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STEM's Good Samaritans

To help children with disabilities become more mobile, educators and students participating in a worldwide outreach program called GoBabyGo use their science, technology, engineering, and math (STEM) skills to modify electric–powered toy cars the children can operate. "GoBabyGo projects combine science, math, social studies, and embodied learning [an educational approach in which learning occurs both intellectually and through whole-body interactions]," says GoBabyGo's creator Cole Galloway, professor of the Department of Physical Therapy at the University of Delaware in Newark, Delaware. Building the cars involves "brains, bodies, physics, and materials…math and science and doing good," he observes.

"The dominant way we learn is through physical interactions with the world. The kids who [need the cars] have little to no mobility, so their interactions [are limited]. With the cars, their brains and bodies change; they can get smarter and stronger and more social," he maintains. In addition, the cars cost less than most pediatric wheelchairs, and only readily available materials are required for the modifications. About 4,000 cars have been refurbished during the past two to three years, he reports.

While modifying the cars, students "learn patience and teamwork…They know they have to get this right for a person in the community, so the child will be able to use the car safely and comfortably," he points out. The project also involves "creative engineering. It's a great starter engineering, science, and math lab," he contends, "and a way schools can address community problems."

JEN WEWERS

Physics and engineering undergraduates and graduate physical therapy students participating in the GoBabyGo program at Rockhurst University in Kansas City, Missouri, modify electric–powered toy cars for children with disabilities.

GoBabyGo is funded by the National Science Foundation and the National Institutes of Health. Galloway and the GoBabyGo staff hold training workshops for building the cars; they provide an instruction manual and resources for starting GoBabyGo programs at *www.udel.edu/gobabygo*. "We can advise [schools] on how [participating schools] have done it safely," he notes.

Skye Donovan, department chair and associate professor of physical therapy at Marymount University in Arlington, Virginia, attended a GoBabyGo workshop and obtained a $2,000 grant from Marymount to launch a GoBabyGo initiative there. "I'm passionate about solving community problems [as a way] to learn science," she declares.

"It's fantastic to get [physical therapy graduate students] involved in service learning, and [the project gives them] more buy-in to the assessment of patients. They're making something with their hands, so they [pay] more attention to detail. And they look at patients in a different way," she contends.

Donovan taught sixth-grade science teacher Luzdary Chamorro of Gunston Middle School in Arlington, Virginia, and sixth graders in an after-school science club to adapt the cars. Students learned how to wire electrical circuits, measure and cut PVC pipe, and use

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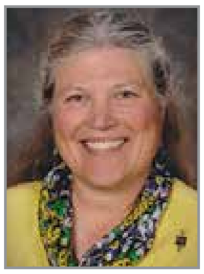
COMMENTARY: **Bev DeVore-Wedding**

Enhancing Science Instruction and Learning Through Reading and Writing Strategies

By Bev DeVore-Wedding



Bev DeVore-Wedding

When was the last time you did *not* use science to make a decision? Did you use your critical-thinking and problem-solving skills when you decided what to eat for breakfast? Perhaps you didn't this morning, but you may have at least once. Usually we consider these skills, scientific literacy skills, in the context of solving larger, complex problems. Scientific literacy uses literacy skills not just for reading, but also for comprehension, analysis, and application of science content to and within our lives.

We make decisions daily about our lives that may not be obviously science-based. From driving to managing our health, choosing healthy foods to finding ways to make life easier, the ability to sort through the claims is essential to our economic and healthy well-being.

Literacy simply defined is the ability to read and write. The National Council for Research defines scientific literacy as "the knowledge and understanding of scientific concepts and processes required for personal decision making, participation in civic and cultural affairs, and economic productivity. It also includes specific types of abilities." The *Next Generation Science Standards* (*NGSS*) states, "Literacy skills are critical to building knowledge in science."

Students must be able to read critically: that is, read, question, and substantiate the claims made in newspapers, on the internet, in textbooks, in nonfiction readings, and in everyday discussions. Identifying the topic sentence and the specific parts of a paragraph or section as taught in language arts is essentially the same as identifying a claim and using data to support that claim in your textbook or other scientific readings. Using the skills taught in language arts classes not only builds students' literacy skills, but their understanding of science content as well.

Literacy strategies that can be used with any material include summarizing verbally or in writing what has been read. In science, breaking up long passages into short summaries can make them less daunting. Sharing with a partner, a small group, or even the entire class helps students to process what they have read as they report to their peers. Reading guides help students focus on important content; having students make their own reading guides can increase their comprehension of the content and their communication skills.

An associated strategy I have used with my students is annotating science articles and textbook passages. Students are encouraged to write notes in the margin with ideas, questions, and "ahas," then to use those notes to summarize their readings. If you do not want students to write on reading materials, have them log comments and questions on a separate piece of paper with the page number and paragraph their annotation refers to within the text, or identify passages with reusable waxed yarn or reading tape.

To encourage critical thinking, have students debate an issue, giving them time to research, and perhaps graphic organizers for collecting evidence. They could write letters to a newspaper, the town council, or county commissioners scientifically explaining a topic of concern.

Improving students' questioning skills also supports their ability to focus on content in readings. Starting early in the course, students may be asked to read an article, then write down a question they still have. The instructions frame the question as one they *still have,* so that questions are not a regurgitation of facts from the article. Using the phrase, "I wonder ..." prompts students to ask more than factual questions.

Using chapter or trade books that complement lessons is another way to improve reading skills, teach content, and connect to the real world and students' own interests. The recently released 2015 NSTA/Children's Book Council Outstanding Science Trade Books for Students K–12 list features more than 40 books spanning many grade levels and content areas. Think about what your students care about, an issue within your community, and find readings related to that topic and the science content you teach. Many nonfiction books capture students' imagination with scientific content such as *At Home in Her Tomb* (Christine Liu-Perkins), *Extreme Laboratories* (Ann O. Squire), *Krakatoa* (Simon Winchester), *Sally Ride* (Sue Macy), and *The Poisoner's Handbook* (Deborah Blum), to name only a few. Instead of assigning entire books, selected chapters can provide depth to a concept or complement a unit of instruction. Instead of writing a book report, students could review the book—emphasizing content and the scientific accuracy—and recommend it to others (or not).

Assessing students' knowledge and understanding requires students to communicate what they have learned. When a student can explain, argue a position based on scientific data, or respond to an open-ended question, his or her knowledge is evidence of his or her understanding.

Eventually, when your students make decisions about their breakfast, route to work, or items to purchase, hopefully they will think about how they decide and thank their science teachers! ●

Bev DeVore-Wedding is NSTA's High School Division Director, on leave of absence from the classroom (after 28 years) while pursuing her doctorate at the University of Nebraska-Lincoln. She has presented locally, regionally, and nationally at science conferences for 18 years on topics ranging from place-based instruction, the NGSS *science and engineering practices, and literacy.*

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NSTA National Science Teachers Association

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power tools, along with "basic safety principles," she explains. "They can see how [science is] applied, instead of just learning for learning's sake. They develop passion for something with real-life relevancy."

GoBabyGo was "perfect with the STEM focus we have this year," says Chamorro. "We did engineering, technology, science, and reaching out to the community," she relates. "We're donating cars to kids at the [Walter] Reed School" in Arlington, which offers special education programs for students ages 2–5 with disabilities.

Chamorro has taken the project to a deeper level. "We're working on how to design the big red button [an accelerator that replaces a small button on the car's steering wheel that is difficult for many special-needs children to use] using a 3D printer." Eighth-grade math teacher Charles Fix, a retired electrical engineer, had the students disassemble the button, which costs $70, to learn about it, Chamorro notes. To save money, "now we'll design the plastic components of the button and print them with the 3D printer," she explains.

In Ajax, Ontario, last year, science teacher Anna Farquhar and 14 eighth graders in an after-school club at Roméo Dallaire Public School built a car for a local elementary student. "We weren't deterred when we were requested by our board of education to contact different levels of government to ensure that all safety standards were in place before releasing the car [to the child]. We learned not to give up," she maintains. "We also had an engineer test the car to make sure it was structurally sound."

Farquhar obtained funding from the Pollination Project of Berkeley, California, which provides $1,000 start-up grants to social change projects. She and her students used half of the funds to build the car. "The students volunteered; they were self-directed and very eager," she recalls.

"We looked at the structure of the car [and how to change it] to fit the child's [needs]," she relates. "We had to determine how much weight the car could hold…We had to find an easy-to-use seat belt; we tested materials to ensure the seat belt wouldn't fray. We used a very large dog collar as a seat belt."

A child operates a car retrofitted by students from Central Connecticut State University in New Britain, Connecticut.

Farquhar's students "earned community service hours for their diploma," she notes. Now teaching at Michaëlle Jean Public School in Ajax, Farquhar says students there will build two cars using her remaining grant funds.

Interdisciplinary Teams

At Central Connecticut State University (CCSU) in New Britain, Connecticut, some of Michele Dischino's technology and engineering education students build GoBabyGo cars. Dischino, associate professor of technology and engineering education and faculty advisor for CCSU's Collaboration for Assistive Resources, Equipment, and Services (CCSU CARES) student club, launched GoBabyGo there. One of her students, CCSU CARES Lead Student Advisor Megan Hislop, obtained $5,000 from CCSU's Student Government Association to fund the first GoBabyGo workshop, says Dischino.

Since then, students in other disciplines, such as engineering and social work, have participated. "Other students bring other skills, including 'people skills' for working with special-needs children," Dischino observes.

Middle and high school teachers contact her to get their students involved, and some of their schools have provided funding. "Bringing in middle schools and high schools has made it more valuable, given that my students are going to be teachers…It makes the experience even better because we can show [younger] students how they can use their [STEM] skills."

At Rockhurst University (RU) in Kansas City, Missouri, GoBabyGo "is student-led and student-run. We have graduate physical therapy students and physics and engineering undergraduates bringing their unique perspectives in science," says Kendra Gagnon, associate professor of physical therapy education at RU. "And now the physical therapy students are starting to understand wiring and mechanics, and the engineering students are learning about posture and movement, all while solving real-world problems."

"Interdisciplinary team building is becoming part of our health care system," observes Karen Patterson, faculty associate for University of Wisconsin (UW)-Madison's Doctor of Physical Therapy Program, which works with UW-Health's outpatient pediatric rehabilitation program on GoBabyGo. Physical and occupational therapy graduate students team with biomedical engineering undergraduates to build the cars. "We have a rough manual, but [students] have to figure it out for themselves according to the needs of each child," she explains.

For example, one child was on a ventilator, and the students "had to build a platform for [it]…The students came up with it, all on their own," she reports. ●

Ensuring Science Classrooms Are Culturally Relevant

With students coming from a variety of backgrounds, it's important to make education relevant and accessible to all. *NSTA Reports* recently asked science educators about their ability to adapt their teaching to students' diverse interests and histories. Sixty-nine percent of respondents said they consider themselves to be effective in making their science classroom culturally relevant for students. Although 40% reported they had never adapted a lesson due to a cultural barrier, 45% said they had minimized parts of their curriculum due to cultural barriers. In addition, 57% reported identifying cultural biases in tests. Sixty percent noted their school culture supports cultural sensitivity as a school improvement strategy, and 95% said their school administration supports making education more culturally relevant. Seventy-one percent indicated their school administration supports the idea of the *Next Generation Science Standards* (*NGSS*) being culturally inclusive, while 82% say they will use the *NGSS* to make their classroom practice more culturally relevant.

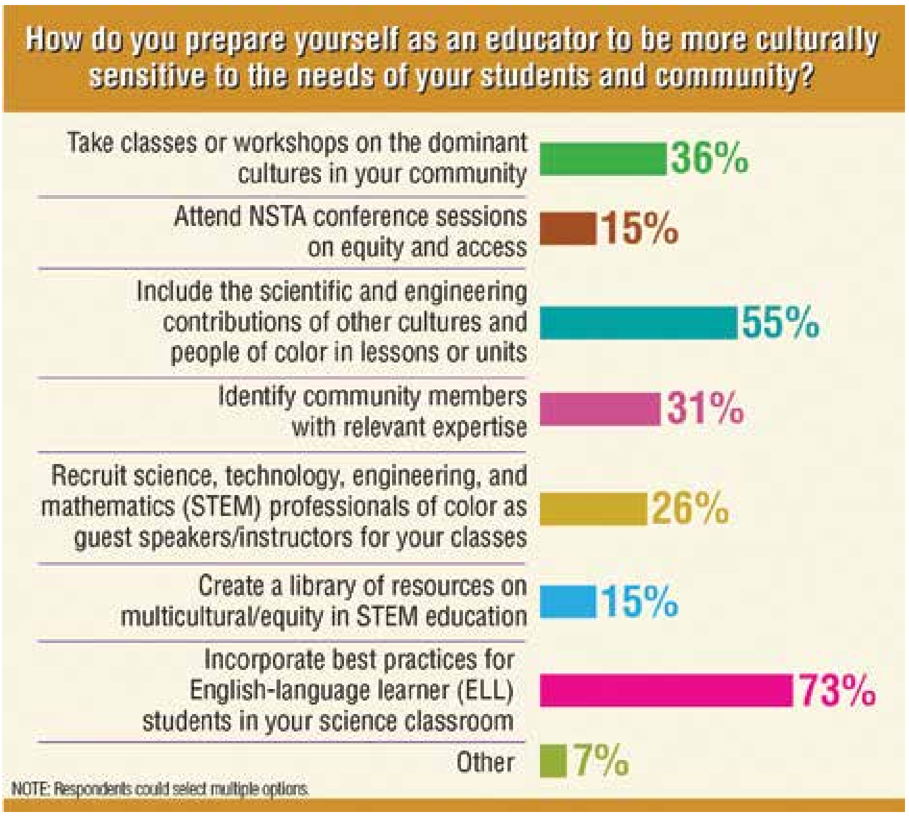
The most common ways educators said they prepare themselves to be more culturally sensitive to the needs of their students and community included incorporating best practices for English-language learner (ELL) students in the science classroom (73%), including the scientific and engineering contributions of other cultures and people of color in lessons or units (55%), and taking classes or workshops on the dominant cultures in their community (36%). One respondent reported learning the language and attending cultural festivals and religious services of other cultures to become more sensitive to students' home culture, while another reported having "an open dialogue with students about issues of equity in science (in particular) and society (writ large)." *[Note—Respondents could select more than one answer to this question.]*

Here's what science educators are saying about their biggest challenges to making science education culturally relevant for their students:

With ELL students from seven different countries, it is difficult to address their needs along with all of the others. *—Educator, Middle School, Massachusetts*

Knowing the audience and what they have experienced.*—Educator, Middle School, Texas*

It is difficult to balance content and culture. I already have...values and character strengths that are not necessarily/specifically culturally relevant, and inclusion of those is hard enough. How to get it all in?*—Educator, High School, Louisiana*



Training my 40+ volunteers who are from a wide variety of backgrounds to be empathetic in their interactions with visitors to the museum.—*Educator, Informal Education Setting, Oregon*

Culturally [relevant] materials for lessons.—*Educator, Middle School, High School, Institution of Higher Learning, Informal Education Setting, Riyadh, Saudi Arabia*

Lack of resources.—*Educator, Middle School, Massachusetts*

Distance and age of materials. —*Educator, High School, Guam*

Finding time to plan lessons including and embedding culturally relevant items in the lessons.—*Educator, High School, California*

Lack of time, lack of training, focus on state-mandated testing.—*Educator, Middle School, High School, Massachusetts*

Avoiding my own bias.—*Educator, Middle School, California*

So much to do; so little time. Don't necessarily go out and search for Pacific Island[er] and Asian contributions to science.—*Educator, High School, Hawaii*

Constantly having to prove how I do it.—*Educator, Middle School, Minnesota*

My biggest challenge is understanding the culture from a language and literacy perspective. It just takes a great deal of time and effort to learn the language, watch foreign language movies, and read foreign language books.—*Educator, Middle School, High School, Vietnam*

My own lack of knowledge.—*Educator, High School, Connecticut*

Labs and activities that show science in our culture.—*Educator, High School, Michigan*

Finding meaningful role models. —*Educator, High School, North Carolina*

I do not have a very diverse school, although we have a small but consistent number of families from India. I try to keep these mostly wealthy, white kids recognizing that there are other people, needs, and outlooks in the wider world.—*Educator, Middle School, Ohio*

My biggest challenge is teaching high school biology to freshmen who do not have algebra and who have not had any science in elementary and middle school. Honestly, cultural awareness is not my top worry...It's helping these students divide by 10 without a calculator.—*Educator, High School, California*

Time.—*Educator, Middle School, Institution of Higher Learning, Pennsylvania*

Getting the students to buy in. I am a Caucasian teacher in a predominantly Hispanic district. They don't think I have any idea what they are going through.—*Educator, High School, Arizona* ●

Learning Science in a Second Language

School districts nationwide have established dual-language immersion programs in elementary schools. Often science is taught in the target language, and for science teachers, "what's important is making it fun and hands-on, and providing opportunities for kids to talk with one another and explore," says Laura Pantin, kindergarten dual-language teacher at Gator Run Elementary School in Weston, Florida.

"I teach all day in Spanish and every subject in Spanish. I incorporate science into our learning centers in Spanish. We also have school-wide STEM [science, technology, engineering, math] days,… and I do those STEM projects in Spanish with my kids," she explains.

"I work extremely closely with the kindergarten dual-language teacher on the English side," she asserts. "When I start a science unit, the next day, students will continue that lesson in English. She and I can see whether the students [are grasping] concepts in both English and Spanish.

"I pair English-dominant and Spanish-dominant students as 'carpet buddies.' They help each other a lot with translating," Pantin maintains.

"Students alternate between taking tests in Spanish and in English. Their grades are based on the English tests," she points out. "[However,] we take into account how they score on Spanish tests. If they did well in Spanish, they understand the concept.

"In the long run, research shows bilingual students will perform better academically. It doesn't slow kids down if you start them early. It helps them socially, too. They are more confident and well-rounded," she asserts.

At Kent Gardens Elementary School in McLean, Virginia, "we teach French by integrating STEAM [science, technology, engineering, arts, and math]. I embed the language objective into STEAM to help engage students and reinforce the grade-level curriculum" taught by the classroom teachers, says French STEAM teacher Marie Hinton.

Students in Laura Pantin's kindergarten dual-language class at Gator Run Elementary School in Weston, Florida, explore the STEM topic of push/pull using ramps and cars.

Students can begin the immersion program in first or second grade and continue through sixth grade.

"The content in French STEAM focuses on the engineering design process, in line with the *Next Generation Science Standards,"* Hinton explains. "I teach students more than the curriculum objectives; I teach them to be global communicators, problem-solvers, and critical thinkers."

She carefully monitors students' classwork to ensure they understand both the language and the content. "Communication with the classroom teacher is key. If a student is below grade level in math, I scale down the math. Sometimes the student has an emotional reaction because it is harder [for him or her] to learn math and science in French. Sometimes the math or science is too hard for the student. I create activities to differentiate so everyone can function at [his or her] own level."

The classroom teachers assess students' content knowledge, but "I keep samples of students' work to show their classroom teachers what they have learned," she reports. Classroom teachers can see, for example, that students' drawings of engineers change radically as they learn more about what an engineer does.

"I'm learning every day as a teacher. I'm learning when to slow down or speed up. I adjust and re-teach concepts when necessary," says Xuefei Zhou, who teaches science and math in Mandarin Chinese to grades K–1 at West Side Elementary School in Cumberland, Maryland.

She begins with familiar concepts, like push and pull. "I can show them the concept in gestures, and have students push and pull doors and toys," she relates.

Like many dual-language teachers, Zhou must speak only in the target language. "At first, students might [repeat] the words in English, but by the second time, they will say the words in Chinese," she reports. "One boy heard the word *addition* in English and asked, 'What is addition?' He only knew the Chinese word for it," she recalls, laughing.

Zhou administers tests and quizzes that she creates in Chinese, although "benchmark tests are given in English. These are district tests," she explains.

Among the program's benefits, "my students are building a bridge between Chinese and English, a bridge of understanding how to transfer what they learned from me into their lives. It's a higher level of thinking for them," she maintains.

"When a student is experiencing two languages, [he or she is] also experiencing two cultures," she contends. "My kids will become very open-minded and tolerant when they grow up. [They'll believe] it's okay to be different, [and will tell others,] 'I respect your language and culture.' They will be able to work better with others on teams."

Raquel Scariot, first-grade teacher at Harris Elementary School in Tooele, Utah, focuses on science, math, and social studies in Portuguese, along with Portuguese literacy, while her partner focuses on English literacy. "We try to combine things. For example, if I tell the students a story in Portuguese, she will teach the same story in English," she explains.

She uses pictures, songs, objects, and videos to teach the content and the language. "I use a lot of concrete things. [For example, while teaching about water,] I used water and ice and had them make vapor with hot water," she relates. Students also play games in which they match pictures of rivers, oceans, and lakes to Portuguese words.

In first and second grade, Harris students don't receive a formal grade for science, says Scariot. "I grade them in math and provide a Portuguese proficiency report to their parents at the end of the year." Immersion students continue to learn science only in Portuguese until fourth grade, she notes.

Challenges and Strategies

"Many [immersion] teachers find that they need a variety of materials. I need prep time to ensure I have the materials table all set up, with [objects labeled] with the words in French to describe [them]. I need to work a lot on vocabulary," Hinton maintains.

"Sometimes it's a challenge to make myself understandable, especially during the first two months. I'm not allowed to speak English. My students don't know that I speak English. I need to repeat, repeat, repeat until they understand me," Scariot relates. "I don't want them to get frustrated and not like the language."

When Pantin and her students went on a field trip recently, it was conducted in English, but Pantin spoke Spanish to the students throughout the trip. "I have to do as much as I can with the Spanish in the limited time I have with students (about two-and-a-half hours with each group)."

Finding materials is another challenge. "It's hard to find quality resources in Spanish for science and social studies. Guided reading books have science topics like planting seeds. I create a lot of my resources," Pantin asserts.

Zhou and the other Mandarin teachers translate the curriculum into Chinese. When they show videos, "we have to mute them and read the transcript in Chinese," she explains. When she finds a poster she'd like to use in class, she often re-draws it and adds Chinese text. "I love drawing. I do this all the time, even for math," she relates. "I also have students draw what they are thinking so I can tell whether they understand the [science] concept."

The Utah Portuguese Dual Language Immersion Team provides a book containing science lessons translated into Portuguese. "It's nice as a guide because it follows Utah Common Core," Scariot contends. "I can use the lessons in the book or create my own. I look for lessons online as well."

Elementary Spanish teachers, take note: Three popular titles in the Next Time You See series from NSTA Kids will soon be available in Spanish. Watch for *La Próxima Vez Que Veas La Luna* (*Next Time You See the Moon*), *La Proxima Vez Que Veas Una Puesta Del Sol* (*Next Time You See the Sunset*), and *La Proxima Vez Que Veas Una Cochinilla* (*Next Time You See a Pill Bug*), by Emily Morgan, in the NSTA Science Store at *www.nsta.org/store.* ●

Quotable

Tell me and I forget. Teach me and I remember. Involve me and I learn.

—Benjamin Franklin, U.S. scientist, inventor, and politician (1706–1790)

PULL-OUT SECTION

SCIENCE TEACHERS' GRAB BAG

Inside this Convenient Pull-Out Section you will find:

Freebies for Science Teachers

Bringing Biotechnology to Life. This resource from the American Farm Bureau Foundation for Agriculture and the International Food and Information Council Foundation, for students and educators in grades 7–10, explores biotechnology and its role in food production. Through seven sequential lessons, students answer questions like these: What is DNA? How can we examine DNA? What is selective breeding? What is biotechnology? How is biotechnology used? How do researchers compare DNA? Where would we be without genetically modified organisms (GMOs)?

The resource also contains a research and public presentation module that guides students through the process of sharing what they've learned with an audience outside the classroom. The lessons support the *Next Generation Science Standards* (*NGSS*) and include student handouts. Refer to *http://bit.ly/1PWjjWW.*

Promoting STEM. STEMJobs.com and the National 4-H Council have collaborated to produce resources for generating interest in science, technology, engineering, and mathematics (STEM) fields and careers among students ages 13–18. The materials include Motion Commotion, an experiment exploring the physics of distracted driving, and the STEM Type Quiz, which helps students discover how their skills relate to STEM. And stay tuned: More resources are expected to be released soon, including articles, blog posts, videos, lesson plans, fast facts, and infographics exploring topics like avionics, geoscience, music technology, toy design, biotech, beauty, extreme sports, and extreme environments. Visit *http://bit.ly/1Ll1GIs.*

SHMUEL SPIEGELMAN

Ask Dr. Universe. Have a baffling science question? Ask Dr. Universe, an inquisitive cat who loves to answer tough, smart questions from curious kids worldwide. Produced at Washington State University, this resource for all ages provides answers to science questions of all kinds: Do animals dream? How are magnets made? What's under a volcano?

Users can search a database of answered questions organized by category (e.g., Brain and Body; Culture, Earth, and Sky; Food and Health; History and Geography; Plants, Animals, and Bugs; and Technology, Engineering, and Math) or submit a new question of their own. Consult *http://bit.ly/1P0EQNP.*

Quantum Spot Academy. High school student Parker Ruth started this service project as a way to spark interest among young people in modern and contemporary physics. Discouraged by what he found to be a lack of approachable, entry-level resources in modern physics, Ruth produced a series of 15-minute videos exploring modern physics concepts in an approachable, understandable way. The videos address concepts such as relativity, black holes, cosmology, quantum mechanics, the Standard Model, and antimatter. See *http://bit.ly/1Xj5DEk.*

Scientists in the Classroom. An initiative from the National Center for Science Education's teacher network connects middle and high school teachers and their students with experts in the fields of evolution and climate change. In the program, teachers are matched with a local scientist who visits the classroom during the semester and collaborates with the teacher to create meaningful learning experiences on climate change science and other challenging-to-teach topics. Students and teachers learn valuable content from the scientist, and students are exposed to new careers in science.

To learn more or apply, visit *http://bit.ly/1Lu7Hm2*. Teachers also can e-mail Kate Heffernan, Scientists in the Classroom intern, at *Heffernan@ncse.com* for additional information.

SaveOnEnergy.com. Created by the recipients of the 2015 SaveOn Energy.com teacher grants, this site's innovative lessons for elementary and middle levels can increase students' awareness of energy issues and the environment. Elementary lesson titles include Do Me a Flavor: Growing Fresh Organic Herbs; Energy 101; Energy Conservation; and Lights! Camera! Action! Save Energy! Middle level lessons include Cooling Costs and Insulation and Understanding Energy Costs. In addition, the website offers kid-friendly tips on saving energy, electrical safety, living a "green" lifestyle, and other topics. See the website *http://bit.ly/1CXndK6.*

See Freebies, pg G2

Freebies, from pg G1

Introduction 2 Design: Engineering Design Courses. SparkFun Electronics and Colorado University (CU) at Boulder have created introductory engineering design courses for the high school and collegiate levels. The semester-long courses teach the fundamentals of engineering design through three components: lectures that deliver technical content like mechanical design, electronic design, and software design; hands-on activities that develop skills necessary for prototyping; and long-term, team-based design projects that require the production of a functional prototype. The courses were field tested in a Colorado high school and at CU; students in both groups reported increased confidence in technical knowledge required of the manufacturing process and in their problem-solving abilities. Access the courses at *http://bit.ly/21c1jvn* (high school) and *http://bit.ly/21c1s1W* (college).

DROW_MALE

Kea: Learn Birds Through Play. This app for iPhone and iPad helps students learn to recognize birds and their calls through games. Beginner mode is for young students (grades K–5) or those just starting out with birds, while timed and scientific names mode keep the game challenging for more advanced students (grades 6–12). In addition, the app offers access to Kea's entire species database, with thousands of bird photographs and sound recordings, covering North America, Europe, Costa Rica, and Australia. Learn more and download the app at *http://bit.ly/1N6uHgi.*

The Story of Climate Change. Earth Day Network's interactive, digital textbook for middle level students offers a stimulating foundation in both climate change issues and solutions. Through this multimedia resource, students can watch glaciers melt, dive into the world's coral reefs, and explore bike-share programs—all from their tablet. The book moves students beyond pages and vocabulary words to practical applications of climate science. It features six chapters—each with photos, animations, and videos; critical-thinking activities; and discussion questions to reinforce unit concepts—and includes a corresponding teacher's guide. The textbook can be found at *http://apple.co/1Mw9A5v* and the teacher's guide at the website *http://bit.ly/1OajImQ.*

Aquarium Webcam Resource Kits. To expand the reach of its educational programs, the Aquarium of the Pacific has created inquiry-based curriculum kits based on its live animal webcams. The online kits contain lesson plans, activities, online resources, and educational videos. The kits, which are targeted for the grade ranges of the *NGSS,* encourage students to make observations using one of the aquarium's live-streaming webcams, including Tropical Pacific (grades K–2); Shark Lagoon, Sea Dragon Habitat, or Penguin Habitat (grades 3–5); and Blue Cavern Kelp Forest (grades 6–8). Refer to *http://bit.ly/1NlA910.*

Mars Fiction With "Reasonable" Science. Many scientists and writers have written stories and novels about future Mars exploration. For a list of some that you and your middle, high school, and college students might enjoy, visit *http://bit.ly/1lDGLLW.* Compiled by Foothill College astronomy professor Andrew Fraknoi, the one-page, Mars-themed document features 15 titles, along with a brief annotation describing each. The document is part of Fraknoi's larger list of science fiction works with "reasonable" science, Science Fiction Stories With Good Astronomy and Physics: A Topical Index, available at *http://bit.ly/1zjuijj.*

Habitat Earth in the Classroom. The California Academy of Sciences' award-winning film *Habitat Earth* takes viewers on a journey through the vast networks of life on Earth and shows them the surprising ways that human and ecological networks intersect. At this website, teachers can access educator guides, video lessons, and collaborative activities for students in grades 3–12 that extend the film's concepts to the classroom. For example, teachers can use the video clips and other resources to explore key ideas such as photosynthesis, the microscopic world within soil, and how ships carry invasive species across global waters while connecting human societies worldwide. See *http://bit.ly/1NUq7OJ.*

KALUPAHANA

"Lab Cleanup in 15 Minutes a Day." This article from the American Association of Chemistry Teachers journal *Chemistry Solutions* offers practical tips for whipping a high school chemistry lab into shape and making it safe. The article breaks down the sometimes overwhelming process of organizing a lab into manageable chunks for teachers.

For example, the author suggests that teachers begin small by making a list of the labs taught in each course, then identifying the chemicals (name and formula) needed for each lab. The article then shares advice on reading chemical labels, storing chemicals, organizing chemicals, and properly disposing of unused chemicals. Read the article at *http://bit.ly/1IgpQcf.*

Early Childhood Astronomy Lessons. The National Optical Astronomy Observatory offers a sequence of lessons for preK–3 students that teach about shadows and how they form. The lessons begin with reading the children's book *Moonbear's Shadow,* by Frank Asch, which engages students in questions about why shadows change and move. Students then use flashlights to learn about the properties of light traveling in a straight line and to explore how the direction of light on an opaque object affects its shadow. The lessons conclude with outdoor activities that explore the relationship between shadows and the Sun's position in the sky. Find the activities, along with links to additional resources, related reading, and relevant research, at *http://bit.ly/1Yy29Af.*

Find Your Park, Love Your Park. To celebrate the 100th anniversary of the founding of the National Park Service in 2016, the National Geographic Society created five educational modules to teach students about the importance of U.S. national parks and empower them to preserve and protect them. Designed for fourth graders, but adaptable for younger and older students, the module activities include such experiences as documenting animal tracks at local parks, geocaching scavenger hunts, using digital maps to explore different parks, and discussing concrete ways students can help solve challenges facing national parks. In addition, educators, students, and their families can take a pledge to visit, protect, and love specific parks on the interactive Pledge to Love America's Parks map. Learn more at the website *http://bit.ly/1PoRUg9.* ●

Editor's Note

An alert reader notified us of concerns regarding the validity of some of the resources on izzit.org, *a website featured in the Freebies for Science Teachers column in our November 2015 issue. We encourage all educators to review resources before sharing them with their students.*

News Bits

- **A new resource from SkillsUSA, a nonprofit group dedicated to creating a skilled workforce, is helping elementary students nationwide explore science, technology, engineering, and math (STEM) careers at an earlier age.**

The Jump Into STEM! curriculum, which is freely available to SkillsUSA's 4,000 chapters nationwide, provides 22 interactive sessions that feature the training and knowledge needed to pursue 11 different STEM career clusters. During these sessions, high school, college, or postsecondary SkillsUSA members present an activity from the curriculum and share information on the career under discussion, which might range from architect to computer programmer to airline pilot. The sessions can be presented as a one-day festival or as a series over the course of the school year.

"We are excited to bring this new resource into elementary schools because it helps shine a light on career and technical education in the community," says Tim Lawrence, SkillsUSA executive director. "Jump Into STEM! allows students to begin having career conversations, and it could spark their interest in a specific career sooner." He adds, "The program also gives our SkillsUSA members the opportunity to practice public speaking and facilitation skills, which helps in the development of both personal and workplace skills."

Elementary schools can participate by contacting their local SkillsUSA chapter. Visit *http://bit.ly/1TlnnhO* to learn more.

- **Girl Scouts in one California county can now add a new badge to their vests: the My STEM Life badge. The Girl Scouts of Orange County created the badge for its scouts ages 11–14 to help reduce the gender gap in STEM.**

About 4,000 girls in Orange County—an area in which three-fifths of the fastest growing jobs are in STEM fields—are eligible for the badge. To earn it, the scouts can work with a robotic mannequin at the Kaiser Permanente Medical Center or monitor fish populations, collect plankton, and supply data for the Crystal Cove Alliance, among other activities. The goal is to encourage them to consider STEM careers at a time when many girls move away from STEM subjects, according to research.

"We're leaving half the population out of the most exciting jobs of the 21st century," says Paula Golden, president of Broadcom Foundation, one of nine local employers that have partnered with the Girl Scouts to make the badge possible. She hopes this new opportunity will help change that.

Read more about the My STEM Life badge and the scouts' efforts to earn it at *http://bit.ly/1XpvK1C*.

- **In response to the teacher shortage in Arizona, one new program allows teacher hopefuls in the state to skip what has long been a staple of traditional teacher prep programs: the student teaching requirement. Instead, the Rio Salado College Teacher-in-Residence (TIR) program allows preservice teachers to complete an online internship while teaching full-sized classes to earn their certifications.**

To participate, preservice teachers must pass a subject-matter test, have completed a Structured English Immersion course, and have an AZ Fingerprint Clearance Card and an offer from a school. The participants teach full-time and receive full pay and benefits while completing the program.

Some community members are concerned that bypassing the student teaching requirement will result in underprepared teachers, particularly at a time when other communities are addressing shortages by focusing on teacher quality. The New Jersey Board of Education, for example, recently passed regulations that require an additional 175 hours of student teaching for certification. Read more at the website *http://bit.ly/1HxLBV4*.

- **A new study shows that undergraduate students who use open educational resources (OER) do just as well—or even better—than students in classes with traditional textbooks.**

Researchers at Brigham Young University, the Michigan State Department of Education, and Lumen Learning, a nonprofit focused on the use of open courseware, led the study, which followed 5,000 students using OERs and 11,000 "control" students using traditional textbooks at 10 universities in 15 different courses. The research focused on five measures of student success: course completion, final grade in the course, final grade of C- or higher, enrollment intensity during the current semester, and enrollment intensity the following semester.

The researchers found no significant differences in course completion, though in some cases, the OER groups showed higher rates of completion than the control groups. In student achievement and final grades, the results were mixed, though in a number of cases, the OER students did better than the control group. And when it came to enrollment intensity, the OER students tended to enroll in more courses.

The researchers note that the slight differences in grades and completion could be attributed to the freely available nature of OERs. All students had access to those resources, for example, while some in traditional courses may have opted not to purchase the required textbook. "Consequently, we would expect some enhanced probability of success for members of the treatment group," the researchers say.

"Given the present research," says John Hilton III of Brigham Young University, who coauthored the study, "policy makers, researchers, and educators need to carefully examine the ethics of requiring students to purchase traditional textbooks when high-quality openly licensed alternatives are freely available." Learn more at *http://bit.ly/1OygdFo*. ●

What's New

FROM U.S. GOVERNMENT SOURCES

National Institutes of Health (NIH)

Laboratory Safety Resources

At *http://1.usa.gov/1XB0aca,* K–college educators can access a comprehensive guide to web resources in laboratory safety. Produced by NIH's National Library of Medicine (NLM), the page offers links to safety information for clinical, academic, and school labs, as well as resources for the safe handling of chemical, biological, and nanotechnology materials. The guide also provides links to safety-related blogs, podcasts, and videos.

National Aeronautics and Space Administration (NASA)

We're With You When You Fly: Aeronautics for PreK

This educator's guide introduces preschool children to aeronautics and science, technology, engineering, and math (STEM). Each lesson is built around a popular children's science trade book and addresses one of six themes: Gliders in Nature, Parachutes, Kites, Helicopters and Airplanes, and World Flyers. The integrated lessons include both pre-reading activities to help students build background knowledge and follow-up inquiries that allow young students to explore firsthand the science concepts introduced in the story.

In Gliders in Nature, for example, students begin by discussing what they know about flying animals and investigating photographs of birds and animals that fly or glide. After reading *The Dandelion Seed* by Joseph Anthony (1997), students continue learning through activities such as a seed sort, an interactive maple seed demonstration, and two simple inquiries (e.g., Wind and Wings and Paper Whirly-Birds). The guide is available at *http://go.nasa.gov/1PbbPxB.*

***Living in the Age of Airplanes* Educators Resource Guide**

Seven standards-based activities help students in grades preK–12 explore the social and scientific advances in the speed and distance of human travel, as well as NASA's contribution to aviation. From comparing walking speeds to flying speeds and calculating how long it will take to reach certain destinations (middle and high school levels), to playing an air cargo game and creating map projections (elementary and middle levels), the interdisciplinary activities incorporate science, math, and geography concepts and show students how air transportation has changed the world. This guide was developed as a supplement for the IMAX feature film *Living in the Age of Airplanes,* released in 2015 by National Geographic. Download the guide at *http://go.nasa.gov/1LpnLfr.*

U.S. Department of Agriculture (USDA)

Hungry Pests Invade Middle School

An interdisciplinary curriculum from the USDA teaches middle level students about 18 invasive species threatening the nation's trees, plants, and crops. The curriculum supports *Common Core State Standards* and *Next Generation Science Standards* and can be used in science, math, language arts, and history classes. Through the curriculum's lessons and online resources, students explore pests including the emerald ash borer, khapra beetle, Mediterranean fruit fly, and Asian longhorned beetle, and learn ways to stop the spread of invasive species.

In the lessons, students closely read relevant texts, participate in team research projects, develop interactive maps, and share knowledge in class discussions. Other activities include creating comic strips and writing news articles about the pests. Teachers can also download a set of invasive species cards with photographs of each pest, descriptions of the harm it causes, and action steps to prevent its spread. See *http://bit.ly/21pNIk6.*

National Park Service (NPS)

Alaska, Virtually

Denali National Park and Preserve in Alaska is an environment of extreme temperatures, tall mountains, and glacial landscapes. The climate and landscape might be very different from where you live. If the park is too far away to visit, you can bring Denali to your classroom! Through several distance-learning programs, targeted for grades K–6, students can meet Denali Park staff via Zoom or Skype videoconferencing connections and learn about the park and the Alaskan environment.

The programs support national teaching standards and address topics such as the geology of the mountain, what makes the park unique, and the science of sled dogs. For more information or to register for a digital learning experience, visit *http://1.usa.gov/1Iig4X6.*

Library of Congress (LOC)

Teaching With the LOC

Read this blog to discover the most effective techniques for using LOC primary sources in K–12 classrooms. Teaching strategies, outstanding primary sources, lesson plans, teacher resources, and current thinking on effective classroom practice are all open for discussion. One recent discussion addressed the topic of brain science and concussions using current and historical primary sources about football. Another discussion explored how three digitized artifacts from the LOC collection—a map from 1977, a poster from 1944, and a newspaper article from 1915—can be used to support a key theory in Earth science. Refer to *http://blogs.loc.gov/teachers.*

U.S. Department of Energy (DOE)

"The Easy Energy Action Plan Checklist"

Promote energy awareness and energy conservation with this DOE checklist. The poster presents 10 Simple Ways to Use Energy Wisely, from familiar ideas like turning off lights and computers when not in use to less common tips such as using "smart" power strips and unplugging chargers when not in use. Interested teachers might host a schoolwide contest to see which classroom can have every student complete the checklist activities in one month; teachers can post the winners on Facebook with the hashtag #ActOnClimate. Access the poster at the website *http://1.usa.gov/1Xt6SpM.*

Women@Energy Series

This series showcases profiles and videos of inspirational women in STEM careers at the DOE. The women share what inspired them to work in STEM, what they do each day on the job, what they appreciate about working for the DOE, and what ideas they have for engaging others in STEM. Introduce your middle level and high school students to Amber Hames, a graduate fellow at Argonne National Laboratory who works on recycling used nuclear fuel using pyrochemical processing; Simona E. Hunyadi Murph, a principal scientist for Savannah National Research Laboratory who specializes in nanomaterials research; or Linda Silverman, senior adviser in the Office of Energy Efficiency and Renewable Energy at DOE headquarters in Washington, D.C., whose interests in math, finance, international business, and international relations led to her current position.

The website has 12 pages of interviews (see *http://1.usa.gov/21RrCal*). It will eventually include sample classroom lessons to engage middle school girls with the Women@Energy series.

U.S. Forest Service

Forest Education Resources

At *www.fs.fed.us/learn,* educators will find K–12 resources to explore U.S. forests and grasslands and how we benefit from them. Students of all ages can connect with Forest Service programs for young adults, enter the Smokey Bear/Woodsy Owl poster contest (for grades 1–5), and learn more about forestry science and careers in the field. Elementary and middle level teachers can find ideas for the classroom as well as multimedia resources, such as Critter Cams (e.g., a bald eagle nest), virtual field trips (e.g., Boise National Forest in Idaho), and live distance-learning adventures about pollination, climate change, wetlands, and other topics.

National Oceanic and Atmospheric Administration (NOAA)

Science on a Sphere Explorer

With NOAA's release of Science on a Sphere Explorer, the desktop version, students can experience an interactive, 3D Earth in the classroom. The software, available to download for PC or Mac and most appropriate for use in middle level and high school classrooms, lets students view the Earth in 3D and provides weather, geological, environmental, geographical, and astronomical visualizations. The visualizations show information provided by satellites, ground observations, and computer models and rapidly animate through real-time global data. The display is interactive: Students and teachers can zoom into, probe, and graph the data, as well as add supplementary material including websites, videos, pictures, and placemarks. Watch an introductory video about the software's capabilities and find ideas on how to use the software in the Earth science classroom at *http://1.usa.gov/1SqfSp8.*

NOAA In Your Backyard

At *http://1.usa.gov/1M3y9mL,* you can find out about NOAA guest speakers, field trips, and professional development in your area. Regions include Alaska, Central, Great Lakes, Gulf of Mexico, Mid-Atlantic, New England, Northwest, Southeast, and Southwest. Information for the Pacific Islands and the Caribbean will be added soon, according to the website.

Learn how to connect with National Weather Service offices for school visits, forecast office tours, and student and educator resources; with the National Estuarine Research Reserve System for field trips, professional development, and educator resources; or with the Integrated Ocean Observing System for curriculum, real-world data, and multimedia. Other organizations featured include NOAA National Marine Sanctuaries and the National Sea Grant Program.

Kids.gov

Career Spotlight: Brain Scientist

Are your students fascinated by the amazing brain and how it works? If so, they might have found a future career path! In this Career Spotlight video targeted for elementary and middle levels, students meet Dave Thomas, a brain scientist from NIH's National Institute on Drug Abuse. Through his work, Thomas studies how the brain becomes addicted to drugs and seeks ways to lessen the grip of addiction by changing the brain. Watch the video at *http://1.usa.gov/1lS7jJl.*

U.S. Environmental Protection Agency (EPA)

Understanding the Clean Water Act

In May 2015, EPA and the U.S. Army finalized a rule under the Clean Water Act to more clearly protect the streams and wetlands that form the foundation of the nation's water resources. Now educators can access fact sheets, videos, and other resources to help students of all ages (and themselves) better understand what the rule does and does not do and learn more about the importance of clean water in our lives. See *http://1.usa.gov/1NZ2MeH.*

For example, the infographic WHY #Clean Water Rules illustrates how streams and rivers are critical for agriculture, healthy communities, the economy, and people; an interactive map shows the percentage of populations that get drinking water from protected streams. The resources could be used in environmental science and biology lessons that involve students in examining and interpreting real data.

Connecting Science With Nature

In this video, Texas science teacher Laura Wilbanks explains how she helps students develop an interest in STEM by teaching them about nature and local environmental issues. Wilbanks has been developing innovative environmental education programs for her students for more than 25 years. Through field investigations and partnerships with local science agencies, her students are learning to understand the science behind environmental issues in their community, from arsenic in drinking water to the impacts of climate change. Watch the video at *http://bit.ly/1NVC2Sh.* ●

In Your Pocket

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

January 28–31

Fund for Teachers Grants

PreK–12 teachers can use these grants to support professional development (PD) experiences of their own design, occurring anywhere in the world. Individual teachers receive up to $5,000 and groups receive up to $10,000 to conduct their own summer projects. Application instructions vary by state; check eligibility and apply online by **January 28** at *www.fundforteachers.org.*

Six Star Science Online Teacher PD Fellowships

The American Physiological Society offers these fellowships for middle and high school science teachers. Over the course of one year, online teacher (OT) fellows learn about Six Star Science, a research-based framework for excellence in science instruction, and develop methods for implementing it in their classrooms. During their fellowship, OTs also engage in online discussions, design experiments, and develop strategies to make their current lessons more student-centered.

Science teachers in any discipline with at least one year of teaching experience and a current appointment are eligible. Teacher teams from one school and those in rural areas, systems with limited resources, or primarily minority schools are especially encouraged to apply. Apply by **January 29;** visit *http://bit.ly/1QKR7Gx.*

The Follett Challenge

This challenge rewards top-notch educators in the United States and Canada who teach 21st-century skills. Entrants create a three- to five-minute video that showcases how their programs teach critical thinking, communication, creativity, and collaboration in innovative ways. A panel of education thought leaders and the public will vote on the best entries. One grand-prize winner will receive $60,000 worth of Follett School Solution products and services; two semifinalists will win $30,000; and 10 People's Choice winners will receive $8,000.

Teachers, technology specialists, administrators, librarians, and media specialists at K–12 schools are eligible. Submit entries by **January 29.** For details, consult *www.follettchallenge.com.*

Rural Trust's Global Teacher Fellowship Program

The Rural Trust provides these fellowships for the personal and professional development of 25 rural teachers. Fellows design their own summer learning experiences—and are particularly encouraged to study abroad—from which to develop interdisciplinary, place-based curricula that meet their state and local content standards. They then attend a two-day, place-based learning institute to create such curricula during the fall after their experience. Individual teachers can apply for grants of $5,000; teams of two or more can apply for $10,000.

Full-time K–12 teachers, counselors, media specialists, and other personnel with four years of teaching experience who work or teach at least 60% of the time in public rural classrooms are eligible. Apply by **January 30** at *http://bit.ly/1fEcyH5.*

SPIE Education Outreach Grants

SPIE, the international society for optics and photonics, provides these grants for optics- and photonics-related education outreach projects. Schools, youth clubs, universities, science centers, optics centers, industry associations, and optical societies are eligible for grants of up to $5,000. Projects are judged by their potential to impact students and increase optics and photonics awareness. Apply by **January 31;** consult *http://spie.org/x36692.xml.*

MAXIMUS Charitable Foundation Grants

The foundation awards these grants to nonprofit organizations serving disadvantaged populations and underserved communities in three focus areas: youth and children development, community development, and healthcare. Preference is given to programs that promote personal growth and serve disadvantaged, low-income youth.

Grants of between $2,500 and $5,000 are available, though larger grants may be awarded to programs with compelling needs. Apply by **January 31;** see *http://bit.ly/LgNOpd.*

Captain Planet Foundation Grants

These grants go to schools and nonprofit organizations that share the foundation's mission: to help youth better understand the world through active, hands-on learning projects that improve the environment in their schools and communities. Grants of between $500 and $2,500 are available, though preference is given to those that have secured 50% in-kind or matching funds. Ideal projects will incorporate both environmental education and service opportunities for youth.

Organizations with operating budgets of less than $3 million can apply by **January 31;** consult *http://bit.ly/N4BTqL.*

February 1

Toshiba America Foundation Science and Math Improvement Grants

These grants are awarded to science and math teachers of grades 6–12 with innovative classroom project ideas. Proposed projects should give students an opportunity to "do science" in new ways that will increase their engagement with the subject matter and improve their learning. Successful projects often tap into students' natural curiosity, enable them to ask their own scientific questions, and incorporate the expertise of community partners.

Applications requesting less than $5,000 are accepted year-round from teachers at public or private schools. Requests of more than $5,000 are due by **February 1.** Visit *www.toshiba.com/taf.*

Project Orange Thumb Grants

Project Orange Thumb funds new garden projects sponsored by public schools, youth groups, and other nonprofit community groups in the United States and Canada. Projects should include horticultural education, community involvement, neighborhood beautification, and sustainable agriculture. Thirty groups will receive $5,000 in cash and tools to support their projects; one group will win a complete garden makeover. Apply online by **February 1** at *http://bit.ly/19NyJm2.*

NEA Foundation Student Achievement Grants

The National Education Association (NEA) Foundation provides these grants to support work at public schools and universities that improves academic achievement and encourages critical thinking and problem solving in any subject area. Grants of $2,000 and $5,000 are awarded to programs that stimulate inquiry, critical reflection, and self-directed learning.

Some funds may be used to support PD, but most should pay for student materials or educational experiences. PreK–12 public school teachers, public education support professionals, and faculty and staff in public institutions of higher education are eligible. Preference is given to support professionals and teachers with fewer than seven years of experience who are also NEA members. Apply by **February 1** at *http://bit.ly/Xo4n8W.*

NEA Foundation Learning and Leadership Grants

The foundation also provides funds for individual teachers and support professionals or groups of them through its Learning and Leadership program. Individual grants support participation in PD programs, summer institutes, conferences, or action research. Grants to groups fund study groups, lesson study, action research, or mentoring experiences for faculty and staff.

Individuals receive $2,000 grants; groups get $5,000. PreK–12 public school teachers, public education support professionals, and faculty and staff in public institutions of higher education are eligible. Apply by **February 1;** see *http://bit.ly/XMe5xB*.

American Honda Foundation Grants

The American Honda Foundation awards grants to youth education programs focused on science, technology, engineering, and math and the environment. Grants of between $20,000 and $75,000 are available. Programs should be imaginative, creative, youthful, forward-thinking, scientific, humanistic, or innovative. Public and private elementary and secondary schools, public school districts, and nonprofit organizations with 501(c)(3) status may apply by **February 1** at *http://bit.ly/OnjIiB*.

American Association of School Librarians Collaborative School Library Award

The American Association of School Librarians (AASL) recognizes teachers and school librarians who have teamed to create a project, event, or program to further information literacy, independent learning, and social responsibility using the school library. Projects should serve as a model for others in collaborative planning. School librarians who are AASL members are eligible.

Winners receive $2,500. Apply by **February 1;** see *http://bit.ly/1gZtp7w.*

February 10–25

Air Force Junior ROTC Grant

The Air Force Association offers grants of up to $250 to promote aerospace education in classrooms and Junior ROTC units. Grants may be used for aerospace-related items, such as books, materials, or field trips to an aerospace museum, Air Force base, or other aerospace facility. Classrooms and units can apply every other academic year. Apply by **February 10;** see the website at *http://bit.ly/18sWJ3p*.

Scott's Miracle-Gro Grassroots Grants

This program provides $1,500 grants to help create edible gardens, flower gardens, and community green spaces across the United States. Projects should include youth, foster community spirit and public service, and promote health and wellness. Nonprofit organizations with plans to create such gardens or green spaces may apply by **February 19.** See *http://bit.ly/1HssNGt*.

World of 7 Billion Contest

This contest is part of Population Connection's World of 7 Billion campaign to promote understanding of the ways our world population of 7 billion affects our neighborhoods and global communities. High school students can enter 60-second videos that illustrate one of the following global challenges: deforestation, public health, or water scarcity. Videos should include how population growth affects the selected issue, why the issue is important, and at least one idea for a sustainable solution.

Free curriculum resources for teachers are available, and student winners will receive cash prizes of up to $1,000. Apply by **February 25.** See the website *http://bit.ly/1QL6u1M*. ●

Summer Programs

Editor's Note

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

Rocky Mountain Field Camp. The Geological Society of America (GSA) will host this field camp during June 19–24. Participants study the geology of central Colorado firsthand and collect mineral, rock, and fossil samples to bring back to their classrooms. They also tour a working gold mine, experience the hot springs, and visit famous geological sites, including the U.S. National Ice Core Laboratory. The ice core samples there are the same ones seen in climate change documentaries.

Participants should be able to hike several miles a day—sometimes in tough terrain. The field camp is for K–12 teachers, preservice teachers, community college professors, college students, and informal educators. Register by **February 15.** For details, visit *http://bit.ly/1ThPAWR*.

Acadia Field Camp. This five-day GSA field camp takes teachers to Mount Desert Island and the Schoodic Peninsula of Acadia National Park to study glaciers, coastal processes, and structural geology. During July 24–29, participants will measure and map faults and dykes, carry out a beach transect, create a beach profile, draw cross sections, observe and interpret rock outcrops, view a granite splitting demonstration, participate in an air quality research project, determine the relative ages of the rocks, and learn about nocturnal animal behavior. Classroom activities will be incorporated into the field camp.

K–12 Earth and environmental science, special education, and preservice teachers and college students are eligible to attend. Apply by **February 15.** Consult *http://bit.ly/1ThPAWR*.

Take-Flight Costa Rica Program. This professional development program, sponsored by Save the Rainforest, Inc., and Fundacion Neotropica, a conservation organization, is open to high school biology and environmental science teachers. Participants spend 11 days in Costa Rica's rain forests, where they learn about sustainability and conversation efforts in this part of the world. All food, travel, and lodging expenses are covered, and up to three graduate credits are available.

Trips will run during June 20–30 and July 15–20. Apply by **February 15.** Visit *www.saverfn.org*.

Mesa Verde National Park and the Construction of Pueblo History. In this National Endowment for the Humanities Summer Landmarks workshop, K–12 teachers will come to Colorado to explore Mesa Verde National Park, Crow Canyon Archaeology Center, and 1,800 years of Pueblo Indian history. Participants do hands-on fieldwork and laboratory analyses guided by Crow Canyon archeologists. Evening lectures and discussions provide resources for teaching anthropology and archeology in K–12 classrooms. Participants receive a stipend to cover travel, books, and other living expenses.

Choose from two sessions: June 26–July 2 and July 17–23. No previous experience in anthropology or archeology is required. Apply by **March 1.** See *http://bit.ly/1Nyvj0w.* ●

BLICK ON FLICKS

Deeds, Not Words: Science and *Suffragette*

By Jacob Clark Blickenstaff

I have been writing Blick on Flicks for nearly six years, and I hope regular readers have noticed a few patterns in the films I review and my approach to their use in science classes. First, I have tried to look for instances when filmmakers get the science right, not just scenes with scientific errors. I also seek out movies and television programs that portray scientists as more than just caricatures: those that depict scientists as women, people of color, and/or men with some social skills. Finally, I have written about films that most people would not expect in a science class (like *Twelve Years a Slave* and *The Devil Wears Prada*). I do this because I believe that putting science into conversation with history, literature, and the arts breaks down artificial barriers between human knowledge. To begin 2016, I take another step in this direction with *Suffragette*.

The film's title refers to women who campaigned for suffrage (the right to vote) in the late 19th and early 20th centuries, particularly those in the United Kingdom and the United States. Major figures in the women's suffrage movement include Susan B. Anthony and Alice Paul in the United States, and John Stuart Mill and Emmeline Pankhurst in the United Kingdom. *Suffragette* combines historical figures like Pankhurst and British suffragette Emily Davison with fictional characters representative of women in the movement.

Carey Mulligan stars as the fictional Maud Watts, who stands in for thousands of women who worked in London laundry facilities in the early 20th century. At the start of the film, set in 1912, we learn that Maud began work in an East End laundry as a child, just seven years old, and is considered to be nearing the end of her work life now that she is in her mid-twenties.

Maud is initially unsympathetic to the women campaigning for the vote through civil disobedience. She becomes part of the movement, first by testifying about the conditions in the laundry where she works, then by protesting when the prime minister takes no action after the testimony. She is beaten and arrested, spending several days in jail. Her husband and neighbors begin to ostracize her for becoming a suffragette.

Eventually, she is fired from her job and takes up more radical action, cutting telegraph lines and blowing up mailboxes with homemade bombs. Though the action of the film ends in 1913, it would not be until 1928 that women in the United Kingdom would enjoy the same voting rights as men.

Historical Science

I see a few possible connections between *Suffragette* and school science, particularly in optics and chemistry. One of the leaders of the movement Maud works with is Edith Ellyn (a fictional character), played by Helena Bonham Carter. Ellyn is a pharmacist (called a chemist in the United Kingdom) who not only supplies medicine to the sick, but also bombs to the suffragettes. A government agent working to suppress the protests refers to the use of "dynamite," but in the one scene where we see Ellyn working on a bomb, she appears to be making gunpowder. (Dynamite is clay or diatomaceous earth soaked in nitroglycerine, while gunpowder is a mixture of saltpeter, sulfur, and charcoal—two very different explosives.)

The government uses an early 20th-century technology to track and publically shame suffragettes: the camera. Early in the film, government agents hold up a large, heavy camera (about the size of a basketball) and proclaim it as nicely portable and compact. They also note that it doesn't require a tripod, and so can be used covertly on the street. We later see many pictures of women entering or leaving meetings, and eventually close-up photos are published in newspapers to make life more difficult for the campaigners. While it is amusing to laugh at their old-fashioned idea of a "compact" camera, it seems to be a bit of exaggeration, as small (grapefruit-sized) Kodak Brownie cameras were widely available in 1900.

An optical phenomenon we see several times in the film is a character looking at a window or other glass surface and appearing to consider both her reflection and the objects on the other side of the glass. This partial reflection and partial transmission is most noticeable when the brightness on both sides of the glass is about the same. All clear surfaces transmit, reflect, and absorb some light, but the relative appearance of each can change depending on the lighting conditions. A person in a bright room after dark will only see the reflection of the interior of the room when looking outside because very little light is coming in from outside. In contrast, someone standing outside at night can easily see into a lit room because virtually all the light is coming out of the lit room. Maud looks through a window at some expensive clothing, but is able to see her own reflection as well since the lighting inside and outside the glass is about the same.

Science teachers could collaborate with a history or social studies teacher in exploring campaigns for women's suffrage in the early 20th century. In addition to the chemistry and optics topics described earlier, the role of steam power in the Industrial Revolution and scientific perspectives on innate intelligence would be interesting starting points for conversation.

Note: Suffragette *is rated PG-13 for some intense violence, thematic elements, brief strong language, and partial nudity.*

Jacob Clark Blickenstaff is the program director for Washington State Leadership and Assistance for Science Education Reform at the Pacific Science Center in Seattle. Read more Blick at http://bit.ly/amBgvm, *or e-mail him at* jclarkblickenstaff@pacsci.org.

Coming Together to Support STEM Education

Fifth graders from St. Theresa's Catholic School demonstrated their robotics knowledge to Iowa Lieutenant Governor Kim Reynolds during STEM Day at the State Capitol last year. The school received a Scale-Up grant from the state to support the HyperStream robotics program.

Educators across the country are challenged to provide engaging science, technology, engineering, and mathematics (STEM) education to all students. In some states like Iowa and Massachusetts, the state government actively supports the dissemination and development of STEM programs, while in others, private industries, nonprofit organizations, and schools are collaborating to boost interest in STEM in their region.

To make sure all Iowa students receive a quality STEM education, the Iowa Governor's STEM Advisory Council launched STEM Scale-Up to identify effective programs and offer grants to help educators across the state implement them.

"The principle of Scale-Up is we search the world for STEM programs, vet programs, [and] make sure they promote diversity, [are] engaging, [have] sustainability, and more," says Jeffrey Weld, executive director of the advisory council. "Current programs include Project Lead the Way, FIRST [For Inspiration and Recognition of Science and Technology] Robotics, HyperStream, and KidWind." The full list of programs is available at *http://bit.ly/21UQ7nh*.

Noting there are "a lot of gymnastics behind the scenes," Weld says a lot is done "in relatively short time. We're lining up all the dominoes on a hope and prayer, and thanks to some great people involved, it works." Programs apply to Scale-Up in the fall; Scale-Up reviews the programs and begins accepting applications from teachers for the approved programs in February and March. Awards are made in April, pending June budget approval. Teachers begin professional development in their programs over the summer.

Participating programs had to reapply this year to show they still meet the criteria. "They had to show data. It's fun to remind ourselves these programs really do work," asserts Weld. "We get incredible data in August every year. Across the board, kids who participate in STEM programs outperform kids who didn't. Kids show greater interest in STEM [subjects and careers]. We also found greater teacher confidence, especially in elementary. Seventy-five percent are still with the program without the STEM Council's monetary support. It's a true seed program."

Scale-Up divides the state into six regions, with a regional STEM manager responsible for sharing program information and working with school districts to identify programs that meet their STEM needs. "The state puts about $3.2 million into this. Each region gets about a half million. Some $3.2 million reached 40,000 kids, 600–700 teachers [when Scale-Up launched in 2011]. Four years later, the same amount of money from the state [is reaching] 100,000 kids, thousands of teachers. [By getting corporate donors and other partners, we] leverage the state's investment and get a lot more teachers engaged," he explains.

"We really do our best to make sure every school district in our region is aware" of the Scale-Up programs, says South Central Iowa STEM Regional Manager Sarah Derry, PhD. The regional managers attend administration meetings with area education agencies as well as "go through our public libraries. We keep tabs on schools that have participated and reach out to schools that haven't participated… Often after one person has applied, we find it spreads. We also advertise to 4H, Boys and Girls Clubs—we go through as many channels as we can in the community."

She adds, "It's very common for an educator to return [applying for new programs]…We hope that once they try a program out, educators will be able to get funding from other sources to sustain and grow that program."

For Ronda McCarthy, the science, technology, and STEM teacher at St. Theresa's Catholic School in Des Moines, Iowa, the Scale-Up program has been transformative.

"This is our third year. We had noticed the STEM grants available [through the governor's council] and had a parent willing to help write grants. We received all four grants we applied for [that first year]. It was our first taste of STEM, and we took off from there. It transformed our entire school," she recalls. "To date, we have received 29 STEM grants from the Iowa Governor's STEM Scale-Up program. We have STEM starting with Pint Size Science through eighth grade. All teachers are teaching STEM, not just science and math teachers. The STEM Scale-Up grants really provide grants for quality STEM programs that make it engaging for students.

"We are very resourceful," continues McCarthy. "We have talented teachers writing grants and getting community support. I'm happy to report that we are sustaining all of [the programs started through Scale-Up], and we're looking for more. Once you get a taste of it, you want every lesson to be a STEM lesson. It's the hands-on learning…I'm amazed how deep the students' understanding of the principles I'm teaching goes with STEM…For me, the biggest change is in the way the students work together to solve the challenges. They develop great collaboration skills that they will use throughout their lives. They develop an appreciation for [one another] and learn that working together to solve problems produces better outcomes."

McCarthy says the entire school has become a STEM school, which has led to another challenge: coordinating how the teachers share materials. She worked with her principal over the summer to map out a school-wide STEM curriculum using the *Next Generation Science Standards* as a "road map." The Scale-Up grants have "changed the way we teach and the way students learn. With STEM, we also link our learning with real-world problems and careers in STEM fields by taking field trips to STEM-related industries and companies. The school came alive with hands-on learning. Student collaboration is unmatched with STEM…Our whole school has changed," she concludes.

A State's STEM Agenda

Weld notes the STEM Advisory Board explored programs in other states when they developed Scale-Up, including @Scale in Massachusetts. The

@Scale grant program, which launched in 2010, funded programs across the state of Massachusetts primarily at the K–12 level. More recently, the state has "focused on how to raise awareness with junior and senior [high school students] of STEM careers, [and] engage students who [may not have thought of themselves] as STEM students," says David Cedrone, Massachusetts' associate commissioner for economic and workforce development.

"Our [current] focus through the STEM Starter Academy [program]…[is on] bridging [students' transition from] high school to community college," he adds. "It's part of a comprehensive statewide strategy…What we're seeing at the community college level is a need to increase the number of students interested in and aware of STEM [opportunities]…The [STEM Starter Academy] represents maturation [of the commonwealth's STEM plan]."

The STEM Starter Academy targets students entering community college who do not have strong math skills. "A major focus with the intensive summer program is assessing gaps [and focusing on those who were not prepared for college-level math] so students are now ready," explains Cedrone. "We are seeing students who enter this program connect with one another and build virtual cohorts. Those relationships serve those students and help retention."

The annual STEM Summit is another part of the state's strategy. The summit brings together approximately 1,500 attendees whose fields include early education, K–12, higher education, and the nonprofit sector to share what they are working on. "People are demonstrating…things teachers could take back to the classroom. We make [a variety of tools] visible to teachers, helping them understand what resources are available."

The state also supports ongoing teacher education through the Improving Teacher Quality (ITQ) grant program. Worcester State University used an ITQ grant to provide graduate courses to early education and child care teachers over three semesters. "Our goals were to improve the science knowledge…[and] science pedagogy of early childhood teachers…[and] at the end of the day, to improve young children's science knowledge," says Carol Donnelly, chairperson of the Department of Education at Worcester State University. "Our partner [school] district was Worcester [a high-needs district]…we had people from Head Start, private nonprofit preschools, and public schools.

"We would take adult-level content and break it down…for early childhood teachers, who are sometimes leery [of science]. We would explore adult topics; they would get some ideas how to implement them in the classroom the next week. Children were learning; [teachers] were learning," Donnelly relates.

Making STEM Collaboratory

In southeast Washington State, a collaboration of scientific research organizations, K–12 schools, higher education institutions, and regional education organizations are working together to impact STEM education. Pacific Northwest National Laboratory (PNNL), Delta High School, the Southeast Washington Leadership and Assistance for Science Education Reform Alliance, and the Yakima Valley/Tri-Cities Mathematics, Engineering and Science Achievement launched the Mid-Columbia STEM Education Collaboratory (Collaboratory) in 2013. The Collaboratory now includes nine more members.

At *www.midcolumbiastem.org*, the Collaboratory introduces education tools developed as part of the IDEA Project, including a design challenge based on the *Three Little Pigs* and a computer science curriculum. Peggy Willcuts, EdD, senior STEM education consultant at PNNL, notes three projects develop, evaluate, and distribute tools, technologies, and resources that support student success, educator effectiveness, and community engagement, including the STEM Flicks Project, which documents paths to STEM careers. ●

MS. MENTOR, **Advice Column**

Tapping Into Student Interests, Games for Vocabulary

It seems like it's getting harder to get my middle school students interested in a topic. I've strained my brain trying to come up with new ideas. Am I the only one in this situation?
—B., Arizona

You are not alone! Students have many distractions (e.g., electronics, social media), extracurricular activities, and other responsibilities competing for their time and energy. I'm sure you've used activities and investigations, multimedia, and a variety of instructional strategies, but it's still a challenge.

Rather than assuming the entire responsibility for making science relevant, ask your students about their interests. You could do this using the questionnaire you give them at the beginning of the year or periodically on an exit ticket in class. You can refer to the list of interests to make connections to lessons and build on student interests.

A KWL (Knows, Wants to know, and has Learned) chart can also provide insights into what students know or want to know (or wonder about). But in my experience, when asked about their interests, middle schoolers often will say "I don't know," try to leave the W column blank, or shrug their shoulders. Sometimes they're afraid to try or think about something new. Sometimes it's "cool" to act disinterested in anything academic. And sometimes students honestly don't know much about the world beyond them.

We shouldn't underestimate the teacher's role in broadening students' interests and horizons. For a professional development project, I conducted focus group interviews with high school students. One of the questions was "Did you ever think that a topic in class was going to be boring, but it turned out to be really interesting?" The students all responded positively, and we followed up with the question "So what made the topic interesting to you?" All of the students said that it was something the teacher did that changed their minds: the teacher's passion or enthusiasm for the topic, the teacher sharing a personal interest or experience, the teacher assigning interesting and challenging projects with options that students could choose from, or the teacher helping them make connections between the topic and their own experiences and interests.

Your enthusiasm can be contagious, as students enjoy hearing stories about your personal interests. When I shared some photos I had taken of coral reefs in the Caribbean, my students were intrigued: "You actually were under water?" I just happened to have some of my gear with me to show them. Several students had traveled with their families to the beach (our school was not in a coastal state) and shared their experiences, too. We took a vicarious dive with a brief video. At that point, most students were hooked on learning more about marine environments.

Providing options and choices is another way to engage students. Technology provides many options. As an alternative to formal reports, students could demonstrate their learning through creating videos, infographics, or presentations, working independently or as part of a team. This requires work and organization on your part, but seeing the students' enthusiasm and creativity is worth it.

Encouraging students to take ownership in the classroom can be engaging, too. One of my colleagues started the school year with blank bulletin boards. During each unit, students added to them: vocabulary cards, reports, news and current events, drawings, photographs, maps, and so on.

Some student interests are independent of what the teacher does. Definitely encourage students to explore on their own through independent study and provide the resources to do so. One of my life science students shared her illustrated journal. She had made a list of biology terms based on Greek and Roman mythology, from the Io and Luna moths to Cyclops, Hydra, and Medusa. I learned a lot from it myself!

Keep trying. It's hard to say what activity, strategy, or content topic will resonate with a student. Consider the teachers who inspired you. What did they do?

I like to provide activities that help students learn science vocabulary, but at a recent department meeting, we discussed the value (if any) of word games and puzzles. Do you have any insights or research on the topic?

–W., New York

Many K–12 teachers use word games and puzzles to help students review concepts and learn vocabulary. The puzzles are available to students who finish other activities early or in emergency packets for substitute teachers. As long as they are not overused, many students seem to enjoy puzzles as well as word games that include active use of the words.

Word search or jumble puzzles focus on word recognition, and I'm not convinced they are effective learning tools worth the time to find, create, or solve (or assign as homework, as I once saw a teacher do). On the other hand, crossword puzzles and similar games ask students to think of words to fit the clues (or clues to fit the words), which reinforces their knowledge of definitions and context, spelling, and differentiating between similar terms.

Teachers spend many hours creating or finding puzzles, duplicating them, and using class time for students to complete them. How do we know if solving these puzzles is an effective learning strategy?

I found a study, "Reviewing for Exams: Do Crossword Puzzles Help in the Success of Student Learning?" (*http://bit.ly/1HGNQ8n*), that examined the value of this type of review. The introduction describes different types of puzzles and a rationale for using each. The results of the study were mixed, but the conclusions are fodder for discussion. For example, do students understand that games and puzzles can help them learn, as opposed to being strictly a recreational or "fun" activity? (I sometimes used a crossword puzzle as an alternative to a traditional quiz. The students were incredulous at first: "This is fun—it can't be a quiz!")

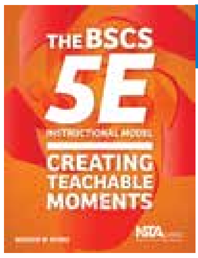
In an article in NSTA's *Journal of College Science Teaching* (*JCST*), "Utility of Self-Made Crossword Puzzles as an Active Learning Method to Study Biochemistry in Undergraduate Education" (*http://bit.ly/1IpFguI*), the authors put a different spin on puzzles. Rather than asking students to complete teacher-made puzzles, the students were asked to create crosswords using key concepts from the course. (The article has the instructions for making puzzles and an example.) A majority of the students felt that the puzzles enhanced their learning of biochemical concepts, and their exam scores were slightly higher (although no level of significance was included).

"Designing and Solving Crossword Puzzles: Examining Efficacy in a Classroom Exercise" (published in *Developments in Business Simulation and Experiential Learning;* see *http://bit.ly/1Nr4QA3*) describes a case study with suggestions and comments from students, including the survey questions that were used. The article also has a discussion of the value of word games in the classroom.

These studies were conducted with college students. It would be interesting to repeat them with younger students, and I thought of some questions that would make interesting action research at the K–12 level (and a professional development opportunity): What would happen if other students were given peer-created puzzles to solve? Would this additional level of review be helpful? Would this provide feedback on the clarity of the clues or help designers target the areas they need to study more? What would the design process look like as a team project?

From the example given in the *JCST* study, it appears that the puzzles were created manually with students manipulating the words, creating the puzzle grid, and submitting a version in which they filled in the answers. Would there be a difference if the students used an online puzzle generator or app in which most of the design work was done by the program? *Hmmm…*

To maintain anonymity when requested, some letters to Ms. Mentor are signed with a pseudonym. We regret any coincidental resemblance to other educators when a pseudonym is used. Check out more of Ms. Mentor's advice on diverse topics or ask a question at www.nsta.org/msmentor.



NSTA PRESS: *The BSCS 5E Instructional Model: Creating Teachable Moments*

A Societal Perspective for STEM Education

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 The BSCS 5E Instructional Model: Creating Teachable Moments *by Rodger W. Bybee, edited for publication here. To download the full text of this chapter, go to* http://bit.ly/1S1nEW9. *NSTA Press publications are available online through the NSTA Science Store at* www.nsta.org/store.

The 20th century was a period of significant scientific advances and technological innovations, both of which contributed to dramatic social progress. As the nation's economy advanced, the requirements for skilled workers increased, especially the need for intellectual skills, including those often associated with the science, technology, engineering, and mathematics (STEM) fields.

By 21st-century standards, the intellectual skills required in the early 20th century were low. With time, the nation's policy makers and educators realized the economic value of creative ideas and efficient means for the production and delivery of goods and services. As the 20th century progressed, the number of individual jobs requiring manual labor and routine cognitive skills steadily decreased, while the jobs requiring intellectual abilities such as adapting ideas and solving non-routine problems increased. In short, work became more analytical and technical. By the 20th century's end, entry-level requirements for the workforce increased to levels beyond a high school education. Taking this general observation to a more specific level, one would have to note the combined role of STEM as a driving force of economic change and the steady shift in requirements for entry into the workforce, especially in developed countries. The changes just described suggest a fundamental place for STEM in our economy, and by extension in our education programs.

Recommendations

Applying the BSCS 5E Instructional Model to STEM education is possible. This section presents several recommendations that will help you use the 5E Model for STEM education.

Identify a Context for Your Unit of Instruction

I have found it particularly difficult to begin with a discipline (e.g., science) and then try to build an integrated instructional sequence that includes other disciplines (e.g., technology, engineering, mathematics). My recommendation is to begin with a local, regional, or global context that has personal meaning for your students. Although there may be others, contexts that lend themselves to STEM include the following:

- Health maintenance and disease prevention
- Energy efficiency
- Environmental quality
- Natural hazards
- Natural resource use

Decide on Your Approach to Integration

A step beyond maintaining separate STEM disciplines requires the consideration and a decision to advance STEM education by integrating the disciplines. This decision can be made at the state level, but in the approach suggested here, the decision is best made at the district or school level.

Several approaches to curriculum integration have been published. I recommend reviewing the following resources: *Designs for Science Literacy* (AAAS 2001); *Meeting Standards Through Integrated Curriculum* (Prak and Burns 2004); *Making Sense of Integrated Science: A Guide for High Schools* (BSCS 2000); and *Interdisciplinary Curriculum: Design and Implementation* (Jacobs 1989).

In addition, the National Academy of Engineering and the National Research Council (NRC) released *STEM Integration in K–12 Education* (NRC 2014). I also note that some of this discussion is adapted from my book *The Case for STEM Education: Challenges and Opportunities* (Bybee 2013).

Different perspectives of STEM education can be described. Here are several variations to consider for the integration of STEM:

- *Coordinate*: Two subjects taught in separate courses are coordinated so content in one subject synchronizes with what is needed in another subject. For example, students in mathematics learn algebraic functions when they need that knowledge in engineering.
- *Complement*: While teaching the main content of one subject, the content of another subject is introduced to complement the primary subject. For example, while designing an energy-efficient car in a technology class, science concepts of frictional resistance (drag), loss of kinetic energy, and mass are introduced to improve the car's design and efficiency.
- *Correlate*: Two subjects with similar themes, content, or processes are taught so students understand the similarities and differences. For example, you could teach scientific practices and engineering design in separate science and technology courses.
- *Connections*: The teachers use one discipline to connect other disciplines. For example, they could use technology as the connection between science and mathematics.
- *Combine*: This approach combines two or more STEM disciplines using projects, themes, procedures, or other organizing foci. For example, one could establish a new course on science and technology that uses student projects to show the relationship between science and technology.

Because of the dominance of the traditional disciplines in state, district, and school standards, curricula, and assessments, you likely will need to provide a rationale with supporting recommendations for integrating STEM disciplines. This is especially the case when you move beyond integration through coordination, complements, correlation, or connections. Combining subjects or designing courses that transcend the separate STEM disciplines will require elaborate and detailed justifications.

There are a few arguments for curricular integration. First, the situations of life and living are all integrated. The decisions that citizens face are not nicely contained within disciplines such as science or mathematics. Life situations typically require the knowledge, abilities, and skills of multiple disciplines. Second, individuals learn best when the context within which they are learning has personal meaning: that is, learning is enhanced when it is related to something people recognize or know, or in which they have a personal interest. Third, there is an efficiency that comes with combining the knowledge and skills of different disciplines, and there is limited time in school days and years. If lessons, courses, and school programs can attain learning outcomes of both content and processes of different disciplines such as engineering and mathematics, that benefits both teachers and students.

Conclusion

The acronym STEM is widely used in education. Although STEM has caught the interest of policy makers and many educators, the meaning remains elusive. In the 21st century, citizens need to have essential knowledge and skills associated with science, technology, engineering, and mathematics. This chapter provided a rationale for STEM education and directed the reader's attention to STEM as it may be applied in the context of curriculum and instruction. Thus, an application of the 5E Model gains specific meaning for classroom teachers. ●

Mark Your Calendar
NSTA Dates to Remember

(All dates are deadlines unless otherwise specified.)

January 15—It's your last chance to **submit a session proposal** for the **Fifth Annual STEM Forum & Expo,** hosted by NSTA, and the **NSTA 2016 Area Conferences**. The STEM Forum will be held July 27–29 in Denver, Colorado. The 2016 area conferences are set for Minneapolis, Minnesota (October 27–29); Portland, Oregon (November 10–12); and Columbus, Ohio (December 1–3). For more information or to submit your session proposal, go to *http://bit.ly/1wI4iQg*.

February 5—It's your final opportunity to maximize savings on your registration for the **64th NSTA National Conference on Science Education**. The conference, themed "Science: Empowering Performance," will be held March 31 through April 3, 2016, in Music City Center, Nashville, Tennessee. Share ideas, connect with colleagues, and discover something new during this four-day event. For more information or to register, visit *www.nsta.org/nashville*.

March 31—The **64th NSTA National Conference on Science Education** opens in Nashville, Tennessee. The conference runs through April 3. Join science education colleagues from across the country as they participate in more than a thousand sessions, workshops, and other activities to gain insight into the latest trends in science education. Participants can follow four strands—Setting the Stage: Scientific Literacy; Building the Band: Involving Community Stakeholders; Harmonizing Concepts: Integrating Instruction; and Stringing It All Together: Three-Dimensional Learning—to focus their professional development experience or attend sessions targeted to particular needs. For more information or to register, visit *www.nsta.org/nashville*.

April 15—Session proposals for the 2017 NSTA **National Conference on Science Education** are now due. The conference will be held March 30–April 2, 2017, in Los Angeles, California. For more information or to submit your session proposal, go to *http://bit.ly/1wI4iQg*. ●

Are you aware of all the advantages you get as an NSTA member? We will be featuring some of the regular benefits NSTA members enjoy, as well as special offers for our members from other organizations, in this space. For more information on NSTA membership, visit *www.nsta.org/membership.*

- **20% off NSTA publications.** All NSTA members receive a 20% discount on their book purchases in the NSTA Science Store (*www.nsta.org/store*), including new titles like *Solar Science: Exploring Sunspots, Seasons, Eclipses, and More,* as well as perennially popular titles such as the Uncovering Student Ideas and Picture-Perfect Science series. Members also receive a 10% discount on all other purchases in the Science Store. Log in to the store with your member ID to automatically receive your discount!
- **50% off Rainforest Journey.** NSTA members receive half off the purchase of this online life science curriculum from EdTechLens by entering coupon code NSTA15 at *http://bit.ly/1OVfZIB*. The code is valid through **February 29.** ●

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Vote for NSTA's Next Leaders!

Have you cast your ballot for NSTA's leadership yet? Voting for the 2016 NSTA election opened on December 16 and runs through 11:59 p.m. Eastern Time, **February 15.** NSTA has adopted a new, simpler voting process for this election: Members simply log in to the NSTA website (*www.nsta.org*) using their e-mail address and member number. Clicking on the "VOTE" button will automatically connect them to the ballot. The ballot features candidates' position statements on science education.

Nominees for NSTA's 2016–2017 President are David Crowther and Craig Gabler. Candidates for division directors are Elizabeth Allan and Ramon Lopez (College Division); John Olson and Mike Szydlowski (Coordination & Supervision Division); and Carrie Jones and Betsy Sullivan (High School Science Teaching Division). NSTA members in District III (Delaware, the District of Columbia, and Maryland), District V (Alabama, the Canal Zone, Florida, Georgia, Puerto Rico, and the Virgin Islands), District IX (Minnesota, North Dakota, and South Dakota), District XI (Kansas, Missouri, and Nebraska), District XV (Idaho, Montana, and Wyoming), and District XVII (Alaska, Oregon, and Washington) also will elect new district directors to represent them on the NSTA Council.

If you need assistance with locating your member number or logging in, e-mail *membership@nsta.org*. If you have forgotten your password, e-mail *webdirector@nsta.org*. ●