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NSTA Reports

National Science Teachers Association

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75th NSTA ANNIVERSARY

Reflecting on the Flipped Classroom

Since educators began adopting flipped classroom strategies—in which instruction that typically occurred in class happens outside class, and instructors help students apply what they learned during class—many have developed new perspectives and new methods. "I don't think of it as [a] 'flipped classroom'; I think of it as [an] 'open classroom,'" says David Osmond, assistant professor of science education at University of North Georgia (UNG) in Oakwood, Georgia. His preservice elementary science education students "do what they need to do [and] choose their priorities."

Osmond and his colleague Donna Governor, assistant professor of science education at UNG's Dahlonega campus, have found that the NSTA Learning Center's SciPacks—which have modules providing self-directed online learning experiences for teachers to enhance their understanding of a scientific concept and its related pedagogical implications for student learning—dovetail nicely with the flipped classroom model. "SciPacks cover the breadth of what preservice elementary teachers need to know: content and pedagogy and its implications, [using] moving images, simulations, and interactive questions to see that they've understood the topic," Osmond contends.

Governor says she discovered that students "don't always do what they're supposed to do before class" as part of a flipped classroom. "I expect them to get the content online [outside of class], but it doesn't always happen

DOUG STITH

Doug Stith uses a form of the flipped classroom he calls Learner-Paced Science with his sixth graders at Londonderry Middle School in Londonderry, New Hampshire. Older students serve as his assistants. Here an assistant (right) helps sixth graders visualize the shape of magnetic fields.

before class. [In class,] I go over a little bit of content, the essential ideas, and hit the highlights for the day's lab activities. Then instead of listening to lectures, students engage in the practices of science, investigate concepts. It can even be meaningful when they dive into the concepts later because they've had the experience and can better understand the content," she adds.

With SciPacks modules, students aren't just reading, "they do lab activities and projects at home," Osmond explains. This frees time for students to "do outside learning experiences [as part of class work,] attend conferences, see museum exhibits, and design their own outside lab experiences," he observes.

While Osmond teaches physical science content, Governor teaches both Earth and life science in one course. "I don't use a traditional textbook because it can't include both subjects [and doesn't provide that breadth of knowledge] to help [preservice teachers learn] to teach the standards,"

See Flipped Classroom, pg 4

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COMMENTARY: **Tom Meagher**

STEMify Instruction Through Student Creativity, Curiosity

By Tom Meagher

Tom Meagher

It's difficult to explain what science, technology, engineering, and mathematics (STEM) looks like from school to school in a single school district, let alone across the United States. Many researchers have tried to define STEM teaching and learning, but it is far harder to explain than to observe. In science education, we understand that exploration and investigation of phenomena—coupled with analysis of data and information and arguing from evidence—is fundamental for effective teaching and learning.

However, if we examine STEM like an equation of equally important fields of study: (S+T+E+M), it adds up to effective learning, and we can see that

- **S**cience is a system of learning by asking questions, collecting data, and finding answers;
- **T**echnology is the tools we create to solve problems;
- **E**ngineering is founded on design and creating solutions for specific problems; and
- **M**athematical pattern analysis of data and information can determine if we have accurately answered our questions.

So STEM is not what we teach, it is *how* we teach; it is how we *learn* in life.

I was invited to Japan in 2018 by Yoshisuke Kumano, a professor of science education at Shizuoka University and the principal investigator on a grant to formulate a national curriculum for STEM education in Japan, to help faculty researchers learn more about STEM education in the United States. There I shared STEM lessons developed by a collaboration of teachers, including me. The integrated nature of these lessons allows them to be tailored to almost any grade level and modified to fit multiple subject areas.

The first lesson I shared—featuring close and careful observation of unfamiliar objects—can introduce students to a new unit or content area. Students are shown unusual objects and choose one to examine carefully. We ask students to describe the objects, draw them, and label various parts, making up names if they don't know the proper name. Students measure the objects and describe what they think they are made of, as well as how the objects may be used by people, animals, or other organisms. The students record their questions about the objects and write a short story about what they think they are and how they came to be in the classroom.

I observed as the Japanese students carefully created their diagrams. They worked quietly, gingerly handling each object and carefully labeling their diagrams. However, they struggled when I asked them to create names for the parts of their objects they didn't recognize. I expected a Japanese version of what my English-speaking students often do, labeling their unrecognized parts "thing-a-ma-jig," "doohicky," or "whatcha-ma-call it." But the Japanese students seemed to find this frustrating: They wanted to be "correct" and accurately label their diagrams.

When I reiterated that they could be creative and make up an appropriate name, the students jumped in with enthusiasm! I observed that Japanese students reveled in the freedom creativity allows, and several told me they wanted to do this more often at school. One PhD student who was observing the lesson said to me, "I wish I had done this in school; I'm enjoying this lesson now." Opportunities for creativity like this can engage students in doing more research to answers their own questions about unusual objects and to discover what they really are.

As the lesson progressed, I introduced simple technology hacks that allowed the students to turn their mobile phones into digital microscopes using laser pointer lenses and bobby pins. The classroom buzzed with fascination and excitement as everyone with a cell phone camera collected beautiful images of moss, sand grains, crystals, or cedar tree leaves. Adding this simple technology created instant engagement and opened new opportunities for exploration, observation, questioning, and creativity.

The Japanese faculty researchers frequently asked, "How can we assess STEM learning?" and "How can we teach Japanese students to be creative like American students?" Creativity is an important 21st-century skill that Japanese college faculty want to instill in their own students. When Japanese researchers visited schools in our district, they were impressed with how a significant amount of time during a STEM lesson is spent teaching students how to work in teams and be creative.

Designing creativity, exploration, and investigation into all of our teaching gives students opportunities to engage as scientific researchers, engineers, innovators, technologists, artists, and entrepreneurs. U.S. students who participate in authentic STEM learning can see how what they do in our classrooms directly relates to their own lives and prepares them with 21st-century skills. The students I met in Japan were focused on performing correctly and accurately, but when given a challenge, they relished the chance to be creative and explore freely. From what I observe in classrooms across Minnesota, the United States, and Japan, kids are kids, and they become excited to learn when given the chance to investigate and discover new things for themselves. Our role as STEM teachers is to provide opportunities for students to be creative and move them from compliance to curiosity, a problem we can solve with S+T+E+M. ●

Tom Meagher, PhD, is a district STEM education coordinator for Owatonna Public Schools in Owatonna, Minnesota, and a lecturer for science and STEM education at the University of Minnesota in Minneapolis. He also provides STEM professional development for K–8 teachers both nationally and internationally.

NSTA Reports

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

Flipped Classroom, from pg 1

Governor contends. "SciPacks have modules for both subjects," and allow her to choose which modules best meet students' needs; "it's a build-your-own-textbook [opportunity]" that allows targeted readings, she observes.

"If I didn't have the flipped model, I'd have to spend that time lecturing. That's not how students learn, so I don't want to do it," Governor maintains.

Osmond notes that SciPacks aren't "the primary way students are in charge of their own learning…For each unit, there's a variety of activities to [choose from], and students don't have to worry about it destroying their grade if one doesn't work out…Their responsibility is to choose what they do to be successful."

The flipped format has allowed Osmond to relax deadlines. "I give students a suggested date…, but no sweat if it's a little late," he explains. During in-class lab activities, "I grade them at the end of class…I can give them immediate feedback and let them try it again…My goal is I want them to fail and know they can improve. If they're not failing, they're not learning anything new," he says.

Suggestions for Success

Michael Moore, a biology instructor and postdoctoral fellow in STEM Education at the Academy of Teaching and Learning at Baylor University in Waco, Texas, says he "spent four years in grad school [at Oklahoma State University], both as part of my research and my professional development, sitting in on my advisor's flipped class. After completing my PhD, I came to Baylor as a postdoc and completely flipped my intro biology course the first semester;…the second semester, I did a hybrid co-instructed flipped course (lecture one day a week and active learning two days a week)."

Moore helped establish Baylor's Learning Assistant (LA) Program, in which trained undergraduate students facilitate discussions and encourage student engagement and responsibility for learning. He says he found that "undergraduates are better able to communicate with younger students because they use their language." The LAs facilitate active learning, involving students in the learning process more directly—which is vital in flipped classrooms, according to Moore.

Moore assigned targeted readings, using basic concepts to teach students how to learn. "The flipped classroom can be done a hundred different ways… You need to understand the theory behind what you're doing…to find resources that work and are easily implemented," he contends.

"[I]t's important to get feedback from students and from other faculty who can observe how what you're doing impacts students," Moore notes. He recommends "leveraging your networks to find those colleagues to give you that feedback" and cites NSTA's e-mail lists and the Flipped Learning Network (*https://flippedlearning.org*) as examples of such networks.

Moore sees two trends in flipped learning. "You can add more structure on the tech end, more engagement points [such as] having students answer questions during lectures. Or you can remove the connection to technology and do targeted reading, give students a reason to go back to their textbooks and have them read about the relevant topics only."

The goal of flipped learning should be "tying learning to a future career. Imparting skills is a key way to help students buy in…This motivates them, and we see the positive effects of this increase in motivation borne out in the literature," Moore relates.

Middle and High School

"I have been running a flipped classroom for about three years in my regents chemistry class, and it has changed each year…The change is always for the better," says Terrie Hunter of Horseheads High School in Horseheads, New York.

When Hunter's students watch her videos after class, they "take notes to prepare for the video check the next day" that reveals their understanding, she explains. She says she includes "a brainteaser or a relevant TED talk or crash-course snippet" along with "questions for students to answer, a definition of a word, for example."

Hunter uses Google Forms—free online surveys—for the video checks "that will automatically grade students. I can assess their understanding [before] teaching the day's lesson based on the results," she relates. Hunter's students' understanding of the material has improved with these innovations. "I had 75 students last year, and only one failed the chemistry regents exam…The flipped classroom model allows for more time for [inquiry-style] labs," she reports. "There is…[time to] allow [students] to make mistakes, then have the teacher 'coach' [them]."

When she taught high school, Drew Wallsworth—now teaching math and science at Lane Intermediate School in West Allis, Wisconsin—had two years of experience flipping the classroom. The first year, she did so for two students in her general environmental science class; the second year, she flipped her entire Advanced Placement Environmental Science (APES) class. Wallsworth notes that in her APES class, "98% of my students were English as a Second Language (ESL) students, and they really benefitted [from the flipped class] because…they could go back and look at resources [after class] and didn't have to [take notes] in class."

Now as a sixth- and seventh-grade teacher, Wallsworth says, "I'm gradually introducing flipped pieces, but as a modified in-class flip…Half of the class does the activity with me and the other teacher, while the other half of the class reads or watches a video. Then they switch."

Doug Stith, science teacher at Londonderry Middle School in Londonderry, New Hampshire, says he is "doing what I call Learner-Paced Science with my sixth graders. I also use seventh- and eighth-grade student assistants to help me interview and guide my sixth graders" and "conduct both small-group and whole-group discussions," he reports.

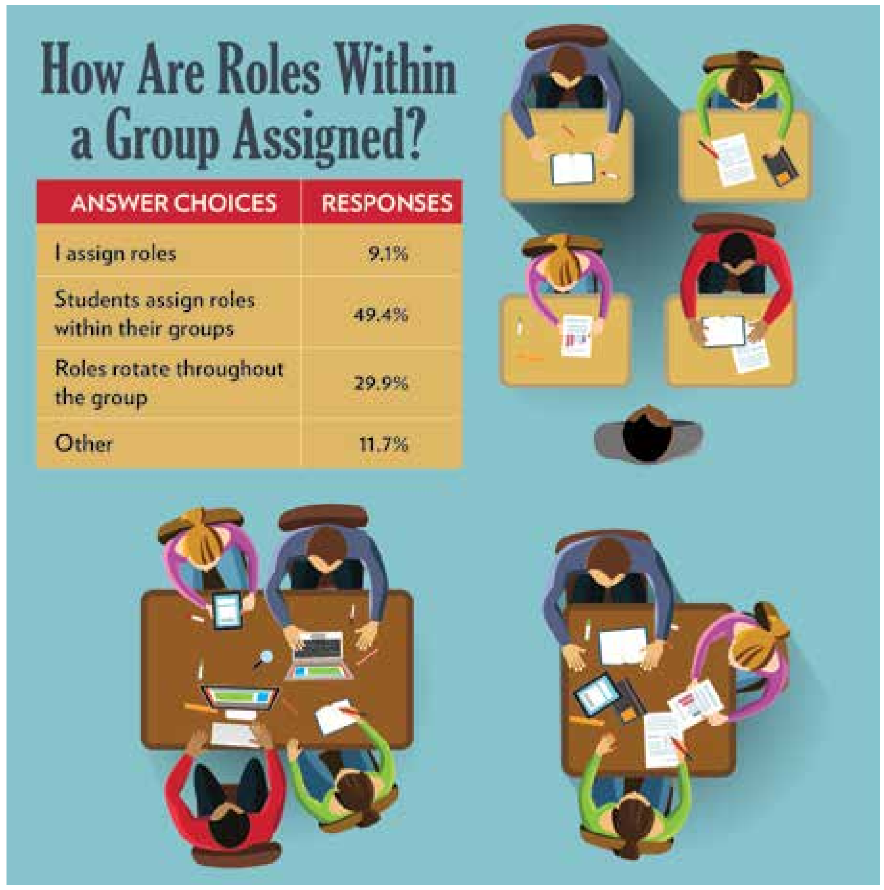
Before he instituted Learner-Paced Science, Stith says, "My classroom always involved a great deal of hands-on activities; however, all students… moved at the same pace." He took time to write up all the activities, enabling students to work at different paces. "Now all students begin on Activity 1 for a given unit. When completed, students…[are] interviewed" to ensure they did it correctly and understand what they learned, Stith explains.

"[I assign] no homework or paper-and-pencil tests. Instead,…students create a product (Google Slides, video, written narrative, annotated poster, etc.) and are interviewed on their product," Stith notes. "I could never go back to my old way, but I rely on my assistants to run this program." ●

Teaching Teamwork

With increasing focus on the importance of the "soft skills," collaboration is becoming a correspondingly more important skill for students. In a recent informal *NSTA Reports* poll, 56.6% of participants reported including collaboration on their grading rubrics when an assignment calls for teamwork. When students work together, 55.8% of respondents said they most often vary group assignments so students learn to work with a variety of peers, 11.7% said they assign groups and try to diversify skill levels, 9.1% assign groups randomly, and 7.8% allow students to choose their own groups. Fourteen percent said they used other strategies, including a combination of assigning groups and allowing students to choose their work groups.

Most of the group assignments were for a short time, with 80.5% saying group assignments are for specific labs or projects and 10.44% reporting group assignments were made a month at a time. Only 3.9% reported changing group assignments only if students are disruptive or request a change. Nearly half of respondents (49.4%) said they allow students to assign roles within their groups; 29.9% have roles rotate throughout the group; and 9.1% assign roles with work groups.



How Are Roles Within a Group Assigned?

ANSWER CHOICES	RESPONSES
I assign roles	9.1%
Students assign roles within their groups	49.4%
Roles rotate throughout the group	29.9%
Other	11.7%

Here's what science educators say about how they coach students on collaboration:

Sometimes I let true inquiry take place and let the students figure it out on their own. Sometimes they are given specific instructions as to their roles.
—*Educator, Middle School, Pennsylvania*

While the groups are working, I listen in on their conversations and offer suggestions. With high school students, what I frequently find is that one or two in the group will want to do all the work to assure it meets their standards; these are the students who are generally more focused on their grade than their learning. I encourage them to step out of their comfort zone and allow the rest of the group to participate.—*Educator, High School, Missouri*

I should probably do more of this. I try to give examples [and] ideas, and share my expectations. I also realize not all kids are as committed as others [are]. I do not feel it is fair or right to expect kids to work together when some do not share the desire to accomplish the same goal.—*Educator, Middle School, Kansas*

Speak explicitly about expectations for collaboration. When a conflict develops, ask [the] team to brainstorm compromises and problem-solve. Treat issues as part of the process, not a failure. Positive reinforcement of collaborative behaviors [works well]. —*Educator, Middle School, Rhode Island*

This is a good question that I hadn't thought about before. It would probably be good to do this rather than to put out fires as they arise.—*Educator, High School, Wyoming*

I begin the year with behavior norms and by telling the students that they will likely be working with other students during the year. I am available to facilitate group social challenges. I spend about 25% of the first five or six classes on team-building activities. This puts me behind, but I can make time up with groups [who] know collaborative skills.—*Educator, Middle School, High School, Institution of Higher Learning, Ontario, Canada*

We coach/teach: communication skills needed to effectively work with all types of folk[s], even those you don't like; how to disagree agreeably; how to get your own voice heard; how to listen/give space to all team members; leadership skills.—*Educator, Middle School, California*

Setting expectations [for] roles and emphasiz[ing] the importance of the role of each member for task completion. Demonstrating [and] praising good collaborators and be[ing] explicit about the traits exhibited. Getting teams to share with the class how the task was successfully completed with good collaboration. Getting pupils to reflect on what they could have done better as a team member.—*Educator, Elementary, Singapore* ●

Quotable

You can't use up creativity. The more you use, the more you have.

—Maya Angelou, U.S. civil rights activist, author, and poet (1928–2014)

Involving Students in Antibiotic Discovery

Involving his students in Tiny Earth, a worldwide network of instructors and students focused on crowdsourcing antibiotic discovery from soil, made sense to Tom Martinez, biotechnology and Advanced Placement Biology teacher at Glenbard East High School in Lombard, Illinois. "Having students participate in real science that contributes to the greater good" is important, and Tiny Earth supports the *Next Generation Science Standards* (*NGSS*), he observes.

Jo Handelsman—a professor in the Department of Plant Pathology at the University of Wisconsin (UW)-Madison and director of the Wisconsin Institute for Discovery, a research institute on the university's campus—founded Tiny Earth (*https://tinyearth.wisc.edu*) in 2012 at Yale University. Based on her work in antibiotic discovery there, she created an undergraduate introductory biology course called Microbes to Molecules, which aimed to address antibiotic shortages and the need for more scientists, and piloted the curriculum with six students.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Enid Gonzalez-Orta, associate professor of biological sciences at Sacramento State University in Sacramento, California, examines bacterial colonies during a Tiny Earth Partner Instructor training workshop.

"We're losing antibiotics every year due to resistance among pathogens. Pharma stopped discovering them in the 1980s because antibiotics became less lucrative than other types of drugs [for companies]," she explains. "We have more untreatable bacterial infections. By 2050, it will be the leading cause of death worldwide."

Because antibiotic resistance is "a very real problem, students feel like they're contributing to science that will affect human welfare," she contends.

As a result, the Microbes to Molecules course became popular, and Handelsman and her colleagues gradually developed it into a larger initiative. When she moved to UW-Madison, she established Tiny Earth there and built it into a network of instructors worldwide. Now nearly 10,000 students are enrolled in some version of the course annually in 45 U.S. states and 15 countries.

Tiny Earth is also necessary because studies have shown "we don't retain students who are really excited about careers in science," says Sam Rikkers, Tiny Earth's executive director. "About 60% of students [who] intend to major in STEM…graduate in a non-STEM field." Tiny Earth is effective because "instead of replicating old experiments, students conduct their own research, and their research is part of a global effort to find new antibiotics," he asserts.

Tiny Earth is "a way to teach what researchers do in science," Handelsman observes. In addition, the course is "not just memorizing organisms, plant parts, or long lists of terms. Research turns this around and gets students motivated to learn the facts because of the problem they are solving."

Tiny Earth Partner Instructor training sessions are held twice annually for high school and undergraduate instructors. "We are committed to making it as accessible as possible. We raise funds from partners and sponsors. Interested teachers just have to pay for their travel: Everything else is covered, free of charge," Rikkers explains.

"If teachers can't get a particular technique to work, they can use the Tiny Earth network to troubleshoot [the problem]," notes Handelsman. "Once trained, we set [teachers] up with a mentor trained by us."

The course can be implemented in a variety of ways, Rikkers points out. Tiny Earth can be a summer course, "a stand-alone elective," or "integrated into Introduction to Microbiology or biology courses," for example, he relates.

Teaching the Course

High school teacher Martinez does Tiny Earth in his classes twice a year. "We talk about antibiotic resistance in our curriculum," he notes, so Tiny Earth helps students "get a real understanding of the issue."

Martinez says he enjoyed the Tiny Earth training, but found it challenging. Though he was already familiar with gram staining (a technique used to differentiate two large groups of bacteria based on their different cell wall constituents), "I hadn't seen all the other techniques [demonstrated because] I hadn't had microbiology in a long time. All the techniques and protocols were new to me," he relates.

He faced other challenges. Unlike university instructors, Martinez says he has "only 48 minutes to set up [the lab] each day," so he has had to adapt what he learned during training to his high school classes. And he estimates that Tiny Earth involves "a $2,000 investment up front for consumables and sequencing [of antibiotic-producing isolates] costs…My district funds me because [Tiny Earth] has a lot of meaning [for students], and without the funds, I couldn't do it."

Safety issues must be considered, he stresses. "You never know what you'll find in the soil. Students have to be conscious of pathogens in soil." When growing bacteria in specific media, "we use ethanol and spray everything down with it…we wear gloves, goggles, and lab coats. There's an element of risk; most high school students aren't aware of this," he contends.

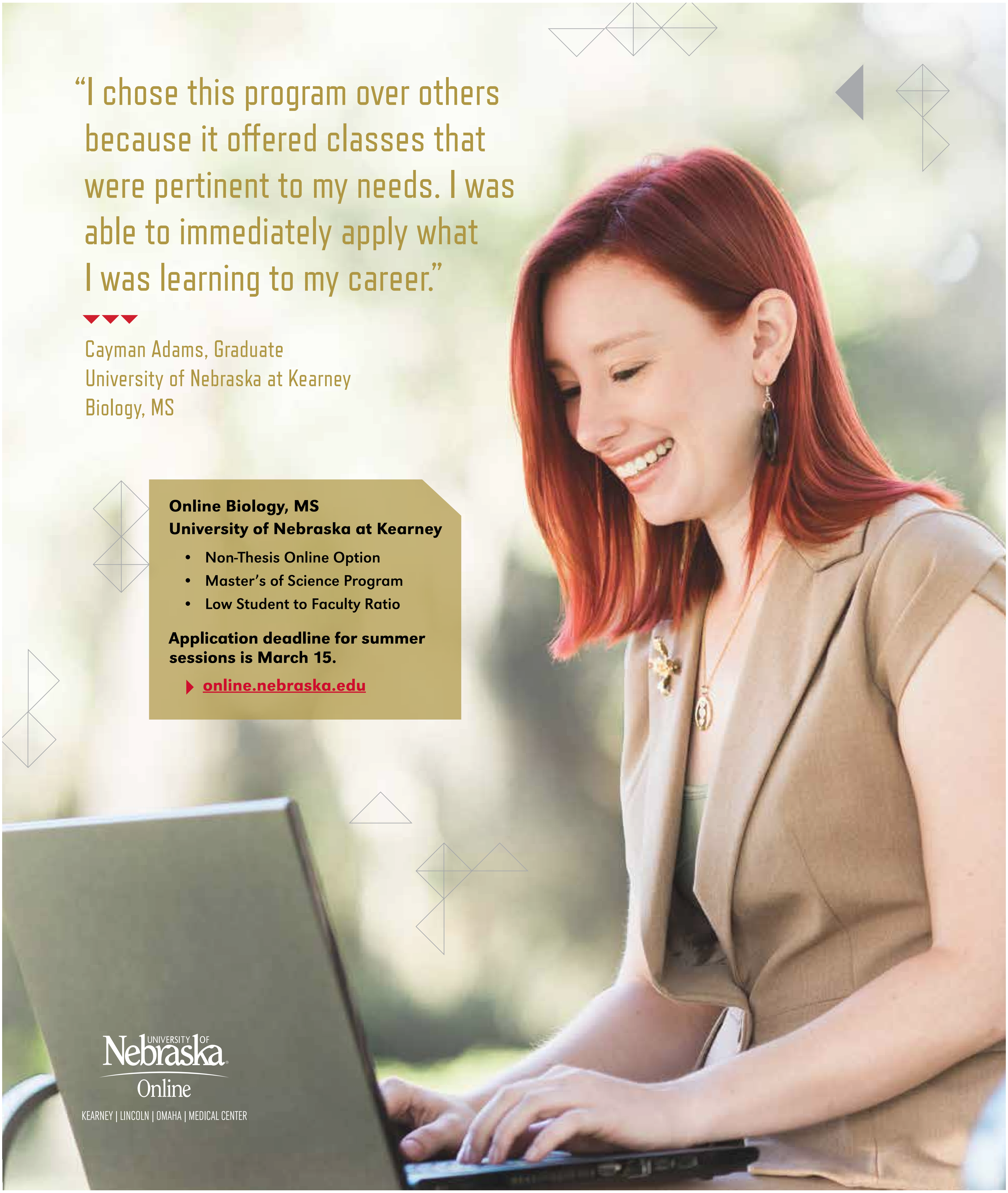
As a result, he says his students "looked at soil in a new way...They had a whole new perspective on food safety, for example, and sanitation." They also learned new skills, such as "plating and using parafilm [thermoplastic material manufactured for wrapping and sealing]," and how to use equipment, such as a Bunsen burner.

Lucy Fenzl, biology instructor at College of the Menominee Nation—which has campuses in Green Bay and Keshena, Wisconsin—incorporated Tiny Earth in her general biology and microbiology courses at both campuses. She says Tiny Earth's "lab techniques drew me to it. [It has] some really unique lab techniques that could expand research opportunities for students." She also received training in chemical analysis, which was a new skill for her. "These techniques can also be used in chemistry courses," she notes.

Tiny Earth "enhanced students' critical-thinking skills; they developed new ways to [conduct research]," Fenzl explains. For example, using the Phenology trail on the Keshena campus, students collect data from 13 different plants to study climate change. They've taken soil samples at each plant site as part of their Tiny Earth work. "I'll take the soil data and add it to the climate change data on the trail," she reports.

In addition, the opportunities to connect with other colleges and universities "took our research to a whole new level," Fenzl asserts. "Students can see and analyze results immediately and connect [their results] with all of the other [Tiny Earth] schools in real time." A nearby college in the Tiny Earth network "let us have freezer space because our freezer doesn't go to [a] temperature that is low enough [for a particular project]," she adds.

A Tiny Earth symposium held in December 2018 in Green Bay "gave students the opportunity to network with other student researchers, sponsors, and future employers to see what other students were looking at, ideas for future research," Fenzl relates. ●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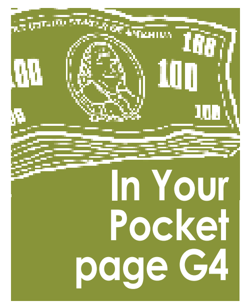


Freebies for Science Teachers

IIHS-HLDI in the Classroom. E M H Developed by the Insurance Institute for Highway Safety-Highway Loss Data Institute (IIHS-HLDI), this website for educators of grades 5–12 focuses on how physics and biology concepts can be applied to understanding car crashes. Through a collection of videos, demonstrations, and *Next Generation Science Standards* (*NGSS*)–supported classroom activities and accompanying materials, students explore physics concepts related to car crashes (e.g., momentum, Newton's Laws of Motion); the biomechanical effects of car crashes on the human body (e.g., reaction time, cell stress/strain); and crash-related engineering design projects (e.g., designing a collision safety device). Visit *https://classroom.iihs.org.*

Creating Inclusive PreK–12 STEM Learning Environments. P K12 Released by the Community for Advancing Discovery Research in Education (CADRE), this brief presents research supporting the need for broadening participation in science, technology, engineering, and mathematics (STEM). Much of the brief's content confirms knowledge previously reported in research literature; however, some insights offer new perspectives on familiar challenges. The brief also includes action steps for establishing inclusive STEM learning environments, such as articulating a clear vision for broadening STEM participation, involving families and administrators in the effort to broaden STEM participation, and recognizing that other things besides grades and test scores can show success in STEM. Read the brief at *https://bit.ly/2RE1kYI.*

Considerations for STEM Education From PreK Through Grade 3. P E This CADRE brief describes research supporting the importance of high-quality STEM educational experiences for young children and the need for STEM-related professional learning for their teachers. The document defines what STEM means, details research-backed benefits of early learning in science and mathematics, and suggests ideas for early educators to support STEM learning and discovery in their classrooms. Read the brief at *https://bit.ly/2SEZC9M.*

JON IRONS

Henry Louis Gates, Jr.

***Finding Your Roots*—The Seedlings. M** A new curriculum based on Henry Louis Gates' popular PBS genealogy series *Finding Your Roots* was inspired by the enthusiasm and creativity of students who attended the first *Finding Your Roots* Genetics and Genealogy camps. Gates and anthropologist Nina Jablonski worked with biologists, geneticists, anthropologists, historians, artists, genealogists, and educators to create this curriculum (see *www.fyrclassroom.org*), which supports the *NGSS* and is suitable for middle school classrooms. The curriculum accompanies a nine-episode web series filmed on the Penn State University campus and featuring the young scientists attending the camps (see *http://bit.ly/2M68OSz*).

IGI Genome Editing Resources. H HE CRISPR—a novel genome editing tool—has been hailed as arguably the biggest biological breakthrough of the past century, as it enables scientists to precisely alter the genetic code of nearly any organism. At the Innovative Genomics Institute (IGI) website at *https://innovativegenomics.org,* high school and college educators can access a host of resources (e.g., graphics, animated videos, and games) to teach genetic engineering science and help explain how the CRISPR technique works. Of particular interest is Phage Invaders, a retro-style video game (available for PC and Mac computers at the website *http://bit.ly/2sszbsO*) that teaches the basics of CRISPR immunity as players learn to stop an army of viral villains from destroying the city of Bacterium.

National Geographic Education Resource Library. E M H HE At *https://bit.ly/2qRRwyS,* educators can access a database—produced by the National Geographic Society and partners—featuring thousands of educational materials for teaching science and other subjects. The resources—which include a wide assortment of activities, articles, collections, infographics, lessons, maps, photographs, videos, and more—address learners from all levels, K–college, and cover numerous subjects (e.g., Earth science, biology, chemistry, engineering, geography, social studies, English language arts, religion, and more). Search for materials by topic, grade level, content type, or subject.

GEMS (Girls Excelling in Math and Science) Clubs. E M Since 1994, this organization has been dedicated to

See Freebies, pg G2

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

Freebies, from pg G1

increasing elementary and middle level students' interest in STEM and encouraging girls—and all students—to discover the fun and wonder of these fields through STEM clubs. The website at *www.gemsclub.org* features resources for educators interested in starting a club; research on gender equity and on the impact of clubs like GEMS; tips for teachers and parents; and links to activities that encourage students to learn more about careers in STEM.

TXLLXT TXLLXT

Soil Health Resource Catalog. **K12** Help K–12 audiences and the public learn about the critical role of soil in our lives with this collection of resources compiled by the education team at the Soil Health Institute (SHI). The resources include videos, infographics, interdisciplinary lessons, PowerPoint presentations, publications, and fact sheets produced by leading soil organizations such as Sustainable Agriculture and Research and Education, the U.S. Department of Agriculture, SHI, Smithsonian Museum of Natural History, and other groups. Access the annotated catalog—which features information (e.g., audience, description, and organization) and links to each resource—at *https://bit.ly/2F8Uver.*

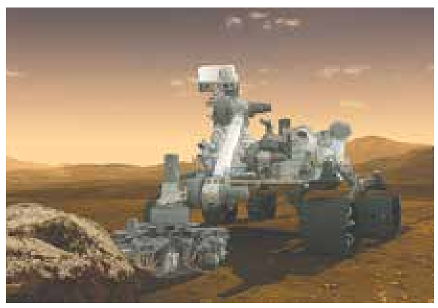
Safe and Smart, Natural Gas website. **K12** Developed by CenterPoint Energy, and targeted for K–12 students, educators, and families, this interactive website explains where natural gas comes from, how natural gas is used, and how to stay safe around natural gas. Click on the Teachers Tab to access a glossary of natural gas terms, fun facts, quizzes, and activities for upper-elementary and middle level. For example, students can conduct classroom activities such as How Is Natural Gas Found?; Let's Build a Pipeline!; Family Q and A; and Organic Matter and Natural Gas, or they can play the Stay Safe and Smart Challenge game. Resources for younger students (grades K–2) include videos, coloring pages, and *Buddy's Big Day,* an e-book about natural gas. High school students can access information about various careers in the energy industry. Find these and other resources at *http://safeandsmart.org.*

The Teacher-Friendly Guide to Climate Change. **H** Published in 2017 by the Paleontological Research Institution, this 294-page book for high school Earth and environmental science educators addresses basic climate change science and offers perspective on teaching a subject that has become socially and politically polarized. In 11 chapters, readers explore topics such as Why Teach About Climate Change?; What Should Everyone Understand About Climate Change and Energy?; What Is Climate?; Climate Change Through Earth History; Evidence for and Causes of Recent Climate Change; U.S. Regional Climates, Current and Future; Climate Change Mitigation; Geoengineering; Climate Change Adaptation; Obstacles to Addressing Climate Change; and Perspectives. Visit *https://bit.ly/2F8rwZc* to download a PDF version of the book. (*Note:* Print copies of the publication are available for purchase.)

Exploratorium's Teacher Institute (TI) Videos. **K12** With titles like *Learning Is Joyful, Meeting Learners Where They Are,* and *Learn Science By Doing Science,* this series of short (about five minutes each) professional development videos highlight core elements of teaching and learning interactions at San Francisco's Exploratorium's Teacher Institute. The videos are meant to guide teachers as they shift instruction to support the *NGSS*. Longer, more extensive videos—such as *Collaborative Learning With Earth and Moon* and *Scientific Inquiry With Mirrors*—enable viewers to virtually experience popular hands-on activities and workshops at the Exploratorium (e.g., Science Snacks, Summer Institute) and access pedagogical annotations. Find these videos at *https://bit.ly/2SzMSlr.*

Learning Through Performance Curriculum. **M** **H** Developed by the Stanford Center for Assessment, Learning, and Equity (SCALE), this project-based, grade six curriculum was created to help teachers envision what year-long, *NGSS*-supported curriculum might look like. The curriculum centers on the project-based learning instructional model and incorporates rigorous, curriculum-embedded performance assessments in every unit. Teacher and student versions of each unit, as well as task cards, are provided.

The teacher versions include unit overviews, standards connections, and other supplementary materials that support the instruction of each unit. Titles include Orientation to Groupwork (Unit O), Energy (Unit 1), Cells and Body Systems (Unit 2), Variation and Heredity (Unit 3), and Climate Change (Unit 4). Learn more and access the curriculum at the website *https://stanford.io/2rguNwG.*



NASA

The Whirligig Aerospace Challenge Lab. **M** Targeted for grades 8–12, this simple activity from Edutopia.org excites students about space exploration and teaches the engineering design process. After watching *Seven Minutes of Terror,* a video that describes the challenges NASA scientists faced in Curiosity Mars rover's final minutes before landing on the surface of Mars, students are given a challenge of their own: Build the slowest whirligig—i.e., Mars lander—from inexpensive supplies (e.g., tape, paper, and paper clips). As students build their models, they work through several key steps in engineering design: defining problems, making models, carrying out investigations, interpreting data, constructing and designing solutions, and communicating information. Find the activity, which includes teacher instructions, whirligig templates, a student reflection sheet, and links, at *https://edut.to/2C3a4Bg.*

GeoInquiries. **E** **M** **H** These short, standards-based inquiry activities can be used for teaching map-based content found in commonly used textbooks in grades 4–12. Developed by educators at Environmental Systems Research Institute (ESRI), each map-based activity is designed around a common inquiry model and can be presented quickly from a single computer and projector or modified for students' hands-on engagement. Click on a theme (e.g., "Earth Science," "Environmental Science," "Human Geography," or "Upper-Elementary"), and choose from a collection of 15–20 lessons on the topic. The Earth Science collection, for example, contains lessons such as Topography and Our Natural Heritage; North American Landforms; Rock Types Tell Stories; Fluid Earth: Winds and Currents; Rivers: Watershed Analysis; and Oceans: Hot Spot.

Most lessons can be completed in about 15 minutes and require only internet access and the lesson plan; however, some more in-depth lessons in each collection require a free school subscription to ArcGIS online. All of the activities engage students in working with data and interpreting maps. Browse the collections at *https://bit.ly/2SaRw8I.*

ChemReview Modules. **H** **HE** Use this resource to help advanced high school and undergraduate students review and learn math fundamentals needed to solve calculations and succeed in first-year college chemistry courses. The tutorials are modules (in PDF format) from the textbook *Calculations in Chemistry,* written by chemistry educators Donald Dahm and Eric Nelson. Module One addresses the topic of scientific notation; Module Two addresses the metric system. To access the materials, click on the link in the upper-right corner (Download Free Chapters), and follow the prompts. Consult *http://chemreview.net.* ●

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

News Bits

- **The Indiana Department of Education (IDOE) will request $20 million from legislators to support a push for science, technology, engineering, and math (STEM) statewide. K12**

The IDOE's six-year plan would require all teachers to learn and implement project-based, problem-solving teaching strategies. Amanda McCammon, IDOE's Workforce & STEM Alliances chief, says helping schools overcome funding challenges and providing equitable access to STEM programs is essential. "We'll see smaller programs within some of our schools be able to afford some of this programming for some of the STEM curricula, but not for every student," McCammon observes. "We want to make sure that, yes, those students receive it, but also our students [who] are meeting the mark or underachieving as well."

Under the new plan, students also will be exposed to STEM careers. Read more at *https://bit.ly/2RLTOLb* and *https://bit.ly/2Q3uH5j*.

- **Stanford University and University of Oregon researchers report virtual reality (VR) could help improve environmental learning gains and attitudes. H HE**

In their study published in *Frontiers in Psychology,* the researchers took a VR experience into various educational settings, including high school classrooms, to test the impact on awareness and understanding of ocean acidification. Lead study author David Markowitz says participants' knowledge increased the longer they spent in the VR learning environment. "Across age groups, learning settings, and learning content, people understand the processes and effect of ocean acidification after a short immersive VR experience," he asserts.

Researchers cautioned that further study is needed to determine how long VR's effects last. Read more at the website *https://stanford.io/2R0Crux.*

- **A study of Maryland's Baltimore County Public Schools (BCPS) shows one-to-one laptops didn't really increase student achievement. K12**

Johns Hopkins University researchers found little improvement following a $147 million one-to-one laptop program implemented four years ago. School officials contend the initiative was not solely meant to raise achievement, but also to provide equity to students without internet service and laptops at home. They add that teachers had too little time to adjust their instruction and lesson plans for achievement gains to be seen, and high school students only received laptops this school year.

Other researchers have studied the impact of one-to-one laptop programs nationwide. A 2016 analysis of 10 studies concluded that giving every student a laptop boosts achievement in science, math, English, and writing. But the authors—from Michigan State University and the University of California at Irvine—cautioned that computers alone don't increase academic performance and must be accompanied by other changes in teaching.

Jennifer Morrison, a Hopkins researcher who studied the BCPS program, suggests the district retain the laptops and examine its curriculum to improve instruction. "The devices are just the delivery mechanism," she observes. "Whether the lessons are on a laptop or not, the underlying instructional message should be the same." Hopkins researchers found that the technology program is largely supported by BCPS teachers and parents, with 85% of teachers surveyed reporting their students appear to be more engaged in their lessons.

BCPS high school science teacher Martin Stranathan says he likes the convenience laptops provide his students for research, but doesn't believe the devices have increased achievement. He contends that funding for the computers could have been used to obtain resources more likely to improve achievement. Teachers also report difficulty in managing students' inappropriate behaviors on the laptops. Read more at the following website: *https://bsun.md/2QNGauu.* ●

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

In Your Pocket

Editor's Note

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

February 22–28

American Electric Power Teacher Vision Grants P K12

These grants go to preK–12 teachers who live or teach in American Electric Power (AEP) service areas: in Arkansas, Indiana, Kentucky, Louisiana, Michigan, Ohio, Oklahoma, Tennessee, Texas, Virginia, or West Virginia. Grants of between $100 and $500 fund projects with an academic focus that improve student achievement. Those that emphasize science, math, technology, energy efficiency, or the study of energy and a sustainable environment are preferred; those that are interdisciplinary or incorporate matching funds, team-teaching, or community resources are of particular interest.

Apply at *http://bit.ly/2CLzJQC* by **February 22.**

National Marine Educators Association's (NMEA) Marine Education Award A

This award recognizes outstanding work and leadership in marine education at the local, regional, or national level by professionals who are not classroom teachers. Nomination letters should describe the candidate's leadership and past or present career accomplishments in the field. Awardees receive a one-year NMEA membership and an engraved award.

Submit nominations by **February 28;** visit *http://bit.ly/1LAe2QE.*

CAP Award for Excellence in Teaching High School/CEGEP Physics H

This Canadian Association of Physicists (CAP) award recognizes an innovative physics teacher who demonstrates a strong understanding of the subject matter and the ability to motivate and engage students. Nominees should use innovative teaching methods, participate in physics-related extracurricular activities, and mentor physics students or new physics teachers.

Awardees receive two free years as a CAP member teacher and a grant that can be used for professional development or to purchase computer software, equipment, or books for classroom use. Recipients can also participate in a week-long training program at a Canadian research institution.

One award is given in each of five regions in Canada: British Columbia/Yukon, Prairies/Northwest Territories, Ontario, Quebec/Nunavut, and Atlantic Canada. Nominees must be Canadian residents and have been teaching physics at a Canadian high school or CEGEP for at least five years. Apply by **February 28;** see *http://bit.ly/2Vrjgs1.*

Monsanto Fund Grants K12

These grants support communities within 30 miles of Monsanto sites. Funds are available for K–12 education, food and nutrition programs, and community development projects.

K–12 programs with a focus on STEM that use evidence-based methodologies and innovative approaches to foster student achievement are preferred. Community gardens, professional development in STEM subjects, afterschool programs, farmer training and agriculture programs, and other projects that fall under the three focus areas above are also eligible.

Applicants must first request an invitation code at *http://bit.ly/2s2sBJu* and be invited to apply. Applications are then due by **February 28.**

March 1

The Leavey Awards K12 HE

These awards recognize elementary, junior high, high school, and college educators who teach students about entrepreneurship and the free enterprise system. One award of $15,000 and up to 20 awards of $7,500 are available.

Recipients must be U.S. citizens or permanent residents who are employed full-time at an accredited K–12 school, college, or university in the United States. Innovative projects that develop a deep appreciation for and understanding of the private enterprise system are preferred. The program, course, or project must be currently operating or initiated during the previous academic year. Submit nominations by **March 1** at *http://bit.ly/2LL4qbE.*

Association of American Educators Classroom Grants K12

These grants of $500 or less fund a variety of classroom projects and materials, including books, software, calculators, audiovisual equipment, and lab supplies. Full-time educators who haven't received a scholarship or grant from the Association of American Educators in the last two years are eligible. Those in Arkansas, Colorado, Idaho, Kansas, Oregon, and Washington compete for state-specific funds and complete a separate application.

Apply by **March 1;** see the website *http://bit.ly/2Vje0GW.*

Arthur Holly Compton Award in Education HE

This award, sponsored by the American Nuclear Society (ANS) to honor physics Nobel Prize–winner Arthur Holly Compton, recognizes outstanding contributions to nuclear science and engineering education. The honoree will receive $2,000 and an additional $2,000 for his or her academic institution. Nominees need not be ANS members nor work primarily in education.

Submit nominations and a letter of recommendation by **March 1;** visit *http://bit.ly/2F8YAiQ.*

Astronomical Society of the Pacific's Thomas J. Brennan Award H

This Astronomical Society of the Pacific (ASP) award goes to an exceptional high school astronomy teacher who is committed to classroom or planetarium education and training other teachers, or to someone outside the classroom who has had an impact on the teaching of high school astronomy in North America. Colleagues, students, and those familiar with the candidate's accomplishments can submit nominations. The honoree will receive $500 and a plaque at the ASP Awards Dinner.

Nominations are due by **March 1;** visit *http://bit.ly/2QhjNJy* for details.

The Richard H. Emmons Award for Excellence in College Astronomy Teaching HE

The ASP presents this award to recognize outstanding achievement in the teaching of college-level astronomy for non-science majors. Colleagues, students, and others familiar with the individual may send letters of nomination highlighting how he or she has distinguished him- or herself in this regard. The winner will receive $500 and a plaque at the ASP Awards Dinner.

Submit nominations by **March 1** at *http://bit.ly/2SvyF8U.*

Apply Year-Round

Duke Energy Foundation Local Impact Grants K12

The foundation provides K–12 Education and Nature grants of $10,000 or less to nonprofit organizations that make an impact in communities where the company operates in Florida, Indiana, Kentucky, North Carolina, Ohio, and South Carolina. K–12 grants should advance energy, engineering, and environmental education through student programming or teacher professional development. Grants are made at the district level.

Nature grants should support species conservation, habitat and forest restoration and protection, or water quality, quantity, conservation, and access.

Applications for both programs are accepted year-round. Power for Students grants of $5,000 or less are also available for afterschool or enrichment programs. Visit *http://bit.ly/2s3Bkv5.* ●

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

What's New

FROM U.S. GOVERNMENT SOURCES

National Oceanic and Atmospheric Administration (NOAA)

2019 Marine Debris Calendar E M

Featuring winning artwork created by K–8 student participants in NOAA's 2018 Keep the Sea Free of Debris contest, this colorful calendar highlights the problem of marine debris and provides links for learning more about it. In addition to creating original artwork, the calendar artists shared their thoughts about what can be done to prevent or reduce the impact of marine debris on the oceans. These ideas included organizing events such as beach cleanup days, recycling metal and plastic products to keep them out of the oceans, and creating signs to inform people about how trash impacts the oceans. Download the calendar at *https://bit.ly/2ArxiRQ*.

Centers for Disease Control and Prevention (CDC)

Winter Weather Safety Infographic K12

It's important for K–12 students and their families to learn how to stay safe in extreme cold and to avoid dangers such as frostbite or hypothermia. A colorful infographic from the CDC available at *https://bit.ly/2R7gF8k* presents information about the symptoms of frostbite and hypothermia, along with tactics for avoiding these dangers and guidance on when to seek medical attention.

National Aeronautics and Space Administration (NASA)

Mars InSight Mission Lessons K12

Generate excitement for space exploration with these lessons, inspired by the Mars InSight mission, for K–12 students (*https://go.nasa.gov/2snPhnB*). Developed by scientists and educators at NASA's Jet Propulsion Laboratory, the activities explore various topics in Earth science, physical sciences, math, and engineering design.

In Exploring the Color of Mars, for example, students in grades 2–5 examine satellite and rover images to learn about the causes of color variation on Mars, then create their own "Marscape." Another activity, Planetary (Egg) Wobble, Newton's First Law, asks students in grades 3–8 to observe the motions of spinning eggs to determine which are raw and hard-boiled, then use these observations to help develop understanding of how scientists might determine whether the center of a planet is liquid or solid. In the Heat Flow Programming Challenge, students in grades 5–12 use microcontrollers and temperature sensors to measure the flow of heat through a soil sample; this experience helps students better understand the purpose of the InSight Mission, which employs similar kinds of equipment and methods to study the interior of the Red Planet.

Fish and Wildlife Service (FWS)

***Let's Go Fishing!* Activity Booklet E M**

Targeted for students in grades 3–7 and their families, and available at *https://bit.ly/2KMZGVE,* this booklet developed as part of the FWS National Park Service Junior Ranger program contains 12 games and activities to foster safe and enjoyable fishing experiences and promote the conservation of native fish and their habitats. Students can learn fishing safety protocols, identify the parts of a fish and fish habitats, and discover helpful tips on being a respectful angler. Other activities discuss fishing gear and different types of fishing. The booklet concludes with a crossword puzzle that reinforces program content and promotes environmental stewardship.

Interested students can turn in the completed booklet at a participating site and receive a Junior Ranger fishing badge. Alternatively, teachers or parents can e-mail photographs of students' completed activity pages, along with name and mailing address, using the form at *https://bit.ly/2LIOAhr,* and students will receive a Junior Ranger fishing badge in the mail.

National Institutes of Health (NIH)

Genomics Image Gallery A

Looking for genomics- or health-related images? Visit the National Human Genome Research Institute's (NHGRI) image gallery on Flickr at the website *https://bit.ly/2s46Wkg.* The gallery features scientific illustrations, infographics, and photographs of NHGRI staff to encourage middle level through college educators and the public to learn more about genomics research and related medical breakthroughs. The images are intended for presentations, school projects, news reports, and other publications and include highlights such as an online family health history tool created by the U.S. Surgeon General's Office and the 11 Neat Facts About the Y Chromosome infographic.

Users can click images to access details and a short caption about each one, scroll without clicking to view image titles, mark image favorites, or comment on the images. The images are free to download; users are asked to credit the organization and artist or photographer when using the images.

NIEHS Games for Kids E

Science research involves finding solutions, which makes scientists excellent problem solvers. Help students in grades K–5 stay engaged in health and environmental topics—and practice solving problems like scientists—with the games, puzzles, and brainteasers from the National Institute of Environmental Health Sciences (NIEHS) website at *https://bit.ly/2EYBaww.* Learn what NIEHS scientists are studying, then have students explore activity pages such as Illusions, Matching Game for NIEHS Birds!, Rebus Puzzle Brainteasers, Science Challenge A to Z, and Science Scrambles Game. Each game page includes links to additional resources about environmental and health topics, such as articles about river and stream pollution, wildlife, ecology, air pollution, and other issues.

National Science Foundation (NSF)

When Nature Strikes: Wildfires M

Use this video and associated activity to teach students in grades 6–8 about wildfires and their impacts. Produced by NSF in partnership with NBC Learn and The Weather Channel, *When Nature Strikes: Wildfires* (*https://bit.ly/2H0v6Xg*) describes how scientists study the interactions of weather and fire to develop a prediction system to forecast wildfire behavior. An activity developed by the National Earth Science Teachers Association, Wildfires—Why Are They a Challenge to Stop? (see *http://bit.ly/2VLCPvy*), teaches students how to use online maps and data tools to identify fire-prone regions in the United States, as well as areas with current fire activity. The activity also teaches students how to interpret computer simulations of wildfire dynamics.●

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

Summer Programs

Editor's Note

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

McDonald Observatory Workshops K12

McDonald Observatory, located in the Davis Mountains of west Texas, will host four workshops for K–12 teachers. Participants meet astronomers and discuss current research, practice basic astronomy skills, tour the facility's telescopes, and conduct nighttime observations. Workshop topics, dates, and grade levels are

- Galaxies and the Hobby-Eberly Telescope Dark Energy Experiment (HETDEX; June 27–29; grades 6–12);
- Elements of the Cosmos (June 23–25; grades 6–12);
- Mysteries of the Universe: Dark Matter, Galaxies, and Beyond (June 18–20; grades 8–12); and
- Explore Our Solar System (July 8–10; grades K–8)

Up to 20 continuing education credits are available. Apply by **February 28** at *http://bit.ly/2TtjRrD.*

Monterey Bay Aquarium's Coastal Systems Teacher Institute E

Teachers of grades 3–5 will explore Monterey Bay's ecosystems while focusing on the *Next Generation Science Standards* (*NGSS*) crosscutting concept of systems. Teachers conduct field investigations, learn to use science notebooks, and experience how authentic science writing can improve students' science literacy.

Participants must attend the summer session July 7–12 and three follow-up Saturday sessions on October 5, and February 1, 2020, and May 16, 2020. They must also use the curriculum with their students, participate in the aquarium's online professional development community, and lead an inservice or action project at their school or district.

Teams of 2–4 teachers from the same or nearby schools are invited to apply. Dorm housing and meals are provided, as are $50 daily stipends upon completion of the program. California State University (CSU) Monterey Bay credits are available for an additional fee. Register by **March 18** at *http://bit.ly/2RdwCKl.*

Monterey Bay Aquarium's Splash Zone Teacher Institute P E

Participating preK–2 teachers will explore the habitats in their own backyards. Participants study survival patterns in various habitats and ways to inspire student conservation efforts. The institute encourages science discourse in the classroom by connecting science notebooks, language arts, inquiry, and technology with a focus on the *NGSS* crosscutting concept of patterns.

Participants must attend the summer session (July 28–August 2) and three follow-up Saturday sessions on October 5, and February 1, 2020, and May 16, 2020. They must use the curriculum with their students, participate in the aquarium's online professional development community, and lead an inservice or action project.

Teams of two to four teachers from the same or nearby schools are invited to apply. Daily stipends of $50 are available upon completion of the institute, and CSU Monterey Bay credit units may be purchased. Dorm housing and meals are provided for the summer session. Register by **March 18** at *http://bit.ly/2RdwCKl.*

Physics of Atomic Nuclei M H

This free residential program for middle and high school physical science teachers in the United States and Canada and U.S. students who have completed at least one year of high school is held at the National Superconducting Cyclotron Laboratory at Michigan State University. Participants will explore the domain of atomic nuclei and their connection to astrophysics and cosmology. The teacher program takes place July 15–19; the student one July 22–26. Apply by **March 29** at *http://bit.ly/WbSAVk.*

Foothills to Tundra: Changing Ecosystems and Biomes of Rocky Mountain National Park K12

During this June 26–28 field course in Rocky Mountain National Park, K–12 teachers will investigate a prehistoric archaeological site and explore a microcosm of ecosystems and biomes. They also will participate in two Citizen Science programs related to phenology and climate change and work with experts from the Denver Museum of Nature and Science, the Denver Zoo, the Denver Botanic Gardens, and the National Park Service.

Teachers should be able to walk 1–2 miles a day over uneven surfaces and participate in a one-day preparation session either on-site or via Skype on June 8. Register by **April 1** for a 25% discount. Visit *http://bit.ly/2TpFSHS.*

Maury Project for Oceanography Educators K12

This American Meteorological Society (AMS) workshop is for precollege teachers and supervisors who teach, or supervise the teaching of, units with significant oceanography content. Participants learn the physical foundations of oceanography, explore how these concepts can be employed in the classroom, and prepare teacher workshops.

Participants attend a two-week training workshop at the U.S. Naval Academy (USNA) in Annapolis, Maryland, July 14–26, and learn from USNA faculty members, National Oceanic and Atmospheric Administration (NOAA) scientists, and others. They also receive graduate credit, a $600 stipend, lodging, meals, travel funds, tuition, and instructional materials. After the workshop, they conduct at least two training sessions for precollege teachers in their home regions, supported by AMS.

Teachers interested in promoting minority participation in science are particularly encouraged to apply (deadline **April 1**). See *http://bit.ly/2cQO2Gz.*

Project ATMOSPHERE K12

The AMS offers this hybrid workshop for K–12 teachers who teach science courses with atmospheric content and their supervisors. Participants learn the latest technologies for sensing, analyzing, and forecasting weather and how to incorporate them in the classroom.

Before the on-site workshop, participants complete online learning modules. Then from July 28 to August 3 at the U.S. National Weather Service (NWS) Training Center in Kansas City, Missouri, they participate in lectures, tutorials, hands-on lab exercises, field trips, and seminars led by NWS and NOAA personnel.

Participants receive graduate credit, a $300 stipend, lodging, travel funds, tuition, instructional materials, and $200 for food and incidentals. Afterward, they must conduct at least one training session for precollege teachers in their home regions, supported by AMS.

Teachers and supervisors interested in promoting minority participation in science are encouraged to apply (deadline **April 1**) at *http://bit.ly/2F5XHsq.*

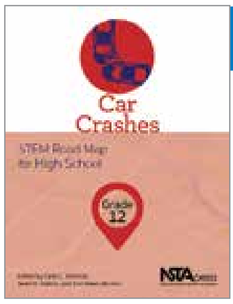
FDA Professional Development in Food Science M H

The Food and Drug Administration (FDA) and NSTA have created a professional development workshop and related curriculum on food science for middle and high school teachers. Participants learn about foodborne illness from industry experts and explore the Science and Our Food Supply curriculum. Air travel, lodging, and meals are provided for the workshop, taking place in Washington, D.C., July 21–27.

In the fall, participants implement the curriculum in their classrooms and conduct a workshop on the curriculum for other teachers. An honorarium and materials are provided.

Certified middle or high school science, health, or family and consumer science teachers with at least three consecutive, full-time years of teaching experience may apply by **April 24.** See *www.teachfoodscience.org/apply.asp.*●

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



NSTA PRESS: *Car Crashes, Grade 12: STEM Road Map for High School*

Crash Reconstruction

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 Car Crashes, Grade 12: STEM Road Map for High School, *edited by Carla C. Johnson, Janet B. Walton, and Erin E. Peters-Burton, edited for publication here. Download the full text of this chapter at* https://bit.ly/2OF5uOc. *NSTA Press publications are available online through the NSTA Science Store at* www.nsta.org/store.

The crash reconstruction industry uses crash reconstruction to determine the speed of cars for law enforcement. The Crash Forensics website (*www.crashforensics.com*) is a good place to start to understand the many possible physical conditions of a car that could contribute to accidents.

Crash reconstruction determines variables before a collision from evidence left at the scene after a crash. Crash reconstruction experts mainly rely on Newtonian physics (motion, speed, forces, momentum, and energy) to analyze the evidence and determine the speeds and directions of the cars before impact. The law of conservation of energy and the law of conservation of momentum are particularly helpful to professional crash reconstruction experts. These professionals need to know what evidence to pay attention to, what equations to apply, and the limits of some of the evidence. Understanding the speed and direction of the vehicles in a crash can be helpful in determining if there was an equipment failure or perhaps human error. Measurements such as point of impact, final resting positions, skid marks, and damage to the vehicles are taken to try to reverse engineer the precollision conditions.

The "Energy Analysis" section beginning on page 11 of a report by the American Prosecutors Research Institute, *Crash Reconstruction Basics for Prosecutors* (*https://bit.ly/2JPHtCV*), may be helpful in identifying variables to be considered in reconstructing a collision.

Common Misconceptions

Students will have various types of prior knowledge about the concepts introduced in this lesson. Table 4.6 outlines some common misconceptions students may have concerning these concepts. Because of the breadth of students' experiences, it is not possible to anticipate every misconception that students may bring as they approach this lesson. Incorrect or inaccurate prior understanding of concepts can influence student learning in the future, however, so it is important to be alert to misconceptions such as those presented in the table.

Table 4.6. Common Misconceptions About the Concepts in Lesson 2

Topic	Student Misconception	Explanation
Vectors	Adding the magnitude and direction of vectors gives the resultant vector.	When adding multiple vectors, each vector can be added in a head-to-tail method, keeping the magnitude and direction the same for each vector. Alternatively, vectors can be first translated to the *x*- and *y*-axes separately, then added and resolved into one vector.
Forces	An object in constant motion in a straight line has a constant force applied so that it keeps moving.	If the object were in an environment with no friction, then according to Newton's First Law, the object would keep moving in a straight line at a constant speed until another force interrupts this path. The only force needed to make an object proceed into motion is an initial force. Once the object is moving, it will keep moving until friction slows it down.

Learning Components

Introductory Activity/Engagement

Connection to the Challenge. Begin each day of this lesson by directing students' attention to the driving question for the module and challenge: Should people be subjected to a law so the government can keep people safe, or should people have the individual freedom to choose? The first day of this lesson, also ask students: What kinds of forces interact with cars? What is the role of forces during a car crash? On subsequent days, hold a brief student discussion of how their learning in the previous days' lessons contributed to their ability to create courtroom "expert witness" presentations for the final challenge. You may wish to hold a class discussion, creating a class list of key ideas on chart paper or the board, or you may wish to have students create a STEM Research Notebook entry with this information.

Science Class, Mathematics Class, ELA, and Social Studies Connections. Have students watch the *MythBusters* video *100 MPH Crash* at *https://bit.ly/2FcR9ZK*, in which a car crashes into a wall at speeds of 50 mph and 100 mph, and answer the first set of questions. Next, have them watch the video *MythBusters: Car Crash Force* at *https://bit.ly/2ASSLUi*, in which two cars both traveling at 50 mph collide, and answer the second set of questions.

STEM Research Notebook Prompt

As students watch the first video at *https://bit.ly/2FcR9ZK*, they should write their responses to the following questions in their STEM Research Notebooks:

- *What are some of the physical things that the MythBusters have to set up to ensure that the collision would be head-on into the wall?*
- *What safety precautions did they take?*
- *What measurements did they take?*
- *What do you think would happen if two cars both going 50 mph crashed into each other head-on? Would they look more like the car that crashed into a wall at 50 mph or at 100 mph?*

As students watch the second video at *https://bit.ly/2ASSLUi*, they should answer the following questions in their STEM Research Notebooks:

- *What did you notice about the differences between a car crashing into a wall at the speed of 50 mph (the red one) and one at twice that speed (the yellow one)?*
- *What are some of the physical things that the MythBusters had to set up to ensure that the collision would be head-on between the two cars?*
- *What safety precautions did they take?*
- *What measurements did they take?*
- *Did they explain the science correctly?*

Then, have students review the following two articles from *Wired* magazine about the *MythBusters* crashes, taking notes in their STEM Research Notebooks:

- "*MythBusters* and Double the Speed," which describes the interaction of mass and velocity in the two scenarios, at *https://bit.ly/2RHFdRe*
- "*MythBusters'* Energy Explanation," which describes the kinetic energy in the two scenarios, at *https://bit.ly/2OzKRCH*

Students should also make note of what concepts they do and do not understand from the videos and articles. Explain to students that throughout this lesson, they will investigate the speed, mass, forces, and momentum of cars in three different crash scenarios: a car striking a stationary object, two vehicles colliding head-on, and two vehicles colliding at an angle to each other. They will need to describe how vectors are used to explain the third scenario. In ELA class, they will write formal laboratory reports to communicate their findings clearly. ●

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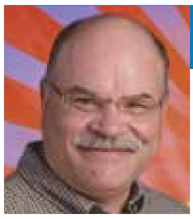

ASK A MENTOR, **Advice Column**

Focusing on Students' Needs

What is the most important part of teaching to remember?

– C., Iowa

I would ask all my student teachers, "What do you teach?" Without hesitation, they would answer science, biology, chemistry, or another discipline. I would then tell them,

"I teach kids."

The most important thing is to remember that you teach *students*. If you are mindful that you are helping to develop their minds and prepare them for the modern world, then throughout your career you will consider your students before your subject, keep up with new ideas in teaching, and be flexible when dealing with students.

As a teacher and perhaps a science specialist, you are among the minority in terms of your love of and interest in learning and science. Most of your students come to your class with different ideas, likes, dislikes, and perceptions. Knowing that, you should aim to inspire the majority of your students to see utility and wonder in scientific pursuit, perhaps by concentrating on how science works. Teachers need to convey important concepts, ideas, and skills that cut across scientific endeavors and demystify science. By doing so, we hopefully can create a scientifically literate populace able to understand science's contributions to society and able to make informed decisions.

I have a few students who chatter excessively and need advice on methods that have worked to quiet the disruption. I also need to involve students who are reluctant to participate.

—H., Arizona

I like a chatty, active classroom—provided the students are on task. I would give students opportunities that allow them to chat and work in groups, but keep them focused on thought-provoking topics or problems. Organize the groups yourself to minimize socializing. Limit discussions to keep them moving forward, and have extension or follow-up activities for those who finish quickly. Require groups to present discussion overviews to pause the talkers and channel their discussion.

When you don't want students to talk, assign seats and be sure to separate friends who chat too much.

My advice for handling shy students changes with the type of group work.

Labs. Create roles for each member for hands-on or lab activities. I have a resource in the NSTA Learning Center describing the responsibilities I assigned for science, technology, engineering, and mathematics (STEM) projects at *https://goo.gl/EshMpi*.

Discussions/Workgroups. I believe shy students sometimes need more time to gather their thoughts and are less likely to join ongoing conversations. "Think-Pair-Share" allows time for individual reflection and ensure that everyone has a turn.

Employ self-assessments or group assessments. You are welcome to use these from my group evaluation resource collection in the Learning Center at *https://goo.gl/UbqmNX*.

I am writing to ask for suggestions to teach visually impaired students science. How do you suggest teaching such students?

—M., Iowa

First, get to know the student as an individual learner. Ask the student how you can support him or her in your class. Then, contact those who support that child—teaching assistants, caseworkers, parents, resource teachers—and ask them what works and what doesn't; which vision and reading technologies are in place and what will you need in your classroom; what services can assist you; and if you can access textbooks in braille or large-print versions.

Only a fraction of legally blind people have 100% impairment, so you need to understand what level or kind of impairment each student has. For instance, a person with retinitis pigmentosa may have lost peripheral vision but retain a small central area of vision. To get an idea of what that would be like, you could spread petroleum jelly on a pair of goggles, leaving a small central area clear, then try out your activities, handouts, and visuals.

Survey your room for mobility hazards. Pair the student with a buddy who can perform potentially dangerous tasks. Physical objects may provide an excellent tactile experience and observational exercise for the student. For dissections, allow them to perform cuts to their degree of ability and have them handle and touch specimens.

I am hoping to have "word walls" in my classroom for subject areas. What would be some beneficial words no matter the age level for the science classroom?

—H., Iowa

I maintain that teaching science is like teaching a new language to students. Teaching vocabulary to use when communicating scientifically is important and should start at an early age.

Along with words highlighting crosscutting concepts, I believe it would be ideal to have actions, skills, processes, and terms that span topics and science disciplines on your word wall.

Rather than putting a list of words on the wall for students to memorize, have students brainstorm the words they believe should be on the wall after some readings or activities on the nature of science. You could have groups present their choices or make a case for including each word.

The wall doesn't have to be static: Add to it as the year passes. To bolster terminology specific to some topics, you could create a temporary word wall alongside your crosscutting words.

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

BLICK ON FLICKS

Mary Poppins Returns

By Jacob Clark Blickenstaff

My kids have been fans of the original Disney *Mary Poppins* (1964) film for years, and we were all there in the theater for *Mary Poppins Returns* (2018). Assuming that everyone knows the storyline of the first film, I'll just give a quick summary of the new one.

The first film is set in 1910. *Mary Poppins Returns* seems to take place about 25 years later, in the mid-1930s. Jane (Emily Mortimer) and Michael (Ben Whishaw) have grown up and own the family home. Michael has three young children—Annabelle, John, and Georgie—whom he has been raising alone since his wife's death.

Michael works at the same bank his father worked for, but also has a loan with the bank that is in default. His boss, Mr. Wilkins (Colin Firth), gives the family a short deadline to pay off the loan or have the house repossessed. Jane and Michael believe they own shares in the bank inherited from their father, but cannot find them. They do, however, find Michael's childhood kite.

Annabelle, John, and Georgie fly the kite at the park, and when a windstorm threatens to carry Georgie off, Mary Poppins (Emily Blunt) saves him. A series of magical adventures ensue, including a trip underwater through a bathtub, into the painted scene on a china bowl, and in an upside-down house. They are accompanied by Jack the lamplighter (Lin-Manuel Miranda).

Unsurprisingly, the house is saved and the children behave better due to Mary's influence. I won't reveal the plot points that get us there, but I do have three ways teachers could use the film.

Gas Lighting

As a lamplighter, Jack lights gas street lamps every evening and extinguishes them in the morning. By the 1930s, gas street lights were being replaced in most cities by electric lights that required less maintenance. I was surprised to learn that London still has more than 1,000 functioning gas lamps. The more modern lamps have battery-powered timers, but others have mechanical clockworks that need to be wound every 10–14 days.

The 19th century was the heyday for urban gaslights. These systems were fueled by "manufactured gas." Manufactured gases were made by heating coal or wood in a closed oven that had essentially no oxygen. The combustible material wouldn't burn, and the gas could be collected and piped to lamps and homes. Manufactured gas included many different combustible compounds, some of which were better for producing bright light; others for generating heat. The combination depended on the original solid fuel and the method of manufacture.

Burning gas produces fewer pollutants and less carbon dioxide than burning coal, which has created interest in a modern version of the process now known as coal gasification.

English China

In *Mary Poppins Returns*, Mary, Jack, and the children visit the Royal Doulton Music Hall via magical transportation through a china bowl. Royal Doulton is a famous porcelain company based in England. Earthenware pottery is ancient technology, but bright white, light, and strong porcelain has only been around for about 1,000–2,000 years.

This fine porcelain was invented in China. Many European pottery manufacturers tried to copy the Asian porcelain, but were unsuccessful until the early 18th century. An English potter discovered that adding bone ash (the remnants of animal bones after heating and grinding them) made his porcelain stronger and more translucent. "Bone china" is England's unique contribution to the development of high-quality porcelain, and it is still made today.

Balancing Act

At one point in the film, Jack needs to get Mary and the children through London on his bicycle. There aren't enough seats, but they take advantage of physics. Jack puts his ladder across a rack over the back wheel, and Mary sits on one side, Annabelle and John sit on the other side, and Georgie sits in a basket on the front of the bike.

Though Mary is heavier than John and Annabelle, she sits closer to the ladder's middle, and John sits toward the end. Similiarly, a lightweight child can balance a seesaw with an adult if the adult sits close to the fulcrum and the child sits far from it. In a high school or college physics course, you could explore balancing the torques on the ladder. In middle school, a qualitative conversation about how far the force is from the fulcrum is likely sufficient.

Chemistry, physics, technology, and even ceramics teachers could use *Mary Poppins Returns* to get students talking about fuels, balancing, and ceramics.

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

Champion Science Education in St. Louis

Saturday Livestream

For the first time, NSTA is offering a livestreaming conference experience for elementary educators who cannot attend in person. The livestream, taking place at 8 a.m.–1:30 p.m. on April 13, includes a presentation by Sean Carroll and breakout sessions with Emily Morgan and Karen Ansberry, authors of the *Picture-Perfect* book series; Carla Zembal-Saul, co-author of *What's Your Evidence? Engaging K–5 Students in Constructing Explanations in Science*; and Linda Froschauer, 2006–2007 NSTA President and former field editor of NSTA's elementary-level journal, *Science & Children.* NSTA members can register for the livestream for $75.

Mike Szydlowski, a K–12 science coordinator for Columbia Public Schools in Columbia, Missouri, expects to find inspiration and renewed energy at NSTA's National Conference on Science Education, taking place April 11–14 in St. Louis, Missouri.

"In all honesty, I couldn't be more excited," says Szydlowski, who is the conference committee chair. "Since I started teaching 20 years ago, I've only missed two NSTA national conferences. I've gotten so many new ideas that I couldn't have gotten otherwise. You get energized when you attend a conference."

He will share that energy with others, noting that his district is sending more than 50 teachers to the conference. "One of the strands this year focuses in part on place-based learning, which I'm really passionate about. I think we often miss that connection to our community. Every idea I've implemented in my classroom has come from or been inspired by an NSTA conference in some way. I'm hoping the St. Louis conference will inspire all our attendees in the same way," Szydlowski adds.

The conference, Champions for Science Education, features retired astronaut Scott Kelly as the keynote speaker, discussing his career and his record-setting space mission in his presentation The Sky Is Not the Limit: Lessons From a Year in Space. In addition, Sean Carroll, research professor of physics at the California Institute of Technology, will present a special pre-conference session on April 10, exploring The Many Worlds of Quantum Mechanics.

Other featured presentations include Equity: The Power of Understanding the Impacts of Equity and Science Instruction from Tiffany Besse and Joseph Davis of Hazelwood, Missouri's Ferguson-Florissant School District; Hulahula and Learn Something...Expressing Science Through Culture and Dance by Kiana L. Frank, assistant professor, Pacific Bioscience Research Center at the University of Hawaii at Manoa; Exploring Nature's Beauty and Teachings by nature photographer and photojournalist Michael Weiss; and Unlocking the

Power of the *Next Generation Science Standards* by Paul Andersen, an educational consultant and YouTube Creator from Bozeman, Montana. The featured panel discussion, Place-Based Phenomena for Extraordinary Learning, includes Leslie Cook, Kevin Krasnow, and Joe Petrick from the Teton Science Schools (TSS) in Jackson, Wyoming, discussing how TSS increases engagement and learning while making a positive impact on the community.

The conference includes hundreds of sessions, many aligned with one of the four conference strands: Three-Dimensional Grand Slam (implementing three-dimensional learning to increase student understanding); Phenomena: Gateway to Learning (exploring the use of the 5E Instructional Model, Claims-Evidence-Reasoning, place-based learning, and project-based learning); Jazzing Up Science With Cross-Curricular Connections (integrating across science content areas and other disciplines to deepen learning and understanding); and Confluence of Equity and Education (create and maintain high expectations, access, and opportunities for all students). Sessions within each strand are targeted by level from novice to advanced.

Grade-level events offer great opportunities to meet colleagues from across the country teaching at the same level! On April 12, the Elementary Extravaganza will kick off at 8 a.m. The same day, Meet Me in the Middle (10:15 a.m.–4:30p.m.) will feature an afternoon Share-a-thon, organized by the National Middle Level Science Teachers Association. On April 13, the High School Share-a-thon will be held at 9:30–11 a.m. Also on that day, the *NGSS*@NSTA Share-a-thon will take place at 9:30–10:30 a.m.

Focused PD

Before the conference gets underway, four Professional Learning Institutes (PLIs) will be held on April 10, offering an in-depth exploration of their topics:

- Designing Meaningful STEM Lessons
- Becoming a Practitioner of Science: Engaging Students in Solving Real Earth Science Problems in Earth, Physical, or Environmental Science Classrooms
- Next Generation Analyzing Instructional Materials
- Selecting Anchoring Phenomena for Equitable 3-D Teaching

During the conference, 12 short courses—covering topics such as ocean plastic pollution, promoting science inquiry and thinking in preschool, and scaffolding phenomenon-, problem- and project-based learning—offer tailored learning. PLIs and short courses require separate ticket purchase.

Attendees can apply for graduate credits from Dominican University of California by completing required assignments and paying an additional fee. Advance conference registration by March 1 costs $325 for members of NSTA and the Science Teachers of Missouri. For more information or to register, visit *www.nsta.org/stlouis*. ●

Mark Your Calendar

NSTA Dates to Remember

(All dates are deadlines unless otherwise specified.)

March 1—Register now to save on your NSTA National Conference on Science Education registration! NSTA members and members of the Science Teachers of Missouri can register for the conference, taking place in St. Louis, Missouri, for $325. Don't miss keynote speaker and retired astronaut Scott Kelly, hundreds of sessions on three-dimensional science education, cross-curricular connections, and more. To register or for more information, visit *www.nsta.org/stlouis*.

March 1—How do you encourage scientific discussion in your elementary classroom and make sure all students participate? Share your strategies on the theme **"Cultivating Classroom Conversations"** for the November/December 2019 issue of ***Science and Children*** **(*S&C*),** NSTA's peer-reviewed journal for elementary science education. General-interest manuscripts may be submitted at any time. Read the call for papers at *http://bit.ly/2StzkHq*.

March 1—*Science Scope* is accepting manuscripts through today for the October 2019 issue, featuring the theme **"ESS3 Earth and Human Activity."** Middle level educators can share how they develop awareness and understanding of the human impact on the Earth and natural resources. Manuscripts focused on making, technology, practical research, and more, as well as general-interest manuscripts, are accepted anytime. Read the call for papers at *http://bit.ly/2zOZUUA*.

April 1—*S&C* is looking for creative, effective strategies for having students take science home and extend their learning. **Submit your manuscript on "Take-Home Science"** for consideration for the January 2020 issue by today. General-interest manuscripts may be submitted at any time. Read the call for papers at *http://bit.ly/2StzkHq*.

April 1—Share how you're **"Using Technology for Instruction and Assessment"** with your middle level colleagues by submitting an article on that theme to ***Science Scope,*** NSTA's middle level journal, by today. What are your favorite apps for students to use? What online programs have challenged your students to develop their critical-thinking skills? General-interest manuscripts, as well as manuscripts focused on making, technology, practical research, and more, are accepted anytime. Read the call for papers at *http://bit.ly/2zOZUUA*.

May 1—Do your students "tinker" in science? Is it different from hands-on engineering? *S&C* will explore these and related topics in the February 2020 issue. Share **your manuscript on "Tinkering vs. Engineering" with elementary students** by today for consideration. General-interest manuscripts may be submitted at any time. Read the call for papers at *http://bit.ly/2StzkHq*. ●

Celebrating 75 Years at NSTA

NSTA's Awards and Recognition program has been recognizing outstanding teachers for 46 years. Over the years, the awards have expanded to include new teachers, classroom veterans, and even students.

1973 NSTA Board establishes its first award, the Robert H. Carleton Award for National Leadership in the Field of Science Education.

2014 NSTA presents the first Robert E. Yager Exemplary Teaching Awards, the most recent ongoing addition to the program.

Blick on Flicks Update

In the January Blick on Flicks column, which featured a review of *The Incredibles 2,* an error occurred in the formula used. Instead of $Energy = Work = F \cdot x = kx^2$, the formula should have been $Energy = Work = F \cdot x$. In addition, since the force would not remain constant over the distance the spring is stretched, the average force would be used, making the equation: $Energy = 1/2\ kx^2$.

The final equation to determine how much Elastigirl needs to increase her gravitational potential energy to reach the top of a 10-meter-tall building should be

$$x = \sqrt{\frac{2(5900J)}{500\frac{N}{m}}}$$

Thanks to alert reader Jerry DeCarlo who checked the math.

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Genetically Engineered Ivy for Cleaner Air

Many people like the ambiance houseplants add to their decor, but what if they could improve a home's atmosphere? Researchers at the University of Washington (UW) have genetically modified a hardy houseplant to remove two common indoor air pollutants: chloroform—commonly released by boiling chlorinated water—and benzene.

In a study recently published in *Environmental Science & Technology*, the UW researchers revealed they inserted a synthetic gene for producing a mammalian protein, cytochrome P450 2E1, into pothos ivy. The modified plants convert benzene into phenol and chloroform into carbon dioxide and chloride ions. When placed inside a tube, the plants removed 82% of chloroform from the air in three days and 75% of benzene in eight days. The researchers suggested similar effects would occur in a home, although airflow would be necessary to maximize the effect. They are continuing to investigate ways to add a protein that would break down formaldehyde, which is found in some wood products and tobacco smoke.

Read the abstract of "Greatly Enhanced Removal of Volatile Organic Carcinogens by a Genetically Modified Houseplant, Pothos Ivy (*Epipremnum aureum*) Expressing the Mammalian Cytochrome P450 2e1 Gene" online at *https://bit.ly/2Fk55j7*. ●