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Solar Panels Enhance STEM Learning

HEATHER MCCULLAR

Columbia Water and Light presented a solar energy demonstration to students at Benton STEM Elementary School in Columbia, Missouri.

Science, technology, engineering, and math (STEM) teachers and students are acquiring solar panels for their schools to save on energy bills and to educate students about solar power. "The price of solar has plummeted, so it's more affordable," says Margo Murphy, science instructor at Camden Hills Regional High School in Rockport, Maine. Murphy serves as advisor for Windplanners, a student club that has raised hundreds of thousands of dollars for a campus wind turbine; "we're now focused on paying off rooftop solar panels," she reports. "We have been very active and focused on moving our campus toward becoming…carbon neutral."

The school acquired its 160-kilowatt system of panels through a Power Purchase Agreement (PPA) with local company ReVision Energy. Under the PPA, for the first six years, "Camden Hills will continue to pay a contracted price to ReVision Energy that is based on the current price paid, but won't change. [It] will allow ReVision to take depreciation over six years; [it's a] way for them to maximize their return while also bringing our cost down…We buy their energy for six years, then buy out the whole system in year seven," Murphy explains. "We [also] determined that if we take out a…loan in year seven from a bank and [repay] it over seven years, we will pay less on the loan than we would on the amount we would have paid ReVision for the power.

The PPA "is a financial tool any school in the United States can use. [It] has helped Maine [obtain solar panels] despite a sluggish economy," she contends.

Windplanners sat in on meetings between ReVision and the school. "Windplanners are learning about the whole development world, writing grants and fundraising." They have written or are writing grants to foundations supporting the environment and education, and to businesses like Lowe's and Home Depot.

Murphy also teaches Honors Global Science, an integrated core science class in which freshmen study renewable energy, and Gardening and Horticulture, an elective course focusing on sustainability. Other classes also incorporate the solar panels; students in a Foundations of Physics course construct solar boats. "We have installed a monitoring system that allows students to access data on energy consumption and production as a whole school. We are able to see our school as an energy system," she relates.

Honors Global Science students do sustainability investigations on topics like "how many solar panels are needed on my home to maintain my family's energy usage? How much solar energy can be produced per year by the school's panels? The students design projects based on their own questions," Murphy explains. "Students can connect to power companies for data about their homes to find the answers."

The *Next Generation Science Standards* (*NGSS*) "have been very helpful in looking at the sustainability piece, in climate and sustainability. Our district uses *NGSS* to guide what we do and how we do it. It gives us the latitude to consider complex, authentic problems with real-world implications," she contends.

Murphy helps students understand "not just the science and how the

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technology works, but also what drives change." When students ask why some states have more solar power, "we do data exploration [to see] how trends have changed worldwide, nationally, statewide, and locally," she explains. "We look at what's happening economically and politically. Students become aware of how policy and laws influence what happens in the state." They come "to understand how some very sunny states may not have well-developed solar, and less sunny states can have a vibrant solar industry."

Finding Resources

Cheryl Esslinger, who teaches an alternative energy unit in her Earth and Environmental Systems course at Rhinelander High School in Rhinelander, Wisconsin, has benefitted from a program offered by energy provider Wisconsin Public Service (WPS). Because her school participates in WPS' SolarWise® for Schools program, it received a 2-kilowatt rooftop solar energy system at no charge. "We can monitor how much power we use and how much the panels provide, gather data and make comparisons," she reports. SolarWise provides a curriculum, "small solar panels and [solar] car building items," and materials for building solar windmills and hot water heaters, she notes.

After participating in WPS teacher workshops, she acquired "three used solar panels with multimeter angles of insolation [the amount of radiation Earth receives from the Sun]… Students use what they learn about insolation and the angle of the Sun to figure the best position for the solar panel," she relates.

SolarWise schools can compete in the annual Solar Olympics renewable energy competition. Events include racing solar cars and building solar cookers. "My students like to see what other students are doing," says Esslinger, who is taking a team to this year's competition.

"My students [develop] a better understanding of how solar panels work and the optimal conditions [for using them]," she contends. "You have to be in an area with lots of direct sunlight for this to be viable for powering your home."

Making Solar Elementary

"We were approached by the UPS [United Parcel Service] Foundation [when] our principal mentioned getting solar panels," says Heather McCullar, STEM Specialist at Benton STEM Elementary School in Columbia, Missouri. The foundation provided $5,000 "because they wanted to support STEM education," she recalls.

The school purchased the panels from local company Dogwood Solar not only because of their price, but also because "they [appreciated] the educational component" of the purchase, McCullar asserts. Installer Dan Shifley has presented on electricity and solar energy in Benton's annual STEM Showcase, where he demonstrates "models of a panel and how it works," she relates.

Benton's panels are located on a flat section of its roof, and are easily observed by students, she explains. "We use [the panels] as part of our Earth science units, mostly in first grade."

In a first-grade unit on observations, "we talk about daylight at various times of the year, and we've expanded that to include solar energy," she explains. Using data from Dogwood Solar's website, "we look at patterns of weather and sunlight…It's a good way to start discussions with students because they can look at and interact with the data," she contends. "It helps students develop a concrete context for science content, vocabulary, and language."

Schools should "find foundations or businesses that support STEM projects and hands-on [investigation]" and compare prices, she advises. "Consider how you want to use the panels with students; have a specific plan for what impact it will have on student learning…There's a lot of money out there for STEM projects. Lots of companies want to support these initiatives." ●

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COMMENTARY: **Colleen Megowan-Romanowicz**

What Is Modeling Instruction?

By Colleen Megowan-Romanowicz

Colleen Megowan-Romanowicz

Perhaps you have attended a conference or read an e-mail list for science teachers and heard or seen comments about Modeling Instruction or Modeling Workshops. You may even have heard people refer to themselves as "modelers." Have you ever wondered what these teachers are talking about?

High school physics teacher Malcolm Wells developed The Modeling Method of Instruction in the 1980s while doing classroom research for his doctorate in physics education research. Modeling Instruction is a guided inquiry approach to teaching science that reorganizes instruction around the handful of conceptual models that form the content core of the scientific disciplines. This method provides a framework for science instruction that approximates how scientists "do science." Students build, test, and deploy conceptual models of physical relationships. Research has shown that students in Modeling Instruction classrooms perform significantly better on measures of conceptual knowledge than similar students in traditional science classrooms.

Little or no lecturing occurs in a Modeling Instruction classroom. The teacher often poses a problem at the beginning of class. Students gather in small groups, collaborate to find a consensus solution, then represent their thinking on a 24" x 32" whiteboard. Moving from group to group while students discuss the problem and outline their solution on the whiteboard, the teacher listens to students' conversations, occasionally offering a comment or asking a question. When the small-group discussions are complete, the teacher convenes a "board meeting" in which the entire class shares and discusses their whiteboarded solutions.

The burden of sense-making in these discussions is on the students, who must make the case for their solution from the evidence. This "think-aloud" process provides the teacher a valuable opportunity to listen to students' thinking and reasoning as it develops and to identify gaps or persistent misconceptions that can be addressed. Skillful teachers find a way to draw students who are uncertain into the conversation so that the class must improve their explanation until even their most confused classmates understand. At the close of a board meeting, the teacher will often request that students summarize their understanding of the model, providing another opportunity to probe the group for uncertainties and misconceptions.

Modeling Instruction units follow a three-phase developmental sequence known as the Modeling Cycle: construct the model, improve and elaborate the model, apply the model. A typical unit begins with a paradigm lab. (Such laboratory activities are based on science education research about student misconceptions and naïve beliefs.) In the class discussion preceding the investigation, students observe a phenomenon, discuss what they observe, identify a relationship between two elements that they wish to quantify and correlate, and make predictions about the expected outcome. They then work in small groups to plan and conduct data collection; gather, analyze, and whiteboard data; and share findings with the whole class. Ultimately students arrive at a set of representations for the model they have constructed that includes a diagram, a graph, and an equation that quantifies the relationship. Once the model under investigation has been defined like this, students engage in a series of deployment exercises and tasks that are carefully sequenced to help them elaborate on this conceptual model and apply it in a variety of contexts.

The quality of classroom discourse is a critical component of Modeling Instruction. The key to establishing a good discourse community is to design a classroom culture that moves the teacher from "center stage" and calls for the students to depend on one another to advance the group's understanding of the model being investigated. This classroom dynamic is very different from the typical school culture, and requires teachers to develop skills in redirecting student questions to the group rather than simply giving the answers.

Modeling Workshops offer face-to-face professional development in which teachers work through a semester of content, just as their students might. They perform labs, whiteboard the results, participate in board meetings, solve problems, develop questioning skills, learn how to listen, read and digest classroom research literature, and have rich discussions in both "student mode" and "teacher mode," gradually recognizing how Modeling pedagogy fits with their own teaching situation. These two- to three-week workshops provide an opportunity for the reflective practice so necessary for building expertise.

Next time you meet a modeler, ask him or her what he or she thinks about the *Next Generation Science Standards* (*NGSS*). Modeling Instruction works well with the eight *NGSS* Science and Engineering Practices. A 2015 study revealed that modelers are significantly more confident in their ability to engage their students in the use of science and engineering practices than other science teachers. ●

Colleen Megowan-Romanowicz is a veteran high school science teacher who earned her PhD in physics education research in 2007. She was an assistant professor of science education at Arizona State University and has served as executive officer of the American Modeling Teachers Association since 2011.

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What the ESSA Means for STEM Education

When President Obama signed the Every Student Succeeds Act (ESSA) into law on December 10, 2015, it effectively brought an end to the highly criticized No Child Left Behind (NCLB) Act, and say advocates, signaled a new era for K–12 education.

The new law ultimately won bipartisan support in Congress for the changes it will bring to states, schools, and districts nationwide.

Republicans worked to reduce the federal footprint in K–12 education and restore power to local districts, states, teachers, and parents. Under ESSA, states and districts have more authority to determine how to use the federal funds to meet their goals.

Democrats established "guardrails" to ensure that all states maintain high standards, that all subgroups of students succeed, and that states and districts take action with low-performing schools, preserving ESSA's role as a civil rights law.

K–12 education will face many changes when the new law takes effect at the start of the 2017 school year. The ESSA includes changes to assessments, school and district accountability, and teacher certification (see sidebar for more information).

STEM in ESSA

A number of allowable uses of federal funds throughout ESSA will support science, technology, engineering, and math (STEM) education.

Under Title I, states are permitted to use a portion of federal funding to support the development of statewide assessments to integrate concepts related to engineering and technology into the states' science assessments.

Professional development for STEM-specific activities is an allowable use of funds under the Title II Preparing, Training, and Recruiting High-Quality Teachers, Principals, and Other School Leaders Grant. As in the previous law, 95% of Title IIA funding goes to the districts for a number of uses (districts must apply to the state for the grant), including "the development and provision of professional development and other comprehensive systems of support for teachers, principals, or other school leaders to promote high-quality instruction and instructional leadership in STEM subjects, including computer science."

Other uses of Title IIA funds include recruiting, hiring, and retaining effective teachers; mentoring and induction programs; recruiting qualified individuals from other fields to become teachers, principals, or other school leaders; reducing class size; early childhood education; and developing assessments and using data in the classroom, to name a few.

A new program under Title II allows the Secretary of Education to use funds devoted to "national activities" to conduct an annual competitive grant program for the states to develop a STEM Master Teacher Corps or to provide professional development for STEM teachers.

A new Title IVA block grant program, the Student Support and Academic Enrichment Grants, would provide funding to support both state- and district-level educational enrichment activities for students that ensure 1) a well-rounded education with programs in STEM, college and career counseling, arts, and civics, and access to International Baccalaureate (IB)/ Advanced Placement (AP) courses; 2) support for safe and healthy students

Every Student Succeeds Act (ESSA) Highlights

Standards: All states must adopt challenging standards in math, English, and science (unchanged from NCLB).

Assessments: Reading and math, annual in grades 3–8 and once in high school. Science, once in elementary, middle, and high school (unchanged from NCLB). It allows states to use federal funding to integrate technology and engineering concepts into science assessments.

Reporting: Schools/states must report not only student scores of the whole school, but also of the student population by race, poverty level, English language learners, students with disabilities, and gender (unchanged from NCLB).

Accountability: Eliminates Adequate Yearly Progress. States are now responsible for holding schools accountable for overall quality. States can develop their own accountability using multiple measures. They are required to turn around the lowest-performing 5% of schools, schools with graduation rates below 67%, and schools with "consistently underperforming" subgroups. States may create their own testing opt-out laws but must maintain the 95% student participation federal requirement.

Flexibility: Consolidates 40 federal education programs (including the current Title IIB Math and Science Partnership program) into a federal block grant (Title IV) and provides more flexibility for states and districts to determine how federal funds should be used. A new Title IV block grant will provide low-income districts with funding for activities that provide students with a well-rounded education (including STEM activities), support safe and healthy students, and support the effective use of technology. Districts can opt to transfer 100% of Title II or Title IV funds to Title I.

Professional Development: Continues the Title IIA funding grant that provides funding to strengthen teachers and school leaders.

Teachers: Eliminates the NCLB waiver requirement that states develop and implement teacher evaluation systems (but states may elect to continue to evaluate teachers). Eliminates the definition of Highly Qualified Teacher. Allows states to establish, expand, or improve alternative routes for state certification of teachers in STEM subjects. Allows states and districts to provide differential pay, or other incentives, to recruit and retain teachers in high-need academic subjects (such as math and science).

Federal Authority: Restricts and greatly rolls back the power of the Education Secretary. The federal government cannot interfere in state accountability, or mandate or incentivize states to adopt or maintain standards.

with programs in such areas as comprehensive school mental health, drug and violence prevention, health, and physical education; and 3) support for the effective use of technology, including professional development for teachers, blended learning, and devices.

States will allocate funds to school districts based on their share of Title I dollars. Any school district that receives a formula allocation of more than $30,000 must conduct a needs assessment and must expend at least 20% of its grant on safe and healthy school activities and at least another 20% on activities to provide a well-rounded education. The remaining 60% can be spent on these priorities, as well as support the effective use of technology. However, spending on devices, equipment, software, and digital content is capped at 15%. If a district receives an allocation of less than $30,000, the law does not require a needs assessment or set aside percentages for well-rounded and safe and healthy students programs. The district must spend money on activities in at least one of the three categories.

Districts can use Title IVA grants to provide students with a well-rounded education and improve instruction and student engagement in STEM by

- Expanding high-quality STEM courses;
- Increasing access to STEM for underserved and at-risk student populations;
- Supporting the participation of students in STEM nonprofit competitions (such as robotics, science research, invention, mathematics, computer science, and technology competitions);
- Providing hands-on learning opportunities in STEM;
- Integrating other academic subjects, including the arts, into STEM subject programs;
- Creating or enhancing STEM specialty schools (which is defined in the law);
- Integrating classroom-based and after-school and informal STEM instruction; and
- Expanding environmental education.

For more information on ESSA, visit the NSTA Legislative Affairs website at *www.nsta.org/about/clpa*. ●

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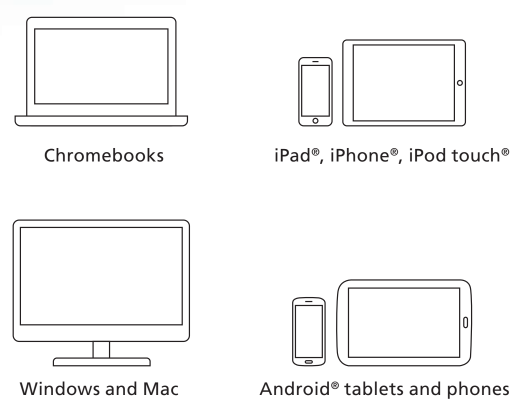

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Quotable

I believe we owe our young an education that captures the exhilarating drama of science.

—Brian Greene, U.S. physicist

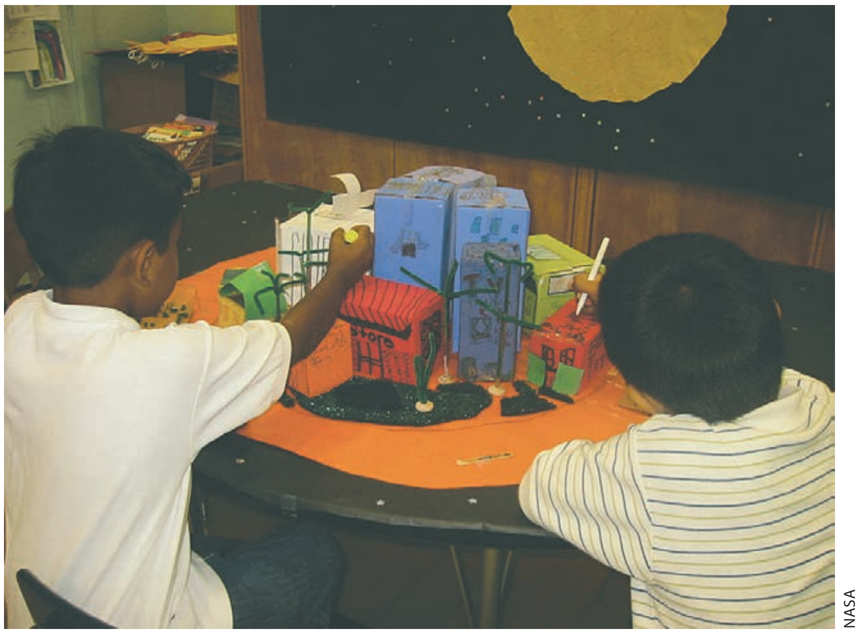
Teaching ELLs Through STEM Content

"Many myths continue to persist about ELLs [English language learners] and science learning. For example, the myth that [ELLs] need to have a strong command of academic English to learn STEM [science, technology, engineering, and math] concepts is wrong and damaging," says Jerry Valadez, NSTA Multicultural/Equity Division Director and director of the Central Valley Science Project at California State University, Fresno. The No Child Left Behind Act "has perpetuated these myths, resulting in marginalizing ELLs in school, especially in elementary school because very little science has been taught [in] the last decade at that level," he contends.

"Even worse, ELLs were often isolated and kept out of mainstream science programs in order to have more English and language arts instruction. Many are still placed into English-learner tracks, which is not effective for learning STEM," he declares. "Programs need to be all-inclusive, especially in elementary school, to establish a science or STEM identity in students. The science in school plays an essential role with English learners both in the development of scientific literacy and English Language Development. Through science teaching aligned to the stages of learning English, science instruction can provide a language-rich environment [in which] ELL students can learn and practice new understandings."

One way to "create scaffolding in science and engineering" for ELLs is "having a classroom culture of productive talk, or science talk," Valadez notes. "ELLs need that opportunity. It is only through expressing oneself about something that another language becomes part of our identities. Engaging with STEM investigations and challenges becomes that something.

"When students explain their projects to peers, their confidence builds. This is a reason for supporting hands-on learning and *NGSS* [*Next Generation Science Standards*] pedagogy. It's powerful to teach kids to listen constructively [because] it also teaches them how to think critically, how to frame argumentation, and apply new ideas to their work.



After studying the environment on Mars, second graders from Buchanan Math Science Magnet School in Los Angeles, California, work on a related art project. Hands-on learning strategies that benefit ELL students also have positive effects for all learners.

"Notetaking and journaling [are] key strategies to also incorporate into instruction. Writing, drawing, and documenting what they experience in science and engineering practices, as promoted through *NGSS,* are important language connections. We use a lot of nature journaling techniques [in which] students stop to draw a plant or animal, and study the plant or animal for a long period of time…[Students will practice] observation, detail, and alignment," and it will also "teach them visual arts skills, patience, and how to communicate on paper what they're learning," he points out.

"Using and integrating the 5E's [instructional model] with *NGSS* Science and Engineering Practices is an important supportive instructional methodology that works for ELLs," Valadez maintains. Engaging students in handling materials helps them "develop a conceptual idea of how things work. Then include the vocabulary, engage students with text...They now have a schema to draw from and make connections," can build projects, and "further practice their new ideas and words through Explain (science talk). Then move on to Elaborate by supporting additional sense-making of science and engineering ideas, and the opportunity to develop a deeper understanding of language uses," he relates.

"The K–8 integrated approach as in the *NGSS* will also be important for supporting good STEM learning for ELLs," Valadez emphasizes. "Embrace the new standards, and include more time for science in the elementary instructional day…ELLs will benefit, as will all students, and our nation!"

Making Progress

"These last few years, we have embarked on a process of change to adapt to *CC* [*Common Core*] and WIDA [a nonprofit cooperative group that develops standards and assessments that promote educational equity for ELLs], and I have seen a lot of progress in ELL students in the science classroom," says Miguel Hernando, lead science teacher at Chelsea High School in Chelsea, Massachusetts. "Science can be used as a vehicle to help students learn English faster, with the appropriate support." Members of his in-school professional learning community "have compared what ELL students write in their classes, and usually their science work shows higher-level vocabulary and more complex grammatical structures than their work in English or other classes.

"Grammar for the sake of grammar is boring," Hernando contends. Observing that students with weak language skills are not motivated by textbooks or notes, he adds, "Kids are curious, and if you give them a science problem or mystery, they're motivated to solve it and will progress in science and literacy."

For students new to the United States, a first unit can include data analysis, recommends Hernando. "Some students may have seen data tables in their home countries," he points out. "Have them look at data tables, and teach them how to use the words in the data table to write a complete sentence. The students will learn about data analysis and the structure of an English sentence."

Next, involve the students in scientific investigations in which they collect data, and have them describe their results in a data table and draw conclusions. "Students will be motivated to learn the language they need to discuss the results of the investigation," Hernando maintains.

After that, many ELLs in his school are ready for more advanced projects, such as researching genetic diseases. "It's a challenge for them because they have to learn lots of scientific vocabulary, then debate which disease the government should provide research funding for. They have to present evidence," he acknowledges. But projects like this build "skills in writing an argument. We've seen that giving students more complex tasks stimulates them to learn English faster."

Teachers need to "figure out what the student brings from his or her home country," Hernando urges. "It's important for educators not to stereotype all ELLs as struggling. They achieve at different levels and need to be given chances to succeed."

Science in ESL Classes

"I use reading materials about climate change in my ESL [English as a Second Language] classes. We also build prior knowledge through films and lectures before we do the readings," says David Fallick, a professor in the American English Language Program at Montgomery College in Rockville, Maryland.

"Climate change is an important topic, and important beyond the classroom," asserts Fallick. "I like to have [students] read about what they can do to reduce their own carbon emissions."

He uses a variety of materials in his classes, having students read excerpts from publications from the U.S. Global Change Research Program (see the website *www.globalchange.gov*) and other government publications (including the National Oceanic and Atmospheric Administration's booklet *Climate Literacy: The Essential Principles of Climate Science*). "My choice of reading materials is pedagogical: Basically, whatever readings I find that fit the reading level needed and that [students] will understand in English," he relates. Students also can obtain articles from the campus library's electronic databases, such as AccessScience (available at the website *www.accessscience.com*).

> ***"Science can be used as a vehicle to help students learn English faster, with the appropriate support."***
> **—Miguel Hernando**

Fallick ensures students are aware of the latest research. "Some older publications say that we're at 388 ppm [parts per million] in carbon dioxide, but now we're at 402 ppm. The older material meets the reading and language objectives, but I inform students about current scientific findings," he relates.

The films he chooses are available online. Closed-captioned videos are helpful because "students can both listen to and see what the narrator is saying," he points out.

When teaching about the greenhouse effect, for example, he'll present a lecture and show a film about it to provide background knowledge. He addresses vocabulary and terms, such as the names of greenhouse gases. "Then we do the readings," he explains. He assesses students on their reading comprehension, but the questions contain scientific content.

Fallick says he wants students "to see that something is being done [about climate change]…It's a pretty heavy topic, so I like to end the semester with 'Here is something you can do to help,' so it won't feel hopeless to them." ●

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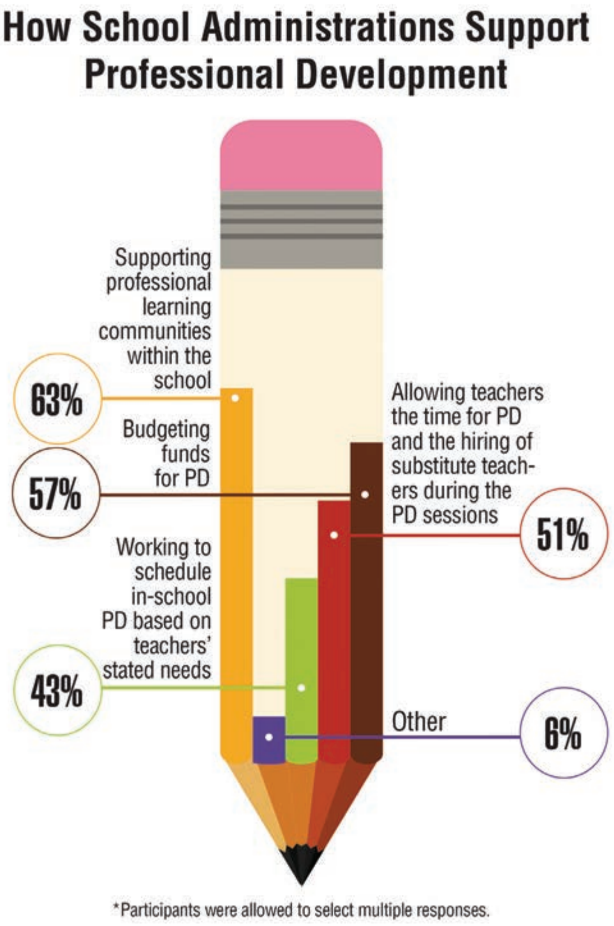
Do Adminstrators Support Hands-On Science? Half Say No

Science educators are nearly evenly split on whether their school administrators actively support hands-on science education, as revealed in a recent anonymous *NSTA Reports* poll. Forty-nine percent reported their school administrators are supportive, with 36% reporting the school administration worked to understand science teachers' special needs, including safety equipment and supplies. Although, more than half of respondents (56%) said administrators are unwilling to learn more about subjects outside their own areas. One participant commented, "My principal has said to my face, 'Science doesn't matter; the only thing lower than science is social studies.'"

However, 76% said their administration supports them in interactions with difficult parents, with 73% saying administrators facilitate meetings between teachers and parents and 61% reporting administrators refuse to arbitrarily override teachers' decisions on discipline and grading (respondents were allowed to select multiple options).

Seventy-eight percent reported administration supported their professional development (PD) primarily through supporting professional learning communities within the school (63%), budgeting for PD (57%), and allowing teachers time for PD and the hiring of substitute teachers during PD sessions (51%). (Respondents were allowed to select multiple options to this question.)



Here's what science educators say are the most effective ways school administrators can support science education:

We need a basic curriculum for all science teachers to work with. Currently, teachers are interpreting *NGSS* [*Next Generation Science Standards*], trying to find resources and science equipment on their own. Teachers are often denied purchasing supplies needed to support *NGSS*, and no discussions [take place] of what to expect in the future. *—Educator, Middle School, Washington*

Lacking STEM [science, technology, engineering, and math] content knowledge/policy seems to become concentrated as teachers move into administration: [A]dministration needs STEM outreach of their own!!! *—Educator, High School, Kentucky*

Give us the time, money, and space to collaborate on great learning experiences.*—Educator, High School, Institution of Higher Learning, Maine*

They need to learn and understand *NGSS* so that they can better recognize, appreciate, and understand what science teachers are doing in the classroom.*—Educator, Elementary, Illinois*

Involve teachers in multiple levels of decision-making.*—Educator, High School, Florida*

Allow time to work collaboratively with colleagues.*—Educator, Middle School, Massachusetts*

With regard to science, understand that budgets need to be fluid to account for new labs and consumables...Administration needs to remember that we are the science experts and support us as professionals in our curriculum choices (activities/labs that are not deemed worthwhile by our administration are not funded or allowed).*—Educator, High School, Michigan*

Listening to my input, letting me teach science instead of trying to configure my class as if science were [English language arts]. Treat me as a professional.*—Educator, Middle School, Oregon*

Allow attendance to the NSTA and other national conferences. By building an infrastructure that supports science education.*—Educator, Middle School, Qatar*

Budgeting for science needs and not packing science classrooms with unsafe numbers of students.*—Educator, High School, Virginia*

Understanding that science should have the same consideration as math and English classes when it comes to class sizes. 32–36 students in a small classroom is not safe, nor is it conducive to learning.*—Educator, High School, Maryland*

Finding and giving the opportunity to participate in more *NGSS* PD. *—Educator, High School, California*

Budget money for professional development and allow for structured teacher planning time within the school day.*—Educator, Middle School, Institution of Higher Learning, California*

Facilitate discussion between middle and high school science teachers; continue to earmark funds; encourage professional development; share successes in statewide testing with the school and larger community. *—Educator, Middle School, Oregon* ●

The NSTA Learning Center

High quality interactive content for K–12 science teachers

Earn graduate credits and advanced degrees

Affordable and user-friendly

Moderated by world-renowned faculty

Gain knowledge exclusive to your area of instruction

American Museum of Natural History

Montana State University

University of Maryland

NSTA Virtual Conferences Online Professional Learning

American Museum of Natural History

Seminars on science, six-week online graduate courses in the life, Earth, and physical sciences, incorporate the museum's resources plus interaction with scientists and educators. CEUs and graduate credits.

Montana State University – Bozeman

Online graduate credit courses for K–12 science teachers through National Teachers Enhancement Network, as well as online offerings for Masters of Science in Science Education. NSTA member discount.

University of Maryland

Designed for science teachers, the Master of Chemical and Life Sciences is a 30-credit, online, interdisciplinary master's degree offering concentrations in biology and chemistry.

NSTA Virtual Conferences

A day-long series of live web sessions delivered via an interactive distance-learning tool. Each conference features content and/or pedagogy from experts in a particular topic. Participants can log on from anywhere with an internet connection and interact with presenters and educators from across the country.

http://learningcenter.nsta.org/onlinecourses

NSTA National Science Teachers Association

PULL-OUT SECTION

SCIENCE TEACHERS' GRAB BAG

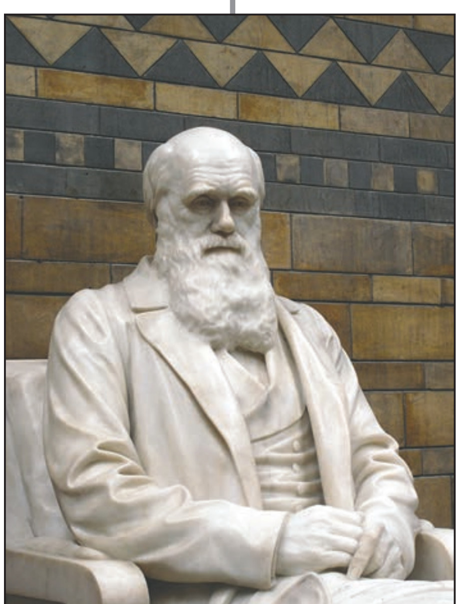
Inside this Convenient Pull-Out Section you will find:

Freebies for Science Teachers

Surrounded by Science Infographic. Produced by the National Environmental Education Foundation, this resource for grades K–12 highlights ways science connects the world around us and shows how citizen science helps increase our understanding of the environment. Accompanying each fact on the infographic is a suggested activity that makes the fact real for students, as well as a link to a related citizen science project. An educator's toolkit provides additional lessons and curriculum guides from environmental and education groups to reinforce the message. Download both at *http://bit.ly/1RALNlm.*

Introducing Bioenergy. Try this introductory bioenergy activity with your high school biology or environmental science students. Developed by Jason de Koff, assistant professor of Agronomy and Soil Science at Tennessee State University, with funding from a U.S. Department of Agriculture–National Institute of Food and Agriculture Capacity Building Grant, the lesson presents an overview of bioenergy; a lab activity in which students investigate which kind of organic material, or feedstock, yeast prefers to make ethanol, a biofuel; and a bingo game that helps students remember the many kinds of feedstocks that can be used to produce biodiesel. Download the lesson at *http://bit.ly/1ZkkKj1.*

STEM Resources and more from the Partnership in Education. Housed at Duquesne University in Pittsburgh, Pennsylvania, the Partnership in Education Program website offers a collection of interest-grabbing movies, apps, games, and curriculum to improve science, technology, engineering, and mathematics (STEM) instruction in K–12 classrooms and increase health literacy among students. Created with funding from National Institutes of Health, these innovative resources support national standards and make science topics engaging for teachers, students, and learners of all ages. Consider the topic of evolution: Partnership resources include a virtual Q&A with Charles Darwin himself; with this app, middle and high school students ask Darwin questions about his likes/dislikes, his work, the principle of evolution, and more. Another resource, the Spiral of Life poster series (for all ages), explores evolution from various perspectives, including animals, plants, birds, and DNA. Visit *http://thepartnershipineducation.com/index.html.*



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Career Girls. Targeted for middle level and high school teens and their teachers, this career exploration website makes it easy for girls to find career information based on their interests. The collection contains more than 7,000 video clips featuring 400 female role models. The women work in careers from astronaut to veterinarian nationwide. Each profiled career includes information about what the job is like, the education needed to prepare for it, estimated salary and job outlook, and videos of role models at work. In the Educators section, teachers can access video-based "empowerment" lessons supporting the *Common Core.* Titles include Career Exploration 101, Why Choose STEM, Science Careers, Technology Careers, Importance of Math, Financial Literacy, Teamwork, and Be Confident. Visit *www.careergirls.org/explore-careers.*

EarthScope Chronicles. Meet the scientists from the National Science Foundation's EarthScope program! This innovative program is essentially a network of observatories acting as an Earth "telescope" focused on the exterior and interior structure and dynamics of our planet. To bring the program to life for students in grades 7–12, TERC and McLean Media have produced the EarthScope Chronicles, a collection of 25 short videos highlighting the work and personal stories of EarthScope scientists that involve students in data-based investigations connected to the scientists' research.

Consider the story of geophysicist Jenny Nakai, a graduate student, whose work includes building an earthquake catalog for the Rio Grande Region. Nakai describes her interest in engineering and science as a means to solve problems and stresses the importance of education in the Navajo culture. She further explains how resource extraction such as coal mining has negatively impacted Navajo land, and how in the past, few tribal members had the knowledge or training to deal with related environmental issues. Today, Nakai shares what she has learned with others and helps scientists communicate their findings to the broader community. Watch this and other videos at *http://bit.ly/ChroniclesOnYouTube.*

See Freebies, pg G2

Freebies, from pg G1

GemKids. Get your sparkle on at Gemological Institute of America (GIA)'s website dedicated to gemology and geology education. Targeted for elementary and middle level students and teachers, the website offers sections such as Gem Explorer, Story of a Gem, and Gem Glossary. Gem Explorer presents information about 24 popular gems including fun facts about color, history, and lore; name origin; image galleries and micrographs of the gem under different microscope magnification levels; and a localities map. Story of a Gem introduces the science of mineralogy and describes how gems form in nature. The Gem Glossary contains more than 160 gemological, geological, and jewelry terms, offering an audio pronunciation and a descriptive image for each entry.

In addition, a Careers section presents students with information on 16 gem-related careers (e.g., gemologist, miner, teacher, manufacturer, appraiser, and curator), and the GemKids for Schools Educator Guide offers lessons for students in grades 3–5 exploring how gems form in nature and the gem industry. Visit *www.gemkids.gia.edu*.

Building Global Interest in Data Literacy. This new report from Education Development Center's (EDC) Oceans of Data Institute spotlights the goal to bring data literacy to 100 million students by 2021. Based on a workshop hosted by EDC and IBM that engaged big data analysts and education experts in discussing how to ensure our K–16 education system fosters data literacy, the report includes a Call for Action to Promote Data Literacy that educators can sign. In addition, the report offers a definition of data literacy; describes key activities a data-literate person is able to do; and examines the role of analytical thinking in data literacy and its applications in workplaces. Download the report at *http://bit.ly/1XWOlQW*.

How a Cleanroom Works. *Cleanroom* is an engineering term describing a controlled environment where products are manufactured. It is a room within a room in which the concentration of airborne particles is controlled to specific limits. While some high

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school or college students may have a general sense of what a cleanroom is, few have a deep understanding of how a cleanroom works. This one-page graphic succinctly describes the basic principles. High school and college educators can use the graphic to deepen students' understanding of real-world engineering and manufacturing processes. Consult *http://bit.ly/1r5OXqh*.

Digital Promise's Research Map. This interactive tool connects education leaders and education-technology developers with relevant research from nearly 100,000 journal articles in education and the sciences. Designed to help educators and developers easily access information to build better programs and products for K–12 classrooms, the map offers two interactive views showing research topics and subtopics and how they connect to one another. Within each view, teachers can access summaries of key findings in various topic areas, along with curated information. The map's MyTiles function allows users to save articles and share them with others. Learn more at *http://researchmap.digitalpromise.org*.

Cell City Mystery. This biology-themed learning game helps middle level students understand how cells function. When playing, students explore science content and practice reading comprehension as they help Sheriff Nucleus figure out what's causing Cell City's inefficiencies. Is it a slacking mitochondrion, an overzealous cell membrane, or a confused ribosome? According to the game's producer, Readorium—developer of educational software that teaches reading comprehension skills to students in grades 3–8 through scientific texts—more learning games are forthcoming. See *http://bit.ly/25F0hNe*.

The Produce Mom's Science Fair and STEM Project Guide Using Fruits and Vegetables. At *http://bit.ly/1U05hTU*, registered teachers can receive an e-Book with 15 experimental projects using fresh produce. Suitable for students in grades 3–8, the projects cover topics in biology, chemistry, physical science, and physics and emphasize science fair requirements and scientific methods. Each project includes a suggested question and hypothesis, along with tips for customizing the experiment according to students' interests. Throughout the book, Josie's Organics Tips encourage students to eat more fresh produce, learn about the produce they grow, and reduce food waste.

Rock-Head Sciences. With its Day in the GeoLife series, this blog offers students the opportunity to learn about the lives of geologists, geographers, and other geoscientists, whether they are working in the field, educating students, managing, interning, or just plain exploring. So far, more than 100 geoscientists have posted about their geo-lives, sharing what's fun about their job and offering advice to students interested in pursuing a similar career. Users can click on specific categories (e.g., mineralogy, modeling, oceanography, physical geography, sustainability, water management, and others) to learn about scientists working in similar fields. The series is a great tool for showing middle and high school Earth science students the interdisciplinary nature of geosciences and the diversity of careers within them. Refer to *http://rockheadsciences.com*.

Coloringnature.org. This site offers more than 500 realistically illustrated coloring pages that can be downloaded and printed for use in K–12 classrooms. Choose from categories such as amphibians, reptiles, mammals, birds, insects, animal homes, pets, biomes and habitats, anatomy, wildflowers, and trees. Use the pages as diagrams, models, or assessment tools, or just for fun. See *www.coloringnature.org*.

Climate Change Through the Arts. This website offers middle and high school educators a unique approach to

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a study of climate change: through the arts. At *www.singingscientific.com*, teachers will find a series of clickable illustrations, each relating to a different aspect of climate change. For example, click on Illustration to draw, color, and label steps of the greenhouse effect. Click on Song to watch and sing along with a climate change song. Illustrated Text provides videos and resources on key components of climate change, such as the carbon cycle, the greenhouse effect, and evidence of climate change.

Decoding Cancer. This standards-supported online curriculum helps high school teachers and students understand the science behind cancer. Produced by Discovery Education, the Val Skinner Foundation, the LIFE Center at Rutgers Cancer Institute of New Jersey, and the Rutgers School of Public Health, each lesson relates to breast cancer and includes an interactive student component and a teacher's guide. Students will learn how cancer develops at the cellular level, explore the diagnostic tools used in breast cancer detection and tracking, and consider the role of genetics in cancer development. Refer to the website *http://bit.ly/1sTq3LO*.

ClassFlow. This all-in-one teaching platform allows teachers to synchronize the use of classroom technology—whiteboards, laptops, and tablets—to enhance learning. Teachers of all levels can create and deliver interactive multimedia lessons and assessments that incorporate student responses in real time. The website also offers a database of teacher-created multimedia lessons for K–12 students in core subjects (e.g., science, math, English, and History and Social Sciences) that teachers can use as a basis for their own lessons. Explore the site and watch an introductory video at *http://bit.ly/1Ps1dwL*. ●

In Your Pocket

Editor's Note

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

August 1–12

Toshiba America Foundation Science and Math Improvement Grants

These grants go to science and math teachers of grades 6–12 with innovative classroom project ideas. Proposed projects should give students an opportunity to "do science" in new ways that will increase their engagement with the subject matter and improve their learning. Previously funded projects have included the design and building of a classroom greenhouse, high-altitude balloon launches, and robotics programs. Successful projects often tap into students' natural curiosity and incorporate the expertise of community partners.

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

NSTA's New Science Teacher Academy

This program is designed to encourage and support 34 early-career science teachers. Fellows in the Academy receive a year-long NSTA membership; partnership with a discipline-specific e-mentor; access to web-based professional development activities, curriculum, and other resources through the New Teacher Center and the NSTA Learning Center; and funds for accommodations, airfare, food, registration, and a Professional Learning Institute at the 2017 NSTA National Conference on Science Education in Los Angeles.

Full-time middle and high school science teachers in their second through fifth years of teaching in Colorado, Florida, Georgia, Maryland, New Jersey, Texas, and Washington, D.C., are eligible. Apply by **August 5** at *www.nsta.org/academy.*

Melinda Gray Ardia Environmental Foundation Grants


MUSSKLPROZZ

These grants help educators develop and test holistic environmental curricula that integrate field activities with classroom teaching. Proposed projects should incorporate basic ecological principles, encourage students to solve environmental problems, and present controversial issues objectively. The goal is to inspire students to approach such problems thoughtfully and to be informed decision-makers.

Grants are available for organizations worldwide with curricula for primary or secondary schools. Applicants must submit a one-page pre-proposal by **August 12.** Selected organizations will submit full proposals by August 26. For details, see *http://bit.ly/1lZdoPJ.*●

GEICO contracts with various membership entities and other organizations, but these entities do not underwrite the offered insurance products. Some discounts, coverages, payment plans and features are not available in all states or all GEICO companies. Discount amount varies in some states. One group discount applicable per policy. Coverage is individual. In New York a premium reduction may be available. GEICO may not be involved in a formal relationship with each organization; however, you still may qualify for a special discount based on your membership, employment or affiliation with those organizations. NSTA is compensated for allowing GEICO to offer this auto insurance program to NSTA members. GEICO is a registered service mark of Government Employees Insurance Company, Washington, D.C. 20076; a Berkshire Hathaway Inc. subsidiary. GEICO Gecko image © 1999-2015. © 2015 GEICO

What's New

FROM U.S. GOVERNMENT SOURCES

National Park Service (NPS)

Channel Islands National Park Webcams

Channel Islands National Park's live webcams deliver the park—and its animal inhabitants—to K–12 classrooms in real time. Watch a live stream from the Bald Eagle Webcam at the website *http://1.usa.gov/1ZcrsaI,* and have students observe and record family dynamics as two bald eagle chicks grow and fly from the nest by late June or early July. In addition, teachers can access videos and information describing the park's efforts to restore bald eagles to the Channel Islands, as well as archived highlights from previous years' streams, allowing students to observe eagle chick feeding at different stages of development and a chick's first flight.

The park's Ocean Webcam (*http://1.usa.gov/24is1kx*) reveals a kelp forest ecosystem. Have students record observations and learn about the natural history of marine fish, mammals, and invertebrates.

National Institutes of Health (NIH)

MedPix for Biology Lessons

Want resources to supplement your high school and college biology and anatomy lessons? The MedPix database from NIH's National Library of Medicine contains more than 53,000 images of medical conditions along with information about the condition's location (organ system), pathology category, and description. Originally developed for use by physicians, nurses, and other clinicians, the database has proven valuable for high school and college educators and for students interested in pursuing careers in clinical fields. See *http://1.usa.gov/1RTejgQ.*

Kids.gov

Summer Teacher's Calendar

Make the most of the summer months with resources from the Teacher's Calendar at Kids.gov (see the website *http://1.usa.gov/1Xpovqn*). Targeted for K–8 teachers and students (and their parents), the calendar presents monthly videos, activities, tips, and resources that can be used in classrooms and summer camps or at home. July topics address UV Safety Month, Parks and Recreation, Fireworks and Fire Safety, Summer Thunderstorms, and the Anniversary of the First People on the Moon (July 20). Watch a video to learn *How Sunscreen Works;* increase your knowledge of national parks with the WebRangers website; get lightning safety tips from the National Weather Service; or be inspired to explore space with photos and images from the historic Apollo 11 mission.

U.S. Forest Service

Finding My Forest

Produced by the U.S. Forest Service, this curriculum for grades 3–8 provides teachers with the tools needed to integrate the wonder of forests into the classroom and foster environmental awareness among students. Through four standards-supported lessons, students explore several key roles of environmental stewardship.

In Lesson One, students serve as environmental journalists, developing a definition of a forest, researching "urban forests," and creating an iForest blog. In Lesson Two, students become ecologists, exploring a local forest and discovering how the different elements of the forest interrelate. In Lesson Three, students are environmental scientists, conducting experiments, mapping their urban forest and understanding its benefits, and developing ideas about conservation. By Lesson Four, students are ready to be outdoor educators, sharing their deepening understanding of the importance of and need for time spent exploring and conserving forests.

The curriculum also includes a calendar of ideas to explore forests year-round and a Finding My Forest grid students and families can use to track time spent and activities conducted outdoors. Refer to *http://1.usa.gov/1XpoSRK.*

Rediscover Woodsy Owl, Smokey Bear

Wildfire prevention and conservation practices can be important lessons during outdoor summer activities, especially for elementary students. At *http://1.usa.gov/1Zkjoot,* teachers can access songs, activity guides, and other materials featuring the popular characters Woodsy Owl and Smokey Bear to start the conversation with students about fire prevention and conservation. Share the history of the Woodsy Owl and Smokey Bear campaigns, explore student resources, and find out how to bring Woodsy Owl or Smokey Bear to your school or camp.

National Oceanic and Atmospheric Administration (NOAA)

Deepwater Exploration of the Marianas

The NOAA Ship Okeanos Explorer is currently investigating the diversity within the deepwater habitats of the Northern Mariana Islands in the Pacific Ocean. On this expedition, scientists are closely examining hydrothermal vent sites, mud volcanoes, subduction zones, seamounts, and the variety of organisms found in these areas. Through an Expedition Education Module—complete with standards-based lessons relating to the Marianas and theme pages on Deep-Sea Corals, Seamounts, and Vents and Volcanoes—your middle and high school students can share in the expedition discoveries alongside the scientists, in real time. Lesson titles include Exploring Live! (grades 5–12), Viscous Volcanoes (grades 6–8), and Sea Serpentines (grades 9–12). Combining these lessons with the live videos and other images from the expedition gives students a rarely seen view of the deep ocean and its inhabitants. See *http://1.usa.gov/1VC8Wti.*

National Aeronautics and Space Administration (NASA)

Teachable Moments Blog

Looking for ways to bring the latest NASA science and mission news into your classroom? Check out the Jet Propulsion Laboratory's (JPL) Teachable Moments blog, which highlights timely and interesting news, activities, and education tips from NASA missions. Consider a recent post from *Star Wars* Day (May "the Fourth"), which highlights the connection between JPL's Dawn Mission and Newton's Laws of Motion—and capitalizes on the popularity of *Star Wars.* The post, May the Force=mass x acceleration, offers a primer on the physics behind the ion propulsion engines that drive the Dawn spacecraft, as well as a lesson for grades 6–12 that shows students how to calculate additive velocity on a hypothetical ion-propelled spacecraft. The lesson addresses both *Next Generation Science* and *Common Core Math Standards.* See *http://bit.ly/jpltms.*

U.S. Department of Agriculture (USDA)

School Gardens Fact Sheet

The USDA's Farm to School Program has produced School Gardens: Using Gardens to Grow Healthy Habits in Cafeterias, Classrooms, and Communities, a document that provides a brief overview of the benefits and educational uses of school gardens. It includes links to successful school garden programs and tips for planning, staffing, funding, and maintaining a school garden. Refer to *http://1.usa.gov/1WSslEa.* ●

Get Your Hands On Science

DO YOU KNOW
All the ways you can use your member discount?

Use your member discount in the NSTA Science Store to stock up on classroom resources from NSTA Press; plus, get substantial member discounts on our Summer STEM Forum and our Fall Area Conferences on Science Education, coming to a city near you! (*www.nsta.org/conferences*)

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NSTA National Science Teachers Association

MS. MENTOR, **Advice Column**

Managing Discussions, Multiple Preparations

I'm looking for suggestions on how to have meaningful class discussions that help students with our learning goals, especially discussing current events or the results of our investigations.

—C., Virginia

The ability to discuss issues and ideas in a productive manner is important. Discussions can be used to focus and share student thinking in terms of summarizing, questioning, comparing/contrasting, making claims and arguments, brainstorming, decision making, and problem solving.

We may think students should already know how to do this. But students may have misconceptions. They may believe that a "discussion" means the teacher asks questions and they respond. This teacher-led interrogation does not include student-to-student questions or in-depth conversations. Or consider what passes for "discussion" on television, when people shout, interrupt, ridicule, and engage in disrespectful and unproductive behaviors.

You may have realized you have to teach students to work cooperatively, take notes in a style related to the task, write informatively, and read science text. It follows that students may need to learn how to discuss issues and ideas among themselves.

Some students may be reluctant to participate because of language issues. Some may feel insecure around louder or more knowledgeable peers. Some students may have ideas to contribute, but need support, encouragement, and feedback to participate.

Consider whether your classroom physically supports large-group discussions. Desks or tables in rows may not be conducive to getting all students involved in these discussions. Try arranging the desks in a circle or open-U format. Sitting in the circle with the students makes a statement about the ownership of the conversation: The teacher is part of the discussion, not an emcee or moderator.

Establish classroom norms for discussions. Model the discussion behaviors you'd like your students to learn: attentive listening, wait time, courtesy, and channeling enthusiasm or expressing disagreement positively. Don't "butt in" when a student says something incorrect or controversial. Ask other students to respond first. A question such as "Do you have anything to add?" or "What did you conclude from this?" can encourage participation.

Students may have "sentence starters" in their notebooks for written work. Perhaps a section on nonthreatening conversation-starters or -continuers could be added: I'd like to know more about… Why do you think that…? Here's what I think you said… What is your source? Can you give me another example? I agree/disagree with that because… Have you considered…?

Students can practice these behaviors in a Think-Pair-Share activity.

Discussing ideas with a partner may help them identify what they might want to say later in a large group. You could start by giving each student a brief reading on familiar or interesting content. In this way, students can focus on the process of discussion rather than the acquisition of information.

As students converse, observe what others are doing. Are they interested? Trying to get a word in? Left out?

Small-group discussions can be very spirited. Don't worry about the noise level unless it becomes a distraction.

The November 2014 issue of *Educational Leadership* has articles related to talking and listening in the classroom. Several are available online without a subscription, including "Talking to Learn," "Now Presenting," and "Research Says: Get All Students to Speak Up."

"Explicitly Speaking," a recent article in *Science and Children,* promotes scientific language and communications through awareness, modeling, supported practice, and integration.

I'm a recent graduate. A school district where I would really like to teach has an opening for a secondary science teacher. The position requires teaching five classes of two different subjects. Is it common for teachers to have more than one subject? How can I do this?
—L., California

I've worked with many schools where teaching more than one subject was the rule. In smaller grades 7–12 buildings, there may be only one or two science teachers! Even in larger schools, it's common for teachers to have multiple preparations, based on student enrollment in required courses, the scope of electives offered, the teacher's area(s) of certification, and sometimes, seniority.

As you learned in student teaching, the obvious advantage of teaching one subject is you can concentrate all of your time and effort. You'll have one lesson plan, one system of assessments, and one set of lab activities. A disadvantage is the time needed to evaluate student work with the same due date.

A disadvantage to teaching multiple subjects is preparation time. You'll need separate unit plans, lessons, and lab activities. But you can schedule separate dates for tests, projects, lab investigations, student presentations, and notebook reviews, spreading out the evaluation.

I actually enjoyed teaching more than one subject. When I taught six sections of life science, it was hard to remember what each class had discussed. I had to remember that even if I had heard a question five times already, to a student in the last class, it was a new idea. I found it intellectually challenging, and I appreciated the chance to update my own content and skills in multiple areas.

You can use many strategies to keep yourself (and the students) organized. Try not to conduct two different labs on the same day. Divide bulletin boards and shelves into separate areas so students know where things are and where to turn in their assignments. I used a different logo for each course, putting it on handouts, quizzes, or other documents. I used separate folders on my laptop and separate binders for each course. I also had a tote bag for each course.

It helps if the subjects are in consecutive periods (e.g., bio in the morning, the other class in the afternoon) so you can keep lab materials set up—a question to ask during the interview.

Your first year or two will be overwhelming, no matter how many subjects you teach! But it becomes more manageable. I hope you will have a mentor or supportive administrator to help you, and NSTA's e-mail lists, discussion forums, and publications can provide support and suggestions. ●

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

BLICK ON FLICKS

Our *Beautiful Planet* As Seen From the ISS

By Jacob Clark Blickenstaff, PhD

Toni Myers has been making IMAX documentary films for decades. She wrote and edited the first IMAX film that was shot on the Space Shuttle, *The Dream Is Alive* (1984), and since then has focused on the Hubble Space Telescope in 2010 and the International Space Station (ISS) in 2002. Her most recent IMAX "space film" is *A Beautiful Planet* (2016), narrated by Jennifer Lawrence and featuring several astronauts on the ISS.

I had the opportunity to speak with Myers and James Neihouse, the director of photography, at the opening of the film at the Pacific Science Center in early May. Both Myers and Neihouse are enthusiastic about the potential impact of their work on young people and are interested in how teachers use films in the classroom. While discussing the relationship between documentary and feature films, Myers mentioned a joint interview she did with Christopher Nolan, director of *Interstellar* (*http://bit.ly/1Vh0LT8*). Nolan discussed how inspired he was by one of Myers' early films, and how much that film influenced his work on *Interstellar*. Myers also told me that Alfonso Cuaron watched her *Hubble 3D* film (2010) many times as he was preparing *Gravity* (2013).

A Beautiful Planet follows several ISS crew members through their time on the station, typically a six-month posting. The ISS is always staffed by an international crew: In the film, we see Russian, American, Italian, Japanese, and Canadian crew members working together. New members arrive and depart on Russian Soyuz capsules, each one carrying three people up to the ISS, then taking three back down to Earth. Supplies like food, water, and other consumables are shipped on unmanned rocket systems such as the Space X Dragon.

In addition to showing what life on the ISS is like for the crew, the film gives a real sense of the fragility of our home planet. Earth can be considered a "space station" for all of humanity, so we need to protect it—a message I am sure science teachers will support. I also noticed some interesting details that teachers could use to make concrete connections to specific science content.

The astronauts discuss watching thunderstorms from the ISS, and how beautiful the lightning flashes are as they happen by the hundreds over huge land areas. The lightning flashes are blue-white in color, while city lights look more orange-yellow. A bit later in the film, another notes that he can recognize commercial fishing vessels in southeast Asia by their green lights. That got me thinking about why each of these three types of light appear so different. The blue-white color of lightning indicates that most of the light energy is in shorter wavelengths (blue and violet are the shortest wavelengths our eyes can perceive). Short

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wavelengths indicate high temperature (lightning frequently reaches 50,000 degrees C).

In the cities, low-pressure sodium vapor lamps produce a distinctive yellow light because the emission spectrum of elemental sodium includes just two bright peaks at 589 and 589.6 nanometers. (When an outer-shell electron in a sodium atom drops back down to its ground state from an excited state, a photon of light is emitted, and that photon has a wavelength of either 589 or 589.6 nanometers.) The monochromatic quality of street lights means that objects in the light often don't look right. Shining yellow light on a blue object makes the blue object look black, since all of the yellow light is absorbed and little or no light is reflected. Sodium lights are used simply because they are inexpensive to operate: The bulbs last a long time, and they don't use much energy.

On the other hand, fishing lights are carefully designed to produce green light as a way to attract fish close to the fishing boat or dock. The idea is that the bright green light attracts small prey animals like phytoplankton and shrimp, which then attract larger bait fish, which then bring in the larger game fish. While lights have been used for a long time, green light-emitting diodes (LEDs) and florescent lights have recently become affordable, and are widely used in the fishing industry.

I was struck by how much exercise the astronauts on the ISS are required to do while on board, and by the zero-g exercise equipment. Each crew member is expected to put in two hours on the treadmill and hydraulic "weight" bench every day. To stay attached to the treadmill, astronauts wear a harness around their waists and over their shoulders that is connected by elastic cords to the base of the treadmill. Since lifting weights doesn't provide much exercise on the ISS, they have a machine that uses hydraulic pistons (like those in car shock absorbers, or to close your screen door) to provide resistance to motion. The exercise not only keeps muscles strong, but also reduces bone loss during astronauts' time on the station.

Finally, one of the funniest moments in the film is when we see how difficult it can be to get out of a spacesuit after an extravehicular activity (EVA). The EVA suit has to protect the astronaut from both high and low temperatures outside the ISS (it is very hot when in the direct sun; very cold when in the shade), keep a breathable atmosphere around him/her, and allow the crew member to get some work done. The suit can't have too much extra room, and without gravity to help keep you stuck to the floor, wiggling out of the gear is very challenging. You'll need to watch the film for the full effect, but seeing one crew member using her arms and legs to push/pull her colleague out of the EVA suit is some good physical comedy.

Teachers who have the opportunity should encourage their students to see *A Beautiful Planet* to take advantage of this chance to get kids excited about space travel, and inspired to protect the Earth. The film also provides the opportunity to talk about light spectra and human physiology and make connections between documentary and feature films. ●

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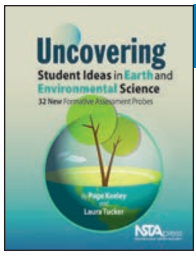

NSTA PRESS: *Uncovering Student Ideas in Earth and Environmental Science*

How Many Oceans and Seas?

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 Uncovering Student Ideas in Earth and Environmental Science: 32 New Formative Assessment Probes, *by Page Keeley and Laura Tucker, edited for publication here. To download the full text of this chapter, go to* http://bit.ly/1XshDXa. *NSTA Press publications are available online through the NSTA Science Store at* www.nsta.org/store.

A group of friends went sailing on the ocean. They wondered how many separate oceans and seas there were in the world. This is what they said:

Kendra: I counted the bodies of water on a map. There are more than 100 separate oceans and seas.

Matthias: I think there are seven separate oceans or seas because they have always been called the Seven Seas.

Alejandra: I think there is really only one ocean because water flows freely through all of them.

Tidir: Because they are named for the basins that form them, I count five separate oceans and 87 separate seas.

Who do you think has the best idea? Explain your thinking.

Teacher Notes

Purpose

The purpose of this assessment probe is to elicit students' ideas about the ocean and seas. The probe is designed to reveal whether students use geographic names and locations to consider the number of separate oceans and seas or use the concept of "one ocean."

Type of Probe

Friendly talk

Related Concepts

Concept of one ocean, global ocean conveyer belt, ocean, ocean basins, seas, water circulation

Explanation

The best answer is Alejandra's: "I think there is really only one ocean because water flows through all of them." It is important for students and adults to understand the concept of "one ocean" to understand the global movement of matter and the flow of energy throughout the world's ocean. Throughout the ocean, there is one interconnected circulation system powered by the wind, tides, the force of Earth's rotation (Coriolis effect), the Sun, and water density differences. The shape of ocean basins and adjacent land masses influence the path of circulation. This "global ocean conveyor belt" moves water throughout all of the ocean's basins, transporting energy (heat), matter, and organisms around the ocean (Ocean Literacy Network 2015).

Although the basins have names that contain the named oceans, all ocean water can move freely around the globe and mix with other named oceans. The term Seven Seas has historically meant the Arctic, North Atlantic, South Atlantic, North Pacific, South Pacific, Indian, and Southern Oceans. Currently, a sea is commonly thought to be an extended body of saline water associated with one of the world's five named oceans (Atlantic, Pacific, Arctic, Indian, and Southern). Because there is no strict scientific definition of the term *sea,* it is not surprising that there is no single defined list of the seas of the world. Some maps may list more than 100 "seas" around the globe.

Administering the Probe

This probe is best used with grades 6–12. Being careful not to give away the answer, point out that the term *separate oceans* means bodies of ocean water that are physically separated from other bodies of ocean water.

Related Core Ideas in Benchmarks for Science Literacy (AAAS 2009)

6–8 The Earth

- Three-fourths of the Earth's surface is covered by a relatively thin layer of water (some of it frozen), and the entire planet is surrounded by a relatively thin layer of air.

6–8 Processes That Shape the Earth

- Thermal energy carried by ocean currents has a strong influence on climates around the world.

9–12 Processes That Shape the Earth

- Transfer of thermal energy between the atmosphere and the land or oceans produces temperature gradients in the atmosphere and the oceans. Regions at different temperatures rise or sink or mix, resulting in winds and ocean currents. These winds and ocean currents, which are also affected by the Earth's rotation and the shape of the land, carry thermal energy from warm to cool areas.

Related Core Ideas in *A Framework for K–12 Science Education* (NRC 2012)

6–8 ESS2.A: Earth Materials and Systems

- All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems.

6–8 ESS2.C: The Roles of Water in Earth's Surface Processes

- Global movements of water and its changes in form are propelled by sunlight and gravity.

Related Research

Feller (2007) identified several common misconceptions about the ocean, including the commonly held idea that the three big oceans are not connected, and each acts alone.

Suggestions for Instruction and Assessment

- Give an inflatable globe to each pair of students. A flat map of the world that is connected as a cylinder can work as well. Have them put a finger on a part of ocean water. Have them attempt to trace a path around the globe or map without crossing any landforms. This should reinforce the idea that we have only one ocean that is connected to all oceans worldwide.
- Examine the Ocean Literacy Framework at *http://bit.ly/1sHzsGJ.* The Framework contains the Seven Principles of Ocean Literacy, including Principle #1: The Earth has one big ocean with many features. The Framework also includes a scope and sequence document and graphical conceptual flow maps.
- Seas of the World (Saundry 2013) can be used to support the scientific practice of obtaining, evaluating, and communicating information related to this probe.
- Students can research the history behind the names of the oceans and seas on our maps. ●

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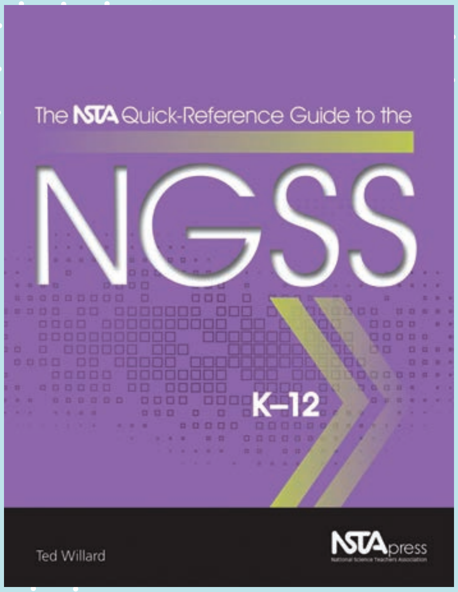

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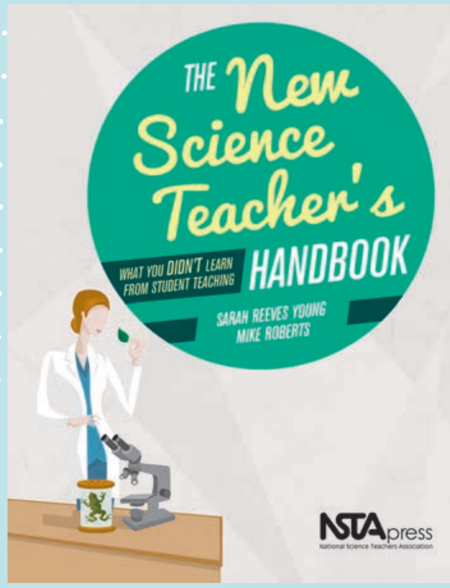

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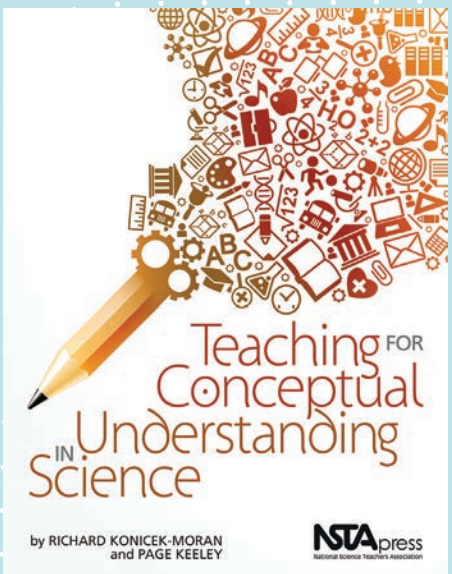

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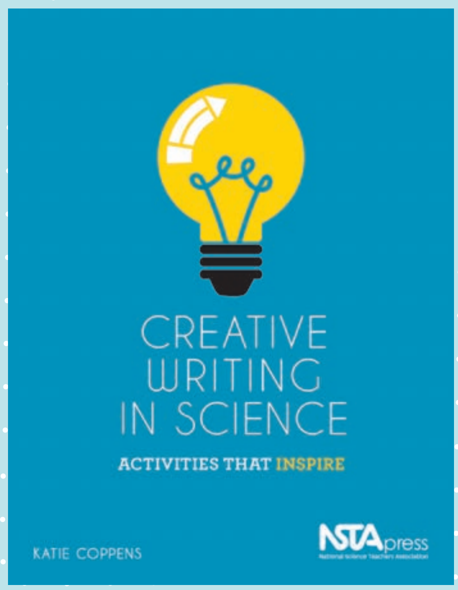

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NSTA Dates to Remember

(All dates are deadlines unless otherwise specified.)

July 15—Don't miss NSTA's **Summer Institute, Implementing *Next Generation Science Standards***, at the University of Nevada in Reno. *NGSS* experts will lead sessions designed to help attendees better understand what *NGSS* looks like in the classroom at different grade levels and content areas. For more information or to register online, go to *http://bit.ly/1QF7boT*.

July 27—The **2016 STEM Forum and Expo** opens today in Denver, Colorado. The conference features a keynote address by Derek Muller, creator of the science YouTube channel Veritasium. The conference runs through July 29. For information or to register, visit *http://bit.ly/1ppHD9d*.

August 1—Share your strategies for teaching **"Early Childhood: Earth Science"** in NSTA's peer-reviewed elementary level journal. *Science and Children* (*S&C*) is accepting submissions on this theme for the February 2017 issue. For more information on how to submit a manuscript on this theme as well as other elementary topics, read the call for papers at *http://bit.ly/1XjHRvr.*

August 1—Submit your manuscript on how you encourage your middle level students to understand systems and use models to construct explanations for the January 2017 issue of *Science Scope*, NSTA's peer-reviewed middle level journal. Manuscripts on the **"Systems Thinking"** theme are being accepted through today; general interest manuscripts, commentaries, and column submissions may be submitted at any time. Read the call for papers and access submission guidelines at *http://bit.ly/1OfgnF0*.

September 1—How do you use the outdoors to inspire young students to study science? *S&C* wants your manuscript explaining how you provide outdoor learning experiences for the March 2017 issue, themed **"Getting Students Outdoors: Designing and Using Outdoor Spaces."** For more information on writing for an NSTA journal and to read the *S&C* call for papers, visit *http://bit.ly/1XjHRvr.*

September 1—***Science Scope*** needs your best practices for teaching middle level students about the essential substance, **"Water."** The February 2017 issue will focus on water, but general interest manuscripts, commentaries, and column submissions are also being accepted. Read the call for papers and access submission guidelines at *http://bit.ly/1OfgnF0*.

September 1—Submit your manuscript today on teaching **"Scientific Discourse and Argumentation"** at the high school level for the March 2017 issue of ***The Science Teacher*** (*TST*), NSTA's peer-reviewed high school journal. *TST* also accepts articles unrelated to a theme at any time. For more information on writing for *TST*, issue themes, and more, go to *http://bit.ly/1saSncP.*

September 14—Learn more about joining NSTA's leadership and taking a role in shaping science education during **Leaders for Science Education: Preparing an Application for the NSTA Board and Council, a free NSTA Web Seminar.** Applications for NSTA's Board and Council Election are due on **October 19.** For more information on NSTA Web Seminars or to register, visit *http://bit.ly/1Iwpg4w.*

October 1—Share your best practices for teaching elementary students about **"Matter and Its Interactions"** by writing for the April/May 2017 issue of *S&C*. Manuscripts on this theme and other elementary science education topics are being accepted. Learn more about writing for an NSTA journal and read the call for papers at *http://bit.ly/1XjHRvr*.

October 1—*TST* seeks articles on teaching **"Science for All"** for the April/May 2017 issue. *TST* also accepts articles unrelated to a theme at any time. For more information on writing for *TST*, issue themes, and more, go to *http://bit.ly/1saSncP.*

October 1—The total solar eclipse that will occur on August 21, 2017, is a rare opportunity for educators to explore the intersection of astronomy, mathematics, and mythology with their students. Help your fellow middle level educators prepare for this event by sharing how you meet this *NGSS* performance expectation—Develop and use a model of the Earth-Sun-Moon system to describe the cyclic patterns of lunar phases, eclipses of the Sun and Moon, and seasons—in the March 2017 issue of ***Science Scope***, themed **"Our Sun and Beyond the Solar System."** General interest manuscripts, commentaries, and column submissions are always accepted. Read the call for papers and access submission guidelines at *http://bit.ly/1OfgnF0*.

December 1—Have you found a way to excite your high school students about engineering? Share your insight and experience in an article for the Summer 2017 issue of ***TST,*** themed **"Engineering: The 'E' in STEM."** *TST* also accepts articles unrelated to a theme at any time. For more information on writing for *TST*, issue themes, and more, go to *http://bit.ly/1saSncP.* ●

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