STEM MAGAZINE

"Smart" Composite Materials
Oak Ridge National Laboratory

Multi-Tasking is a Myth
Know your boundaries

Cognitive Priming
Engage their minds

A Favorite STEM Career
- it has legs...

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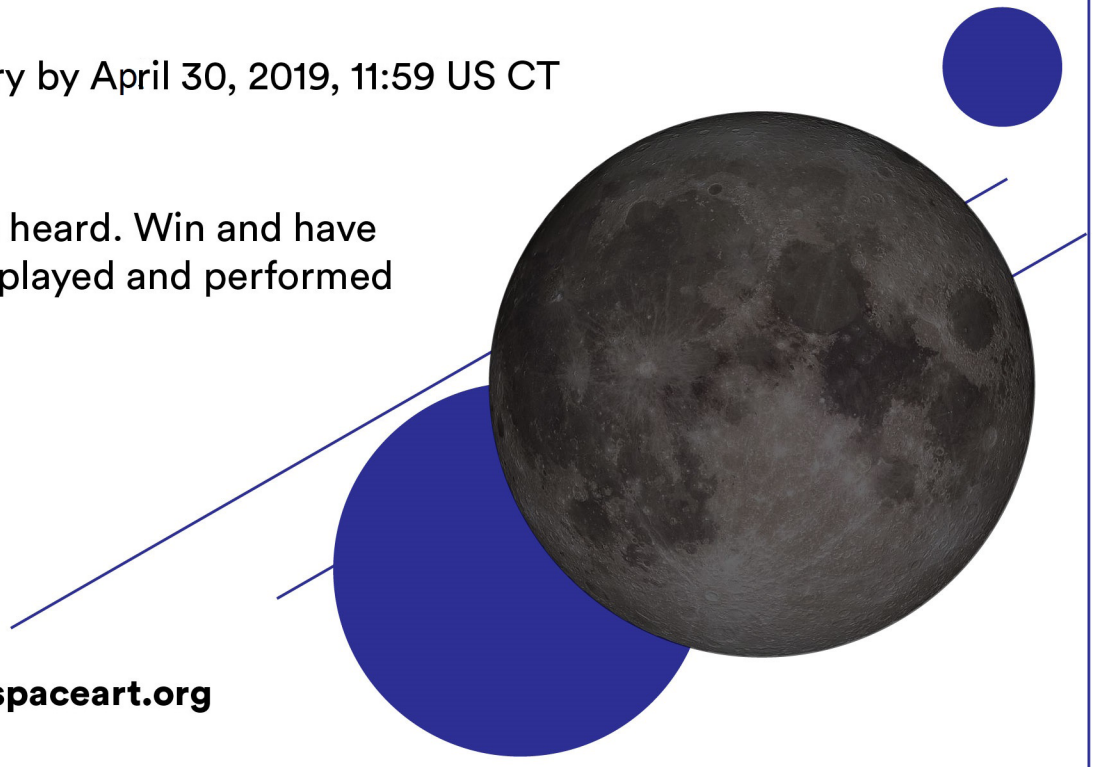

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STEM Magazine is a monthly subscription non-profit education publication for educators, students, their parents and industry professionals.

Read monthly in 67 countries, STEM Magazines strive to encourage the educator to better understand the importance of STEM skills, their use in every school subject, the need and ease of integration into curriculum and the urgency for students to embrace STEM.

To understand STEM...

...you must DEFINE STEM, but you cannot define an acronym using the words it stands for; you must define the words the acronym stands for.

Universities and organizations around the world continue to debate what a STEM career is. There is no doubt that "every career" uses STEM skills and this observation remains the focus of STEM Magazine.

Science: "The systematic accumulation of knowledge" (all subjects and careers fields)

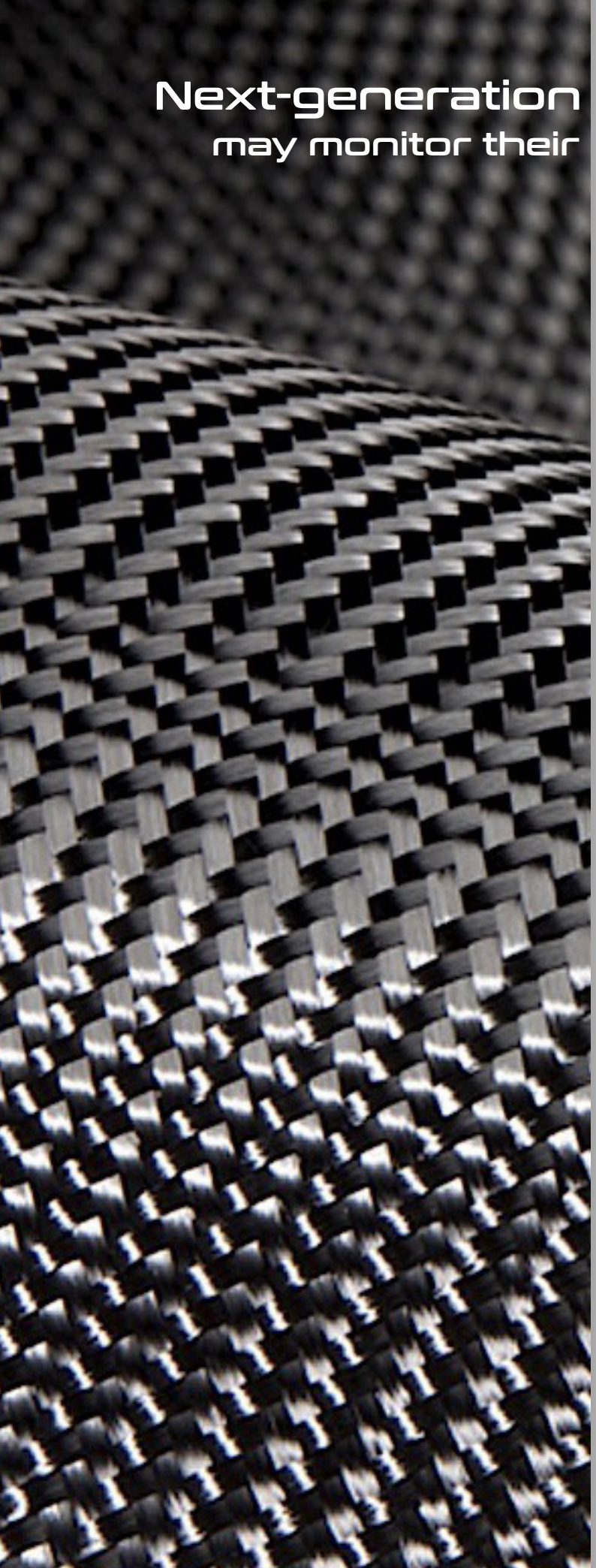
Technology: "The practical application of science" (all subjects and careers)

Engineering: "The engineering method: a step by step process of solving problems and making decisions" (every subject and career)

Math: "The science of numbers and their operations, interrelations, combinations, generalizations, and abstractions" (every career will use some form[s])

For a moment, set aside any preconceived notions of what you think a STEM career is and use the above dictionary definitions to determine the skills used in any career field you choose.

These definitions are the "real" meaning of STEM and STEM careers.

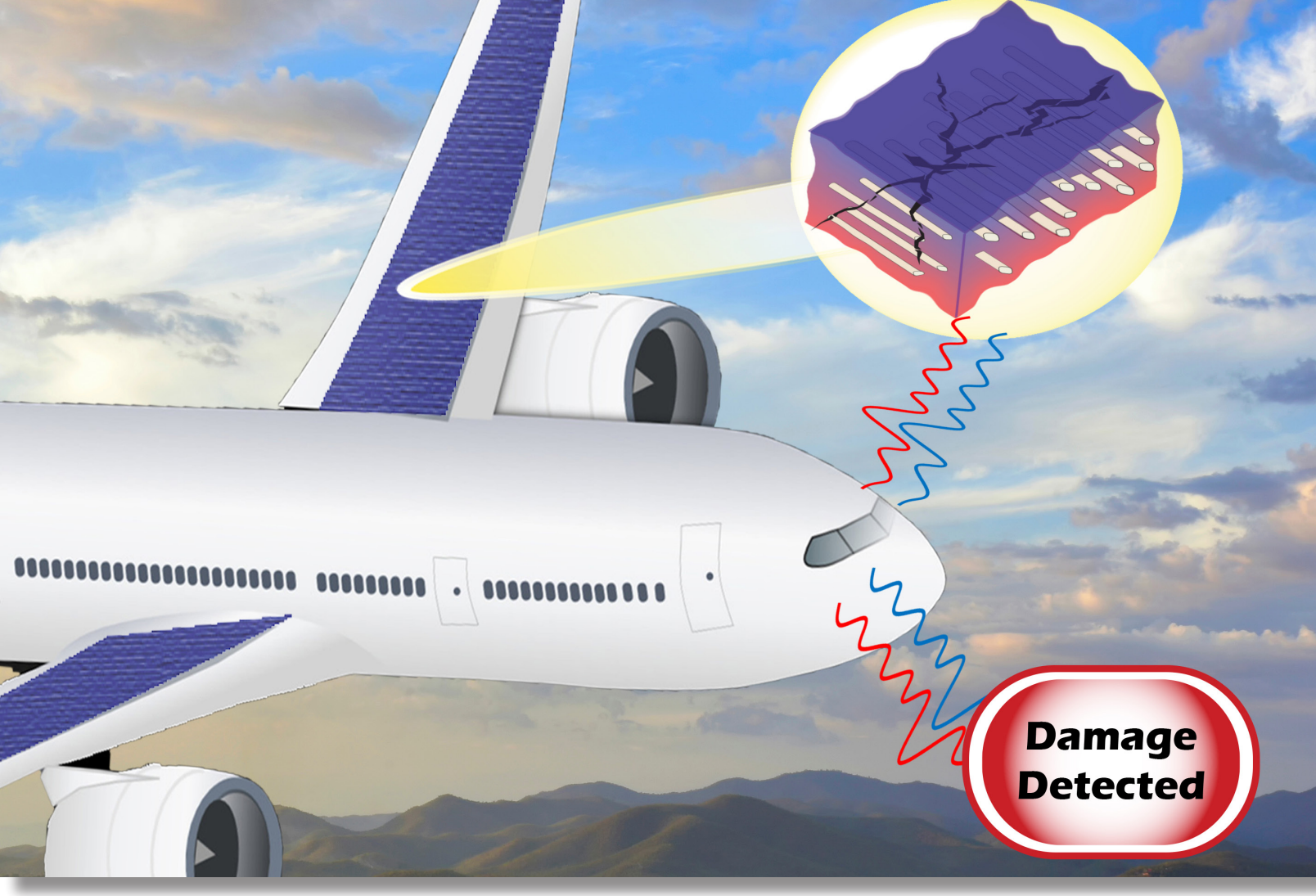


Next-generation COMPOSITES may monitor their own structural health

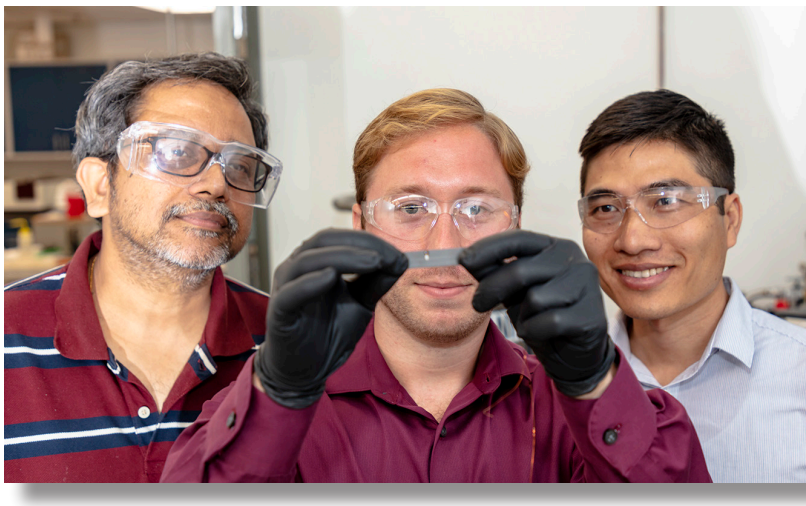
by Dawn Levy

Carbon fiber composites—lightweight and strong—are great structural materials for automobiles, aircraft and other transportation vehicles. They consist of a polymer matrix, such as epoxy, into which reinforcing carbon fibers have been embedded. Because of differences in the mechanical properties of these two materials, the fibers can detach from the matrix under excessive stresses or fatigue. That means damage in carbon fiber composite structures can remain hidden below the surface, undetectable by visual inspection, potentially leading to catastrophic failure.

"Carbon fiber composites fail catastrophically, so you won't see damage until the entire structure has failed," said Chris Bowland, a Wigner Fellow at the Department of Energy's Oak Ridge National Laboratory. "By knowing what's going on within the composite, you can better judge its health and know if there is damage that needs to be repaired."



Recently, Bowland and Amit Naskar, leader of ORNL's Carbon and Composites Group, invented a roll-to-roll process to coat electrically conductive carbon fibers with semiconducting silicon carbide nanoparticles. This nanomaterial-embedded composite is stronger than other fiber-reinforced composites and imbued with a new capability—the ability to monitor its own structural health.



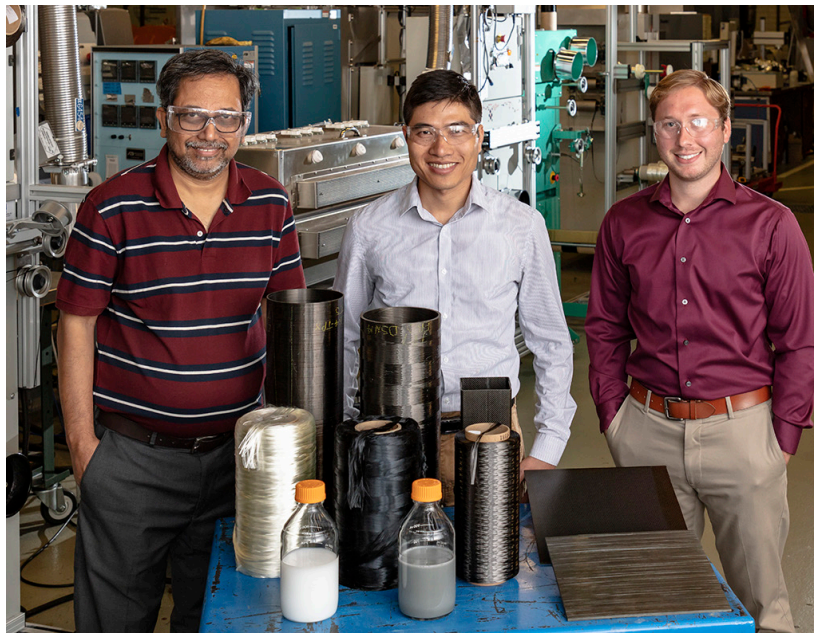
Amit K Naskar Christopher C Bowland Ngoc A Nguyen

When enough coated fiber is embedded in a polymer, the fibers create an electrical network and the bulk composite becomes electrically conductive.

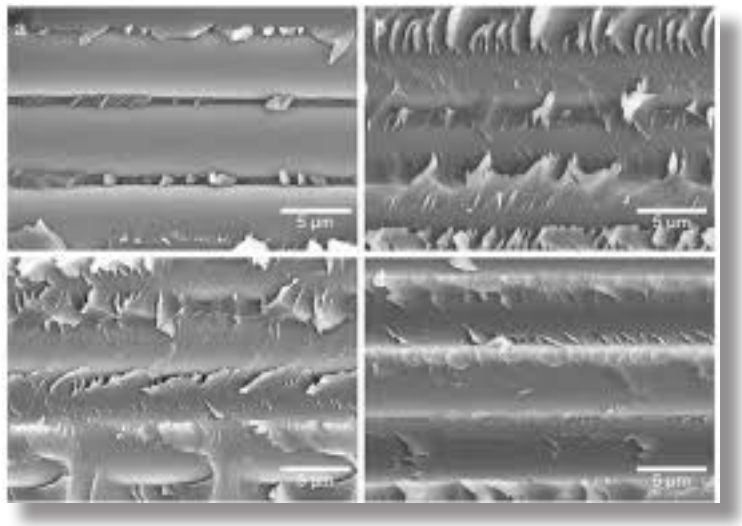
The semiconducting nanoparticles can disrupt this electrical conductivity in response to applied forces, adding an electromechanical functionality to the composite.

If the composite is strained, the connectivity of the coated fibers is disrupted and the electrical resistance in the material changes. Should storm turbulence cause a composite airplane wing to flex, an electrical signal may warn the plane's computer that the wing has endured excessive stress and prompt a recommendation for an inspection. ORNL's roll-to-roll demonstration proved in principle that the method could be scaled up for high-volume production of coated fibers for next-generation composites. Self-sensing composites, perhaps made with a renewable polymer matrix and low-cost carbon fibers, could find themselves in ubiquitous products, even including 3D-printed vehicles and buildings.

To fabricate nanoparticle-embedded fibers, the researchers loaded spools of high-performance carbon fiber onto rollers that dipped the fiber in epoxy loaded with commercially available nanoparticles about the width of a virus (45–65 nanometers). The fiber was then dried in an oven to set its coating.



To test the strength with which nanoparticle-embedded fibers adhered to the polymer matrix, the researchers made fiber-reinforced composite beams with the fibers aligned in one direction. Bowland conducted stress tests in which both ends of this cantilever were fixed while a machine assessing mechanical performance pushed on the beam's middle until it failed. To investigate the sensing capabilities of the composite, he affixed electrodes on both sides of the cantilever.

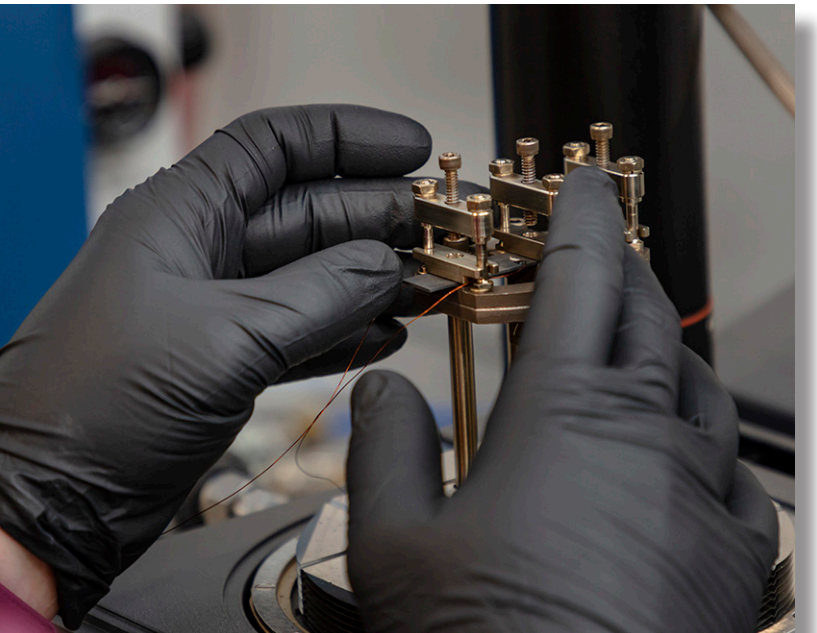


SEM images of the fracture surfaces of two different composites after short beam shear testing

In a machine called a "dynamic mechanical analyzer," he clamped one end to hold the cantilever stationary. The machine applied force at the other end to flex the beam while Bowland monitored the change in electrical resistance.

ORNL postdoctoral fellow Ngoc Nguyen conducted additional tests in a Fourier-transform infrared spectrometer to study chemical bonds within the composites and improve understanding of the enhanced mechanical strength that was observed.

The researchers also tested composites made with different amounts of nanoparticles for the ability to dissipate energy—as measured by vibration-damping behavior—a capability that would benefit structural materials subjected to impacts, shakes, and other sources of stress and strain. At every concentration, the nanoparticles enhanced energy dissipation (by 65 to 257 percent).



Bowland and Naskar have applied for a patent for the process to make self-sensing carbon fiber composites. "Dip coating offers a new route to utilize novel nanomaterials under development," Bowland said.

ORNL's Laboratory Directed Research and Development Program supported the research, which is published in ACS Applied Materials & Interfaces, a journal of the American Chemical Society.

The title of the paper is "Roll-to-Roll Processing of Silicon Carbide Nanoparticle-Deposited Carbon Fiber for Multifunctional Composites."

UT-Battelle manages ORNL for DOE's Office of Science. The single largest supporter of basic research in the physical sciences in the United States, the Office of Science is working to address some of the most pressing challenges of our time. For more information, please visit https://science.energy.gov/.

OAK RIDGE National Laboratory

Looking to the Future

Oak Ridge National Laboratory is marking three quarters of a century as a research institution in 2018. A few areas at the Department of Energy national laboratory still look like they did in 1943, particularly the Graphite Reactor Museum, where visitors can roam where physicist Enrico Fermi worked with other scientists and technicians in spartan, hastily constructed conditions, cloaked in secrecy.

In recognition of the 75th anniversary of Oak Ridge National Laboratory's founding as a world leader in innovative research and technology, STEM Magazine will be including a monthly video highlighting some of ORNL's amazing history.

MULTI-TASKING

In order to tackle the exhaustive list of homework and career responsibilities, most people attempt to turn to multi-tasking to get it all done in time. The truth is, effective multi-tasking is an oxymoron. Research has shown that your brain can only process one activity at a time by effectively and rapidly switching from one task to another.

MIT neuroscientist Earl Miller (Think You're Multitasking? Think Again: John Hamilton, NPR October 2008) says, "Switching from task to task, you think that you're actually paying attention to everything around you at the same time. But, you're not." You are actually toggling between tasks at amazing, but flawed, speeds.

Apparently, we were never multi-tasking.

It's a myth!

To the point, the more we attempt to multi-task, the longer it actually takes to complete our list of tasks. As far back as 2001, scientists at the Center of Cognitive Brain Imaging at Carnegie Mellon University discovered that when people were driving in traffic and conversing, two tasks most of us consider easy and natural, the area of the brain that managed these functions was overwhelmed. Researchers found that brain activity didn't double, but rather it decreased, so each task was completed less efficiently and less expertly than when being conducted separately. That's why texting and driving is so dangerous.

On top of that, the rapid swapping between tasks also generates pulses of stress hormones, which contribute to heath issues like memory dysfunction and higher anxiety.

The last thing our students need is more anxiety and distractions. The average attention span of an adolescent is one minute per year of age; that's when they're trying, had breakfast and a good night's sleep. We expect a 14 year old (14 minutes of attention span) to sit in a 55 minute class with focus, attention, interest and comprehension- then do it again next period and again next period, until the day is done.

Why do we get upset at their restlessness after 20 minutes? Maybe we forgot who they are or haven't evaluated the best way to present today's material.

You can't blame the student. As educators, let's reassess our process. Is there a better way? Could a different approach improve class behavior, attention, interest, productivity, quality and results? Are we flexible enough to consider it?

Technology in class has so many advantages, but some devices that were designed to make us more productive are now creating a new set of productivity problems.

When laptops and cell phones are close by, it's suddenly a challenge to keep their focus on the teacher or subject. It's just too compelling and easy to check email, text messages and surf the web. Of course these workers think that they are multitasking. But, when it comes to the brains ability to pay attention, the brain focuses on concepts sequentially and not on two things at once. In fact, the brain must disengage from one activity in order to engage in another. It takes several tenths of a second for the brain to make this switch. We are biologically incapable of processing attention-rich inputs simultaneously."

Prioritize

If you think it makes you look more efficient (or important) to be continually checking your laptop or cell phone for messages, think again. What seems like a harmless activity to the observer sends a nonverbal message of disinterest and dismissal to the rest of the group. That's why some teachers and educators have installed the "topless" meeting – banning all laptops, phones, Blackberries, etc.

Everyone who uses mobile devices have what's called continuous partial attention. We juggle several tasks partially and poorly. It takes longer to get things done and the consequence is a poor result; poor homework assignment, poor class preparation by the teacher, poor presentation by the speaker.

"We are biologically incapable of processing

The closest thing to multitasking we do involves engaging in two tasks simultaneously that use different parts of the brain, like walking or eating, and two activities involving different types of brain processing, like auditory and visual... like driving and listening to the radio. There is still a disintegration of effectiveness, but to a lesser degree and hopefully not life threatening.

Bad news parents….kids can study effectively while listening to classical music, since reading and listening use different parts of the brain. But if you listen to music with lyrics, your reading comprehension significantly drops. That's because both tasks activate the brain's language center. Similarly, you can talk and watch television at the same time, but you can't carry on two conversations at once.

As I write this article, the television is on and I find myself being distracted every few minutes by something that is said, disrupting my focus and train of thought. I turn down the T.V. or switch to another channel that's of no interest. Why do I behave this way? The background noise is, if not too loud, is a pleasant distraction since my children are grown and gone, I no longer have a pet and the neighbors are amazingly quiet. I guess other parts of my brain have a need to be entertained while I'm being productive with the other portions.

The problems these distractions and inefficiencies create become a problem in the workplace, classroom and especially during homework. The lack of focus keeps us from being better than we could be and more productive than we should be.

Research shows that if we have 5 things that need done in the next 5 days, the worst thing we can do is work on all of them piecemeal, a little here and a little there. The end result is it takes us 7 or 8 days to get it done.

On the other hand, prioritizing and focusing on one thing at a time until completion results in finishing our 5 to-dos in 4 days rather than 7.

attention-rich inputs simultaneously."

The added plus is the quality of the work…..it's superior. If the tasks required memorization, comprehension or retention, we did it better and it lasts longer.

I know this goes against our daily routine and mythical notions that we are accomplishing more, but this multi-tasking merry-go-round isn't fun, drains our energy and becomes discouraging when the end results are average or worse.

Just try it for a month. Whether it's cleaning the house, writing a paper, preparing classroom presentations or shopping (men get that one) you will get it done faster and better. What does better mean? Higher productivity at work, testing prep, better grades and more free time.

You will find that when you completely focus and concentrate on one deadline task at a time to completion before moving on to number two, the work is more thorough, comprehensive, accurate and done faster. Comprehension will be broader and memory deeper.

Don't get me started on driving while eating and taking on your hands-free device.

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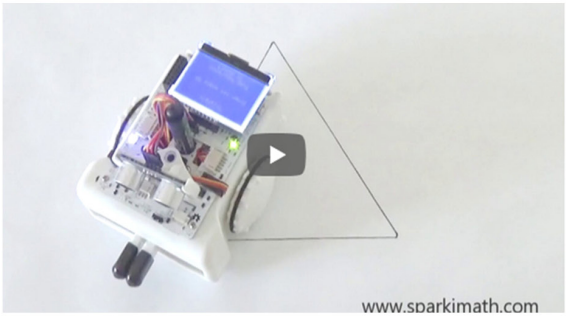
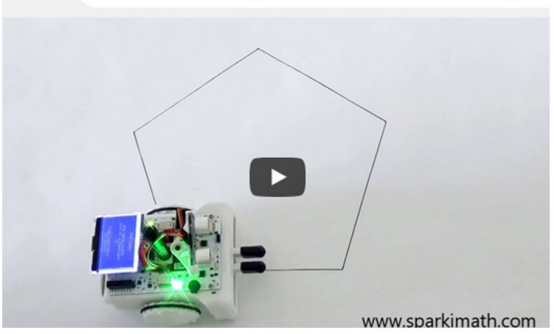
Watch Sparki Draw Triangles



Watch Sparki Draw Shapes



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"I Hated Science...Then Came 8th Grade Biology"

By Amjad Abdirahman

Like most eighth graders, I wasn't sure which career path I wanted to pursue. But I knew what I didn't want—a career in science. After enrolling in online school, I started to think twice about that decision.

I, of course, had seen the news reports and read the statistics that say women are underrepresented in science, technology, engineering and mathematics, or STEM.

This is certainly the case in the medical field where women are desperately needed in specialties like orthopedic and neurological surgery. Women make up just five and 7/8's percent of the physician workforce in these areas. However, it wasn't until my eighth-grade biology class at Georgia Cyber Academy (GCA) when I thought about

how this all applies to me and other young women my age.

When I was in traditional brick-and-mortar school, I earned good grades in my science classes yet I simply didn't like doing the work; it felt dull and repetitive. I excelled in my other classes too, but I eventually grew bored. Soon, I started thinking about ways I could work at a faster pace and have more control over my course schedule.

So after exhausting nearly all the honors and Advanced Placement (AP) courses that my middle school offered, I decided to take on a new experience in the online classroom. I knew this change would mean more course options and a rigorous class schedule. I also knew this schedule would include a more demanding science class. I was finally up for the challenge though. I didn't want to run away from science anymore.

In online school, I finally had the classes that I couldn't access in my local school:
- AP courses in history,
- American government,
- and literature.

Weeks later, no one was more surprised than I was that my favorite class wasn't even a part of this list…it was biology! Each week my teacher mailed me a science kit, complete with instructions for an experiment inside. And each week, I looked forward to conducting the next experiment.

For one class, I observed how soil reacts under a microscope after adding water and other substances to it. For another, I detailed the lifecycle of a flower by planting a seed and watching it grow. I eventually started to question why I had avoided science so much in the first place. And I started to believe that maybe, just maybe, instead of pretending to be a scientist, I could actually become a real one someday.

This thought prompted me to ask my science teacher, "What can you do with a biology degree anyway?" She explained that one option was to attend medical school and become a doctor. I felt a jolt of excitement because I immediately knew that was the career

path I was destined to take. As a physician, I could blend my passion for science with my desire to help others. And I could do my part to help close the gender gap in the medical profession. Suddenly I couldn't wait to take more science classes so I could be as prepared as possible for medical school.

Every week, I still have the chance to conduct weekly biology experiments. But now, I conduct them from a college lab at Georgia State University.

As a sophomore student, I'm relishing in all the things that make science come alive for me—things like microorganisms and human anatomy. I'm so grateful to the online classroom for pointing me in the direction of my dream career. I truly owe it all to that eighth-grade biology class.

Amjad Abdirahman is a graduate of Georgia Cyber Academy, a K12-powered school.

STEM MAGAZINE

Content Request

STEM Magazine requests the privilege of including your content or the content of your students in 2019 issues. This is a great opportunity for students to be published and for educators and industry professionals to share their insights and wisdom regarding careers nation-wide.

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Clarice Phelps:

Dedicated service to science and community

by Sean Simoneau

More than 70 years ago, United States Navy Captain Hyman Rickover learned the ins and outs of nuclear science and reactor technology at the Clinton Training School at what would eventually become the Department of Energy's Oak Ridge National Laboratory. Rickover applied his knowledge towards the creation of the US Navy's nuclear-powered ships and submarines, earning him the moniker of "father of the nuclear navy."

Decades later, ORNL researchers like Clarice Phelps carry on the Navy Nuke legacy and use their nuclear expertise to solve some of the grand challenges of science.

After graduating from Tennessee State University with a degree in chemistry, Phelps joined the Navy Nuclear Power Program, partly out of fascination and partly to dispel some of the fear others had towards the field.

"What drew me to nuclear science was the mystery of it," she said. "No one I knew was in that field, so I wanted to

know more about it and thought it was something really interesting to take on."

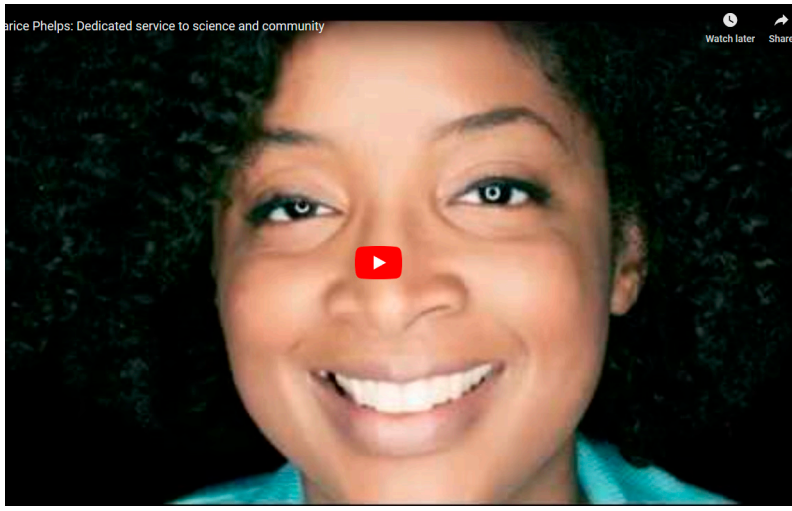
The Navy taught her about nuclear power, reactor theory and thermodynamics, but it also instilled fundamental lessons that she still uses in her work at ORNL.

"You build a very good work ethic, making sure that whatever you do is done right the first time," Phelps said. "That means putting a lot of forethought into what you do before you even go into it. It helps to have a 'Type A' personality in this type of work." This conscientiousness and meticulous nature are necessary for the type of sensitive work Phelps performs as project manager of ORNL's nickel-63 and selenium-75 industrial use isotope programs. She is also a researcher in the Medical, Industrial and Research Isotopes Group (MIRIG), where she works on the separation and analysis of elements such as europium, samarium, actinium and lanthanum.

Phelps also has experience with several large, notable research projects. She has collaborated with researchers at Argonne National Laboratory's Californium Rare Isotope Breeder Upgrade (CARIBU) to electroplate platinum and stainless-steel plates with californium-252 to analyze nuclear fission fragments.

She has also contributed work on plutonium and neptunium for NASA's plutonium-238 project. Additionally, she was also on the team tasked with purifying the berkelium-249 used to confirm the discovery of element 117, tennessine.

In every project, Phelps said, collaboration was key to the scientific process. "Collaboration allows you to have a more robust and more diverse conclusion to your results," she said. "It is vitally important because you can't think of everything yourself on these multi-dimensional projects. The part we played in the confirmation of element 117 was definitely a collaborative team effort."



Phelps said her attitude on teamwork and the willingness to commit her skills towards the bigger picture is another lesson carried over from her time in the Navy.

"You gain the sense that what you're doing is for the betterment of everyone," she said. "It's not just about you and your niche field of research, it's about what your research is doing to impact everyone else."

One way to expand your impact and broaden your niche, Phelps said, is to engage with your community, both socially and professionally. As a member of the American Chemical Society, Phelps recognizes the benefits gained from reaching out to the greater scientific society.

They made science fun and engaging, she said, and their emphasis on experimentation helped translate scientific principles from words on a page into reality.

Today, Phelps tries to pass on the same lessons through her work with the graduate chapter of Alpha Kappa Alpha sorority's ASCEND program, which teaches concepts like robotics, drones, circuitry and coding to Knoxville high school students.

"I think it is important to be involved in professional organizations because iron sharpens iron"

Professional societies not only provide a way for researchers to stay updated on the latest advances in their field and look for new ideas and collaborations, but also provide an outlet for individual researchers to make their voice heard and to positively contribute to global research efforts.

Phelps is also involved in a number of STEM outreach programs dedicated to mentoring and encouraging local students to pursue scientific careers. Phelps said her own love of science was sparked early by a microscope set and encyclopedia-based science kit given to her by her mother and kindled by her middle and high school science teachers.

"Going out to the schools and doing STEM outreach is something I really love to do because you can just see the light come on in the students' faces," she said. "You can see the questions forming and the beginning of the scientific process."

Quality STEM outreach needs to be more than just talking to the students, Phelps said. It requires a dialogue and the chance for students to get hands-on experience so they can be self-driven and make their own discoveries, much like Phelps did with her microscope set.

"You can either help explain it to them,

or you can help them find the answer on their own," she said. "I think helping students and other kids independently think for themselves is key to creating those new scientists and engineers."

Phelps also works with the ORNL Nuclear Science and Engineering Directorate's Educational Outreach Program, National Nuclear Science Week activities and the ORNL Traveling Science Fair trailers. By diversifying her engagement outlets, Phelps is able to reach students of all ages and bring the world of science and technology closer to reality for those who may have found it mystifying or intimidating.

"You have to reach out to the community, because that's where you future scientists and your new ideas are going to come from," she said. "A lot of kids run from science, but by doing outreach and making it as fun for them as it was for me, it makes it more realistic as a possible future career choice."

ORNL is managed by UT-Battelle for the Department of Energy's Office of Science, the single largest supporter of basic research in the physical sciences in the United States. DOE's Office of Science is working to address some of the most pressing challenges of our time. For more information, please visit http://science.energy.gov/.

It is time to change the STEM stereotype

Dr. Tamara Franz-Odendaal
Professor, Department of Biology, Mount Saint Vincent University &
NSERC Atlantic Chair for Women in Science and Engineering
Halifax, Nova Scotia, Canada

Most people imagine a scientist as someone who works in a lab and wears a white lab coat. Probably this person is a man. Likely in his mid-50's or older with some grey hair. This male lab coat clad stereotype of a scientist is so ingrained in society that it is no wonder that the percentage of girls entering STEM programs sits at around 37% in Canada despite more girls going to university than boys (Natural Science and Engineering Research Council of Canada, 2010).

It's a huge misconception to think of scientists in this way. Not only are there a myriad of careers that are STEM–based but many scientists don't even wear lab coats on a daily basis. Many do field work in exciting places. All work in a team. This is not an isolated work-alone profession for men only. The other STEM professions are the same. All help communities in different ways.

These aspects of the STEM sector need to be realized, acknowledged and shared, particularly with girls.

Currently only 29% of the STEM workforce in Canada is women, only 5% of skilled trades persons are women and only 15% of our full time professors in the life sciences are female. Similar statistics can be found across the U.S. and Europe, yet, these women are critical role models for girls.

Supporting women in the STEM sector is good for business. Research by the Harvard Business Review (2011) shows that having a diverse team brainstorming a problem increases the collective intelligence and will lead to greater innovation. This is good for all industries and economies.

Women represent an untapped resource that can fulfill the STEM labor market shortages nation wide (WinSETT Centre). This is good news. So the next time your child asks what a scientist does, tell them about the successful women in STEM of our past – Marie Curie, Jane Goodall or Rosalind Franklin. Twelve Nobel Prizes have been awarded to women in the science disciplines in the last fifteen years –

Jane Goodall; Scientist, *World famous primatologist*

these include Ada Yonath (chemistry, for her work on the cellular structure that reads genetic codes), May-Britt Moser (physiology/medicine, for her work in understanding how cells find their positions in the brain), and Elizabeth Blackburn (physiology/medicine, for her work in figuring out how chromosomes are protected from damage inside cells).

Women should not have to fit into the stereotypical mold of STEM, rather the STEM mold itself needs to change. This includes having policies in place that ensure that there aren't any negative repercussions on careers when maternity leaves are taken.


"One of our favorite

We've run this before, but we just love the STEM example of what a STEM career really is.

S.T.E.M. Careers"

Bug Exterminator

As with many careers, it's not until we take a closer look at it that we discover the complexities and S.T.E.M. applications used everyday.

The Bug Exterminator is one of those.

The SCIENCE of extermination:

Organophosphate Pesticides - These pesticides affect the nervous system by disrupting the enzyme that regulates acetylcholine, a neurotransmitter. Most organophosphates are insecticides. Some are very poisonous (they were used in World War II as nerve agents). However, they usually are not persistent in the environment.

Carbamate Pesticides affect the nervous system by disputing an enzyme that regulates acetylcholine, a neurotransmitter. The enzyme effects are usually reversible. There are several subgroups within the carbamates.

Organochlorine Insecticides were commonly used in the past, but many have been removed from the market due to their health and environmental effects and their persistence (e.g. DDT and chlordane).

Pyrethroid Pesticides were developed as a synthetic version of the naturally occurring pesticide pyrethrin, which is found in chrysanthemums. They have been modified to increase their stability in the environment. Some synthetic pyrethroids are toxic to the nervous system.

Chemicals such as these can be VERY dangerous to children, pets and even adults if not used for the appropriate reasons in the correct doses.

The responsibility of the exterminator is to determine which chemical is right for each pest and use the correct one keeping in mind the location it will be affecting. Are there children in the area? Will your dog or cat come in contact with it? How much is enough or too much?

This is just a taste of extermination science.

The TECHNOLOGY of extermination:

How the chemicals are delivered to the area, either by spray, tablet, tape, aerosol, gel, or some other, the proper technology delivery must be used for chemical effectiveness and safety. You can just throw some poison down and walk away.

What is the safest, yet most effective and how long will it last?

How it's applied can be an important part of the answer.

The ENGINEERING of extermination:

Since the engineering method is a decision making process, here's how it would work for the exterminator.

1. What's the problem bug?

2. What are the possible chemicals that can be used to exterminate them?

3. Which of the chemical choices is the safest but most effective for the place I need to use them?

4. After making my choice, I will determine the best way to spread or deliver the chemicals.

5. After application, I will see if it worked, make sure it was safely applied and see how long it lasts.

That is the decision making process called the Engineering Method. We use it every day to make decisions about everything. Try and think about how you have already used it today.

The MATH of extermination:

This part of the S.T.E.M. process is just as important as the others and in some ways more so.

Mixing the raw chemicals in the right amounts and combinations takes exact mathematical calculations.

It may be simply measuring them using a measuring cup or specialized cylinder, but no mistakes are allowed.

The math of extermination is fairly basic, but you still have to calculate the right mixture of chemicals to cover the need area in square feet in the right strength with the right delivery system.

We will always need bug exterminators making it a dependable S.T.E.M. career field everywhere in the nation. As bugs build up defenses against our current chemicals, new ones will be designed and the exterminator will have to adapt and get continuing education about how to use them in the S.T.E.M. formula.

Exterminators may work for a company or be their own boss. The salary for the average American exterminator is about $30,000 per year, but may be as high as $42,000 in some regions with over-time or weekends.

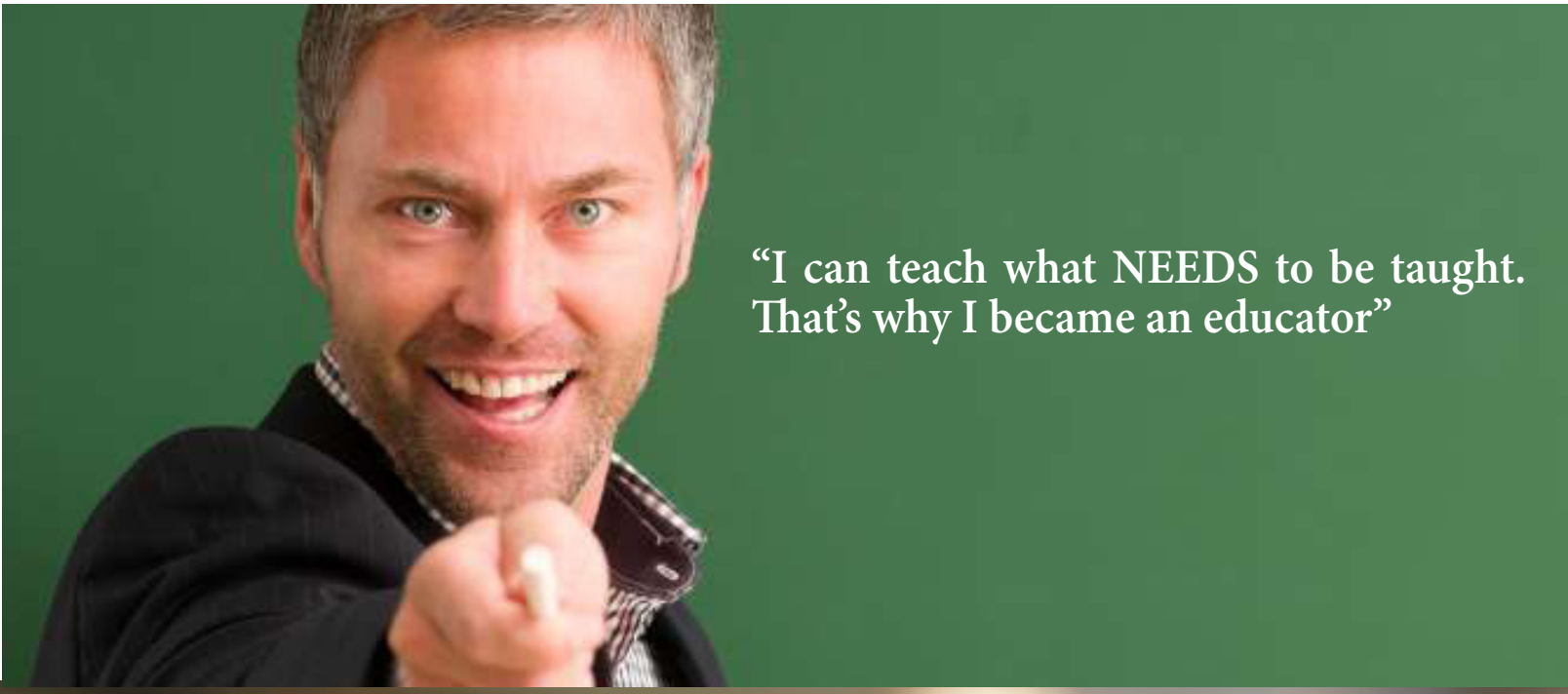
The next time your exterminator comes over, check out what they do and remember it's a challenging and complicated S.T.E.M. career.

If you love bugs and want a career being close to them, there are careers available for you.

Wayne Carley
Publisher

If we eliminated standardized testing, within the first 6 months here is what would happen....

- *Teacher retention would improve by several million (Huffington Post)*
- *Student and teacher moral would improve beyond measure*
- *Student and teacher stress would drop over night / better health*
- *Student drop out rates would decline / graduation rates up*
- *Student grades would improve along with interest and retention / pressure*
- *What else would change?*



Cognitively Priming Students for Learning

Dr. Judy Willis

Cognitive [kog-ni-tiv]

adjective
1. of or relating to cognition; concerned with the act or process of knowing, perceiving, etc. : cognitive development; cognitive functioning.

2. of or relating to the mental processes of perception, memory, judgment, and reasoning, as contrasted with emotional and volitional processes.

Priming (prime) [prahym]

verb (used with object)
1. to prepare or make ready for a particular purpose or operation.

2. to cover...with a preparatory coat or color, as in painting.

3. to supply or equip with information, words, etc., for use:
"The politician was primed by his aides for the press conference."

"It preps their minds to engage."

There are some standards or units of instruction that, for whatever reason, you know aren't going to be runaway hits with students. While you can certainly reconsider the unit design, there are other strategies you can use to help prime student brains for learning.

Among the simplest of these strategies is promoting curiosity -- and students' natural tendency to predict -- by advertising the content the same way that a marketing company might. This promotes advance interest, and the resulting questions increase the student curiosity, opening the brain's attentive intake filter. In short, it preps their minds to engage.

How might this work?

Try advertising a coming unit by cutting up a related, compelling image, and then adding pieces
daily to reconstruct that image as the "advertisement" gradually takes form.

Similarly, different clues -- visual or otherwise -- could be added
every few days leading up to the new unit's introduction.

For fractions, these clues might be:

- An x-ray image of an arm fracture.
- Sheet music with half, whole, and quarter notes.
- A carrot cut into quarters.
- A photo of an iceberg showing the parts above and below water.

These both visualize the content and prime the mind to learn new content. Even though curiosity gradually decreases in favor of caution, the need to find out if a prediction is right or wrong is part of the brain's permanent wiring. The brain strengthens future predictions and corrects any inaccurate prior knowledge leading to incorrect predictions through a prediction-reward system fueled by dopamine pleasure. In short, even if students gradually become less interested, it won't diminish their need to know as the unit begins.

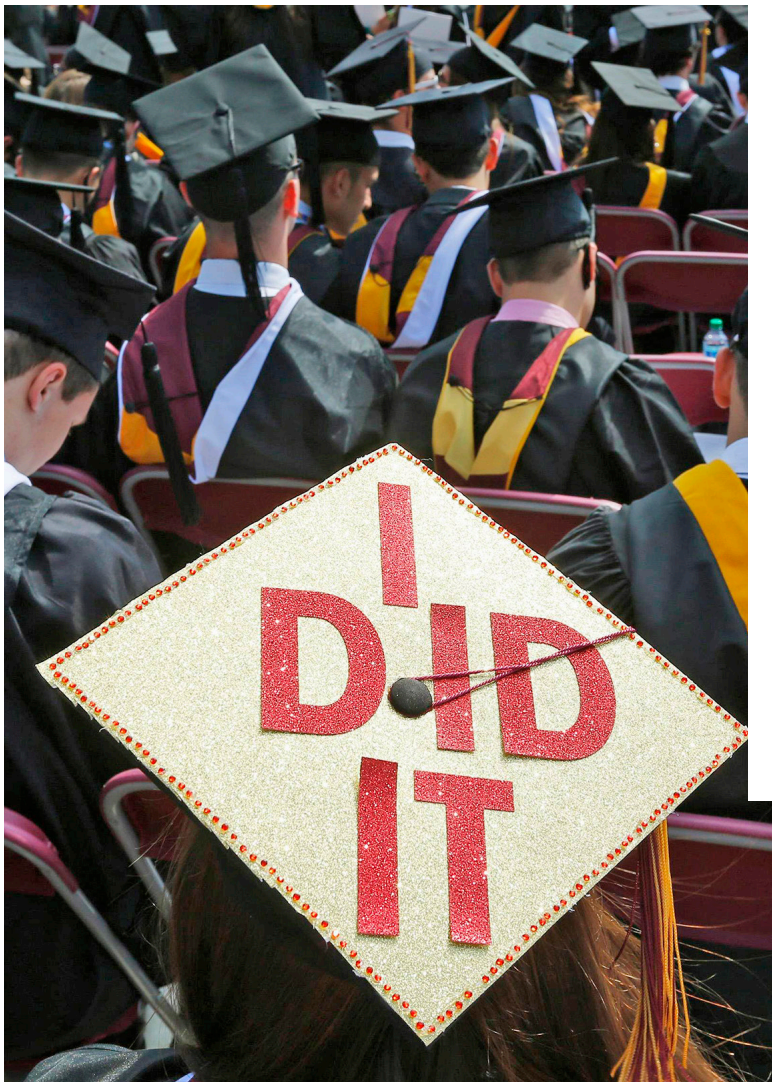
On the day the unit is scheduled to begin, students' curiosity, along with their written or verbal predictions, will tune their brains into the perfect zone for attentive focus. They are like adults placing bets on a horse race. Students may not be interested in the subject matter itself, but their brains need to find out if their predictions are correct, just as the race ticket holder needs to know if he holds a winning ticket.

Now the students' brains want to know what you have to teach! If nothing else, you're set to reach them from day one.

The brain is wired for high interest when clues prompt prediction, anticipating the pleasure of the dopamine reward response. There is no such intrinsic motivation for drills and memorization of rote facts and procedures.

Isolated skill practice is contrary to the brain's instinct to preserve its energy, because there is no expectation of pleasure from energy output. On the other hand, when students want to know required information to create solutions to problems that interest them or to create products that they care about, the brain applies the effort to learn what is required to achieve desirable goals.

This isn't a personality thing, or a characteristic of apathy, but a fundamental neurological system that preferentially attends to and stores input considered useful for desired goals.



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