical thinking, the 3Cs Method of information evaluation (Challenge, Consider, and Conclude), and the "Red Flags of Pseudoscience." A hands-on activity, DIY Spirit Orbs, lets students discover for themselves how something seemingly extraordinary can be the result of completely ordinary factors. See *http://principlesofcuriosity.com.*

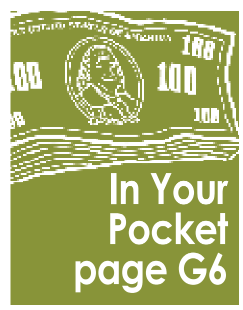
Lessons With LEGOs. **P E M** At *http://goo.gl/sLXaWG,* preK–8 teachers will find lesson plans for using LEGO bricks and other LEGO Education materials or products. Created by teachers, the lessons foster curiosity, engagement, and collaboration and address topics in engineering, coding, computer science, creative exploration, and Maker learning. Selected highlights from the elementary lessons include Jeesun and Jayden Need to Work It Out (grades preK–K), which helps students learn to work cooperatively and resolve conflicts; Spinning Tops (grades 1–2), which examines the effects of balanced and unbalanced forces on an object's movement; and Robust Structures (grades 3–5), which uses an earthquake simulator constructed from LEGO bricks to explore characteristics affecting a building's resistance to an earthquake. Make a Digital Accessory (grades 6–8) engages learners in the engineering design process as they design, build, and test a digital accessory for a mobile device made from LEGO bricks that solves a real-world problem.

LEGO Education Academy for Teachers. **P E M** Don't let students have all the fun and learning with LEGOs! Microsoft's Educator Community at *http://goo.gl/48ngLT* offers self-paced courses to help teachers make the most of

See Freebies, pg G2

Inside this Convenient Pull-Out Section you will find:





Freebies, from pg G1

LEGO Education tools and enhance student experience and the tools' learning effectiveness. Teachers can, for example, access a three-part course on LEGO MINDSTORMS covering everything they need to know about the tool, from a general overview (Getting Started) to exercises and practice working with different programming bricks (Programming) and successfully integrating LEGO MINDSTORMS into existing STEM curriculum and daily lessons (In The Classroom).

Learningscience.org. **K12** Imagine a website brimming with high-quality science interactives and other resources designed to involve K–12 audiences in learning science. Learningscience.org has links to interactive lesson plans, data sources, image galleries, and more, grouped by discipline (e.g., science inquiry; physical, life, Earth and space; science and technology; science and society; and history and nature of science) and national science learning standards for grades K–4 and 5–12. You'll also find links for Tools to Do Science (e.g., graph papers, rulers, timers), Google Resources (e.g., Google Earth, Google Sky, Google Gadgets, and others), YouTube Science Channels, and citizen science opportunities. Visit *www.learningscience.org.*

Color Me Physics. **E M** Introduce students to physics and some of its most famous characters with this activity book from the American Physical Society. Targeted for grades 3–8, the book includes coloring pages and short descriptions of pioneering physicists such as Copernicus, Galileo, Newton, Franklin, Bouchet, Curie, Einstein, Fermi, Goeppert-Mayer, and Feynman. You can download the book by individual page or in its entirety, and it includes links to additional information about each scientist. See the website *http://goo.gl/eCY8yH.*

Celestia. **M H HE** This space simulation software lets users explore the universe in three dimensions. Targeted for middle and high school learners and students in introductory college astronomy courses, Celestia allows

NASA

users to move throughout the solar system to more than 100,000 stars, or even beyond the galaxy. Controls enable users to orbit stars, planets, moons, and other space objects; track space objects such as spacecraft, asteroids, and comets; and pass through nebulae and irregular, elliptical, and spiral galaxies.

The program runs on Windows, Mac OS X, and Linux platforms. See the website *http://celestiaproject.net* to learn more and download Celestia; click on Related Sites for ideas for using it in the classroom.

Owlcomics.com. **E M H** Engage students in grades 5–12 in learning science through comics. Helpful for English language learners and struggling readers, the comics present topics in cell biology, ecology, genetics, anatomy, evolution, health, and environmental sciences in an easy-to-digest format. Each comic begins with a simple summary statement and includes the *NGSS* that the content supports. Use the comics as a fun hook when class begins, incorporate them as visual aids in a topic lecture, or share them to help students prepare to read a more complex science passage. Visit *http://goo.gl/8bKS9g.*

What Engineering Looks Like: Preschool to Middle Level. **P E M** A well-designed engineering curriculum includes eight distinct design elements that support effective learning, says the Engineering is Elementary (EiE) Project, an initiative developed by the Museum of Science Boston to study how children learn engineering. The table at *http://goo.gl/7i9Akv* presents learning trajectories for each design element, showing teachers how engineering can be implemented in preschool, elementary, and middle level classrooms, including specifics about what the implementation looks like at each age level.

Clickteam Fusion Science Simulation Tutorials. **H** High school educators can use Multimedia Science's Clickteam Fusion to create software applications, including simulations and games. At *http://goo.gl/UeuEih,* chemistry teachers can access tutorials to create a Molecular Simulator and a game about elements, Element Shootout. Tutorials for physics teachers demonstrate how to create motion simulations featuring a road and spacecraft, as well as circular motion simulations with a ball moving in a circle and a ball moving alongside it. Each tutorial runs about 30 minutes and includes examples of finished software designed for teaching high school chemistry or physics using the tool.

Science With Engineering Education (SEEd) Storylines. **K12** These storylines give relevance to classroom science activities by setting them in a narrative that drives the understanding of a big idea. The storyline format moves lessons away from the traditional teaching method of going from topic to topic like a textbook does, instead moving the student through an inquiry-based narrative with a set outcome. Developed by the Utah Science Curriculum Consortium, the SEEd standards are the basis for the unpacking and building of the storyline format. The SEEd standards—available for grades 6–8—are built upon the *NGSS'* three-dimensional science practices, crosscutting concepts, and disciplinary core ideas. K–12 teachers interested in learning more about the storyline format and designing a coherent *NGSS*-supported storyline can find information and guidance at *http://goo.gl/jYDQnM.*

Visualizing and Understanding the Science of Climate Change. **H** Targeted for high school chemistry educators and instructors of introductory college science courses, this set of peer-reviewed, interactive, web-based materials explores the underlying science of climate change. Filled with interactive features such as embedded vocabulary definitions, clickable learning tools, and visualizations/animations of various Earth processes, the set contains nine lessons focused on the fundamental chemistry involved in processes affecting Earth's radiation balance and climate. Titles include Introduction to Earth's Climate; Heating It Up: The Chemistry of the Greenhouse Effect; Climate: A Balancing Act; A Global Issue: The Impacts of Climate Change; Greenhouse Gases: A Closer Look; Climate Feedback Loops; Climate Change and the Ocean; What Now? Responding to Climate Change; and Is Climate Change Happening? Each lesson has a "Test Your Knowledge" section with comprehension questions that reiterate key ideas. Refer to *http://goo.gl/pQtsih.*

NOAA PHOTO LIBRARY

This Is What STEM Looks Like! **P E M H HE** This guidebook presents strategies and tools for families and educators to inspire, motivate, and prepare girls ages 5–19 (grades preK to college) to succeed in STEM fields. The resource includes an overview of the status of girls and women in STEM, definitions of STEM-related terms, and a call to action. Subsequent chapters offer strategies for motivating girls of specific age groups, as well as benchmarks to strive for in each stage of girls' lives to prepare them for future STEM opportunities. Consult *http://goo.gl/wspCQU.*

Electric Erin vs. The Steel Stalker. **E M** Learn about electrons and positive and negative charges in this text-based adventure game from Readorium.com. Written for grades 5–8, the clickable interactive follows the adventures of Electric Erin, a middle-school superhero with the power to move electrons, as she discovers how to defeat the villain Steel Stalker by learning about electric currents and magnetic fields. Play it at *http://goo.gl/Zi1GKp.* ●

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

News Bits

- **Science, technology, engineering, and math (STEM) education should be rebranded to excite students and address a nationwide talent shortage, says a study.** M H

Randstad US surveyed 1,000 students, ages 11–17, to uncover key motivations, beliefs, and perspectives about STEM topics. The researchers found interest in STEM studies and confidence in STEM skills fades as students grow older.

The findings revealed most students didn't associate STEM with mainstream brands, haven't asked anyone about STEM jobs, and agreed that if they knew how STEM skills relate to real jobs, they'd find courses more interesting. In addition, students aren't familiar with many STEM jobs, and a major gender gap in STEM subjects still exists.

Alan Stukalsky, chief digital officer for Randstad North America, says an awareness campaign is needed. "Young people are self-selecting out of higher STEM education classes because they can't see how these skills apply to different professions and employers they're excited about. It's…a serious economic problem…." Read more at *http://goo.gl/kwx2ti*.

- **In Missouri, one middle school will separate science and math classes by gender.** M

Northeast Middle School in St. Louis, Missouri, will try separate math and science classes for sixth graders. The curriculum and standards will remain the same. Principal Jennifer Sebold says the separation is not mandatory: Parents may still keep their children in combined environments. "We felt like giving separate space for boys and girls allows them to really explore their brilliance and figure out who they are as a learner and build confidence," she explains.

Middle school math teacher Greg Herndon says one reason for the change is to address children's negative mindsets about math, which are "…consistent across boys and girls. But I think I see it more in girls. Just the belief that they're not math people or…that their parents weren't, so they may not be."

Tricia Frank hopes male-only classes will boost her son's confidence. "He doesn't consider himself a math guy. He's timid…So I think this will help him feel comfortable in answering questions," she contends. Read more at *http://goo.gl/f2KEXd*.

- **A Tennessee school district believes health science electives in middle schools will encourage interest in health care careers.** M H

After a pilot program, Bradley County Schools' Board of Education is voting on whether to expand its health science program—already offered in high schools—to middle schools. If approved, the introductory courses would begin in the 2018–2019 school year, starting with seventh graders. Students would continue taking classes in eighth grade, and would progress directly into high school programs.

Arlette Robinson, the school system's Career and Technical Education coordinator, says the courses fill a need for more career exploration in middle school. "We are excited to begin, so the students can begin to discover their passions."

Taught by science educators, the high school health science courses allow students to specialize in areas such as emergency medicine, sports medicine, and long-term health care. Middle school classes would introduce students to topics like anatomy, physiology, and first aid. See *http://goo.gl/sdiUvN*. ●

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

What's New

FROM U.S. GOVERNMENT SOURCES

U.S. Department of Energy (DOE)

Women in STEM 2017 Coloring Book E M H

Celebrate the lives and accomplishments of five women who overcame significant racial and gender-based discrimination to carve a path in science, technology, engineering, and math (STEM) fields largely closed to women: civil engineering (Nora Stanton Blatch Barney), genetics (Barbara McClintock), biochemistry (Ruby Hirose), invention (Hedy Lamarr), and mathematics (Evelyn Boyd Granville). Visit *http://goo.gl/hC61Du* for Five Fast Facts (blog posts) about each woman, then print out their pictures for students to color. Share the resource with students in grades 5–12 to inspire them to persevere in STEM.

National Park Service (NPS)

Junior Ranger Resources E M

The NPS Junior Ranger programs invite students ages 5–12 to become Park Service ambassadors. After visiting a national park and completing activities in a Junior Ranger Activity booklet (and submitting the finished booklet to the Ranger at a local national park), prospective Junior Rangers take a pledge to care for national parks. As a Junior Ranger, students participate in park stewardship by respecting rules, helping wildlife, learning park history, keeping parks clean, and telling others about national parks.

For example, students can become Junior Rangers by completing activities in the book *Junior Cave Scientist* (*http://goo.gl/xAhRrj*) or the book *All About Bats!* (*http://goo.gl/4jURVA*). In addition, the Junior Ranger radio program features fun songs highlighting plants and animals found in the parks (e.g., elks) and why it's great to explore, learn, and protect national parks. Listen to these songs at the website *http://goo.gl/PzMMiu*.

U.S. Geological Survey (USGS)

The Story of Water in Dryville E

The Story of Water in Dryville helps upper-elementary students understand the critical role of water in the development of a new town. The story takes students to the desert to start a new town and shows them how water plays a part every step of the way, from finding an initial water source to getting water to homes, creating a system for wastewater, and meeting additional needs as the town grows. The website (*http://goo.gl/dbqfuC*) has links to vocabulary terms used in the story (e.g., water table, reservoir, aqueduct, runoff, storm drains, flood plain) and a script version of the story, which can be used for a class play.

A Journey With H2O Activity Book E

This simply illustrated coloring book teaches elementary students where water comes from, what happens to it when it goes down the drain, and how it returns. Download *A Journey With H2O* at *http://goo.gl/UtYZ44*.

National Oceanic and Atmospheric Administration (NOAA)

Creature Feature Videos E M

NOAA's National Marine Sanctuaries are living classrooms that students can explore through interactive digital labs and activities. In the Creature Feature videos, students can learn about marine animals living in the national marine sanctuary system, including humpback whales, seals and sea lions, green sea turtles, moray eels, dolphins, birds, and octopuses. Most appropriate for grades 3–8, each short video shows the animal in its natural habitat and provides facts about its behaviors. Watch the videos at *http://goo.gl/eoztK2*.

Earth Is Blue K12

This social media awareness campaign highlights the diversity of species found in NOAA's National Marine Sanctuary system and its 14 marine-protected areas nationwide. Through daily photos and weekly videos, K–12 teachers and students can see the beauty of the animals that call these habitats home and the work NOAA does to protect them. Spiny lobsters, masked boobies, leatherback turtles, Atlantic sea nettles, and California brown pelicans are just some of the many images at the website *http://goo.gl/LVhWtf.* Each image includes an informative caption about the animal or place depicted.

Games@NOAA E M

You'll find more than 20 games and interactive activities focused on ocean and air themes at the NOAA website *http://games.noaa.gov*. The games were developed for K–8 audiences by NOAA and other agencies and organizations promoting environmental stewardship. Choose from games such as Ocean Challenge Puzzle, in which students answer questions about ocean literacy to reveal puzzle tiles to complete a picture; Trash Smash, in which students learn to correctly dispose of marine debris and help clean up the environment; and Mix and Match, in which students create their own weird-looking animals as they study the creatures living in the Chesapeake Bay.

U.S. Environmental Protection Agency (EPA)

Basic Ozone Layer Science H

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

Conduct a Chemical Survey Activity E M

In this activity, students in grades 5–8 conduct a simple survey of household chemicals and cleaners used in and around their home. With parental permission, students look for chemicals in the home and answer questions about how many and what kinds of chemicals they found. Students also brainstorm ideas about how chemical safety can prevent pollution at home. Available at *http://goo.gl/v7v5h3*, the lesson plan includes teacher background information, activity procedures and wrap-up, assessment, extension ideas, and student handouts.

National Aeronautics and Space Administration (NASA)

NASA Knows! For Students 5–8 E M

Do you or your students have a space science topic you're eager to learn about? Visit the NASA Knows website (*http://goo.gl/DzFHcC*) to learn about topics such as rockets and space vehicles, astronauts, the International Space Station, technology, and NASA history. Each broad topic contains four or five articles, and each article includes NASA links for more information and a "Words to Know" section. The Astronauts collection, for

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example, features profiles of space pioneers such as Alan Shepard, John Glenn, Neil Armstrong, and Sally Ride, as well as articles on what astronauts do on a spacewalk and how a spacesuit protects an astronaut in space.

NASA Knows! For Students K–4 E
NASA has the answers to your elementary students' questions about airplanes, astronauts, rockets, planets, and other popular space topics. For example, click on NASA Knows: The Solar System and Beyond to access age-appropriate informational articles on Mercury, Mars, The Rings of Saturn, eclipses, black holes, and "space junk." Also included are images and phonetic pronunciations of challenging vocabulary words. Visit the website *http://goo.gl/CKKq8Y.*

U.S. Drug Enforcement Administration (DEA)

Operation Prevention E M H
Operation Prevention educates elementary, middle level, and high school students about the impacts of prescription opioid misuse and heroin use. Developed by the DEA and Discovery Education, the program uses science to teach students about these drugs' effects. Take a virtual field trip to learn The Science Behind Opioid Addiction (grades 3–12), and further student learning with age-appropriate, hands-on activities.

In Proactive Prevention (grades 3–5), for example, students follow medication on a path through the body to investigate how medication works when used responsibly. In Our Brain and Body on Opioids (grades 6–8), students learn how prescription opioids and heroin cause changes in the body, then create a social media campaign for peers that communicates at least one takeaway they learned about the science of physical dependency and withdrawal. Opioid Use: The Signs, the Symptoms, the Science (grades 9–12) presents a series of investigations about the science of chemical dependency, after which students apply their knowledge by explaining the science behind authentic stories of prescription opioid misuse and heroin use. See *http://goo.gl/1QvHsL.* ●

Quotable

We keep moving forward, opening new doors, and doing new things because we're curious and curiosity keeps leading us down new paths.
—Walt Disney, U.S. cartoonist and entrepreneur (1901–1966)

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

In Your Pocket

Editor's Note

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

October 31

State Farm Company Grants K12

The State Farm Companies Foundation awards grants of $5,000 or more to K–12 public schools for teacher development, service learning, and education reform or systemic improvement. The foundation aims to advance access, equity, and inclusiveness through these funds. Apply by **October 31;** see *http://goo.gl/Ytfrcg.*

Whole Kids Foundation U.S. Extended Learning Garden Grant K12

The foundation awards this $2,000 grant to edible educational gardens that aren't located in a school setting. Nonprofit programs that support gardens for K–12 students, such as boys and girls clubs, YMCAs/YWCAs, after-school programs, educational farms, and children's museums or hospitals, may apply. Organizations must be located in the United States. Apply by **October 31.** Refer to *http://goo.gl/H3SYE3.*

November 1–10

Spencer Foundation's Small Research Grants K12 HE

These grants fund education research projects with budgets of $50,000 or less. Proposed projects should improve education generally, and sometimes fall within these areas of inquiry: education and social opportunity; organizational learning; purposes and values of education; teaching, learning, and instructional resources; and the new civics. Most proposals, however, support the foundation's general mission but not one of the specified inquiry areas; proposals in this category are called "field-initiated."

The principal investigator (PI) and co-PIs must have a doctorate degree or equivalent experience in an education research–related profession. Proposals are accepted from the United States and abroad, but must be written in English and propose a grant amount in U.S. dollars. Apply online by **November 1** at *http://goo.gl/VZ9ATt.*

The Lawrence Foundation Grants K12

These grants go to organizations that support education, the environment, human services, and other causes. Public schools, libraries, and nonprofit organizations may apply. Both program and operating grants are available. The average grant amount ranges from $1,000 to $5,000.

Apply by **November 1.** Learn more at *http://goo.gl/31WYmB.*

ACS Award for Achievement in Research for the Teaching and Learning of Chemistry K12 HE

This American Chemical Society (ACS) award recognizes an individual's contribution to experimental research that has improved the teaching and learning of chemistry and increased understanding of chemical pedagogy. The winner will receive $5,000, a certificate, and up to $2,500 for travel expenses to attend the meeting at which the award is presented. Submit nominations by **November 1;** see *http://goo.gl/aR4EKX.*

ACS Award for Encouraging Disadvantaged Students Into Careers in the Chemical Sciences HE

This award goes to an individual who encourages students underrepresented in the profession to pursue careers in engineering or the chemical sciences. The recipient may work in academia, industry, government, or any other professional setting in the United States. The prize consists of $5,000, an ACS certificate, and up to $1,500 for travel expenses to accept the award. The Camille and Henry Dreyfus Foundation will also present a $10,000 grant to an academic institution of the awardee's choosing to help it better meet this award's objectives.

Submit nominations by **November 1.** See *http://goo.gl/EsUcpa.*

ACS Award for Research at an Undergraduate Institution HE

This award honors a chemistry faculty member whose research with undergraduates has significantly contributed to the field and to students' development. The prize consists of $5,000, a certificate, and up to $2,500 for travel expenses to the meeting at which the award is presented. The Research Corporation for Science Advancement will also provide a $5,000 grant to the honoree's institution.

Nominees must be tenured faculty members at a predominantly undergraduate institution that doesn't have a doctoral program in chemistry. Nominations are due **November 1;** consult *http://goo.gl/4pYLT9.*

George C. Pimentel Award in Chemical Education K12 HE

The award recognizes outstanding contributions to chemical education, including integrating chemistry into the educational system, training professional chemists, and disseminating reliable information about the field to prospective chemists, students in other fields, members of the profession, and the public. The activities recognized by this award may be in the fields of teaching (at any level), administration, research, writing, or public enlightenment. The awardee will receive $5,000, a certificate, and $2,500 for travel expenses to accept the award. Submit nominations by **November 1** at *http://goo.gl/q5EtoK.*

James Bryant Conant Award in High School Chemistry Teaching H

This award goes to one outstanding high school chemistry teacher in the United States or its territories. Nominees should demonstrate quality of teaching, the ability to challenge and inspire students, extracurricular work that helps stimulate student interest in the field, and a willingness to stay current. The winner will receive $5,000, a certificate, and up to $2,500 in travel expenses to attend the meeting at which the award is presented. Nominations are due **November 1;** see *http://goo.gl/Hdm9fd.*

Samsung Solve for Tomorrow Contest M H

This competition asks teachers nationwide to design a lesson plan outlining how science, technology, engineering, art, and math (STEAM) can be applied to help their local community. One teacher of grades 6–12 from each state will be invited to submit a video showcasing his or her solution and will receive $25,000 in technology for his or her school. The public will then choose 10 national finalists, who will receive $50,000 for their schools and present a prototype to a panel of judges and a live audience in New York City.

Judges will select three national winners to receive $150,000 worth of school technology and $20,000 for a charity of their choice. One community awardee will be selected by online vote and receive $20,000 worth of technology and $15,000 for a chosen charity.

Public schools and charters receiving at least 50% of their operating funds from public sources are eligible. Apply for the competition's first round online at *http://goo.gl/8goxrH* by **November 1.**

Dreyfus Foundation Educational Grants K12

The foundation provides grants of between $1,000 and $20,000 to community-based nonprofit programs in the United States. Schools, museums, educational and skills training programs, environmental and wildlife protection activities, and youth programs may apply. Proof of 501(c) (3) status is required. Applications must be postmarked by **November 10;** see *http://goo.gl/2akrYR.*

November 15–26

Whole Kids Foundation School Garden Grants K12
In partnership with FoodCorps, the foundation awards these $2,000 grants to support new or existing edible gardens on school grounds. Applicants must have support from a specific partner organization in the community, such as a nonprofit, farm, local business, Whole Foods store, or garden club. K–12 public schools, nonprofit private or charter schools, and nonprofit organizations working with K–12 schools may apply by **November 15.** See *http://goo.gl/wcmS3g.*

NSHSS IB Teacher Grants H
These $500 grants from the National Society of High School Scholars (NSHSS) support International Baccalaureate (IB) instruction in any subject. Funds can be used for supplies, materials, field trips, or other resources that enhance the delivery of such courses. High school teachers at public or private schools in the United States or abroad are eligible.

Applicants must register as an educator with the NSHSS and submit applications by **November 15.** Learn more at *http://goo.gl/vZ1wGR.*

Whole Kids Foundation 2017 Canadian Extended Learning Garden Grant K12
The foundation awards this $2,000 grant to edible educational gardens not located in a school setting. Nonprofit programs that support these gardens for K–12 students, such as boys and girls clubs, after-school programs, educational farms, and children's museums or hospitals, may apply. Organizations must be located in Canada. Apply by **November 15** at *http://goo.gl/FbHqLz.*

CAP Medal for Excellence in Undergraduate Teaching HE
The Canadian Association of Physics (CAP) presents this award to faculty members who have comprehensive knowledge of their subject areas, an exceptional ability to communicate that knowledge, and a proven record of high-achieving physics students. Nominees must be members of a CAP-approved professional science society and have spent half of their teaching career in Canada or made a prominent contribution to the teaching of physics there.

CAP members can nominate outstanding faculty members until **November 15.** Consult *http://goo.gl/iupjCV.*

Albert Einstein Distinguished Educator Fellowship K12
This program provides current science, technology, engineering, and math (STEM) teachers in K–12 public and private schools an opportunity to work in public policy. Fellows spend 11 months in Washington, D.C., where they work in a federal agency or U.S. Congressional office to help bridge the gap between the legislative and executive branches and the STEM community. Applicants must be U.S. citizens and have at least five years of full-time teaching experience in a STEM discipline. They should also be currently employed by an elementary or secondary school and be able to obtain a leave of absence for the duration of the program.

Fellows receive a $7,500 monthly stipend and a $5,000 housing allowance, as well as reimbursement for moving expenses. Apply by **November 16** at *http://goo.gl/5ef2fs.*

Real World Design Challenge H
This annual competition requires students in grades 9–12 to work in teams on a pressing engineering challenge with support from a coach and mentor. Teachers leading these teams get access to $1 million in professional engineering software and training, curriculum, and mentors. Students compete first in a state-level Governor's Cup, and the team with the best design then competes in the nation finals in Washington, D.C.

Each student on the winning team will receive a $50,000 scholarship to Embry-Riddle Aeronautical University. Register your team by **November 17** at *http://goo.gl/qcRKZF.*

The United States Crystal Growing Competition K12
K–12 students and teachers compete to grow the biggest and highest-quality single crystal. Individual certificates and cash prizes are awarded for the Best Overall, Best Quality, and Coolest Crystal in two grade bands: K–8 and 9–12. Winners receive $200 for first place, $100 for second, and $50 for third, and one lucky teacher gets $100 for the Best Teacher's Crystal. All winning entries will go on display at the Department of Chemistry at the University of Buffalo, State University of New York.

Participating teachers can get free crystal growth materials on a first-come, first-served basis. Submit entries by **November 26.** Learn more at *http://goo.gl/azjAQp.*

February 22

Population Education's World of 7 Billion Contest M H
The contest can engage students in grades 6–12 with sustainability issues surrounding population by having them create a 60-second video relating human population growth to one of three global issues. World of 7 Billion aims to promote understanding of the ways the world's population of 7 billion affects neighborhoods, the environment, and global communities. Free curriculum resources for teachers are available, and student winners will receive cash prizes of up to $1,000.

Entries are due **February 22, 2018.** For this year's contest topics and more information, consult the website at *www.Worldof7Billion.org.* ●

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Summer Programs

Editor's Note

Visit www.nsta.org/calendar to learn about other summer professional development opportunities.

Smithsonian Libraries Neville-Pribram Mid-Career Educators Awards M H HE

This program allows mid-career educators working on publications or curriculum development projects to be in residence at one of the Smithsonian's Libraries and use its collections to further their research. This year's program will take place at the Dibner Library of the History of Science and Technology, which offers collections in astronomy, theoretical physics, experimental physics, engineering technology, scientific apparatus and instruments, mathematics, and classical natural philosophy, which would be particularly well-suited for science, technology, engineering, and math educators. The awardee will also be able to engage with Dibner researchers and attend symposia, festivals, and other Smithsonian events.

Participants receive $750 weekly stipends. After the summer residency, educators will give a presentation on their research and submit a short report to the Dibner Library.

Middle and high school teachers, college professors, and museum educators may apply, but applicants must not be located within commuting distance of the Smithsonian and can't use the award to further doctoral or postdoctoral research projects. Apply by **October 31;** learn more at *http://s.si.edu/2feBbMk.*

Honeywell Educators @ Space Academy E M H

At Space Academy in Huntsville, Alabama, science and math teachers from around the world will learn new ways to bring science to life for their students ages 10–14. During June 13–19 or June 20–26, teachers will participate in space simulations and engage in activities meant to promote lifelong learning. Program scholarships include tuition, roundtrip airfare, program materials, flight suit, meals, and double occupation accommodations. Apply by **November 14.** Learn more at *http://goo.gl/ovg967.*

SEE Turtles Nicaragua Sea Turtle Volunteer Expedition A

Volunteers spend a week helping critically endangered hawksbill sea turtles and exploring Nicaragua's Padre Ramos Estuary, one of only two major nesting areas for the turtle in the Eastern Pacific. During August 5–12, participants will explore the country and work with conservationists to study and protect the turtles. Proceeds from the trip will save at least 100 hatchlings per participant. Consult the website *http://goo.gl/ScQeDC.*

SEE Turtles Costa Rica Leatherback Turtle Volunteer Vacation A

Participants will spend four nights in Costa Rica patrolling nesting beaches, measuring leatherback turtles, collecting eggs and moving them to hatcheries, and working with the turtles once they hatch. During the day, participants can explore the rainforest, help clean up the beach, or simply rest and relax. Trips are available May 5–11 and June 11–17. Proceeds from the trip save at least 100 hatchlings per participant.

Individuals and groups of up to 15 may apply. Visit *http://goo.gl/vfAiZH* for details.

SEE Turtles Costa Rica Leatherback Turtles and Marine Debris Research Trip A

This eight-day trip, sponsored in conjunction with the Oceanic Society, allows participants to study how plastic pollution impacts the leatherback population at Las Tortugas Research Station on Costa Rica's Caribbean coast. During June 17–24, participants will spend three nights patrolling the beach for turtles and debris and two days exploring the rainforest and snorkeling the coast of Cahuita National Park. Individuals, families, and groups may apply at *http://goo.gl/zM5med.*

Student field trips may also apply, though group size is limited to 12. Learn more at *http://goo.gl/52WsbP.* ●


#ONLYatNSTA

MS. MENTOR, **Advice Column**

Making the Most of Prior Experiences

I see many good activities for middle school involving plants, but what if students already did something similar at the elementary level? I don't want to spend time on duplicate activities or get the eye-roll meaning "we already did this."

—M., Arizona

I posed this question to a middle school biology teacher. His students came from several elementary schools, so it was hard for him to determine what activities they did at those levels. When he surveyed his students, he found that many had never grown plants from seeds or it was part of a once-and-done observation activity

He turned traditional plant-growing activities into investigations by encouraging additional questions and incorporating scientific practices and crosscutting concepts. For example, he guided students beyond descriptive observations toward a more robust approach to experimental research—variables, experimental and control groups, measurement, graphing, and basic statistical analysis. The students shared their data electronically, creating a database of their measurements and discussing discrepant data. They differentiated between observations and inferences when describing their results.

He concluded that embedding new experiences and elaborations within the context of a familiar activity helped students to focus on higher levels of thinking. And for some of his students, the "aha" of watching plants grow was a new experience.

A colleague from an e-mail list suggested Planting Science (*https://plantingscience.org*). It looks like a good resource on science methods and worth browsing even if you don't formally participate in their projects.

Who knows where a newfound interest in plants will lead? In some schools, future botanists and horticulturists have expanded their investigations into school gardening or hydroponics.

My first year of teaching biology was challenging, but I made it! Do you have any suggestions for what I should do to improve for this year?

—C., Virginia

Congratulations for completing your first year! A good way to prepare for next year is to reflect on this one, learning from your experiences.

How did you know a lesson was successful? What did you do when things didn't go as planned? Were your classroom management routines and procedures effective? How did you deal with disruptive students? How well were you able to access and use the technologies available in your school? Are there any strategies you would like to consider, in terms of instruction, classroom management, or communications?

Were you surprised by any misconceptions or lack of experience among your students? Should you change the amount of time or emphasis invested in some topics? Did you have an effective combination of content, processes, and interdisciplinary connections? Do you have any gaps in your own knowledge base?

Were your lesson plans detailed enough to adapt or modify? How well did assignments and projects align to unit goals and lesson objectives? Did your lab activities go beyond cookbook demonstrations to help students develop their own areas of inquiry? Did you provide opportunities for students to reflect on their own learning (e.g., through a science notebook, comparing their work to the rubrics)?

Did your students seem to enjoy learning science? Did you enjoy teaching and learning with them?

Your reflections can be the basis for this year's goals.

Do you have ideas for helping my middle school students become more thoughtful, independent learners?

—J., Michigan

In my experience, self-assessment and reflective activities gave students ownership in their learning.

Self-assessment is more than students "correcting" their own papers. When students self-assess, they reflect on the results of their efforts and their progress toward meeting the learning goals or performance expectations. They examine their work for evidence of quality and decide what they should do next.

But if you ask middle school students to "reflect," you may get puzzled looks or blank stares. Students don't necessarily have this skill. They may initially think that an assignment or project is good simply because they spent a lot of time on it, they enjoyed it, or they worked very hard on it.

Students may need to be taught strategies for self-assessment through examples and practice. Take a piece of student work (with no name on it) and guide students through the process of comparing the work to the rubric. You may have to do this several times before students feel comfortable critiquing their own work.

Share with students how they could reflect on their own learning with responses to prompts such as *I learned that… I learned how to… I need to learn more about…* It's very powerful if you share your responses to your own work.

In their notebooks, students could reflect on their work with prompts such as *From doing this project I learned… To make this project better, I could…* or *Our study team could have improved our work by…*

Honest self-assessment and reflection are difficult processes, even for adults. But they are valuable tools for developing lifelong learners.

Retooling, Not Retiring

I did not have a formal mentor when I was a new teacher. As I struggled, several colleagues and an administrator must have seen some potential and offered me advice and support. I was glad to return the favor during my career as a classroom teacher and administrator. However, when eligible for retirement, I was not ready to give up my role as a science educator. I saw this advice column as a way to retool rather than retire!

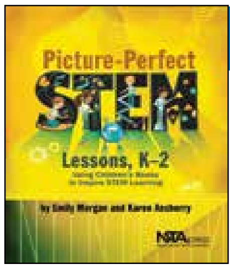
After nearly 10 years and 400 *Ms. Mentor* blog posts, it's time to pass the baton to another. Thanks to all those who submitted questions, added comments, and shared resources through the blog and *NSTA Reports*.

Once again, I'm retooling, not retiring. I still write professionally, and I'll continue as an online advisor in NSTA's Learning Center Discussion Forums. I'm involved in local environmental groups, citizen science projects, and informal science organizations.

Helping students learn about the world around them as a science teacher is a noble calling. We have a responsibility to model our own interests while engaging students in STEM topics as they develop into informed residents of our communities who enjoy science as part of their lifelong learning.

—Mary Bigelow, also known as NSTA's Ms. Mentor

To read more advice on diverse topics or to ask a question, visit www.nsta.org/mentor.



NSTA PRESS: *Picture-Perfect STEM Lessons, K–2*

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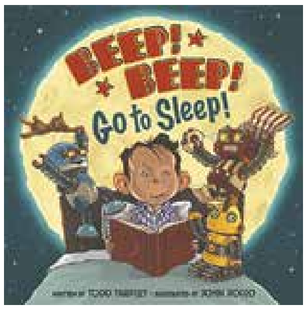

Beep! Beep! Go to Sleep!
National Geographic Kids: Robots

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 Picture-Perfect STEM Lessons, K–2, *by Emily Morgan and Karen Ansberry, edited for publication here. To download the full text of this chapter, go to* https://goo.gl/r48dTd. *NSTA Press publications are available online through the NSTA Science Store at* www.nsta.org/store.

Description: After sharing what they know about different types of robots, students model how robots are programmed to perform tasks. They learn that every robot is designed for a specific job, and that job determines what a robot looks like. They also make a labeled drawing of a robot that could complete a particular task in their own home or at school, and they compare it with another technology designed to solve the same problem.

Engage

Beep! Beep! Go to Sleep!
Read-Aloud

Inferring

Show students the cover of *Beep! Beep! Go to Sleep!* and introduce the author, Todd Tarpley, and illustrator, John Rocco. *Ask:*

- Based on the cover, what do you think this book might be about? (a boy and some robots)
- How do you know? (The boy is reading a book called *3 Little Robots*, and there are three robots on the cover.)

Then, read the book aloud.

Questioning

After reading, *ask:*

- What kinds of jobs do robots do? (Answers will vary.)
- What job do you think the robots in the book were designed to do? (Entertain the boy or take care of the boy; students may notice that the first two-page spread has pictures on the wall showing that the robots have been with the boy since he was a baby.)
- Do most robots look like the ones in the book? (Answers will vary.)

Explore

Robot Arms

Tell students that most robots look nothing like the cute, funny ones featured in the book *Beep! Beep! Go to Sleep!* In fact, robots that consist of just a moving "arm" are among the most common robots used. Show students the robot arm on pages 22 and 23 of *National Geographic Kids: Robots.* Tell students they are going to do a fun activity to model how one of these robot arms works.

Before beginning the activity, divide students into teams of two. Tell students that one member of each pair is going to be the "robot arm," and the other member is going to be the "programmer." (They will switch roles after the first trial.)

Explain that all robots need to be programmed to do their job. This means that engineers must write a very specific set of instructions called a computer program and then upload, or transfer, the program to a robot's computer. The student who is the programmer will be reading these instructions to the student who is modeling the robot arm so that this student knows how to do his or her job. (You may want to read the Robot Program together if your students are not yet reading independently.)

Give a sandwich bag of pasta (spirals and either tubes or bowties) and a precut folder (to act as a screen) to each pair. Give a Robot Arm Program Card to each programmer. Then, read aloud the directions below.

Directions for Robot Arms Activity

1. Stand the folder on the table. The first person to be the robot should place one hand through the hole in the folder and lean over until his or her forehead is touching the folder. The robot should not be able to see his or her own hand (but may use the other hand to keep the folder standing up).
2. The programmer should dump the pasta into a bowl in front of the folder, within reach of the robot arm.
3. The programmer will tell the robot how to do its job by reading a set of instructions called the Robot Program.

When all pairs are set up and ready to go, call out, "START!"

Robot Program

1. Pick up a piece of pasta from the bowl.
2. IF the pasta feels like a spiral, THEN place it to the left of the bowl, or ELSE place it to the right of the bowl.
3. IF any pasta is still in the bowl, THEN GO TO step 1, or ELSE END program.

After a few minutes of pasta sorting (or more if necessary), call out, "STOP!" Next, have the programmers remove the folder so their partners can see the results. Then, have students trade roles and repeat the activity.

Explain

Robot Arms Discussion

Questioning

After everyone has had a chance to be both a programmer and a robot arm, *ask:*

- What was the job the robot arms had to do? (Sort the pasta.)
- How well did the robot arms do their job? (Answers will vary.)
- Is this a job you would want to do? (Students will most likely answer no.)
- Why or why not? (It would be boring or too repetitive, and your arm would get tired.)
- What parts or structures on the robot arms helped them do their job? (movable elbows, wrists, hands, fingers, etc.)
- Did the programmer ever have to give the robot additional instructions? (Answers will vary.)

Explain that real robots can only do what they are programmed to do. Every step of a task must be spelled out in the robot's program. If the program is not detailed and exact, the robot won't be able to do its job very well or at all. Discuss the Robot Program used in the model. Point out that many types of computer programs are similar to this one: They are made up of a series of logical statements that include the words IF, THEN, ELSE, GO TO, and END. You may want to give students the opportunity to write another simple program for a robotic arm, such as a program for sorting and placing different-shaped blocks into containers.

Next, explain that robot arms are typically used in factories, doing jobs that people might not want to do because they are so repetitive (meaning they are repeated over and over). Many different types of robot arms are used in industry. One kind is designed to spray-paint cars. Another kind welds metal together. One of the most common kinds found in factories and warehouses is called a pick-and-place robot because it is designed to pick things up and place them somewhere else, usually into some sort of package. The robot arm they modeled is a type of pick-and-place robot. ●

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BLICK ON FLICKS

The Princess Bride—30 Years Later

By Jacob Clark Blickenstaff, PhD

With September 25 marking the 30th anniversary of its release, I thought it would be fun to rewatch *The Princess Bride* (1987) and consider ways to connect this fantasy classic to the science classroom. Also, after seeing Robin Wright take on military leadership as an Amazon in *Wonder Woman* (2017), I wanted to note how far she has come since playing Buttercup in *The Princess Bride*. Though fantasy might not be the first place most educators look for science, I can see ways to get students thinking about zoology, genetics, and thermodynamics with scenes from *The Princess Bride*.

Given the 30-year history of this movie as a staple comic fantasy (and its appearance on many fan lists of top comedies of all time), I won't provide a plot summary. It is enough to say that it features monsters, a giant, sword fighting, torture, revenge, and of course, true love.

Genetics

One of the film's primary villains is Count Rugen (played by Christopher Guest), who works closely with Prince Humperdinck (played by Chris Sarandon). Rugen is notable for the enjoyment he takes in torturing Westley (Carey Elwes), and for the fact that he has six fingers on his right hand. (Another character is looking for the Six Fingered Man who killed his father.)

Having extra fingers or toes is known as polydactylism, a congenital physical anomaly that is more common than often recognized. Overall, it occurs in about 1 in 500 live births, though in some sub-populations, the frequency can be as high as one in 150. The extra finger or fingers can appear on the thumb side of the hand (radial), on the pinky side (ulnar), or most rarely, in the middle (central). Most often, the extra digit has no bone or tendons, so it can be easily removed surgically in infancy.

Count Rugen appears to have a fully formed radial digit, as we can see it move in his gloved hand at one point. A variety of genetic mutations can cause polydactylyism; some types are dominant traits, while others are recessive. Males are significantly more likely to have the trait than females, so a Six Fingered Man is much more likely than a Six Fingered Woman.

Biology

Westley and Buttercup take refuge from pursuit in the Fire Swamp at one point. The Fire Swamp has three main hazards: flame spurts, lightning sand, and Rodents of Unusual Size (ROUSs). Flame spurts are jets of flame that shoot up from the ground after a characteristic popping sound; lightning sand is a kind of dry quicksand; and ROUSs are rats about the size of a large dog (technically actors in giant rat suits) that attack in small groups.

Rodents are a hugely successful order of mammal that live in virtually every corner of the world and can range from a 20-gram house mouse up to a real ROUS, a 60-kg capybara. Their most obvious distinguishing feature is their large, constantly growing upper and lower incisors. Rodents continually grind these four teeth on one another, which maintains their sharpness and makes it likely they will gnaw through almost anything given enough time.

Capybaras are native to South America, and live a semi-aquatic life eating grass, aquatic plants, and tree bark. The Fire Swamp is a plausible habitat for capybara, though probably not ideal since it doesn't appear very wet for a swamp. Adult capybara are about a meter long, 60 centimeters tall, and can weigh up to 66 kg (about 150 lbs.). They are not vicious hunters like the ROUSs, but they do live in groups of about 20–40 individuals and are very social animals. To people living in Europe and North America, the capybara is a Rodent of Unusual Size, though not so dangerous as the ROUSs in *The Princess Bride*.

Thermodynamics

When the time comes for Westley, Inigo (Mandy Patinkin), and Fezzik (Andre the Giant) to storm the castle and save Buttercup, the gate is guarded by 60 men. Westley, only recently revived from being mostly dead, is unable to fight. The team has Westley's brain, Fezzik's strength, and Inigo's steel. And it turns out, a Holocaust Cloak, which Fezzik picked up at Miracle Max's cottage. The Holocaust Cloak protects the wearer from the effects of fire, so Westley comes up with a plan to frighten nearly all of the guards away, making it possible for the three heroes to get in.

The Holocaust Cloak has properties very similar to the multi-layer coat and pants that firefighters wear to protect themselves: Both are non-flammable, and both insulate the wearer from heat. The outer layer of modern firefighting gear is very tough Nomex® or Kevlar® fabric; the middle layer is quilted material to block heat; and the inner layer wicks perspiration away. One thing the Holocaust Cloak must do (although you can't see it in the film) is protect Fezzik from smoke. Smoke is actually the main hazard in a house fire: Breathing toxic smoke can kill or injure people far from the heat and flame of the actual fire. Firefighters wear face masks and carry tanks of breathable air when entering a structure's fire to protect them from this danger, and the Holocaust Cloak must somehow do the same for Fezzik.

Science teachers seeking a fun way to introduce thermodynamics, fire safety, genetics, or zoology could take advantage of the classic comic fantasy *The Princess Bride* around the 30th anniversary of its theatrical release.

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

Mark Your Calendar
NSTA Dates to Remember

(All dates are deadlines unless otherwise specified.)

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

October 21—Explore in-depth effective assessment strategies to accompany the three-dimensional learning and teaching of the *Next Generation Science Standards (NGSS)* and similar standards during the **virtual conference on Assessing Three-Dimensional Learning.** This four-hour event opens at 10 a.m. ET. The general session will be followed by three breakout sessions that will be archived for later access by all conference participants. Registration costs $63 for NSTA members; a certificate of participation is available for an additional fee. For more information or to register, visit *http://bit.ly/1Iwpg4w.*

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

October 26—Learn how to challenge your students with agriculture during **A Sustainable Journey to 2050, a free NSTA Web Seminar**. The interaction with agriculture (InterAgtion) seminar will explore how to include science and engineering practices, crosscutting concepts, and disciplinary core ideas as students learn about sustainable agriculture. The session will run from 6:30 to 8 p.m. ET. For more information on NSTA Web Seminars or to register, visit *http://bit.ly/1Iwpg4w.* This seminar is underwritten by the National Agriculture in the Classroom Organization and the National Center for Agricultural Literacy.

November 2—Attend this **free NSTA Web Seminar** to learn **How to Prepare a Manuscript for Submission to *Science Scope*,** NSTA's journal for middle school science educators. *Scope* field editor Patty McGinnis and Ken Roberts, managing editor, will explain the submission process. The session will run from 6:30 to 8 p.m. ET. For more information on NSTA Web Seminars or to register, visit *http://bit.ly/1Iwpg4w.*

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

November 9—The **NSTA Area Conference in Milwaukee** opens today! The conference features the theme "Making Waves: Moving Science Forward!" Onsite registration costs $230 for NSTA members. For more information or to register, visit *www.nsta.org/milwaukee.*

November 16—Discover new ways to spice up science, technology, engineering, and mathematics (STEM) lessons by **Contextualizing STEM in the Science of Food, a free NSTA Web Seminar.** Follow food's journey from the farm through processing to the market and the various effects of STEM along the way. The session will run from 6:30 to 8 p.m. ET. For more information on NSTA Web Seminars or to register, visit *http://bit.ly/1Iwpg4w.* This seminar is underwritten by the National Agriculture in the Classroom Organization and the National Center for Agricultural Literacy.

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

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

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

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

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To apply to a committee or board, access the online application form at *https://goo.gl/PPds2J*. More information on the individual standing committees is available at *https://goo.gl/cys8c6*, and on the advisory boards and panels at *https://goo.gl/jxZMgP*. Applications are due by **December 4.** Appointees will be notified beginning in late February 2018, with the term of office beginning on June 1. ●