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Science and the *Star Wars* Universe

When *Rogue One: A Star Wars Story* debuts next month, science teachers who use the *Star Wars* films in their classrooms will have another tool not just for teaching science, but also for integrating it with other subjects. The films "are a great place to integrate science and the arts," says Jacob Clark Blickenstaff, NSTA's media reviewer and Director of K–12 Engagement at the Pacific Science Center in Seattle. "If teachers are worried about STEM (science, technology, engineering, and math) leaving out the arts, [the films] are a great place to make that connection."

John Derian, who teaches ninth- and 10th-grade Living Environment and Physical Science to newly arrived immigrants at The Brooklyn International High School in New York City, uses the first three *Star Wars* films to do just that. After learning sculpting from an art teacher, he incorporated it in a *Star Wars* project-based unit he created for a school-wide interdisciplinary portfolio project with the theme "Adaptation": something young immigrants can readily relate to.

Working in groups, "students design and sculpt an alien animal adapted to a specific *Star Wars* planet and identify its unique sequence of DNA by investigating ecology of different ecosystems, animal adaptations, and protein synthesis," Derian explains. (See *http://bit.ly/2dyOOrR*.)

"Students model their animals around real animals and adaptations… We look at animal skeletons" to prepare them to create their alien animal's framework, he relates. Students "look at the *Star Wars* animals with a critical eye [and ask the] big questions, such as, 'Did [George] Lucas consider adaptations when he created [those animals]?'"

In addition to completing written assignments, students create time-lapse videos showing the creation of their alien animal. Derian says he asks students to do this "to be more cognizant of the design process in the moment. Additionally, the requirements for the final fully edited time-lapse video require students to reflect on the design process and how they collaborated together."

JOHN DERIAN

John Derian uses Star Wars *films in his Living Environment and Physical Science class at The Brooklyn International High School in New York City. Here students are doing a peer tutoring activity about protein synthesis using magnetic nucleotides to build DNA and mRNA.*

Because the protein synthesis of real animals involves sequences of 50 to 1,000 amino acids, Derian does short sequences with the alien animals instead. "I've never had students more enthusiastic about learning protein synthesis," he asserts. Using their *Star Wars* animal "makes [it] more purposeful."

"Darth Maker"—a.k.a. Dave Marriott, makerspace lab facilitator at Stateside Elementary School in Jacksonville, North Carolina—incorporates *Star Wars* in subjects like robotics to provide students with authentic experiences for applying science and math. "I show students the clip from *Episode IV* [in which] Luke is buying droids. [Then I ask,] 'What is their purpose?'" says Marriott.

"We'll have a discussion: Could we have a lightsaber or autonomous droids? Or I'll show the clip from *Episode II* with C-3PO, a droid, making other droids. Then I'll show a video of robots building cars, assembly-line robots, so [students] can see how they're used in society," he relates.

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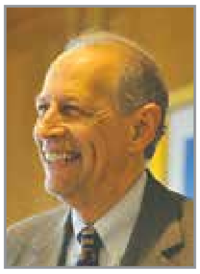
Competitions to Support STEM Education and Learning Goals PG 3

COMMENTARY: **Arthur Eisenkraft**

Competitions to Support STEM Education and Learning Goals

By Arthur Eisenkraft



Arthur Eisenkraft

Every day across the country, teachers rise to the challenge of supporting student learning in science. In their efforts to provide the very best instruction, some teachers overlook opportunities to enrich their classroom experiences through student involvement in competition programs. When appropriately organized and directed, science and engineering competitions can provide a lifelong appreciation of, interest in, and enjoyment of science and engineering activities in much the same way that involvement in sports competitions fosters a lifetime enjoyment of sporting events. Schools recognize athletic, music, and theater talents, as they should. However, we also have to provide ways to hail our science stars: Winning a competition can do that.

For six years, the White House Science Fair has celebrated winners from a broad range of science, technology, engineering, and mathematics (STEM) competitions from across the United States. This year, monetary and scholarship prizes will be awarded to student participants in longstanding prestigious competitions, including the Siemens Competition in Math, Science, and Technology; the Google Science Fair; the FIRST Robotics Competition; and the Toshiba/NSTA ExploraVision Competition. Competition programs can add incentives to learning science, augment current curriculum, and provide a creative outlet for students while fostering integration with the *Next Generation Science Standards*. For example, for the ExploraVision competition, student teams identify a present technology, then speculate how that technology will have changed 20 years from now. They must investigate the science and engineering breakthroughs that will be necessary to make their vision a reality. Recognizing that all technologies have both positive and negative consequences, they must also identify the potential effects of their technology on society.

This year, Congress passed the Every Student Succeeds Act (ESSA), which replaced No Child Left Behind. Per the new federal education law, state and district leaders must engage in meaningful consultation with a broad range of stakeholders, including families, students, educators, private school officials, and community partners, when developing state accountability plans and deciding on the use of ESSA funding. The act has a strong emphasis on STEM education. Educators can benefit by using project-based learning and competition programs to foster STEM education.

In the landmark report, *Education for Life and Work: Developing Transferable Knowledge and Skills in the 21st Century* (NRC 2012), the National Research Council explains how "deeper learning" is gained through facilitating opportunities such as a) case-based learning of real-world situations; b) multiple, varied representations of concepts; c) collaborative, self-directed, life-wide, and open-ended learning; d) learning for transfer across life beyond the classroom; e) interdisciplinary studies showing how different fields complement one another; and f) personalized and connected learning that encourages students to confront challenges and pursue opportunities that exist outside of their classroom and schools. Competition programs, which can encompass all of these opportunities, facilitate this "deeper learning."

According to the National Center for Education Statistics, about 50.1 million students attended public elementary and secondary schools in 2015. The U.S. Department of Education estimates jobs in the STEM fields will increase up to 62% by 2020. It is apparent to the government that educators are working to help our students meet this demand, and it is also important for more corporations (domestic and international) to increase their involvement. The success of longstanding and widely recognized competitions like the Google Science Fair and Toshiba/NSTA ExploraVision can serve as models for other corporations. Teachers and scientists can work with industry partners and incorporate these opportunities into the classroom. As corporations step up to support science through competition programs, teachers must also step up by introducing their students to these programs. Teachers can encourage students to "give it a try" and "do their best" and thereby offer students the satisfaction of having participated. ●

Arthur Eisenkraft is the Distinguished Professor of Science Education, professor of physics, and director of the Center of Science and Math in Context (COSMIC) at the University of Massachusetts Boston. He has been involved in the ExploraVision competition, the Duracell/NSTA Scholarship Competition, and the NYNEX Science and Technology Awards competition, and initiated the participation of the United States in the International Physics Olympiad. He can be reached at arthur.eisenkraft@umb.edu.

Students from Chapman Hill Elementary School in Salem, Oregon, envisioned SMART Moves, a flexible bodysuit equipped with pressure sensors, accelerometers, and more, as a potential future solution to mobility issues for their winning entry in the Toshiba/NSTA ExploraVision competition.

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"Kids want to build what they see," Marriott contends. When they build robots, they "see where science fiction turns into reality, even if their robot looks more C-3PO than I'd like."

May the Force Game With You

Amy Alexander, science teacher at Angola High School in Angola, Indiana, uses *Star Wars* to teach evolution and created an activity with a gaming element. "[S]tudents [read] a page from *Star Wars: The Essential Guide to Alien Species,* which describes the characteristics of dianogas, the slithering, one-eyed creatures who live in the garbage chutes of spaceships. I show students the clip from *Episode IV* [in which] Han, Luke, Leia, and Chewie escape down the chute, and Luke gets pulled under by the dianoga."

Next, "students roll dice to determine how the next generation of dianoga will evolve. They then get to decide the path of evolution, and roll a die to determine what type of environmental change will occur. They then make a determination as to whether the new trait will be beneficial in this new environment or not.

"They go through this cycle 4–5 times and draw their final dianoga in its new environment. This really gives students a chance to be super creative," she contends.

Megan Menker, middle division teacher at Marburn Academy in Columbus, Ohio, incorporated *Star Wars* in her grades 7–8 physics unit to teach about forces, vector diagrams, and net force. In one game-like activity, she gave each student a paper lightsaber with an amount of Newtons specified on it. "They took their lightsabers up to the blackboard for a duel and drew vector diagrams demonstrating the force of their lightsabers," she relates. "They then determined who is stronger by subtracting the difference between the forces to find the net force."

Then as a class, "we combined forces to overcome Darth Maul, and drew vector diagrams to represent that. By themselves, each Jedi was not strong enough...The students realized they had to combine forces to beat Darth Maul," she points out.

Attacking Science Flaws

Some educators have their students explore the films' scientific inaccuracies. In her sound unit for preservice teachers, Mary Lamar, science manager and chemistry lecturer at Eastern Kentucky University in Richmond, Kentucky, has students "write a letter to George Lucas to explain why they would not hear the Death Star explosion in space if they were [in] X-Wing fighter[s] with their back[s] to the Death Star and the communications system [was] down."

After her eighth graders complete a unit on force, energy, and motion, Rebecca Kern, Year 2 and 3 Integrated Science Educator at Channing Hall International Baccalaureate World School in Draper, Utah, shows her students a *Star Wars* film. "While viewing [it], students take notes about all of the 'misuses' of physics" in it, she notes. When the film ends, "students immediately start writing an argumentative essay that includes topics such as Newton's Laws of Motion, lightsabers, sound in space, jet engines, and explosions in space. I also give the students links to supplemental materials, such as Discovery Channel's *MythBusters* episodes on *Star Wars*..., that they can use as evidence to back up their claims" in the essay, Kern explains.

Theresa Jones, science teacher at Hackensack Middle School in Hackensack, New Jersey, shows her fifth graders *Episode IV*. They then "brainstorm all the science fiction in the film" and create a list of topics for a research paper, says Jones. Their papers include "what the real-world equivalent technology/invention would be"and "the scientific principles involved in making it a reality," as well as the benefits and negative effects of it, she relates.

"Kids typically like doing the research paper because they really want to know if these crazy things just might be possible," Jones contends. ●

Innovations in Teaching Space Science and STEM

Teachers around the country are coming up with new ways to excite their students about learning space science and science, technology, engineering, and math (STEM). As part of Jon Amundsen's new space science exploratory class at Bluffs Middle School in Scottsbluff, Nebraska, for example, sixth graders are taking a "journey" to Mars in nine weeks.

"I just started [the space exploratory class] in my district this year. I am the [district's] only teacher" of a space exploratory, says Amundsen, who also teaches sixth-grade Earth science and reading. Chosen in 2013 as a Nebraska Education Space Ambassador by the University of Nebraska Omaha, Amundsen says the training he received through the Nebraska Space Ambassadors Program inspired him to design the exploratory course. "We had trips to Kennedy Space Center and Johnson Space Center" and attended Space Center Houston's Space Exploration Educators Conference, "where we were provided with lesson plans and ideas," he reports.

During the first week of the class, which he teaches to "20 to 27 students" each quarter, Amundsen says he covers "the basics of spaceflight, basic rocketry, the history of spaceflight, and the future of space travel." Every week, the class has what he calls "Flight Fridays," when students get to launch rockets they have built based on actual NASA rockets.

Students work in "flight groups" of four or five, and "each student has a specific job, [such as] pilot," within the group, he notes. As the class progresses, students learn about landing a spacecraft, study Mars rovers and robotics, and consider what they would need to survive in a colony on Mars. With each topic, students do a hands-on activity.

"I want to open their eyes to space, technology, and engineering and design challenges," Amundsen explains. He says he also wants to help students overcome "that constant [expectation to have the teacher do everything, and]…figure out things on their own and problem-solve" instead of just memorizing facts. "And for the mission to succeed, everyone must cooperate," he emphasizes. Students have to "put aside the labels and work together on the same level."

The class has become so popular that Amundsen has a waiting list of students eager to take it.

Students from Apollo Elementary School in Titusville, Florida, examined a Moon rock as part of Space School, a program that provides an opportunity for students to interact with the exhibits at the Kennedy Space Center Visitor Complex.

Building a Space Probe

This year, students at Sir Wilfrid Laurier School in Calgary, Canada, became the first junior high school–aged students to work with the Canadian Space Agency (CSA). They were chosen to be part of CSA's stratospheric balloon experiment, which launched in August. With help from CSA engineers, Laurier students built a probe that was attached to the high-altitude balloon; it contains a camera, GPS, and sensors to measure forces acting on the probe, temperature, humidity, and magnetic force and direction.

The project began when the students' former teacher, Jamie Parkinson, e-mailed CSA in 2014. Due to budget cuts, CSA "didn't have a specific program [for students], so [I] and a group of [CSA] engineers…persuaded the decision makers to give schools a shot," says Parkinson, who now teaches at West Island College in Calgary.

The 20 students who built the probe "were all self-selected from a range of classes," he notes. They worked on the project in class and during lunchtime.

Four student teams tackled engineering, logistics, project management, and manufacturing duties. Teamwork kept the students motivated during the six months they built the probe because "the teams competed with [one another]. The element of competition helped," Parkinson observes.

The project also received support from Ninesquare, a company formed by teachers from Canada and the United Kingdom to bring affordable STEM projects to schools. Ninesquare employees helped students, and the company donated materials and equipment. The school paid for the rest, "less than $100," says Parkinson, noting students helped create the budget.

Students benefitted from the project because working with the CSA engineers helped build their confidence, he asserts. "It also helped them see how the curriculum relates to real life."

Parkinson says he plans to send data from the probe to the Laurier students so they can analyze it. "Some will use it for their science fair project," he notes. And students "from the West Island College Engineering Institute are already working…to create a stratospheric glider, and students at a local high school… [aim] to launch their own probe into near space" by late 2017.

"We really want the probe to be reused" by other schools; "our aim is to start a space race" to get more students involved in science and engineering, he maintains. "And if schools in the United States want to take us on, we're ready," he asserts. For more information on how to do a similar project, e-mail *JamieParkinson@mywic.ca*.

Space School in Florida

Fifth graders from three Titusville, Florida, schools—Apollo Elementary, Oak Park Elementary, and Coquina Elementary—are piloting Space School, a program that enables them to spend four days at Kennedy Space Center's (KSC) Visitor Complex in Titusville studying science, technology, engineering, art, and math and exploring "careers and career fields associated with science and technology," says Sandra Harper, a fifth-grade teacher at Apollo Elementary who is spearheading the pilot. A partnership among the KSC Visitor Complex, hospitality company Delaware North, and the KSC Education Foundation funded the program and made it available to the Brevard Public Schools, with the hope that it eventually will expand to all elementary schools in the district.

Apollo Elementary teachers designed the curriculum, which lets students interact with the Visitor Complex's exhibits and NASA astronauts and engineers and do hands-on learning projects, such as graphing the heights and diameters of rockets in the Rocket Garden. The students will "see every venue at [the Visitor Complex], all tied in with standards for science and math," Harper explains. Apollo's teachers chose 15 books for students to read that "align with the exhibits" and convey the history of space exploration, she notes.

In August, Harper provided training and suggestions for student activities to Oak Park's and Coquina's fifth-grade teachers. Those teachers will also create new student activities for Space School. "We want to grow the program and grow the amount of material to support it," she observes.

Some Apollo Elementary students from the group that went to the Visitor Complex in January served as tour guides for another Apollo Elementary group in May. "These students were able to lead the activities because they had already done them. They enjoyed it very much," Harper relates. A "pre-test and post-test" of students in the January group "for the academic standards we're providing instruction for" showed differences in scores of 30–90%, says Harper.

The groups attending Space School this semester will do so earlier, "before the concepts are taught" in the classroom, she observes. "They will not have all the answers, so they'll have to explore and come up with the answers themselves." ●

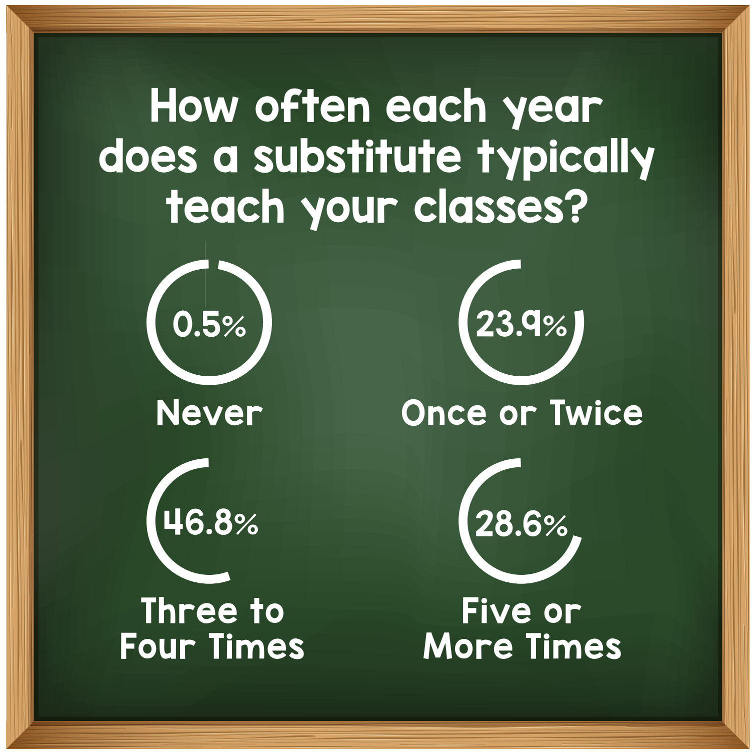
Quotable

What we are teaches the child far more than what we say, so we must be what we want our children to become.

—Joseph Chilton Pearce, U.S. author (1926–2016)

The Mixed Blessings of Substitute Teachers

Like all educators, science teachers rely on substitutes to lead their classrooms when they have to take a day (or more) away from the classroom. In a recent anonymous *NSTA Reports* poll, 46.8% of participants reported needing a substitute for their classroom three or four times a year, with 28.6% reporting they depend on substitutes five or more times annually and 23.9% only once or twice a year. All reported leaving lesson plans for substitutes ahead of a planned absence, and 75% report maintaining "emergency" lesson plans for an unplanned absence. Most (77%) report that substitutes usually followed the plans. Nearly 87% say they take steps to prepare their classrooms for a substitute ahead of a planned absence. Educators say they leave seating charts, set up labs, check the room's organization, "label everything," lock up all lab equipment, or "hide materials that may be stolen or damaged." Eighty-four percent reported preparing their students for a substitute—many by reviewing class rules, expectations, and agendas. Few (8%) report substitutes typically have a background in the subject matter, and a majority (65%) don't get to approve or screen the substitutes who will teach their classes.



Here's what science educators are saying about the challenges of having a substitute:

Having them teach new content is scary, especially since each class coming in that day has its own atmosphere for learning. I'm afraid things will not be taught with the same passion that I teach them with.—*Educator, High School, Indiana*

You can't leave a lesson and expect it to be taught, but at the same time, it's hard to give up valuable teaching time.—*Educator, Elementary, Washington, D.C.*

Abuse and neglect of my workspace [has occurred].—*Educator, Middle School, Maryland*

Not all of the subs are respected by the kids. We have a sub shortage in our area, so when we are out sick, many times other teachers are losing planning time to sub for me.—*Educator, Middle School, Pennsylvania*

I must leave a boring lesson. Something anyone can do...I can't have students do an activity because I don't know the background of the teacher. I use lots of technology in my lessons, but I can't leave the same type [of lesson] for a sub.—*Educator, Middle School, California*

Writing the plans is very time consuming. Every step has to be explained, and that takes a lot of time. Making an answer key and practice problems is time consuming...Subs often don't follow the plans. They skip steps and don't insist that students complete things. Subs can have terrible classroom management, and that leads to problems when you return. Subs don't clean up or ask the kids to clean up.—*Educator, Elementary, Massachusetts*

You aren't entirely sure if students are getting what they need out of a lesson. Also, you can't be 100% sure the lesson will actually get completed.—*Educator, Middle School, Connecticut*

I cannot expect them to teach science because they do not have the training and expertise to conduct activities with an awareness of health and safety in the science classroom.—*Educator, Elementary, Wisconsin*

[It's unknown w]hether or not we will actually have a dedicated sub or if there will be other teachers covering a particular class. I could have six different people monitor my classes.—*Educator, High School, New Jersey*

Having to skip labs or adjust activities when I can't get a sub with science background.—*Educator, High School, Illinois*

Holding students accountable for what did or did not happen while I was out.—*Educator, High School, Washington*

Unfamiliarity with technology; late arrivals (not arriving before students arrive means no time to read plans or prepare); our district pays the worst sub wages in the county; subs don't seem to have intuitive behavior management skills, so problem behaviors escalate; lesson plans need to be "dumbed down" significantly, or lesson time is wasted because the sub made changes to the plan.—*Educator, Elementary, New York*

Having a sub who doesn't "believe" in science. I had one—for a two-day absence while I was at a conference—try to convince my students that climate change wasn't real, and scoffed though the entire video clip and reading the students were to complete.—*Educator, Middle School, Connecticut*

Not knowing exactly what happens in my room throughout the day. Substitutes do not always leave the best or most detailed notes. If you send a student out for any reason, I need to know why.—*Educator, Middle School, Michigan*

How much to prepare for them...can they fill in the spaces of a general lesson outline?—*Educator, High School, British Columbia, Canada*

As a control freak, not having control of what is done in my classroom. —*Educator, High School, Maine*

Content knowledge and ability to help the students with high school science concepts [is important].—*Educator, High School, Illinois*

Are they technologically competent? Do they have enough content knowledge to respond to student questions? Will they follow my lesson plan to the best of their ability?—*Educator, High School, Hawaii*

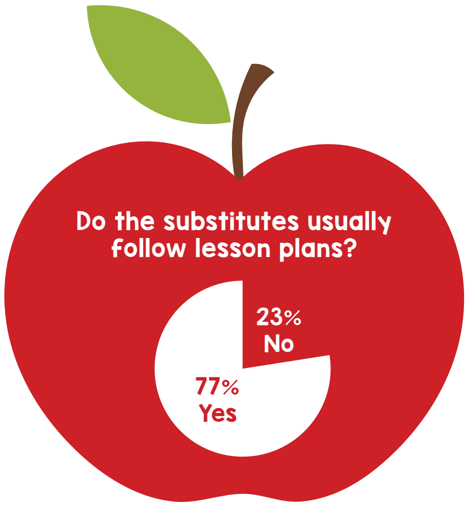
Getting everything prepared, and trying to think of anything they might need or what could possibly go wrong and trying to prevent it takes up a lot of time. Our school requires a sub notebook. Setting it up in the beginning takes time, but it's really helpful once it's done.—*Educator, Middle School, Oklahoma*

Classroom management issues—the room is torn apart, and the assignment is not distributed.—*Educator, High School, Washington, D.C.*

Creating lesson plans and not knowing who my sub is and then praying that [he or she] will follow the plans. —*Educator, Middle School, Iowa*

Creating lesson plans that are self-standing so that if my sub has no knowledge of science, which is typical, the students can still move ahead.—*Educator, High School, Minnesota*

Developing lessons that the sub can handle and [that] tie to the concept



being taught at the time. I do not want it to be a wasted day.—*Educator, Middle School, California*

Finding a competent substitute for an extended period of time [is difficult]. —*Educator, Institution of Higher Learning, Missouri*

Every person handles things differently. Subs tend to be more lenient with discipline in the classroom. Some subs will work hard and walk around to make sure students are doing what they are supposed to, as well as assist the students. Some subs just sit at a desk and do nothing, letting the students run wild.—*Educator, Middle School, High School, Pennsylvania*

Finding activities that are suitable for someone who does not necessarily have a science back ground [isn't easy].—*Educator, High School, Nevada*

I feel that it is too dangerous for the substitute to do labs, so students miss out on hands-on activities.—*Educator, High School, West Virginia*

I never have a lab scheduled for that day. There are way too many safety concerns, and a background is needed to know that what they are doing (or not doing) is correct and will not put anyone at risk.—*Educator, High School, Illinois*

Not following the detailed plans I spent months preparing [before] maternity leave. I had to reteach an entire unit. —*Educator, High School, Rhode Island*

Lack of support for the sub [occurs] in our school. Some students tend to behave horribly and take advantage. [The o]nly repercussion may be from [the] teacher when [he or she] return[s]. —*Educator, Middle School, New Jersey*

It is difficult to maintain an inquiry-based classroom with a substitute. —*Educator, High School, Nebraska*

Making sure I have all of the details spelled out. I once had a sub think the activity was too boring the way it was supposed to be done, so she let the students do whatever they wanted with the materials. Luckily there weren't any chemicals that [could have] had bad interactions [when mixed] out. —*Educator, Middle School, Iowa*

No matter how hard I try to make my lessons self-explanatory and easy to follow, I end up needing time before and after a lesson to make sure kids understood the material. Often sub days lead to misconceptions and missed concepts. I also have to leave *detailed* notes on kids so that there aren't behavior problems. The subs in my building do not trust kids and seem to not even like teenagers, so they rarely give kids what they need to be successful unless it is explicitly written down.—*Educator, Middle School, Wisconsin*

Subs rarely follow lesson plans at my school or reinforce class expectations and norms. I have had class materials stolen or damaged while I have been out.—*Educator, High School, Michigan*

The fact [is] my district only pays $85 a day, so it's hard to even get a sub to cover classes, much less a qualified science teacher.—*Educator, High School, Colorado*

[I dislike the] time wasted planning "sub-proof" lessons and missing instructional time with my students. —*Educator, High School, Michigan*

There are not enough substitutes available, so when calling in an absence, I do not know if the school will actually find someone.—*Educator, High School, Michigan*

Not knowing how they are going to treat my students [troubles me]; the majority of my class is special [education]/behavioral.—*Educator, Elementary, Alabama*●

Making STEM Relevant Through Agriculture

"All science comes from agriculture. Biology, zoology, botany—it all comes from agriculture," asserts John Cole, an agriculture science teacher at Columbia High School in Lake City, Florida. "I feel like agriculture science is a foundation course for all science…If we had not learned to grow things…we would not have science like we know it today."

Cole's agriscience classes incorporate history (the origins of agriculture) and math (calculating acreage, fertilizer use, and growth rate). He says the hands-on aspects of agriculture also help him demonstrate that "science is not boring." Working in the school greenhouse and garden gives students a chance to "take what they learn [from a book and] apply to it to a real-world situation. It allows them to learn better and retain it better."

Cole is not alone in these views. Many educators, whether they teach agriculture science as a separate course or integrate it into other science courses, contend that agricultural science is essential and particularly applicable to project-based learning.

Denise Scribner uses agriculture in her ecology, biology, and forensic crime science courses at Eisenhower High School in Goddard, Kansas. Forensic science is a particularly "neat way to look at agriculture," she says. "I like to integrate [agriculture] with other sciences. Many schools have separate classes [for agriscience], but by integrating it, I can share our agricultural heritage in a variety of ways."

"Agriculture has always been a significant factor in the sustainability and development of human society. Unfortunately, the important role of agriculture as a foundation for secure and durable civilization is not always apparent to those outside of agriculture. Before taking my classes [in which] I apply 'real-world' concepts of agriculture into my lessons, my students saw it only in terms of narrow stereotypes: a farmer, a cow, a tractor," Scribner says. "My students represent the future leaders of society, the people we will depend on to support, regulate, and advocate for agriculture. That is why I expose them to trending issues like sustainable farming, natural resources, and energy."

When it comes to agriculture and science, technology, engineering, and math (STEM), "if you're involved in it, you're going to be applying it," says Matthew Eddy, agriscience teacher at Southeast Polk High School in Pleasant Hill, Iowa, where he uses the Curriculum for Agricultural Science Education (*www.case4learning.org*). Eddy says the curriculum is a "very hands-on, project-integrated program…I'm usually there helping them figure things out; it's not lecture-based by any means."

When comparing students' reactions to being told they would be designing their own hydroponic systems versus finding out they would be studying statistics and probabilities (concepts applied in hydroponic design), Eddy laughs, noting a lack of enthusiasm for statistics and probabilities. However, he adds, "once you get the connection between what you're learning in science and where it's applicable, that's where students start to become engaged."

"Since agriculture is the basis of our community and state economy, I decided to bring it into my classroom," explains Stacey Balbach, Wisconsin farmer and grades 9–12 STEM lead teacher at Cuba City High School.

"I integrate it at every moment I can, and with the *NGSS* [*Next Generation Science Standards*], it is so easy to do. For example, I was beginning a unit on DNA in my biology class, and I had my students grind up some soybeans from [my] field. We isolated DNA from the soybeans. That was an exploratory activity that included making qualitative and quantitative observations from an experiment and asking questions," she adds. "Other examples are in chemistry: Polymers—soybeans and wax; colloids—milk; mixtures—butter; homogeneous and heterogeneous materials (food science). In Chemistry II: [I]solate the set of genes that are in GMOs [genetically modified organisms], and discuss GMOs, fractional distillation of ethanol."

Brian Shmaefsky, professor of biology at Lone Star College-Kingwood in Kingwood, Texas, teaches agriscience as part of a year-long freshman environmental science course. "I wouldn't do [environmental science] without agriculture," he says. The majority of his students come from urban areas, and he says, "urban kids have every misconception under the sun [about farming]. They find alternative agriculture interesting. The rural kids are not used to looking at sustainability. We have a lot of pollution issues" from highway runoff that his students are studying on a test farm.

Denise Scribner (left) works with students at Eisenhower High School in Goddard, Kansas, to identify insects during a "BioBlitz," part of a biomass study of the on-campus ecosystem in her agriculture science–based ecology course.

"Agriculture makes a more natural integration of science then just biology, chemistry, or physics," Shmaefsky says.

"The materials I use in life science and Earth science provide a relevance to the learning about environmental interactions, genetic challenges and innovations, and green technologies," states Sue Meggers, seventh- and eighth-grade science instructor at Interstate 35 Secondary School in Truro, Iowa. "We have a three-acre prairie and 12-acre corn/bean test plot that we use for hands-on diversity, soil quality, water quality, and sustainability studies. This hits home since we live in rural Iowa, and helps the 'bedroom' community kids understand the value of agriculture and ecology as a harmonious unit. Engagement is tenfold better when we do these hands-on, real-world activities.

"Agriscience supports the *NGSS* standards regarding humans and Earth changes; water cycle/quality; life science ideas regarding genetics, sustainability, evolution; [and] physical science regarding the chemistry of life," she adds. Meggers finds agriscience resources through state extension services, the U.S. Geological Survey, Environmental Protection Agency, and the National FFA, among others.

"For our sustainable future, we need to give our students the experience and concepts for the farming of the future (based upon sound science) that can be applied at the local level," maintains Wayne Oelfke, grades 6–12 agriculture instructor and FFA advisor at Fort White High School in Fort White, Florida. Oelfke has always integrated science into his agriculture courses, and he has begun working with science teachers on lessons on decomposition and soil quality. "Agriscience research and problem solving are a part of our curriculum…we start with 'what's the problem' and go through the whole thing." He says students have designed experiments to investigate ways to grow crops while reducing water use and to identify the most beneficial nitrogen fertilizer with the lowest leach rate.

"Agriscience and sustainability should be integrated," he exclaims, "I love agriscience being a method, a delivery vehicle for STEM!" ●


Educational resources on infectious disease
hhmi
BioInteractive
www.BioInteractive.org/infectious2

PULL-OUT SECTION

SCIENCE TEACHERS' GRAB BAG

Inside this Convenient Pull-Out Section you will find:

Freebies for Science Teachers

***NGSS* Standards vs. Curriculum.** **K12** Have you ever wondered about the differences between the *Next Generation Science Standards* (*NGSS*) and curriculum that supports effective *NGSS* instruction? If so, this professional development book, *Key Differences Between* Next Generation Science Standards *and Curriculum,* is for you. Written for K–12 educators and administrators, the book helps readers differentiate between curriculum and standards; promote mastery of skills over task performance; analyze science, technology, engineering, and math (STEM) tasks and curriculum; and gain insight into the next generation classroom experience. Download the book at *http://bit.ly/2c66b2q* (free registration is required).

Gotscience.org Teacher Discussion Guide. **M** **H** Targeted for grades 7–9, this online guide can help teachers enrich instruction and spark conversation in science courses. Created by nonprofit publisher Science Connected, the guide contains articles and video clips on a range of real-world science topics from birdwatching and how bees make honey to explorations of how airplanes work and how to extend the life of a mobile phone battery. Accompanying each resource are comprehension questions that help students process the resource content; discussion questions that expand students' thinking on the topic; and hands-on projects to reinforce students' understanding. Consult *http://bit.ly/2auTeSf.*

STEM Lesson on Gray Wolves. **H** How do you create a balanced, unbiased STEM lesson plan about a controversial topic like gray wolves? You invite all stakeholders to the table (hunter, wilderness advocate, Native American, wolf-watching ecotourist, rancher, wildlife manager) and collaborate to ensure all perspectives are accurately represented. In Gray Wolves in the Northern Rocky Mountains: A Conservation Puzzle, an interdisciplinary lesson for students in grades 9–12 produced by Bear Trust International, students use geographic information system (GIS) software to map the geographic distribution of gray wolf packs in the northern Rocky Mountains. Students then analyze the real-world data to determine if gray wolves in the northern Rockies have delisting criteria.

As a capstone activity, student teams participate in a stakeholder meeting about gray wolf conservation. Watch an introductory video about the lesson and access lesson materials, including teacher guides, answer keys, and student pages, at *http://bit.ly/2d1sjKR*.

MONGO

STEMStudy. **H** Florida Polytechnic University's website and app provides a centralized source of articles, videos, and interactive content dedicated to guiding high school students to STEM-focused careers and helping them through the college preparation and the application processes. The website features student timelines, application checklists, a STEM scholarship guide, a STEM career glossary, and a quiz that helps students identify their STEM passion with a related career path. Visit *http://stemstudy.com* and get the app at *http://apple.co/2d3Hhl1*.

***Everybody's Got Questions* Rap.** **M** Spread the power of science curiosity with this catchy rap video created by music loving, eighth-grade science teacher Tom McFadden. A parody of the song "Choices," by rapper E-40, the song video features cameos by 76 scientists, engineers, and educators, including Bill Nye. The lyrics highlight each of the *NGSS* Science and Engineering practices, as well as the importance of asking questions about the world. Find the video, song lyrics, and a list of featured scientists and educators (and their occupations) at *http://bit.ly/2ducwa5*.

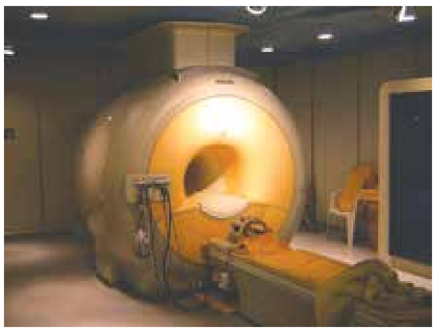
Next Generation Science Training Resources. **K12** Take an in-depth look at the principles and concepts of the *NGSS* and deepen your understanding of the intent of the standards and the changes in instruction needed to implement them in K–12 classrooms. Available at the Sonoma County, California, Office of Education's website (*http://bit.ly/2dA7LbV*), and created by Arthur Beauchamp of the Sacramento Area Science Project, the series of documents offers an overview of the *NGSS* and its structure, along with lessons for teachers that model *NGSS* practices and core ideas for elementary (K–5), middle level (grades 6–8), and high school (grades 9–12).

See Freebies, pg G2

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

Freebies, from pg G1

Surrounded by Science Educator Toolkit. K12 Collated by the National Environmental Education Foundation, this collection of K–12 lesson plans and curriculum guides from leading environmental and education organizations (e.g., Discovery Education, National Wildlife Federation, NASA) helps teachers introduce students to the kinds of science occurring around them, both in the classroom and in the field. The resources address four topic areas: pollinators (At Home), wildlife habitat (In the Neighborhood), watersheds (In Your Region), and weather and climate (In the World). Each topic has activities for elementary, middle, and high school levels, along with links to related citizen science projects for students. Visit *http://bit.ly/2d4MVks.*



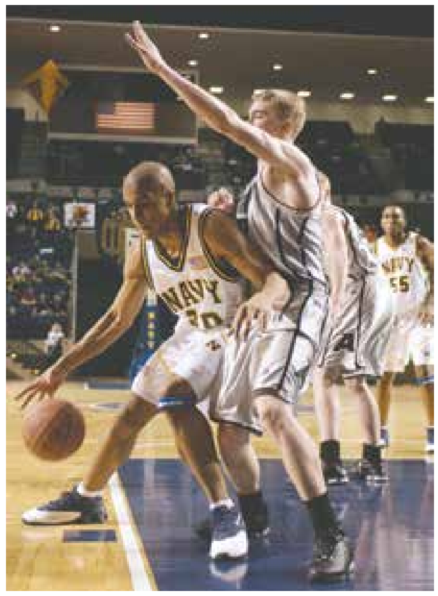
KASUGAHUANG

Radcademy. M H Introduce middle and high school students to the world of medical imaging and radiation therapy. At *http://bit.ly/2d1uYGk,* teachers can access videos and other resources that offer an in-depth look at the radiologic sciences and related technology. The videos feature teens and real-world settings, helping students better relate to the content and envision themselves pursuing careers in the field.

#CleanWater: Brought to You by Chemistry. M H This video from the American Chemistry Council highlights some of the ways chemistry is involved in keeping our water supply flowing and our drinking water safe. Did you know that aluminum and chloride salts remove impurities to keep water clear? Or that phosphate-based chemistries and epoxy resins help keep metals out of water systems by preventing pipe corrosion and creating barriers between water pipes and the water they carry? Chemistry is involved in water conservation, too: Chemistry-driven purification technologies allow water to be recycled and reused. Share these and other facts in your middle and high school lessons; watch the video at *http://bit.ly/2cJh2le.*

Wildlife and Climate Change Educator Resources. H HE Learn how our changing climate impacts biodiversity through educator resources from the World Wildlife Federation. Designed for advanced high school and college teachers, the resources include an educator packet with background information, wildlife vulnerability assessment tools, and links to citizen science opportunities to engage students in global conservation work. Teachers can also access a PowerPoint presentation for teaching about wildlife and climate change and self-paced, interactive courses to strengthen their knowledge of climate change issues. See *http://wwf.to/2cUb8w7.*

Do-It-Yourself (DIY) Project Guides. K12 Created as part of the Allen Distinguished Educators (ADE) Program, these project guides encourage K–12 teachers working in unique educational settings to bring award-winning innovative computer science, engineering, and entrepreneurship projects to their classrooms. The guides feature video tours of successful projects created by ADEs alongside detailed project plans that enable teachers to implement similar projects in their own classrooms. Projects include the 52 Minute Challenge, in which high school students get 52 minutes to find a real problem on campus, document it, develop a solution, and prepare a market-based presentation to be given the following day; Circuit Arcade, in which middle level students gain an understanding of the engineering design process as they build a cardboard arcade game for which winning or losing completes an electrical circuit; and Hermit Habitat, in which elementary students discover the importance of collaboration when working under a tight deadline, as they design a hermit crab habitat, document it, develop a solution, and prepare a market-based presentation to be peer-reviewed the following week. See *http://bit.ly/2dmJRSq.*



U.S. NAVY PHOTO BY PHOTOGRAPHER'S MATE 2ND CLASS DAMON J. MORITZ

Game On! Sports in the STEM Zone. E M Created by the Chevron Corporation as part of STEM Zone, a hands-on educational exhibit exploring the science behind sports, these standards-supported lesson plans and student pages use the excitement of sports to motivate students in grades 4–8 to learn STEM concepts. Explore parabolic arcs and conservation of energy in the context of a basketball game; investigate how chemistry and engineering contribute technology that makes ice safer for hockey players; and learn why the quarterback's grip and spin on a "prolate spheroid" (a.k.a. football) are critical to the game. Each lesson provides opportunities for students to develop cross-content skills in the *Common Core,* such as by journaling (recording observations and data in a science notebook) and reading expository text and locating evidence within it to support a claim. These materials can be found at *www.chevronstemzone.com.*

Problem-Based Engineering Science Modules. E M In this Boeing Corporation and Teaching Channel initiative, Boeing engineers were matched to teachers in grades 4–8 to create problem-based engineering design science modules. Each two-week module presents an engineering design challenge, taking students through the engineering design process from first conception (identify a need) to final reveal (present results and redesign) and every step in between (brainstorm possible solutions, select the best solution, construct a prototype, and test). Access the modules—including teacher materials, student handouts, and classroom videos—at *http://bit.ly/2d5ToeW.*

***NOVA* Black Holes App.** M H Learn about black holes and outer space through this app created by the PBS science series *NOVA*. Targeted for students in grades 6–12 (and lifelong learners), and available for the iPad, the app explores the science behind black hole detection, gravitational waves, and more. In the game, players start with a star and play more than 50 levels to watch it become a black hole. Hurl your star across space time to hit your target. Navigate fields of cosmic objects and hazards—like neutron stars and quasars—in your quest to become more massive. Reach the end, and your star collapses…to become a black hole. Preview the app at *http://apple.co/2cKp5OC.*

KnowAtom.com. K12 At this website, K–12 teachers can access lesson plans, webinars, e-books, videos, interviews, and other resources that promote STEM as a way of thinking. The resources, all of which support the *NGSS,* can be searched by resource type and topic. For example, teachers can find a webinar on Mastering the *NGSS* in Your State as well as a video presenting *A Guided Tour of the* NGSS *Science Unit*. Teachers also may want to Talk to a KA Expert, an option allowing teachers to connect online with a STEM curriculum expert and create customized lessons that address *NGSS* and meet their classrooms' specific needs. Visit *http://bit.ly/2cKpPTY.*

Inside Biotech: A 360-Degree Tour. H What does a biotech company look like? You and your high school students can take this interactive, 360-degree tour of biotech company Amgen's manufacturing process. The tour highlights the stages of the manufacturing process, including Cell Culture, Recovery and Purification, and Formulation to Distribution. On each page within each stage, students will find a short summary of what happens at this stage and a brief video sharing more information on the topic. Clickable facts describe various parts of the photo. Spark students' interest in biotech by taking the tour at *http://bit.ly/2dBJ2sb.* ●

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

News Bits

- **The San Francisco 49ers' STEAM Education Program is offering free science, technology, engineering, art, and math (STEAM) content for K–8 teachers and students through the nonprofit education organization Khan Academy. E M**

The 49ers are the first professional sports organization to partner with Khan Academy. "Khan Academy will enable our program to go beyond the walls of Levi's Stadium and provide students who[m] we couldn't previously reach with unique, exciting content that combines STEAM with football," says Jesse Lovejoy, director of the STEAM Education Program and the 49ers Museum.

So far, more than 90,000 students have participated in the team's education program, which brings students into Levi's Stadium to teach them about STEAM and how it applies to professional football. Read more at *http://bit.ly/2dEspLg.*

- **Redshirting isn't just for athletes anymore: Now, it's for engineering students, too. HE**

Thanks to a $5 million National Science Foundation grant, "academic redshirt" programs at six universities are enrolling promising students from low-income households and giving them an extra year of math and science classes before they declare an engineering major—just as an athlete sits out his or her first year on the team to continue maturing as a player. The grant will fund 800 student scholarships and help expand existing programs at the University of Washington (UW), Washington State University, and the University of Colorado, Boulder, and launch new programs at Boise State University; the University of California, San Diego; and the University of Illinois, Urbana-Champaign.

Existing programs have helped retain students. At UW, for example, 80% of the 91 students enrolled in the program are on track to graduate, which is better than the national average of 50%, Eve Riskin, associate dean of diversity and access in UW's College of Engineering, told the *Seattle Times.* In addition, 67% of students in UW's program are the first in their families to attend college, 37% are female, and 45% are underrepresented minorities, she reports. Read more at *http://bit.ly/2dAXgph.*

- **Some science, technology, engineering, and math (STEM) faculty at major universities are creating their own systems to evaluate their teaching, says an Oregon State University (OSU) study. HE**

STEM faculty at large universities often do so because they lack access to data about their teaching beyond the standard end-of-semester student evaluations, which often "arrive too late, are too vague, and have too little student participation to be of much use," says Jana Bouwma-Gearhart, an OSU associate professor of science and mathematics education and the study's lead author. Some STEM professors use quantitative data about their students' performance and qualitative data from student feedback on mid-semester surveys they've designed or informal conversations they've had with students to better inform their teaching, the study found.

"Some faculty have really created these elaborate data and analysis systems, even though they are not yet required to," Bouwma-Gearhart notes. "They are using these systems to talk about their instruction and to help inform decisions about programs and curriculum." Because retention is an issue in STEM fields, using data to inform faculty teaching can be crucial, she contends. Learn more at *http://bit.ly/2be9owE.* ●

What's New

FROM U.S. GOVERNMENT SOURCES

National Park Service (NPS)

Whale Watching in the Classroom E M

Alaska's Glacier Bay is home to the endangered humpback whale. Each year, these whales make a 2,000-mile journey from their breeding grounds in Hawaii to the cold, nutrient-rich waters of the North Pacific. Teach students in grades 5–8 more about this endangered species through a live distance learning program led by a park ranger from Glacier Bay National Park. The program, available Monday through Friday in January and February, explores how humpback whales interact with their environment and what park researchers are doing to protect them.

To learn more and register, visit *http://bit.ly/2djQ0Pv.* Programs are available on a first-come, first-served basis, and videoconferencing capabilities (not Skype) are required.

Snow Desk E

In this program, park rangers from Wyoming's Grand Teton National Park broadcast live to your classroom from a desk made of snow, located at the base of the Teton Range. During this interactive "talk show," targeted for grades 1–5, students learn how wildlife adapts to weather and an extreme climate. Snow Desk is available January through March on selected days.

To learn more or register, visit *http://bit.ly/2dRytQM*. Programs are available on a first-come, first served basis, and Skype technology is required.

Ask a Ranger Q & A E M H

In this distance learning program from Wyoming's Grand Teton National Park, students in grades 4–12 research topics of choice, then participate in a live question-and-answer session with a park ranger. The ranger presents a general introduction to the park, then spends the rest of the time answering students' questions. Suggested research topics include biodiversity, geology, climate, wildlife biology, ecology, and botany.

To learn more and register, visit *http://bit.ly/2dzt8cA*. Programs are available on a first-come, first served basis, and Skype technology is required.

Encouraging Ocean Stewardship H

Connect live with park rangers from Alaska's Kenai Fjords National Park, and discuss the impacts and hazards of marine debris worldwide. In this distance learning program for grades 10–12, students participate in a facilitated dialogue to learn how to protect the oceans. The program features relevant photo and video content from the Kenai Fjords area.

Registration for the program—available on a first-come, first-served basis and requiring videoconferencing capabilities (not Skype)—begins on January 2, 2017, for broadcasts in February and March 2017. Consult *http://bit.ly/2dKsXMT.*

U.S. Fish and Wildlife Service (FWS)

Conservation Connect Video Series E M H

Conservation Connect—a web-based video series created in partnership by FWS and NSTA—helps students ages 10–15 connect to the outdoors and to conservation careers. New episodes are broadcast the third Wednesday of every month throughout the school year at 2 p.m. Eastern Time (ET). Each five- to seven-minute episode features an interview with a wildlife specialist and live footage of a species.

Highlighted species have included the American bald eagle, bat, bog turtle, Cheat Mountain salamander, condor, and monarch. To view the episodes and access accompanying classroom resources and lesson plans, visit *http://bit.ly/2dVReU0*.

U.S. Environmental Protection Agency (EPA)

Meet a Scientific Diver K12

EPA divers can visit K–12 classrooms to talk with students about ocean stewardship. Often these visits include pictures and video of aquatic creatures as well as images of polluted water sites that inform students how EPA uses scientific diving to help protect our underwater environment. Some divers also bring diving equipment for students to see and touch, helping students to better understand what is involved in undersea research, including the importance of math and science in scientific diving.

Interested in having a scientific diver visit your classroom? Contact the Unit Diving Officer at the nearest diving unit. To locate diving units and get more information, consult *http://bit.ly/2cLKrGp.*

U.S. Department of Agriculture (USDA)

School Garden Fact Sheet K12

Created as part of the USDA's Farm to School Program, a four-page fact sheet—*School Gardens: Using Gardens to Grow Healthy Habits in Cafeterias, Classrooms, and Communities*—provides information on successful gardening in K–12 settings. Topics addressed include using school garden produce in the cafeteria, maintaining food safety in the garden, staffing and funding school gardens, using the garden as a classroom, and maintaining the garden when school is not in session. The document contains links to articles with more information on each subtopic, along with tips and highlights from successful school garden programs around the country. Access it at *http://1.usa.gov/1WSslEa*.

National Aeronautics and Space Administration (NASA)

The Solar System and Beyond E M

Calling all space-heads! NASA has launched a new playlist of videos on

YouTube for Kids. Most appropriate for elementary and middle level students, the playlist features 33 intriguing, kid-friendly videos from NASA exploring topics such as our solar system's formation, the scale of the universe, space weather vocabulary, and conditions on Mars. View the full playlist at *http://bit.ly/2dki5GF.*

Museum in a Box: Aerodynamics K12

NASA's Museum in a Box program offers a collection of hands-on/minds-on lessons in aerodynamics for K–12 audiences in both schools and informal settings. Use the lessons to spice up your classroom and inspire future scientists, mathematicians, and engineers to consider careers in aerodynamics. The lessons address a range of topics, from Dressing for Altitude and the History of Flight to Parts of an Airplane, the Principles of Flight, and Structures and Materials. Still more lessons address topics in Propulsion, Future Flight, Careers in Aerospace, and Airspace. Access them at *http://go.nasa.gov/2dIcI5A.*

SciJinks and the *NGSS* M H

Having trouble shifting your instructional practices and building Earth science lessons for middle and high school students that support the *Next Generation Science Standards* (*NGSS*)? SciJinks is here to help! Educators can visit *http://go.nasa.gov/2dVKnGj* to access a tool to search for SciJinks content that matches the elements of the *NGSS:* disciplinary core ideas, science and engineering practices, and crosscutting concepts.

Visions of the Future Posters A

At NASA's Jet Propulsion Laboratory (JPL), scientists are working to advance the edge of possibility so that someday, with the help of new generations of innovators and explorers, humans might travel to destinations like Mars, Venus, and Jupiter or to other planetary objects (moons, stars) and realms. Originally conceived as a series of posters to explore exoplanets—planets that orbit other stars—the series grew to include destinations in our solar system that JPL is currently exploring. The posters are appropriate for space enthusiasts of all ages. Download them and read a background information sheet about their development at *http://go.nasa.gov/2dBNyDs.*

Library of Congress (LOC)

LOC Science Resources A

At *http://bit.ly/2dCzaPa,* science teachers can a find a list of useful science resources for elementary, middle, high school, and college levels. Highlights from the LOC's Science Reference Services include Everyday Mysteries sheets, which provide answers to kid-friendly questions such as these: Why do we yawn? How does sunscreen work? What causes the sound of thunder? In addition, the Science Reference Services offers Research Guides for many disciplines, including aeronautics, astronomy, biology, chemistry, environmental science, geography, and health and medicine.

Other popular resources identified in the list include The Teaching With LOC blog, which has numerous articles about using primary sources in science classrooms, and articles from the Newspaper and Periodicals Reading Room's Topics in Chronicling America page, which presents historical newspaper articles, many of which address science-related topics such as Darwin, Nicola Tesla, the invention of the telephone, Yosemite National Park, and Halley's Comet. In addition, the Library's Science, Technology and Business Division has brought many speakers to the LOC, including NASA scientists; many of these programs were webcast and are archived online. The webcasts have addressed topics as diverse as space weather and black holes to the surprising history of birdfeeding.

National Institutes of Health (NIH)

Disaster and Disaster Preparedness Resources K12

How does your school teach students about disasters and disaster preparedness? NIH's K–12 education team recently compiled a list of disaster-related resources for schools and classrooms. The resources are vetted for accuracy and include lesson plans, curriculum, games, and fact sheets. Students will learn about the science involved in natural disasters such as droughts, earthquakes, floods, hurricanes, tornadoes, and wildfires. Use the resources to teach planned curriculum or to help students learn what to do during a disaster or national emergency. See *http://k12.nlm.nih.gov* (click on Disasters).

Drug and Alcohol Facts H

January 23–29, 2017, is National Drug and Alcohol Facts Week (NDAFW). Sponsored by NIH's National Institute of Drug Abuse (NIDA), this annual, week-long observance brings together teens and scientific experts at events around the country for judgment-free conversation about substance use and the science of addiction. At the NDAFW website, teachers can find classroom activities to promote NDAFW as well as other materials that can be used year-round to help students understand the effects of drug and alcohol use on the body.

Teens or teachers interested in hosting an event at their school or other community venue can access online resources to help create the event, publicize it, find an expert, and obtain scientific information about drugs. Others may wish to participate in the Drugs and Alcohol Chat Day, taking place on January 26, 2017, from 8 a.m. to 6 p.m. ET. In this annual online chat, scientists answer high school students' questions about drugs and drug or alcohol abuse. For more information about this and other NDAFW events, visit *http://1.usa.gov/11oGjXQ.*

National Oceanic and Atmospheric Administration (NOAA)

Deepwater Animal ID Guide H

NOAA's Office of Ocean Exploration and Research has produced a collection of images photographed on-site, created from video frame grabs taken from Deep Discoverer (D2) remotely operated vehicle (ROV) video. Known as the Benthic Deepwater Animal Identification Guide, the resource serves as a taxonomic reference of deepwater animals encountered during D2 ROV dives around the Hawaiian Archipelago and Johnston Atoll during the Hohonu Moana expedition in 2015. The guide is organized according to major taxa, and identifications were made with assistance from taxonomic experts who specialize in deepwater animals.

Species identifications will be periodically updated as errors are detected and reported by taxonomists and other users, or when taxonomic revisions are made to the various groups included in the guide. Taxonomic revisions are particularly common for deepwater animals, which are poorly known. Share the guide with high school biology students to help them see how science research is dynamic and changeable. Access the guide at *http://bit.ly/2cMOqCS.*

U.S. Department of Education (ED)

Redesigned WWC Website A

Finding educational interventions that help students succeed just became easier with ED's redesigned What Works Clearinghouse (WWC) website. WWC reviews existing research on programs, products, practices, and policies in education to provide preK–college educators with the information they need to make evidence-based decisions. The website, which includes a science section, now has a Find What Works tool, which helps educators identify programs, products, practices, and policies with the strongest evidence of effectiveness.

Users can sort and filter their searches by gender, race and ethnicity, school setting, and grade level, and compare interventions to find the right fit for their students. Browse the site and watch an introductory video at *http://bit.ly/2dBUXlo.*●

In Your Pocket

Editor's Note

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

November 25–30

Space Foundation Teacher Liaisons A

The Space Foundation invites educators who teach about space to apply for this program. Teacher Liaisons receive training and cutting-edge resources to further integrate space in their classrooms and serve as links between the foundation and their respective schools and districts. Liaisons also work with other space organizations, such as NASA, and get complimentary registration for and special recognition during the foundation's annual Space Symposium. Once selected, Teacher Liaisons remain active in the program as long as they continue to meet its requirements.

Public, private, and homeschool teachers; school administrators; and informal educators in preK–20 settings are eligible. Apply by **November 25;** see *http://bit.ly/ V3cPbO.*

KEN HAMMOND, USDA NATURAL RESOURCES CONSERVATION SERVICE

SeaWorld Environmental Excellence Awards A

These awards recognize students, teachers, researchers, and other individuals working at the grassroots level to protect and preserve the environment. The organization funds work in four major areas: conservation education, species research, habitat protection, and animal rescue and rehabilitation.

Apply by **November 30.** For more information, consult the website *http://bit.ly/1FvfiQe.*

December 1–31

Wyland National Art Challenge K12

This competition asks students in grades K–4, 5–8, and 9–12 to submit classroom murals that celebrate conservation. The winning class in each category will receive $1,000 for art supplies. At least five students in each class must also submit a drawing or painting to the individual art contest. The winning student in each category wins a $50 gift certificate for art supplies, and one high school junior or senior will also get a $1,500 scholarship to attend an accredited four-year college or university. Students can also enter the photo contest for the chance to win a college scholarship or a new camera.

Submit both class and individual entries by **December 1;** see the website *http://bit.ly/1j9njF4.*

AAPT's Barbara Lotze Scholarships for Future Teachers H HE

The American Association of Physics Teachers (AAPT) provides grants of $2,000 and one-year AAPT student memberships for aspiring high school physics teachers. Undergraduate students enrolled in physics teacher preparation programs at accredited two- or four-year universities, or high school seniors admitted to such programs, are eligible. Applicants should show academic promise and be U.S. citizens. Apply online by **December 1** at *http://bit.ly/1N2jAq3.*

Fulbright Distinguished Awards in Teaching Program K12

This program provides opportunities for educators to study abroad at a university, observe classes, or complete a project pertaining to their field of inquiry for three to six months. Applicants propose an inquiry project of their own design that will enhance both their learning and their teaching back home. Participants must

- be U.S. citizens;
- be employed full-time at an accredited school in the United States or a U.S. territory;
- be in at least their fifth year of full-time teaching;
- spend at least 50% of their time teaching or working directly with students;
- demonstrate experience conducting professional development activities; and
- have received teaching awards or exemplary evaluations.

Opportunities for the 2017–2018 school year will take teachers to Finland, Botswana, Greece, India, Israel, Mexico, Morocco, the Netherlands, New Zealand, the Palestinian Territories, Singapore, Taiwan, the United Kingdom, and Vietnam. Apply by **December 1;** refer to the web page at *www.fulbrightteacherexchange.org.*

Pets in the Classroom Habitat Contest K12

Teachers with classroom pets can submit a picture of their habitat to win a $100 Amazon gift card. Two winners will be selected: one by vote and one at random. Include a caption for your habitat, and share it on your social media accounts using the hashtag #habitatcontest. Submit your entry by **December 10** at *http://bit.ly/2dqI41E.*

Walmart Foundation Grants K12 HE

The Walmart Foundation provides grants in four core areas: sustainability, career opportunity, hunger relief and healthy eating, and women's economic empowerment. The foundation also provides grants for K–12 public, private, and charter schools; community or junior colleges; and state and private universities through its Local Giving Program. Grants of between $250 and $2,500 are available, and should be used to benefit areas served by a Walmart, Sam's Club, or a company logistics facility. Apply online by **December 31** at *http://bit.ly/181X2Nu.*

January 15–Feb 23, 2017

AAPG Foundation's Teacher of the Year Award K12

The American Association of Petroleum Geologists (AAPG) presents this award to an outstanding K–12 geoscience teacher. One finalist will be selected from each of six regions: Pacific, Rocky Mountain, Mid-Continent, Southwest, Gulf Coast, and Eastern. Applicants must have three years of full-time teaching experience and be currently teaching at a K–12 school.

The winner will get $6,000: $3,000 for his or her school, which should be used at the teacher's direction, and $3,000 for his or her own personal use. In addition, the winner receives an all-expenses-paid trip for two to the AAPG Annual Convention and Exhibition in Houston, Texas, taking place in April 2017, to receive the award. The runners-up in each area will receive an honorable mention and a $500 cash award.

Teachers must apply directly through their local geological society by **January 15.** Learn more at *http://bit.ly/2diFUzA.*

World of 7 Billion Contest H

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

Free curriculum resources for teachers are available, and student winners will receive cash prizes of up to $1,000. Apply by **February 23.** See the website *http://bit.ly/1QL6u1M.* ●

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.

Miami University's Earth Expeditions A

This program pairs university courses with field experiences that allow teachers to engage in inquiry and action research projects at conservation hot spots worldwide. Educators build relationships with scientists, naturalists, and conservationists in Africa, Asia, Australia, and the Americas. Afterward, they continue work on these projects in their schools and communities.

Earth Expeditions are open to preK–12 teachers, administrators, and university faculty, as well as educators, naturalists, and other professionals from non-school settings. Courses are for stand-alone graduate credit or can be applied toward a master's degree. Apply by **January 28, 2017;** see *www.EarthExpeditions.org.*

National Park Service Teacher-Ranger-Teacher Program K12

As Teacher-Ranger-Teachers (TRTs), teachers spend the summer learning, and often living, in a U.S. National Park. TRTs participate in park education projects, learn about park resources, and develop classroom lesson plans; tasks assigned will depend on the teacher's interests and the park's needs.

Program dates vary by park, but typically last four to eight weeks. Housing is available in some locations; TRTs receive a stipend to help cover travel or living expenses incurred during the program once they've completed it. Professional development and graduate credits from the University of Colorado, Denver, are also available.

TRT is open to K–12 teachers; those who work with underserved students in urban and rural school districts are especially encouraged to apply. Visit *www.teacherrangerteacher.org* for a list of program contacts by region. Application dates vary by park, though many are due by **January 31.**

Maury Project Workshop for Oceanography Educators K12

This free American Meteorological Society (AMS) workshop is for precollege teachers and science 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 taught, and prepare workshops to disseminate these ideas to teachers in their home states afterward.

Educators attend a training workshop at the U.S. Naval Academy (USNA) in Annapolis, Maryland, July 9–21, and receive instruction from USNA faculty members, National Oceanic and Atmospheric Administration (NOAA) scientists, and other science educators. Participants receive graduate credit, a $600 stipend, lodging, meals, travel funds, tuition, and instructional materials.

Teachers interested in promoting minority participation in science are particularly encouraged to attend. Apply by **March 20;** consult *http://bit.ly/2cQO2Gz.* ●

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

Improving Wikipedia, a Class at a Time

College instructors looking for an alternative to the typical research paper have found one option in Wikipedia. With support from the Wiki Education Foundation, hundreds of educators have assigned students to either create or revise entries in the online encyclopedia, according to LiAnna Davis, director of programs and deputy director at Wiki Education Foundation (*www.wikiedu.org*).

Wikipedia's "openly editable" content, most contributed by anonymous volunteers, is often viewed as a less-than-reliable resource. But with millions of articles, it has a pervasive online presence. The nonprofit foundation was launched to "support university faculty who assign students" to create content for Wikipedia, explains Davis. "We've been working on this program since 2010…Along the way, we've found students get much more out of writing for Wikipedia compared to writing a traditional research paper…Wikipedia gives them an opportunity to write for a broad audience."

Wikipedia is promoting its "Year of Science" now, with the goal to expand the variety of science information available, "especially in STEM [science, technology, engineering, and mathematics] and the social sciences," Davis continues. Writing for Wikipedia simulates a work experience, as students often work in groups and receive in-class peer review before an entry is submitted to the site. "We've supported several hundred classes in the last six years," she explains. "Many instructors return to use Wikipedia every term...Students have deeper understanding as they develop the ability to distill research down to its essence and communicate it to the public."

At Louisiana State University, Cameron Thrash, an assistant professor in the department of biological sciences, was inspired by another faculty member's use of Wikipedia assignments to incorporate them into his upper-division microbiology course. "I recognized the advantages [over] a typical term paper. The fact that it was public made [their research] more useful…[It] creates external peer pressure...The possibility it could be deleted encourages students to work [harder]," he says.

Writing for Wikipedia encourages his students to develop critical-thinking skills as they evaluate the quality and reliability of their sources and consider those aspects in sources used in other Wikipedia articles. The Wikipedia assignments are often his students' first experience working with primary literature and objective writing. "Their opinions are not involved…it's a struggle for them to write objectively in a journalistic way," he says. "Since students aren't experts, it's about how students absorb information from experts…I think they get a lot out of interpreting [primary literature]. [The Wikipedia assignment is] about getting them evaluating information; [they have to] seek it out on the internet, [recognize] the hallmarks of good information."

Thrash assigns his students to research a microorganism, write an entry about it for Wikipedia, and present their findings to the class. Students, usually working in pairs, have to develop proposals detailing the microorganism they want to research and how they're going to conduct that research. Both proposals and Wikipedia articles are peer-reviewed by four different students. Once students have completed their research articles, Thrash does a "final run" to make sure they haven't plagiarized any of the content and have complied with Wikipedia's publishing rules. After the article is posted, his students must complete a final step.

"They have to Google their organism...It drives the point home that if someone searches for their organism, their wiki page is going to be [among] the top hits," he proclaims.

The assignment has proven to be very motivational. "When I ask them about what they're most excited about, almost all say the Wikipedia assignment," Thrash says. His end-of-class assessments validate the Wikipedia research assignments, and his students have told him they value contributing to the body of knowledge, and many share their Wikipedia entries with family and friends. Thrash admits that the "quality is variable," but his students' articles generally earn a "B+ or better."

Sarah Wyatt, a professor of plant biology at Ohio University, first used Wikipedia assignments in her 2015 scientific writing class for graduate and upper-level undergraduate students before incorporating it "unofficially" in her introductory-level course on plant molecular biology this year.

"In my writing class, the goal is to teach students to write professionally," including manuscripts, posters, and scientific literature, Wyatt explains. "From the very beginning, I wanted to have [a focus on] how to bring science to the general public." She had an "amorphous" assignment that would typically result in papers discussing outreach. After learning about the Wiki Education Foundation, she says she "decided to try it, but I wasn't convinced…I'm amazed at how well it works."

Students in the writing course pick a Wikipedia article in their topic area and do an official evaluation, working with Wikipedia editors. At a minimum, students must add two references to their selected article, but Wyatt says, "Some get quite excited and do a lot more...I try to give them the idea that 'You are an authority on a subject and can add to Wikipedia,'" Wyatt notes.

She did have some early trouble grading assignments. "My student may not be the only person editing [a particular article]. It hadn't occurred to me," she acknowledges. "But it's a fairly minor thing."

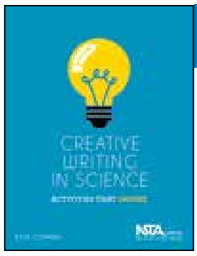
In the introductory course, Wyatt has started using Wikipedia to foster critical-thinking skills. She selects four Wikipedia articles of varying quality related to the lecture, which her students then critique. "The purpose is twofold: One, they get more interaction with the material, and two, they [learn] how to use Wikipedia. They have a better shot at evaluating whether material is good or not…We talk about what makes a good article," she relates. "Because it's an introductory class, evaluating scientific articles is above their level, but [this assignment introduces] them to critical reading as they evaluate sources."

Wyatt says the Wikipedia assignments would not be possible without Wikipedia Education resources, including booklets on how to evaluate and edit articles, as well as the feedback her students have received from Wikipedia editors.

Although Wiki Education works exclusively with college instructors, Davis says high school teachers "aren't banned" from creating Wikipedia assignments, but she doesn't know of any specific support for that group. High school teachers can use the foundation's online brochures, but those who aren't experienced Wikipedia editors could "run afoul of the myriad Wikipedia guidelines," she cautions. "We definitely encourage anyone who isn't supported by an organization like ours who wants to teach with Wikipedia to spend a month or two getting their feet wet, writing articles…so they can understand more firsthand how Wikipedia works."

Since Wikipedia's targeted reading level is high school, Thrash speculates that the Wikipedia assignment could be adapted to that level. "I could imagine a scenario [in which] a group of students could take [subsections of a page]. I would have loved to have done that when I was in high school!" he says. ●

NSTA PRESS: *Creative Writing in Science*



Creative Writing in Science

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 Creative Writing in Science, *by Katie Coppens, edited for publication here. To download the full text of this chapter, go to* http://bit.ly/2dFtizg. *NSTA Press publications are available online through the NSTA Science Store at* www.nsta.org/store.

Chapter 1—Why Write Creatively in Science?

Creative writing allows students to apply their knowledge in an imaginative way. To engage students and meet a range of learning styles, this book demonstrates a variety of writing forms—from fictional narrative essays to poetry to comics.

By assessing students through creative writing, you will see new strengths in your students and have a better understanding of their writing skills and science knowledge. Each student's approach to an assignment may be different, which allows students to take pride in the individuality of their final product. Before integrating writing into the content area, you must ensure that students have a solid foundation of the knowledge and vocabulary of a given unit. Assignments throughout the book could serve as formative assignments if you implement them while teaching your unit. The assignments could also be summative assignments if you use them after a concept has been taught or at the end of your unit.

The activities and rubrics were written to meet a range of grade-level and teacher needs. Depending on your class or grade level, the same assignment may be used by one teacher as a class activity, by another teacher as homework, and by a third teacher as his or her final assignment for a unit.

To help meet the needs of teachers and students, each assignment supports the *Common Core State Standards* and the *Next Generation Science Standards* (*NGSS*). At least one model of writing is also included for each activity to help students understand expectations and to inspire their own creativity.

Chapter 5—Postcard From a Biome

Writing Styles

Narrative, descriptive

Purpose

Students will work individually to apply knowledge and vocabulary of a biome to a piece of fictional writing.

Overview

For this activity, students write a postcard to show their knowledge of the organisms and landscape within a biome. On the blank side of an index card, students draw a picture to show visually what the biome looks like. On the other side, students write a message that contains information about the biome.

Language Arts Connections
Discuss the proper letter-writing format. Remind students to begin with "Dear_______," and to sign the postcard "Sincerely, ___________," or another salutation and closing.

After brainstorming on the organizer, have students circle the five most important concepts and vocabulary words that will show their knowledge of the biome. Because writing space is limited, the assignment makes them choose the most important information to put on their postcards.

Differentiation Strategies
You can help students who struggle to start their writing by giving them an opening sentence, such as the one in the model: "I have been in the _______ for six days, and I can't believe all that I have seen." If drawing is not a strength of students, they could always make a collage on the cover of their postcard. Emphasize capturing the colors of the biome and including at least one organism.

Some students may feel that their writing style is limited on a postcard. They could be given the option to write a letter instead. Rather than including a picture, they can use their words to fully describe what the landscape looks like.

Connections to the Next Generation Science Standards
- 3-LS4-3: Construct an argument with evidence that in a particular habitat, some organisms can survive well, some survive less well, and some cannot survive at all.
- MS-LS2-2: Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.
- MS-LS2-4: Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

Applications to Other Science Areas
You could have students write a postcard from a planet. They could explain how long the journey was to the planet and what the environment is like there. Or students could write a postcard from Europe and describe how the metric system is used. ●

MS. MENTOR, **Advice Column**

Strategies to Make the Most of Class Time, for Teachers and Students

I'm frustrated by my sixth graders. When they're supposed to be working cooperatively, they are unfocused: It seems more like a social event. By middle school, shouldn't students know how to work cooperatively? Or are they too immature?

– G., Virginia

Immaturity is not an excuse. I've seen wonderful cooperative learning taking place in kindergarten classes, with teacher guidance, modeling, and monitoring. One might assume students have specific skill sets and experiences, but I've learned never to take anything for granted. If the students attended different elementary schools, their science backgrounds and the emphasis their schools placed on science investigations will vary. You will have to teach (or remind) students what cooperative learning in science looks like.

Defining roles is a key component. Common roles in middle level science labs include group leader, presenter, data recorder, measurer, equipment manager, liaison/questioner, artist/illustrator, online researcher, timekeeper, and notetaker. Some roles can be combined.

It may help to have students define the roles. Ask, "What would a data recorder do?" (Students must answer without using the words *data* or *recorder*.) You can add suggestions, especially regarding safety. Job descriptions could be shared as posters or student-created videos, or put into students' notebooks. Rotate roles periodically so all students have a chance to experience each one.

If some students lack polished interpersonal skills, start with brief, structured activities. Model cooperative behaviors and share appropriate language.

If students understand the purpose and learning goals for the project or investigation, they're more likely to stay focused and on-task.

My principal asked me to mentor a new science teacher. I received a checklist of high school policies to review, but how can I help him in other ways?

– T., New Jersey

In my experience, a good mentor can be a role model, a good listener, a source of suggestions and resources, a critical friend, and a shoulder to cry on. New teachers are often overwhelmed, so it's important to initially focus on a few essentials. Let him know that it's okay to learn from mistakes (and we all make them).

You'll want to be helpful, but not overbearing. For example, as a beginning teacher, I struggled with classroom management and ways to deal with difficult students. (I came to realize that the two were connected: Establishing expectations and routines provided a structure that many students needed.) We did not have a formal mentoring program, but another teacher took me under her wing. One day, she mentioned she was having problems with students X and Y. I also had these students, and she asked if I had any suggestions. I was astounded! She (a legend in the community) was asking me for advice! Whether she really needed my advice or not, her approach made me feel like a colleague—not just a rookie. I realized that veteran teachers also have challenges, and student misbehavior was not necessarily a personal attack.

In addition to your checklist, discuss effective safety practices in science; you can find many resources on the NSTA safety portal (*www.nsta.org/safety*). New teachers should understand that if an activity or demonstration cannot be done safely, it should not be done at all, no matter how interesting or engaging or how mature students may seem.

NSTA's position statement, Induction Programs for the Support and Development of Beginning Teachers of Science (*http://bit.ly/2dkgYFG*) has a good description of the roles and responsibilities of mentors and mentees.

At the beginning of class, it takes my students a long time to settle down. We are wasting time as I try to get their attention. Any suggestions?

–T., Maryland

It helps to have an established routine so students know what to do when they enter the classroom.

One method I found effective was posting an agenda. When students entered the lab, they saw what the learning goals were, what activities they were going to do in class, what needed to be turned in, and what materials they needed (pencil, science notebook, paper, and so on). As they assembled these materials, they still had a little time to socialize, which is important to middle schoolers. When we started the lesson or lab investigation, they had their materials in order.

Another suggestion is to have a warm-up or bellringer activity. Students should get started immediately, even before the bell actually rings. The students are focused while you take attendance, distribute materials, or return assignments. Some examples include

- Answer a question about yesterday's work or another related topic;
- Respond to a statement or visual to uncover misconceptions or activate prior knowledge;
- Do a "quick write" with several sentences on a theme or topic; and
- Do a "quick draw" on a theme or topic.

You can ask the students repeatedly to quiet down—or you can help students take responsibility for using time purposefully through guidance and modeling (and persistence).

I get frustrated when I give directions for an activity and students immediately have questions about what to do. How can I help them become more confident and self-sufficient?

—C., Michigan

Students have us trained! We offer directions or suggestions, and students know we'll go over them again (and again). Some students panic immediately if they are confused about something. Others are perfectionists, are afraid to make a mistake, and want constant reinforcement.

My students did a lot of projects, and I would work with students individually. When other hands went up, I would acknowledge the questioner with a "wait-a-minute" gesture, indicating that I would be with him or her shortly. Once I reached the student, I often heard, "Never mind; I figured it out."

I was intrigued. *Wait time* (*http://bit.ly/2cUSFwC*) was a staple in my classroom discussions, and I wondered if students benefitted from comparable "figure-it-out" time during investigations or activities.

In my action research, I asked the students about their original problem and how they solved it: They responded, *I asked a friend, I re-read the directions, I thought about it, I tried something to see how it worked, I looked at the rubric*. A high-five or thumbs-up from me reinforced these strategies, and we modeled them in class.

We rush to help students in our desire for them to be successful (and obviously we must respond immediately if a student is engaging in unsafe or disruptive behaviors). But sometimes students just need time to figure out a solution.●

Check out more of Ms. Mentor's advice on diverse topics or ask a question at www.nsta.org/msmentor.

BLICK ON FLICKS

Blending Art, Science, and Fantasy in *Star Wars*

By Jacob Clark Blickenstaff, PhD

The *Star Wars* franchise began nearly 40 years ago with *Episode IV: A New Hope* (1977). I was not old enough to see a *Star Wars* movie in the theater by myself until *Episode VI: Return of the Jedi* (1983), and I remember that event very clearly. Characters from the first three films are so well known that it is hard to imagine a world without Luke, Leia, Han Solo, R2D2, Yoda, or Darth Vader. The language of the films even entered the political sphere when the missile defense program proposed by Ronald Reagan was dubbed the "Star Wars" defense system.

Most adults and children are familiar with the basic plot outline, and with new films in the franchise coming out, we will have many opportunities to re-connect with the *Star Wars* universe. I will not address the plots or characters that appear only in the novels, comic books, or video games that exist in parallel with the main movie series.

Sound and Lasers in Space

Nearly all science fiction filmmakers choose to ignore the fact that sound requires a medium to travel from the source to our ears. On Earth, that medium is usually air, though liquids (like water) and solids also carry sound waves. Liquids and solids are actually better at transmitting sound, which is how whales can hear one another from thousands of miles away and why you feel your neighbor's loud music if you're sitting on the floor. The vacuum of space cannot carry sound from one ship to another, so all those explosions and laser bursts should be silent.

Speaking of lasers, if you've ever played with a laser pointer, you have probably noticed that the beam doesn't show up in clear air: You just see a dot on the wall where the beam hits it. If you want to show students the laser beam on the way to the wall, you'll have to introduce some kind of particles for the light to hit. In the bad-old days, physics professors blew cigarette smoke into the beam, but in the 21st century, most employ a fine mist of water. So when Han and Luke are shooting lasers at enemy TIE (twin ion engine) fighters, we shouldn't see anything at all if they miss. If they hit, we should see a bright dot on the enemy, then not hear a thing as the fighter falls apart. Not a very exciting space battle, I guess.

Biodiversity

From the Tatooine cantina scene in *Episode IV* to Maz's cantina in *The Force Awakens*, we have seen a pretty wide range of alien life forms represented. In some other sci-fi universes, the aliens all look basically human with one or two features slightly altered (Vulcans, for example). In the *Star Wars* films, we see creatures with many more eyes than we have, very different mouth parts, and head shapes that we don't see on Earth. Admiral Akbar (of the famous "It's a trap" line from *Return of the Jedi*) looks a bit like a sunburned catfish, but not at all human.

If life has evolved on other planets, we have no reason to believe that it would look even remotely human, so the variations in *Star Wars* provide an opportunity for teachers to consider what kind of world would produce the aliens we see in the movies. It does seem that the underlying chemistry (using oxygen from the air to "burn" food to produce energy) is basically the same for all the life in the movies, since rebels from different planets are all able to work together in the same spaceships.

In contrast to the range of aliens we see working together, it seems that most planets in the *Star Wars* galaxy have only one inhabited biome: Tatooine is a desert, Hoth is frozen, Dagobah is a swamp, and so forth. Weather and climate on Earth are very complex systems, but it is difficult to imagine a situation in which a planet otherwise so similar to ours could have a uniform temperature over its entire surface. Different parts of the Earth get different amounts of sunlight, elevation dramatically affects temperature, and bodies of water moderate temperature changes compared to large land mass. The more direct rays near the equator make the "middle" of the planet much warmer than at the poles, and the amount of precipitation varies widely on the eastern and western sides of the Cascades in Washington, just 50 miles apart.

Space Fighters ≠Airplanes

When you watch the dogfights between X-Wings and TIE Fighters, you might notice how much they resemble airplane dogfights on Earth depicted in films. That certainly looks cool and familiar: Pilots bank their craft into turns; they swoop and dive as though they have to always move forward to keep flying. This is true for airplanes: They rely on lift generated by their wings to stay aloft, and that lift is mostly generated by air moving over and under the wings.

An X-Wing fighter in space will keep moving in a straight line until an outside force acts on it. It could turn in any direction while moving in any direction, which is a great tactical advantage, but would look weird to us. The folks who made *Battlestar Galactica* from 2004 to 2009 allowed for this kind of flexibility in the dogfights between Vipers flown by humans and their Cylon enemies.

I look forward to seeing where the *Star Wars* saga goes in the remaining "main sequence" films, as well as learning a bit more backstory in upcoming stand-alone releases like *Rogue One: A Star Wars Story.* Teachers will certainly be able to use all the films to generate conversations about how life adapts to different biomes, look for errors in how physics is represented, and discuss the properties of lasers.

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

Quotable

You don't want to cover a subject; you want to uncover it.

—Eleanor Duckworth, Canadian cognitive psychologist and constructivist educator

Mark Your Calendar

NSTA Dates to Remember

(All dates are deadlines unless otherwise specified.)

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

December 1—Don't miss the first day of the **NSTA Columbus Area Conference on Science Education**, **Champions of Science: A Game Plan for the Future!** The general session features "science evangelist" Ainissa Ramirez. The conference offers three strands (Training Camp: Strengthening Fundamentals in Elementary Education; Game Time: Tackling Scientific Problems and Pitching Engineering Solutions; and Science Boosters: Taking It to the Next Level). On-site NSTA member registration costs $225. For more information or to register, visit *www.nsta.org/columbus.*

December 1—***Science and Children*** (*S&C*), NSTA's peer-reviewed journal for elementary science education, wants your **manuscripts on "Preservice and Inservice Experiences: Enhancing Science Teachers' Repertoires"** for the September 2017 issue. General-interest manuscripts may be submitted anytime. Read the call for papers at *http://bit.ly/1XjHRvr.*

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 *The Science Teacher* (*TST*), themed **"Science and Engineering."** NSTA's peer-reviewed high school–level journal 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.*

December 1—Submit your manuscript on **"Innovative Teaching"** for consideration for the Summer 2017 issue of ***Science Scope,*** NSTA's peer-reviewed journal for middle level science teachers. General-interest manuscripts, commentaries, and column submissions may be submitted anytime. Read the call for papers and access submission guidelines at *http://bit.ly/1OfgnF0.*

December 6—Have a great way to teach science, technology, engineering, and mathematics (STEM) that you want to share with your fellow educators? Submit your **session proposal now for the Sixth Annual STEM Forum & Expo**, hosted by NSTA! The STEM Forum will be held at the Gaylord Palms Resort/Kissimmee in Orlando, Florida, July 12–14, 2017. For more information on submitting a session proposal, visit *http://bit.ly/1cFqzAG.*

December 7—The Shell Science Teaching Award recognizes innovative science teachers with a $10,000 award, but you can't win if you don't submit a strong application. Learn how to do so from Peggy Carlisle, chair of the Shell Science Teaching Award Judging Panel, during **Developing a Competitive Application for the Shell Science Teaching Award, a free NSTA Web Seminar**. The session will run from 6:30 to 8 p.m. ET. For more information on NSTA Web Seminars or to register, visit *http://bit.ly/1Iwpg4w.*

December 15—Are you a middle or high school science teacher dreaming of a lab makeover for your school? Don't miss **Developing a Competitive Application for the Shell Science Lab Challenge, a free NSTA Web Seminar**. Learn about the application process and tips for creating a strong application from Ruth Ruud, judging chair for the Shell Science Lab Challenge. The session will run from 6:30 to 8 p.m. ET. For more information on NSTA Web Seminars or to register, visit *http://bit.ly/1Iwpg4w.*

January 1, 2017—***Science Scope*** wants to share how you "**Integrate STEM"** in the September 2017 issue. Submit manuscripts on this theme by today. General-interest manuscripts, commentaries, and column submissions are welcome anytime. Read the call for papers and access submission guidelines at *http://bit.ly/1OfgnF0.*

January 17—Sharing what you've learned is an essential part of professional development. Submit your **proposal for the 2017 NSTA Area Conferences** in Baltimore (October 5–7), Milwaukee (November 9–11), and New Orleans (November 30–December 2). For more information on submitting a session proposal, visit *http://bit.ly/1cFqzAG.*

February 1—***S&C*** **is accepting manuscripts** on the theme **"Early Childhood: Life Science"** for the October issue. Share how you use local resources, provide problem-solving opportunities, and more with your fellow early childhood educators. General-interest manuscripts may be submitted at any time. Read the call for papers at *http://bit.ly/1XjHRvr.*

February 1—**Submit your manuscript on teaching about "Climate Change"** now for the October issue of *Science Scope!* 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.*

April 17—Proposals for **sessions at the 2018 NSTA Atlanta National Conference on Science Education** are due now. The national conference will be held March 15–18, 2018. For more information on submitting a session proposal, visit *http://bit.ly/1cFqzAG.* ●

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Nominate Outstanding Educators for NSTA Awards

Across the country, teachers are inspiring their students and developing innovative teaching strategies. The NSTA Awards and Recognition Program honors these top teachers at every career stage and grade level, in both formal and informal education. While prizes vary by award, winners all receive recognition of their efforts to improve science education.

The program features 19 educator awards—including the Robert H. Carleton Award for National Leadership in the Field of Science Education (NSTA's highest honor), NSTA Fellow Award, Faraday Science Communicator Award, Sylvia Shugrue Award for Elementary School Teachers, Robert E. Yager Excellence in Teaching Award—and the Angela Award, honoring one female student in grades 5–8.

NSTA updated the online application process to include an option to nominate educators for all awards. When a teacher is nominated by someone else, NSTA notifies him or her by e-mail and encourages the teacher to complete the application.

The NSTA Awards and Recognition Program is sponsored in part by Bio-Rad, DuPont/Pioneer, Northrop Grumman Foundation, PASCO, Sea World Parks and Entertainment, Shell, and Vernier Software & Technology. All entries must be received by **11:59 p.m. Eastern Time on December 15,** except entries for the Shell Science Teaching Award, which are due by **January 6, 2017.** No fee is required to enter. For more information on the NSTA Awards and Recognition Program, to submit an application, or to nominate an educator, go to *www.nsta.org/awards*. ●