October 2019

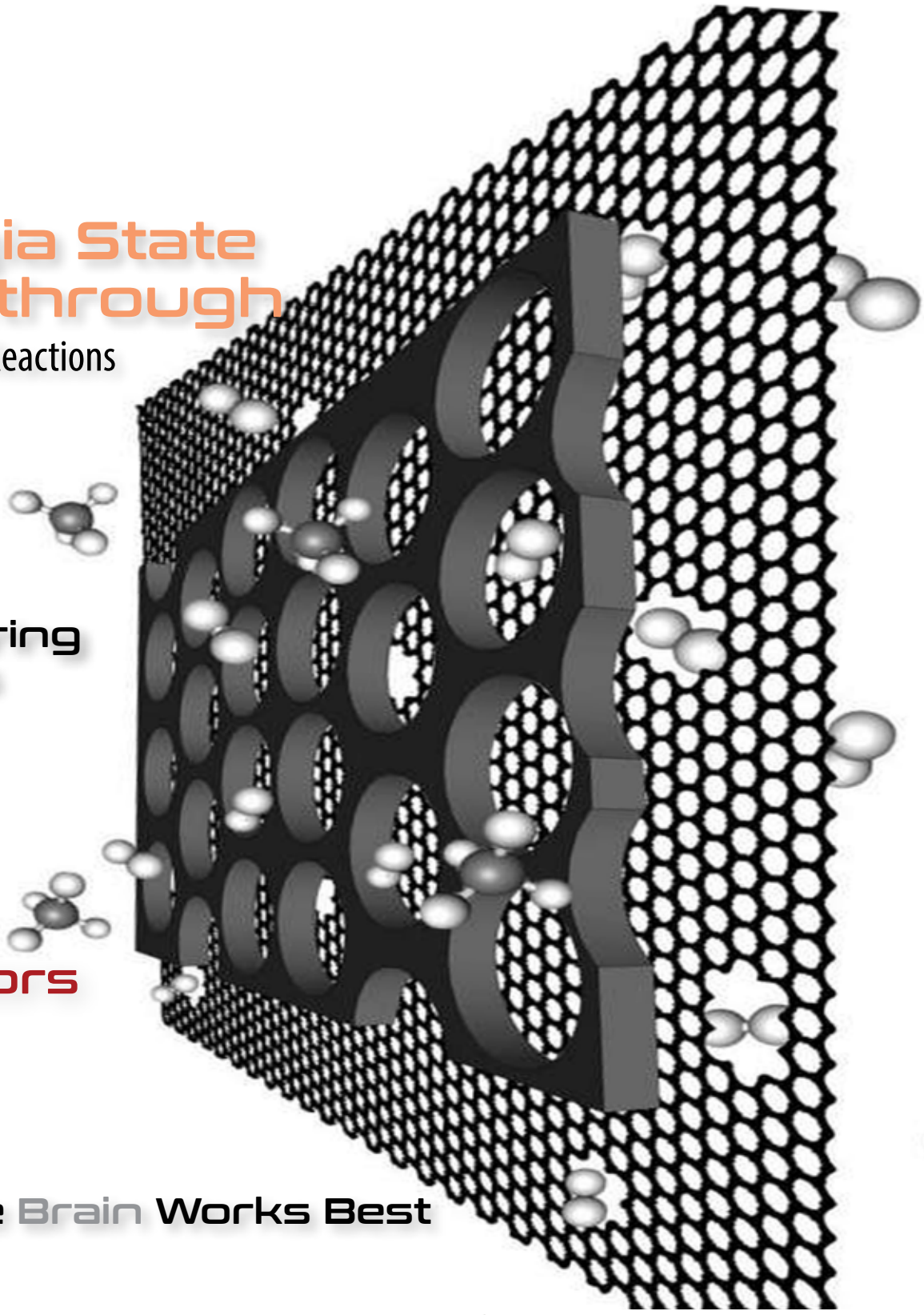
GEORGIA PATHWAYS
MAGAZINE

Georgia State Breakthrough
Nanoconfined Reactions

Engineering Mentors

Impostors

How The Brain Works Best



TAG Technology Association of Georgia
TAG TAG-Ed Education Collaborative

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What are these kids saying?

Copy the code and use this link to find out.

https://lingojam.com/BinaryEncoder&Decoder

Welcome to our latest edition of Georgia Pathways STEM Magazine.

Georgia has much to be proud of when it comes to STEM education efforts. Recently, four Georgia teachers received top national STEM teaching awards.

U.S. President Donald Trump announced the recipients of the Presidential Awards for Excellence in Mathematics and Science Teaching (PAEMST), the highest award given by the U.S. government to K-12 teachers of mathematics and science, including computer science. Teachers are selected based on their distinction in the classroom and dedication to improving science, technology, engineering and math (STEM) education.

Meanwhile, the University of Georgia (UGA) has joined a national alliance that is working to enhance diversity among STEM educators. UGA's participation in the Aspire Alliance, according to a release, adds to several programs on campus that aim to broaden participation in STEM disciplines.

And Georgia College & State University is the recent recipient of a $5M grant to create a new teacher program focused on recruiting undergraduate STEM majors who aspire to become middle school math and science teachers.

Our state, with its competitive and expansive university system, advances STEM education projects and initiatives in ways that set Georgia apart and offer unprecedented opportunities to our students, both K-12 and beyond.

In part these efforts have created our globally competitive technology industry and precedent-setting educational and career opportunities for all students who aspire to STEM careers.

TAG is proud to support STEM education efforts through the TAG Education Collaborative (TAG-Ed). This publication is distributed to educators, students, parents and technology proponents who want to inspire students and teachers to continue bolstering STEM curriculum.

I hope you will be inspired by what you find and use what you learn to start or expand your own STEM project. Thanks for your support!

Larry K. Williams
President
TAG-Ed

Larry K. Williams serves as the President and CEO of the Technology Association of Georgia (TAG) and President of the TAG Education Collaborative (TAG-Ed). TAG-Ed's mission is to strengthen Georgia's future workforce by providing students with relevant, hands-on STEM learning opportunities by connecting Technology Association of Georgia (TAG) resources with leading STEM education initiatives.

The Technology Association of Georgia Education Collaborative (TAG-Ed) strengthens the future workforce by providing students with relevant, hands-on STEM learning opportunities and connecting them to Technology Association of Georgia (TAG) resources. Formerly the TAG Foundation, TAG-Ed is a 501(C)(3) non-profit organization formed by TAG in 2002. Later, the organization's name was re-branded to TAG Education Collaborative to facilitate our role as the leaders for K-12 STEM education in Georgia.

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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)

MATHEMATICS: "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.

Georgia State Chemists' Surprising Discovery of Nanoconfined Reactions Could Aid Catalytic Design

by Anna Varela
Director of Communications and Public Relations
College of Arts & Sciences

Georgia State University chemistry researchers have unlocked one of the mysteries of catalytic reactions on a microscopic scale, allowing for the design of more efficient industrial processes.

Catalysts — which speed up chemical reactions in everything from the digestion of food to combustion engines in vehicles — are essential in turning raw materials into useful products in industries, including petroleum, plastics, paper, pharmaceuticals and brewing. Understanding how reactions occur can help scientists engineer better catalysts that are more energy-saving and environmentally sustainable.

The researchers established a new imaging strategy that can track single molecules as they shimmy through tiny pores in the shells of silica spheres and monitor the chemical reaction dynamics on catalytic centers at the core, producing the first quantitative measurements of how confinement on a nano scale actually speeds up catalytic reactions.

Understanding this surprising "nanoconfinement effect" could help guide the precision design of more efficient industrial catalysts that can conserve energy.

"You want to make a specific product and you have the choice of different porous materials that can make different things. Which one will give you the best conversion rate and highest speed?", said Ning Fang, associate professor in Chemistry at Georgia State, who published the results of the research in Nature Communications. "Now we have a theory based on experimental evidence that we add to simulations to have a better prediction of what might be the result of using certain catalysts."

Study of catalytic reactions was previously limited to theoretical and computational models. The single-molecule imaging system, designed by Georgia State postdoctoral research associate Bin Dong and published in Nature Catalysis, allows researchers for the first time to see and measure the reactions occurring on a tiny multi-layered porous sphere. This sphere was created by collaborators at Iowa State University led by professor Wenyu Huang and postdoctoral research associate Yuchen Pei.

The reactant molecules have to orient themselves in a specific direction to fit through nanopores – openings that are roughly 100 times smaller than the width of a strand of hair.

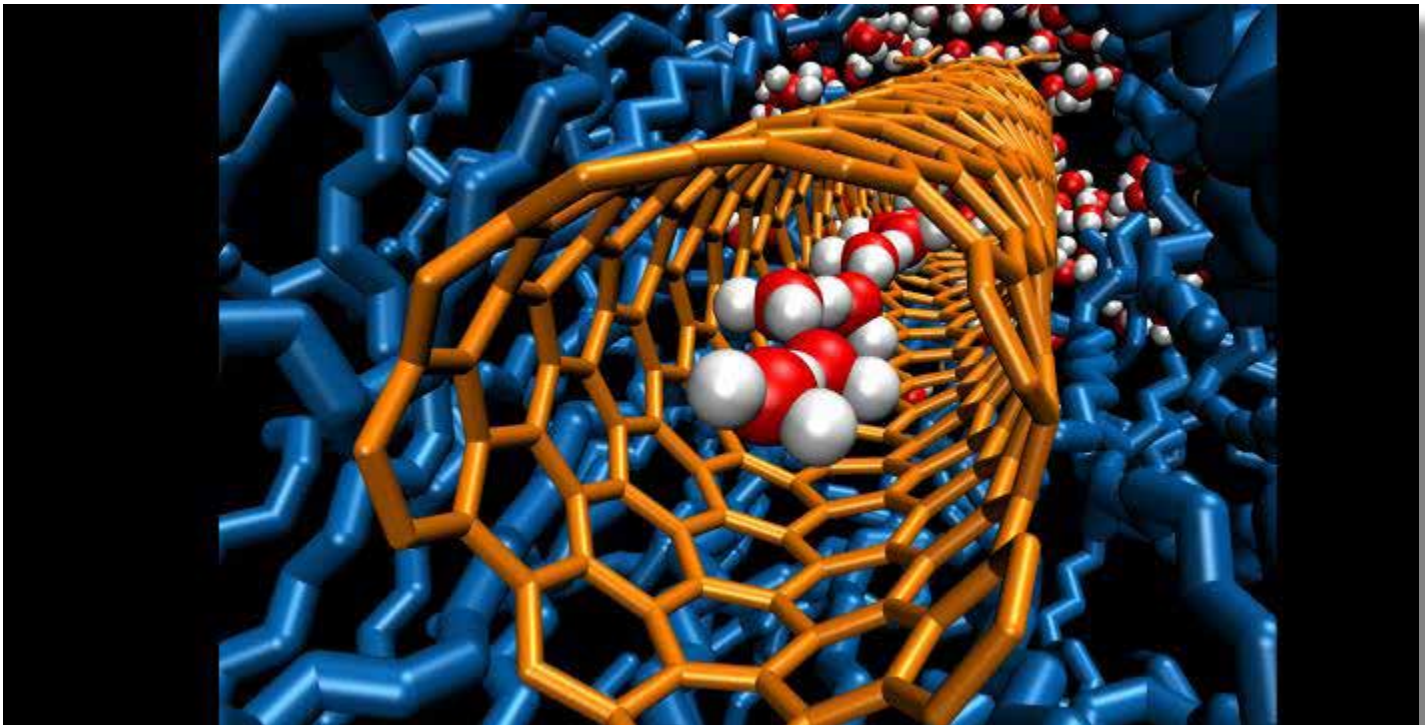
The nanopores are comparable in diameter to the size of the reactant molecule and when its tip reaches the active core, it immediately triggers the first step of the reaction upon contact. The generated intermediate product, however, is trapped by the nanopore as the reaction continues through three steps to form the final product molecule.

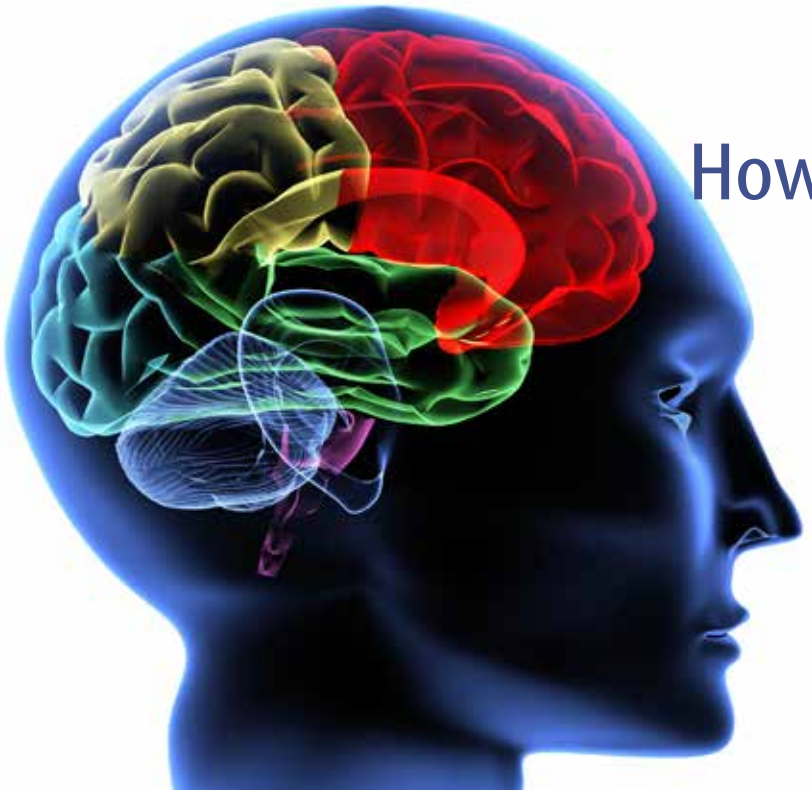
Contrary to conventional theory, this "nanoporous barrier" speeds up the reaction instead of slowing it down, based on Fang's experimental measurement of activation energy. Despite molecular movement being restricted by the presence of a porous shell, the process is actually magnified by the confinement, the study found.

"Instinctively, one would expect a decreasing activity when catalytic centers are shielded away from reactant molecules by a nanoporous shell," Fang said. "However, our experimental evidence tells a different story. And more surprisingly, the catalytic activities are further enhanced for catalysts with longer and narrower nanopore structures until the benefits of nanoconfinement are overtaken by the restrained molecular transport in the nanoporous shell." This discovery could have major implications in the engineering of new catalysts.

For example, the equivalent of more than 500 million barrels of gasoline is used every year to convert ethane and propane into alkenes that are used to make plastics, detergents and other products.

Applying more efficient catalysts on a grand scale could save a lot of energy in the process.





How the Brain Learns Best

by Jay McTighe and Judy Willis

The brain is always changing, as a result of environment and experience. Every lesson, assignment, and interaction shapes your students' brains. Understanding how the brain converts information into learning provides keys to the best instructional strategies and learning experiences.

As a result of breakthroughs in neuroscience research, including neuroimaging and neuroelectric monitoring of neurons (brain cells) firing, we now can observe how the brain responds during learning. These technologies provide visible representations of the brain's response to instructional practices, revealing neurological activity as information travels from the body's sensory intake systems through the attention and emotional filters, forming memory linkages and activating the highest cognitive networks of executive function.

This research has illuminated our understanding of how various factors—classroom environment, activation of prior knowledge, attention-getting techniques, use of graphic organizers, mental manipulations, and others—influence the transformation of sensory information into networks of durable long-term memory and conceptual understanding.

As you build your knowledge of the strategies that promote optimal brain processing, you'll recognize that neuroscience research may well support strategies you've already found most successful in your experience as an educator. Our goal is to help you increase your understanding of why "best practice" strategies and tools work at the neurological level.

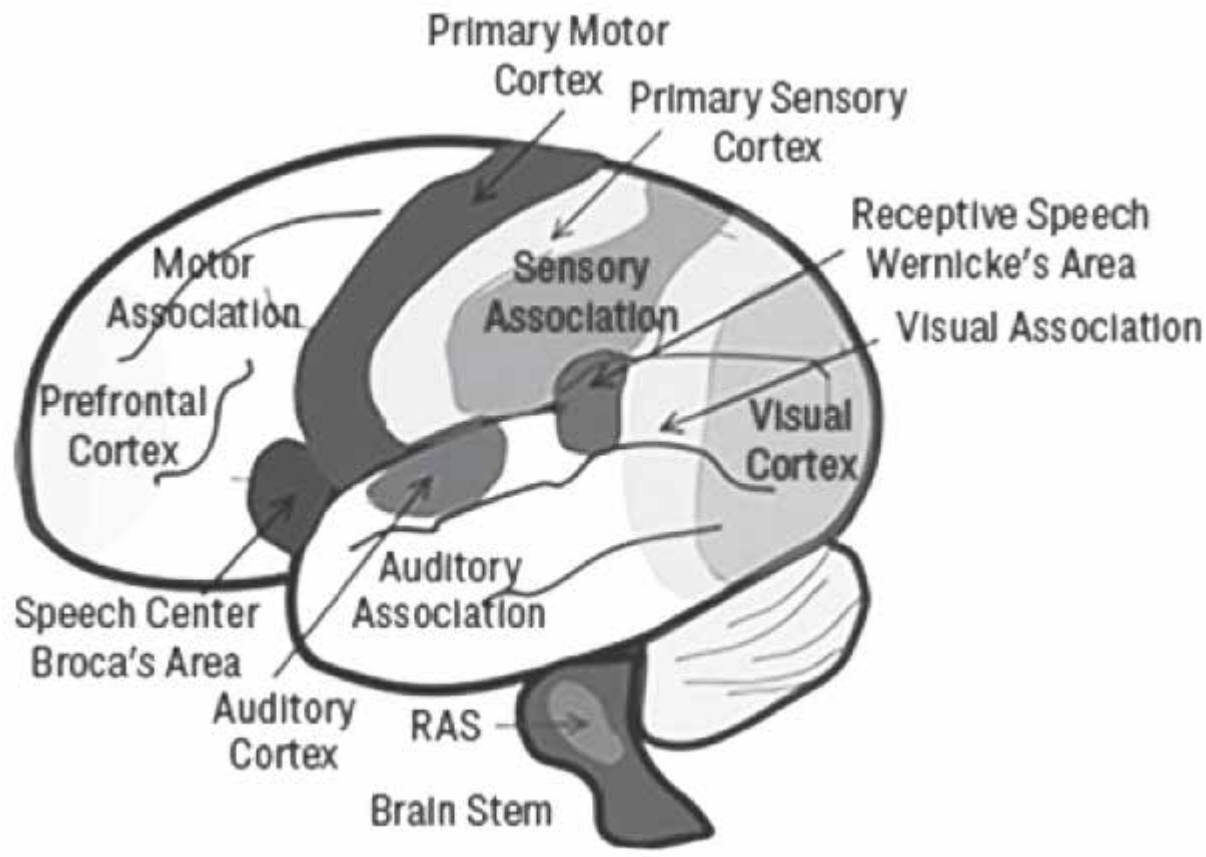
The RAS: The Brain's Attention Filter

All learning begins with sensory information. Our brains are constantly bombarded with information from the body's sensory receptors. Continuous data reports flow from specialized sensory systems (hearing, vision, taste, touch, smell) and from the sensory nerve endings in our muscles, joints, and internal organs. These receptors do not evaluate the data.

They just transmit constant status reports. Of the millions of bits of sensory data available each second, only about 1 percent are admitted to the brain, whose various areas are associated with different functions. Once information enters the brain's processing systems, it is relayed by numerous "switching stations." Ultimately, conscious or higher-level processing takes place in the outer covering of the brain, called the cortex.

and nutrients the body consumes. From a survival standpoint, it makes good sense for the brain to be a couch potato!

Because it is impossible for the brain to consciously sort through all the sensory information that is available every second, it is programmed to prefer selected input. To deal with this selection, the brain has a sensory intake filter, called the reticular activating system (RAS), in the lower part of the posterior brain.



One reason for restricting the enormous amount of sensory input is that the brain is rather stingy with its mental effort because it needs to preserve its limited fuel. Unlike other organs, it has no stored nutrients or oxygen. The average brain weighs only about three pounds, but it is so dense and metabolically active that it requires over 20 percent of all the oxygen

The RAS determines what the brain attends to and what information gets in. Its involuntary programming gives priority to sensory information that is most critical for mammals to survive in the unpredictable wild. Any change in the expected pattern can signal a threat of death or, alternatively, a source of nutrients that can help ensure survival.

This "hard-wired" criterion of selection for entry is essentially the same for humans as for other mammals; the brain gives priority admission to sensory input about change in the expected pattern—what is new, different, changed, unexpected.

Students are often criticized for not paying attention, but we now know that failure to focus on a teacher's instruction does not mean the student's brain is inattentive. A student's RAS is always paying attention to (letting in) sensory input—but not necessarily the input being taught at that time.

The Amygdala: The Brain's Switching Station

Deep within the brain is the emotionally responsive limbic system, which includes two structures (one on each side of the brain) called the amygdalae, which direct communication between the lower brain and the upper brain. The lower brain is the more primitive control center that directs bodily functions that are largely automatic, such as breathing and digestion, as well as reactions that are largely involuntary, such as the fight-or-flight response. The upper brain, known as the prefrontal cortex, is where memory is constructed and neural networks of executive functions guide voluntary behavior with reflective, rather than reactive, choices.

The amygdala can be thought of as the switching station for traffic flow between these upper and lower structures in the brain. After sensory information is selected to enter through the RAS, the level of activity taking place in the amygdala determines whether the information will travel down to the lower, involuntary, reactive brain or up to the reflective and memory-storing "thinking brain" (the prefrontal cortex).

Information perceived as possibly threatening is directed through the amygdala to the reactive lower brain. Input passing through the amygdala to the prefrontal cortex finds the home of logical thought, judgment, emotional self-management, and other executive functions needed to generate more accurate predictions about new information and direct more considered responses.

When a mammal is in a state of actual or perceived stress, new information does not freely pass through the amygdala's filter to gain access to the prefrontal cortex. Instead, input is diverted to the lower, reactive brain, which has a limited set of behavioral responses that can be summarized as involuntary survival responses to a perceived threat.

In fact, it is these primitive mammalian responses that we are likely to observe in students when they are highly stressed by fear, frustration (e.g., as a result of repeated failure to succeed in a task or subject), alienation, anxiety, or sustained boredom (e.g., when they are asked to do lessons or drills on topics they have already mastered or that they see as irrelevant). Here are some examples of specific school-related stressors that can trigger the amygdala to send input to the lower, reactive brain:

- Anxiety related to speaking in class, answering questions, or oral presentations
- Fear of being wrong
- Physical and language differences
- Test-taking anxiety
- Boredom as a result of prior mastery or absence of personal relevance to the material
- Frustration with material students believe exceeds their understanding
- Feeling overwhelmed by the demands of school assignments

- Inability to effectively organize time in response to the demands of academics, extracurricular activities, and out-of-school chores and jobs

- Feelings of isolation or lack of acceptance by peers or teachers

- During these states of stress, students are likely to display involuntary lower-brain responses, manifested in acting-out or zoning-out behaviors.

The Brain and Mindset

Because the brain seeks to preserve its limited energy resources, it directs its behaviors based on the probability that the effort expended will result in success.

Understanding this survival programming provides new perspective about students' choices and responses. It is now evident that low intelligence, lack of initiative, or laziness may not be the most likely reasons students don't always remain fully attentive, remember everything they are taught, persevere at tasks, or manage their emotions.

A more fundamental explanation for nonproductive student behaviors is rooted in the brain's design, which focuses sensory intake, reacts to stress with survival responses, preserves its resources, and minimizes outputs of effort.

The brain's expenditure of voluntary effort is linked to the expectation of positive outcomes. If students fail after repeated efforts to achieve goals and academic challenges, their willingness to put forth effort will decline.

These negative self-expectations can grow progressively year after year with repeated failures, further compromising the likelihood of academic success. Psychologist Carol Dweck (2007) has coined the phrase ***fixed mindset*** to characterize the conviction of those learners who do not believe that their effort can lead to achievement and is therefore fruitless. This contrasts with a growth mindset, which attributes success to effort, perseverance, and use of strategies.

In survival terms, withholding effort when past experiences predict failure is beneficial for animals in the wild. Consider a fox living in a region where prey is limited and whose den is surrounded by three hills. One of those hills is particularly steep and covered by dense underbrush where the prey hides.

To repeatedly chase prey up that hill is to exert effort—in this case, energy—without the likelihood of achieving the goal of an energy-restoring meal. In the interest of survival, the fox's brain ultimately develops a mindset that deters it from chasing prey up that particular hill.

As students' efforts toward achieving a goal repeatedly fail, they might develop the fixed mindset that their intelligence and skills are predetermined, limited, and unchangeable. They become less likely

to expend the effort necessary to persevere on challenging learning tasks, and they fall behind academically. Without the needed foundation of knowledge and skills to understand subsequent instruction, the gap widens further and they become even more susceptible to the stress-related blockades.

Seeking Patterns to Make Predictions

The brain's programming promotes survival of the animal and the species. This programming has guided mammalian development and adaptations for survival in the unpredictable and perilous environments in which most mammals live. The human brain continues to follow two prime survival directives: to seek patterns and pleasure. These directives drive the brain's memory, effort, and actions.

Patterning refers to the brain's meaningful categorization and organization of sensory data based on relationships or commonalities. The brain stores new information by linking it to patterns of related information already stored in neural circuits of existing memory. These clusters of related information stored together in memory are what psychologist Jean Piaget (1957) described as cognitive frameworks, or schemas.

It is through this pattern matching with previously constructed and related neural networks that our brains recognize and make meaning of the thousands of bits of sensory input received every second.

By linking information newly stored in memory networks with relevant prior knowledge, the brain can sift through the barrage of ongoing input to make sense of the world.

Storing information in memory by relationship patterning allows for easier, more efficient retrieval of information, which is essential to interpreting and predicting, and enacting the best response to something new.

...to be continued next month.

Impostor Syndrome: We Are All a Work in Progress

by **JJ DiGeronimo**
President of Tech Savvy Women, author of "Accelerate Your Impact" and "The Working Woman's GPS" to retain, develop and advance diverse talent in STEM- based organizations.

Impostor Syndrome is a common feeling among women professionals. Have you ever felt like you didn't belong? Have you feared someone would point and say – "You don't know what you are doing, how did you ever get this job?"

Overcome Impostor Syndrome

As a professional woman expert, I discuss, share and educate women on how to recognize and work around overcoming Impostor Syndrome. Here are a few tips:

1. Slow down to recognize your thoughts; your inner dialogue.
2. Be aware of your feelings (Self Esteem) which drives your actions (Confidence).
3. Think about the times you have succeeded when you were unsure about the situation.
4. Remind yourself that you have the skills and knowledge to create a positive outcome.
5. Find a friend or coach to champion you along when you are swimming in self-doubt.

Remember that Impostor Syndrome is common, however, few ever admit to their insecurities. Take comfort in the fact that you are not alone. If you examine your past successes, you can feel confident in your future outcome.

Five Types of Impostor Syndrome

According to The Muse, there are 5 types of Impostor Syndrome:

The Perfectionist: Do you feel like your work must be 100% perfect, 100% of the time?

The Superwoman: Do you stay later at the office than the rest of your team, even past the point that you've completed that day's necessary work?

The Natural Genius: Are you used to excelling without much effort?

The Soloist: Do you firmly feel that you need to accomplish things on your own?

The Expert: Do you shy away from applying to job postings unless you meet every single educational requirement?

We have perhaps felt like one or all of these people at one point in our career.

However, just because we suffer from the occasional bout of self-doubt does not mean that we aren't qualified.
Remember: ***we are all a work in progress.***

Lesson-Sharing

Services Fulfill a Demand

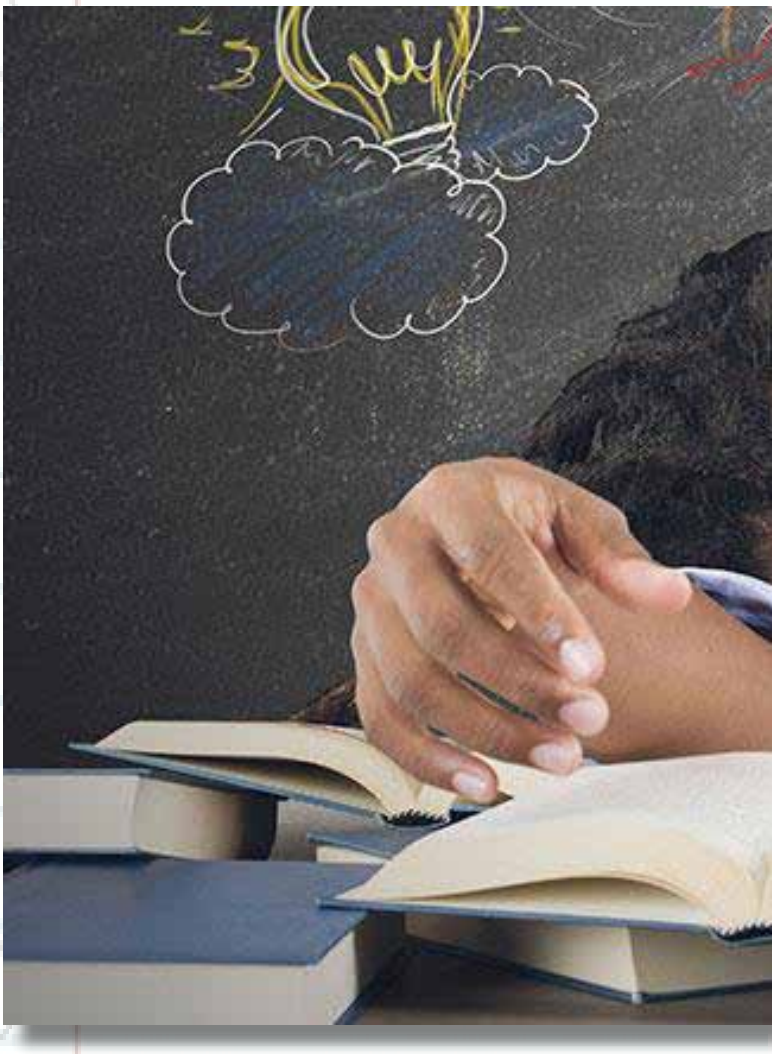
Dr. Richard Larson MIT

Lesson sharing occurs when a teacher prepares her/his lesson for others to use and posts it on the Internet. In recent years, lesson-sharing services have grown exponentially. Demand for shared lessons is creating a large supply. Common standards make this possible. Teachers in the United States are overwhelmed by teaching hours, both in class preparation and in front of the classroom.

A recent OECD study found that U.S. teachers rank second after Chile in terms of class time spent in front of students. For instance, despite Japanese schools teaching four extra weeks per year, Japanese primary school teachers only spend 707 hours per year teaching compared to the 1100 hours per year for their US counterparts (OECD, 2012).

This difference is even greater at the middle- and high-school levels, where US teachers spend 1070 and 1050 hours respectively compared to 602 and 500 hours for Japanese teachers. Despite these large differences in instructional time, teachers in the two countries work comparable hours in total (1899 hours in Japan and between 1913 and 1998 hours in the United States, according to the OECD).

Teachers in the United States are expected to grade student work, perform administrative work, and prepare high quality lessons, all within one hour for each hour they spend in front of the classroom. Japanese teachers have approximately three hours of preparatory time for each hour they spend actively teaching. While many U.S. teachers compensate by working even longer hours, such a path is not sustainable and contributes to high teacher turnover rates.

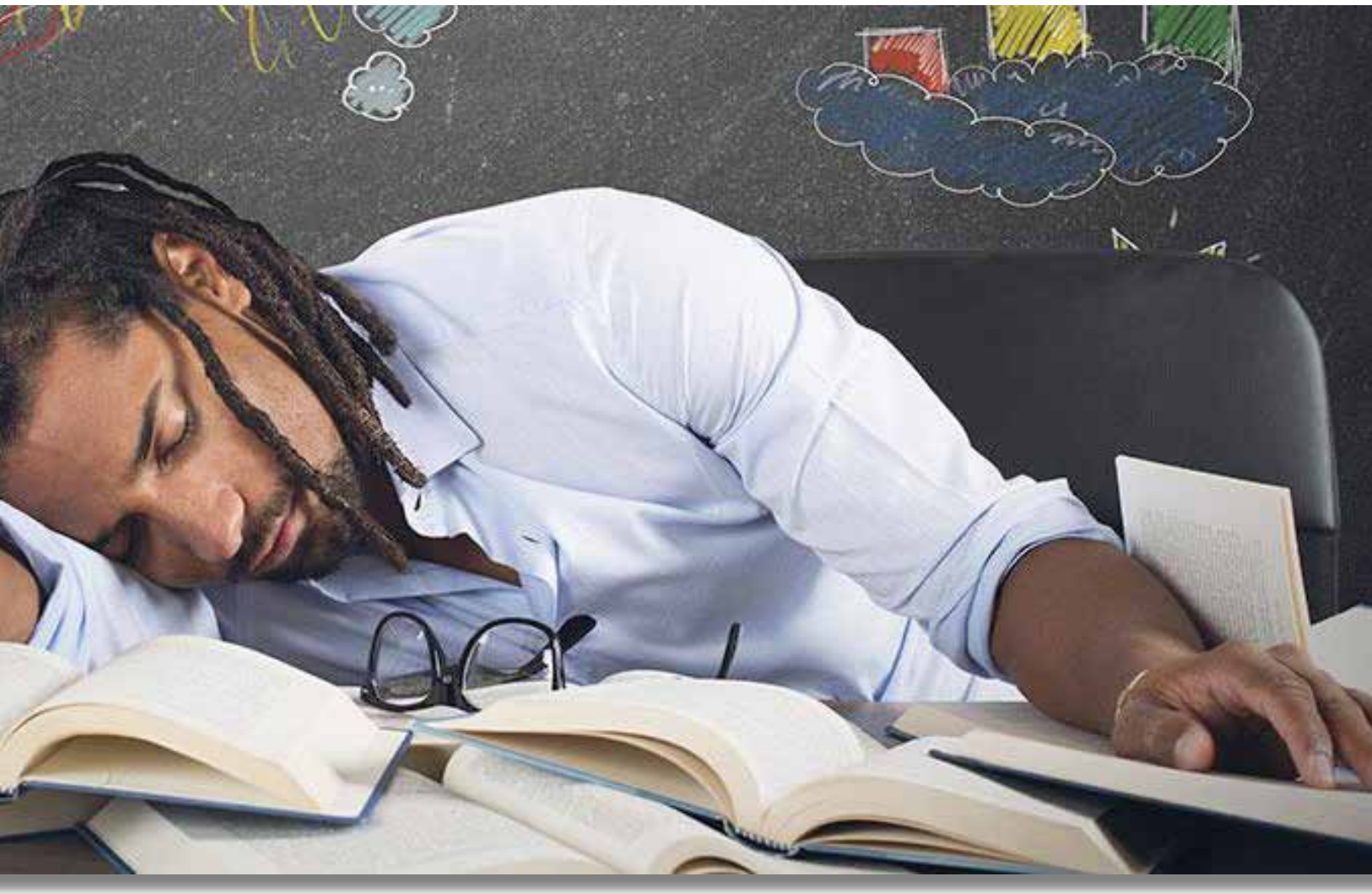


In a bid to help overwhelmed teachers move away from daily handmade lesson planning, some educators have begun to share their lessons online.

While lesson sharing traditionally occurs within individual schools, the Internet allows teachers to post their lessons online so colleagues from around the globe can benefit. Today there are numerous lesson-sharing services. They typically consist of large databases of lesson plans, as well as accompanying materials or videos, organized by content and grade level. In this way, lesson-sharing services can be viewed as an attempt to "crowdsource" lesson planning and allow teachers to harness resources that have already been created elsewhere.

TeachersPayTeachers.com, for instance, has more than 750,000 lessons that have been downloaded 13.7 million times (TeachersPayTeachers.com). One kindergarten teacher, Deanna Jump, has earnings from TeachersPayTeachers in excess on $1,000,000. Total teacher earnings have exceeded $30,000,000 (EdSurge, 2013).

BetterLesson.com has more than 600,000 lessons, and in 2013 averaged greater than 300,000 visitors a month. ShareMyLesson.com, a project of the American Federation of Teachers, has been one of the fastest growing of these services, with nearly 250,000 lessons contributed in its first year of operation.



Khan Academy has more than 3000 lectures created by Sal Khan and other experts; combined, they have been viewed more than 320 million times (KhanAcademy.com).

MIT BLOSSOMS has more than 100 shared interactive lessons created by teachers and students in nine different countries. Although the online lesson-sharing space is diverse and each of these services utilizes a unique approach, all lesson-sharing services have two main goals: public posting of lesson plans and curation to help organize and identify the appropriate lesson for each teacher. To achieve these goals, lesson-sharing services either use experts or crowd-sourcing, with and without money exchanged.

Crowd-sourced lesson sharing is accomplished by enabling teachers to upload their lesson plans, to be shared online. BetterLesson, ShareMyLesson and TeachersPayTeachers are examples. Participating teachers are motivated either by altruism (BetterLesson and ShareMyLesson) or by possible monetary gain (TeachersPayTeachers).

Crowd-sourcing results in each of the sites having hundreds of thousands of lessons. However, such large numbers create problems for users. There is little information about lesson quality, and the numbers are so large that individual experts cannot curate the collections to identify high-quality lessons. Instead, these services often rely on user-teachers to rateeach lesson individually; this happens after or, more likely, before they ever use them in their classrooms.

With such unreliable ranking systems, teachers must spend time sorting through myriad online lessons for potential adaptation to their own specific needs, often leading to little or no time saved compared to the homemade craft alternative.

This is cool

You thought drones were cool....check this out.

If you are considering a profession in the medical field, which is of course a STEM career and FULL of STEM skills and applications, the innovations you'll learn about and use will seem like science fiction. This is way cool.

When you don't know what's happening in your body, it's hard not to worry. The PillCam SB capsule endoscopy procedure is a safe, simple way to view your entire small bowel from the inside out. Seeing parts of your body that you've likely never seen can give your doctor insight – and give you confidence in your treatment plan.

PillCam SB doesn't require sedation, the use of potentially dangerous chemicals or injections or inserting tubes into your digestive tract. And, aside from not eating for 10 hours before the procedure (generally overnight), it requires no preparation.

Direct visualization of the small bowel is necessary to accurately and fully assess early disease activity and progression. PillCam SB is able to directly see the early stages of small abnormalities, where other X-rays and scans may not be effective.

Because PillCam SB can aid in the early detection of problems and early disease responds better to treatment, it could potentially improve your overall quality of life.

The capsule is equipped with a miniature video camera and light source It travels painlessly through your entire digestive tract. It captures images quickly and sends them to a recording device you wear during the procedure. Keep in mind, your digestive system is 23 feet long, so it takes a while for the Pill Cam to take its trip. What a great addition to the family photo album.

"With fewer than 5% of working engineers being women of color, more attention and support could help to increase diversity in the engineering profession," said Roberta Rincon, manager of research at SWE.

So Many Engineers Helped Mentor Me

and Now I "Pay It Forward" by Mentoring Others

By Sol Rosenbaum

Several years into my career, I was at a networking event when the topic of mentoring came up. As the conversation continued, one of the guys noted that he never had a mentor to whom he could turn.

"Wait" I interjected, "You mean that nobody at your firm took you under their wing to help you or that you just didn't have a good mentor?" He responded that he simply never had a mentor during engineering school nor in the years since he had graduated and entered the engineering industry. This was a shock to me. After all, I had several family members who were engineers and they supported me through the ups & downs of engineering school.

When I was in engineering school, I was connected with upperclassmen and recent engineering graduates that I could turn to work advice and guidance. As I entered the engineering world following graduation, I had a string of great bosses and senior co-workers that mentored me and really helped guide my career.

It had never occurred to me that my situation was not the norm and I started to investigate this a bit further.

I set up a survey and sent it out to all of the engineers I knew and asked them to share it with others as well.

After a few weeks and a fair number of responses, I had the data I needed to dig further into this topic.

My primary finding was that there has been a significant change in the percentage of mentors within the past 20-25 years. When asked if they had a mentor in the first few year of their career, those in the industry for 15+ years answered that they had a mentor at an 85% rate. In contrast, those with around 10 years of experience had a 72% rate and those with 3-5 years had a 55% rate. Keep in mind, all of the respondents were asked about their first few years, so the higher rate among the older engineers is not due to the fact that they have been in the industry longer and have had more years in which to have a mentor.

I started to look at the data to try and find any trends in the data or perhaps some reasoning behind this disparity. What I found was that the rate was fairly steady regardless of engineering major, region, or industry one entered.

However, where I did find higher rates were among higher ranked universities and among students who entered engineering school 2-3 older than the "norm". This makes sense as the higher ranked schools often offer more programing to ensure successful graduates to keep their elite status. Similarly, the maturity of older students led them to seek out advice at greater rates than the younger students.

So why does any of this matter? What I found is that the rates of mentorship correlate greatly with the general happiness one has at work, their general career satisfaction, and with greater ambition to strive for new heights. Therefore, we are shortchanging the future of engineering by not properly supporting our younger engineers with mentorship. If we care about the future of engineering, then we need to care enough to cultivate the engineers that will follow in our footsteps. This ideal led me to begin actively start mentoring younger engineers with the following four pillars as my guiding force. I wanted to know that:

- Younger engineers had somewhere to turn for job search advice (and also when to leave a toxic one).

- Younger engineers need somewhere to turn when they feel like they are in over their heads (aka: Impostor Syndrome) and need a pep talk.

- Younger engineers knew it was ok to search for their interests and to change career trajectories.

- Younger engineers understood that non-technical skills are an important part of their future success.

With these guiding pillars in mind, I started out small and was just helping a few of the engineers in my office as well as ones I had been in touch with through various networking programs. My plan was to be a resource for them and give them the tools with which they could then make their own decisions.

Over time, I found that I could reach more engineers by connecting with engineers on sites such as Quora and Reddit and by creating a website to provide materials that could be accessed by young engineers across the world. Unfortunately, I found that mentoring rates in other countries were even lower than in the US, so expanding my reach internationally had an out-sized impact.

Through this process, I was always focusing on giving back as a way to "pay it forward" for all of the mentoring I had received over the years. What I had not expected for was how much I gained from this process. It was really eye opening to see that what I took for granted was not afforded to others and it truly was a gift that has enabled me to have a successful engineering career.

This has led me to be more grateful for the "little things" in life and to recognize how they have helped me reach where I am today.

Further, on a technical level, I think it has also help sharpen my skills since teaching others requires you to have a real understanding of the little details of the problem.

However, the greatest thing this process has given me is hope & confidence in the future of the engineering field I love so much. To see so many young minds really diving into engineering with such enthusiasm is really beautiful. I know that when the time comes for me and my colleagues to retire that the industry is in good hands.

So where do we go from here? If you are already in the engineering field and I inspired you to mentor some engineers, here are three simple things you can do to in your office to help the younger crowd:

1. Get to know the new guy. Even if you are not an official mentor, let the new hires know that you are there for them as the more experienced engineer

2. Set up an internship program. Having engineering students work for shorter periods of time in a limited capacity can really help them understand the profession and build skills that they can use when they graduate.

3. Have a giving mindset. Think about ways you can give to others in an effort to pass down the information that others have given to you. Don't worry about what someone can (or can't) do for you, just help them out.

If you are an engineering student or in the early years of your career, I encourage you to reach out and try to form a bond with someone who can help mentor you. While I do not believe that I can replace a mentor who knows you personally, I do invite everyone to check out my website, www.TheEngineeringMentor.com. The articles are geared towards younger engineers with a focus on helping them towards successful careers.

Finally, keep in mind that although this article focused on the younger engineers, you are never too old to have a mentor and are never too old to have some outside guidance. After all, even the greatest of Olympic athletes still have coaches.

About the Author:

Sol Rosenbaum, PE, CEM, CPMP, GGP received his BS and MS in mechanical engineering from Columbia University and has worked in the energy engineering industry for 18 plus years.

Currently, he is the Director of Green & Energy Services at GRS Group, a Commercial Real Estate transactional services firm. Mr. Rosenbaum has passion for helping out younger engineers and is the founder of The Engineering Mentor.

He is active on LinkedIn and invites readers to connect with him there or at his website, www.TheEngineeringMentor.com.

My Fourth Grade Students' Foray into Construction

Three Benefits of Partnering with Local Industry to Enhance Project-Based Learning

By Doug Robertson

Nowhere in the standards does it say, "make a bench," yet designing and making a bench is what my fourth-grade students sought to do last year. My job was to link their experience into the standards. In Gresham-Barlow School District we embarked on an initiative to develop Pathways to Career Success by fostering partnerships with local businesses in conjunction with the launch of our construction pathway.

The construction pathway, sparked by the leadership of our superintendent, Dr. A. Katrise Perera, developed opportunities for business representatives to collaborate with teachers from the elementary through high school level to create experiences for students that would spark their imagination, inspire them to be engaged learners, and help them see how their learning connects to the wider world.

As an elementary teacher who already uses project-based learning as an instructional tool for student engagement, I was asked to be involved in this effort. Because I'm always seeking out new, worthwhile learning experiences for my students, I said yes and dove right in.

Starting in January, my class was paired up with Fortis Construction, which is currently rebuilding one of our high schools. When presented with an initial packet of project ideas deemed "elementary-appropriate," I tossed them aside and explained that we needed more of a challenge — my students had already developed experiments involving marbles and ramps and had recently built a cardboard arcade.

They were ready for projects pitched at older students. This led to a lively brainstorming session with Fortis that revolved around the question: "How can the product be visible and exist in the real world for a real amount of time?" Soon we decided that students could design benches for the school community that Fortis would then build and install.

Brainstorming designs

We planned four dates for Fortis to come visit the school over the next few months. During their first visit, Fortis representatives presented the bench challenge to students and supplied them with basic parameters like how long the benches could be, how tall, how wide, and what materials they needed to use (wood only). Importantly, they encouraged students to be creative. Over the next week, my students got to work. We decided to break the class up into eleven groups with each group designing its own bench. Fortis and a panel of experts would ultimately choose four of the 11 designs to actually build.

During this phase of the project, the creativity and energy in the room was palpable, and the number of math problems that organically stemmed from this project was remarkable. A couple groups designed benches to look like our school mascot, the panther, and one of those groups even put a tail on their bench design to wrap around to the front and serve as a footrest.

Other groups, who were concerned about rain or too much sun, got busy engineering covers that would extend over their benches. Students sat on yardsticks trying to figure out how many people could sit on one bench, while others were stopping Kindergärtners in the hall to see where their knees bent so the benches would be accessible for children of various ages.

I didn't learn until later that the Fortis representatives were initially skeptical that the students could pull it off. But the next two times they came in to visit, they realized they'd not only be getting workable designs, but ones that were also deep, creative, and thoughtful. Recognizing this, they enthusiastically moved about the room visiting with each group to offer advice, not stifle ideas.

Making blueprints

In my classroom, I always require my students to plan everything they build so

they don't end up with materials scattered all over the floor and nothing to show for their efforts. I warned the particularly inventive groups (the ones with tails or covers for their benches) that I wasn't sure their designs were build-able, but I also advised them not to hold back and ask for help from the pros. So they did, backed by solid measurements and hand-drawn blueprints. The Fortis representatives also taught students to make much more sophisticated blueprints with three views and demonstrated how those views work together.

In the next couple weeks, I also introduced my students to Tinkercad, the free 3D design program. I asked them, "Wouldn't it be cool if you designed your benches in Tinkercad so you could see them in three dimensions and rotate them?" But rather than teaching them how to use the program, I showed, suggested, and moved aside. Soon they were diving in, figuring out for themselves how to transfer their blueprints to TinkerCad and improve their models along the way.

Pitching to the panel

We invited the Fortis representatives, their superintendent, my principal, my superintendent, and a few others to sit on a panel and judge the students' presentations based on specific criteria.

Pitches were scheduled to take place on the fourth week of the project, but before the big day, students needed to prepare, so they began giving mock presentations to the class. I gave them very specific, Paul Hollywood-style feedback about presentation style, content, models and designs. The fact that they would soon be presenting for an authentic audience inspired them to rehearse at length.

On the big day, each group spoke eloquently and shared their designs both on paper and on Tinkercad, touching on all the design elements we had explored in class. They argued persuasively about why the benches were needed and how their particular design best solved the challenges they identified. In sum, they nailed it. The panel deliberated, and after much debate, chose four winning bench designs.

Soon Fortis set to work on the construction. Since the plan was to use the benches outside in our school garden, my students began collaborating with the fifth grade class that was redesigning the garden. They wanted to be sure their bench designs matched the garden plans in progress.

A few weeks later, the benches were delivered, unpainted, but built, and it was time for the grand reveal. The students were overjoyed. But they soon learned another lesson. While the plan was for the wooden benches to be painted purple and black, according to their designs, Fortis had used a very high-quality wood to make them, and some of the adults argued they would look best without any paint at all.

The students compromised and agreed to a stain that would still show the grain of the wood. They also had to compromise on where the benches would be placed. Although students had designed the benches to go outside to help create an outdoor classroom area that would complement the fifth-grade garden, it was decided by powers above us that they were too nice to be left outside.

It was difficult for the kids to accept a change in plans, so they wrote letters to Fortis. The students were thrilled to hear back that Fortis understood their disappointment and would build them eight benches cheaper, simpler, sustainable benches that could be placed in the garden.

Lessons learned

Ultimately, there were three main benefits to our bench project.

- Hands-on, relevant learning — While I'm not out to prepare my fourth graders for the future workforce, I am getting them interested in creating and making. If they can then see how their ideas make an impact and how the making process connects to actual work, even better. This project allowed students to see their work take shape in real life, while using math, design, presenting, writing, and problem-solving.

It helped students see what is possible and make connections between their classroom work and the wider world. It also taught them to pivot — when one idea failed, they were quick to try another.

- High levels of engagement — The level of student engagement throughout this project was sky-high. Students were energized by the fact that the objects they were designing would soon exist and that they could bounce their ideas off industry professionals.

A project-based learning approach engages students in a way that changes their attitude toward learning. In this type of environment, students are simply too busy to play around. It also gives those who don't feel successful with traditional forms of education an outlet to exercise their considerable capacities.

- Self-reflection — From the start, I was very clear that this project was not about building benches. My students will most likely never need to know how to build a bench. Instead, we were teaching them so much more, including the essential skills of communication and collaboration, perseverance, creativity, and innovation.

We were also teaching them to reflect on their process. All throughout, my students had many conversations with each other, with me, and with Fortis about what they were learning.

With directions, parameters, and help, but not nudging, my fourth graders planned, blueprinted, measured, and justified these benches into existence. But we couldn't have done it by ourselves.

Through the close collaboration of everyone involved — the Fortis representatives, various district personnel, my principal, me and my class — plus the freedom to dream new projects into existence, we were able to turn this unique partnership with our local industry into a meaningful project for students, one that I believe they will remember for years to come. And now I'm trying to figure out how to top it this school year.

"I wonder if we can build something that flies..."

Doug Robertson teaches fourth grade and has written three books about teaching:

He's the Weird Teacher, THE Teaching Text (You're Welcome), and A Classroom Of One. Doug also tweets at @TheWeirdTeacher.

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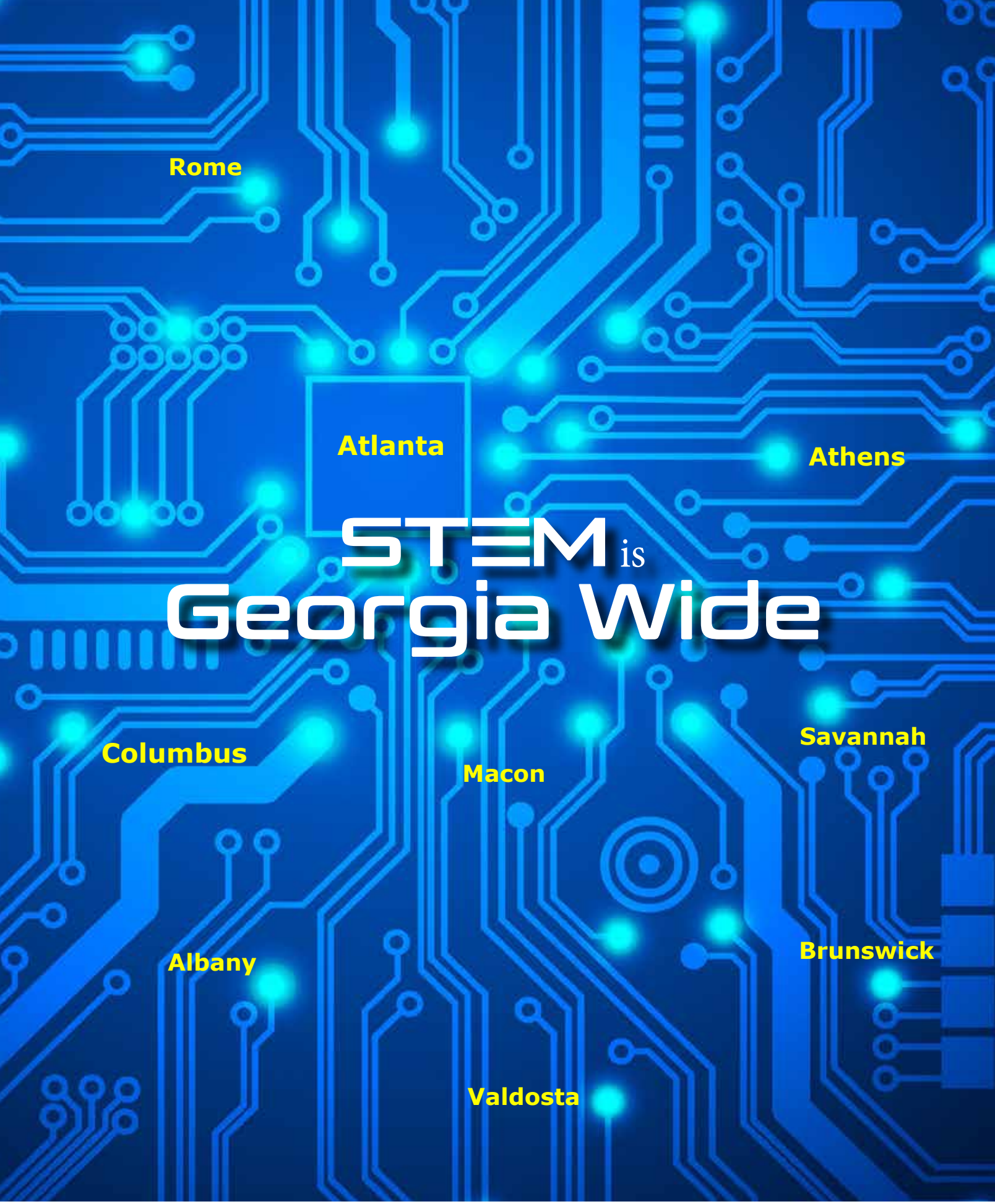

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