December 2021

GEORGIA PATHWAYS

MAGAZINE

Pathways To Leadership

TAG-Ed workforce development

NASA Contest

Register Soon

Ask Better Questions

TAG
Technology Association of Georgia

TAG | TAG-Ed
Education Collaborative

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 2000. 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.

President / CEO
Larry K. Williams

TAG-Ed Executive Director
Heather Maxfield

Publisher
Wayne Carley
wayne@tagonline.org

The Technology Association of Georgia (TAG) and
TAG Education Collaborative
4400 North Point Parkway
Suite 155
Alpharetta, Ga. 30022

http://www.tagedonline.org

Welcome to the December issue of Georgia Pathways Magazine.

TAG
Technology Association of Georgia

Georgia and innovation are synonymous across an array of industries contributing to the health of our state's economy and workforce.

As we look forward to 2022, TAG and TAG-Ed is proud to support Georgia's growing network of 30+ Corporate Innovation Centers. From Delta, Boeing and Pratt industries to NCR, Comcast and Home Depot, the list of amazing company Innovation Centers is impressive. With a robust density of accelerators, incubators and co-working spaces, Georgia is at the forefront of talent recruitment, technology development, and collaboration across public and private sectors.

These Innovation Centers have similar goals to TAG-Ed, the education and career development arm of TAG. TAG-Ed's mission is to strengthen Georgia's workforce by providing career enhancement opportunities, mentorship and continuing education in a wide spectrum of industries across Georgia and the nation.

Having access, exposure and awareness of these resources is a primary goal for TAG-Ed as we reach out to a diverse population seeking to improve their livelihoods and our state's wellbeing.

As you review programs TAG-Ed has on tap for 2022, you'll notice the underlying focus on relevant and innovative professional development opportunities. These programs make vital immersion and mentor connections that are invaluable to every industry in Georgia.

For every young and seasoned professional in our state, continued development, enhancement and incorporation of new innovations in software, economics, cybersecurity, conservation and services, will lead to a healthier, more productive and rewarding Georgia economy and workforce.

To learn more about these wonderful Innovation Centers, visit https://www.georgia.org/industries/corporate-innovation-centers/all-companies

Larry K. Williams
President
TAG / 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.

TAG | TAG-Ed Education Collaborative

Pathways To Leadership

Twenty twenty-one has seen some exciting and encouraging opportunities through the efforts of the Technology Association of Georgia Education Collaborative. One such career development programs is the Pathways To Leadership program launched this past summer.

Pathways to Leadership provides a unique opportunity for ambitious young professionals to learn directly from industry experts and executives. For these future C-Suite professionals and TECH leaders, this program doubles as a valuable learning experience and a diverse networking opportunity. The graduating class of 2022 will have the necessary skills to not only succeed but thrive in their careers.

Having the drive and enthusiasm to accel in your field of endeavor is often not enough alone, but when a rare and effective mentoring and networking opportunity is mixed in, tremendous things happen for all of the participants.

The current group of participants has been attending sessions, tailored to their needs by industry expert instructors and commentary from executive team leaders. Some of the issues which are being discussed include creative problem-solving, strategic agility, conflict management, navigating change, effective leadership and more.

Participants are being given the opportunity to work with the Atlanta Zoo, who has partnered with Pathways to Leadership to reach many of these goal and objectives to make this group of young professionals as effective as possible going into 2022. Open discussion style sessions take place one Tuesday a month, from 4-6pm. Executive team leaders include Jeffrey Buzzelli, Senior VP of Comcast

Business, Kyle Tothill, Co-Founder & Managing Director of eHire, Phyllis New-House, CEO of Xtreme Solutions Inc. and Founder of Athena Technology Corp., and many other talented and experienced individuals as well.

These Cohort members for the twelve-month program have been chosen based on their nomination by an executive within their organization or community. Nominations were accepted from community organizations, businesses, and in the future – PTL alumni.

To date, this new initiative from TAG-Ed is showing to be not only popular among participants and leadership, but is already sparking enthusiasm among those looking in from the outside, planning their participation in the next offering for the 2022-23 season.

Be sure and check the TAG-Ed website this spring for information about the next registration and nomination opportunities. Self-nomination is welcome, so your initiative and drive will not go unnoticed.

Thank you again to those currently involved and our communities and state at large are excited to benefit from your professional growth and effectiveness.

https://www.tagedonline.org/pathways-to-leadership/

LUNABOTICS JUNIOR

CONTEST

K-12 STUDENTS! DESIGN A ROBOT AND YOU COULD

WIN A VIRTUAL SESSION WITH A NASA EXPERT

WIN A LUNABOTICS JR PRIZE PACK

WIN A VIRTUAL CHAT FOR YOUR CLASS WITH NASA

Sign up for the contest (it's free!), learn about the Moon, and submit your entry at:
www.futureengineers.org/lunaboticsjunior

(TEACHERS CAN SIGN UP AN ENTIRE CLASS!)

ENTRIES DUE JAN 25, 2022

IN SUPPORT OF
NASA'S HEOMD AND OSTEM

NASA Lunabotics Junior Challenges Students to Design Moon-Digging Robots

NASA seeks young engineers to help design a new robot for an excavation mission on the Moon. The Lunabotics Junior Contest https://www.futureengineers.org/lunaboticsjunior, open to K-12 students in U.S. public, private, and homeschools, starts accepting entries on Wednesday, Oct. 20, and runs through Jan. 25, 2022.

The competition, which is a collaboration between NASA and Future Engineers https://www.futureengineers.org/lunaboticsjunior, asks students to design a robot that digs and moves lunar soil called regolith from an area of the lunar south pole to a holding container near a future Artemis Moon base https://www.nasa.gov/specials/artemis/.

"Developing mining capabilities on the Moon will require innovation and creativity, and students are some of the most creative thinkers," said Mike Kincaid, NASA's associate administrator for the Office of STEM Engagement. "The next generation always brings new perspectives, inventive ideas, and a sense of optimism to the challenges NASA puts in front of them. I'm really looking forward to seeing the designs they submit to Lunabotics Junior."

NASA's Artemis missions are returning to the Moon with the first woman and first person of color, and will create a long-term human presence that will serve as a springboard for future Martian exploration. Lunar regolith is instrumental in this development, and could be used to create lunar concrete, reducing the amount and cost of materials that need to be transported from Earth.

Artemis Student Challenges https://stem.nasa.gov/artemis/ such as the Lunabotics Junior Contest create unique opportunities for a diverse group of students to contribute to NASA's work in exploration and discovery while celebrating their creativity and innovation.

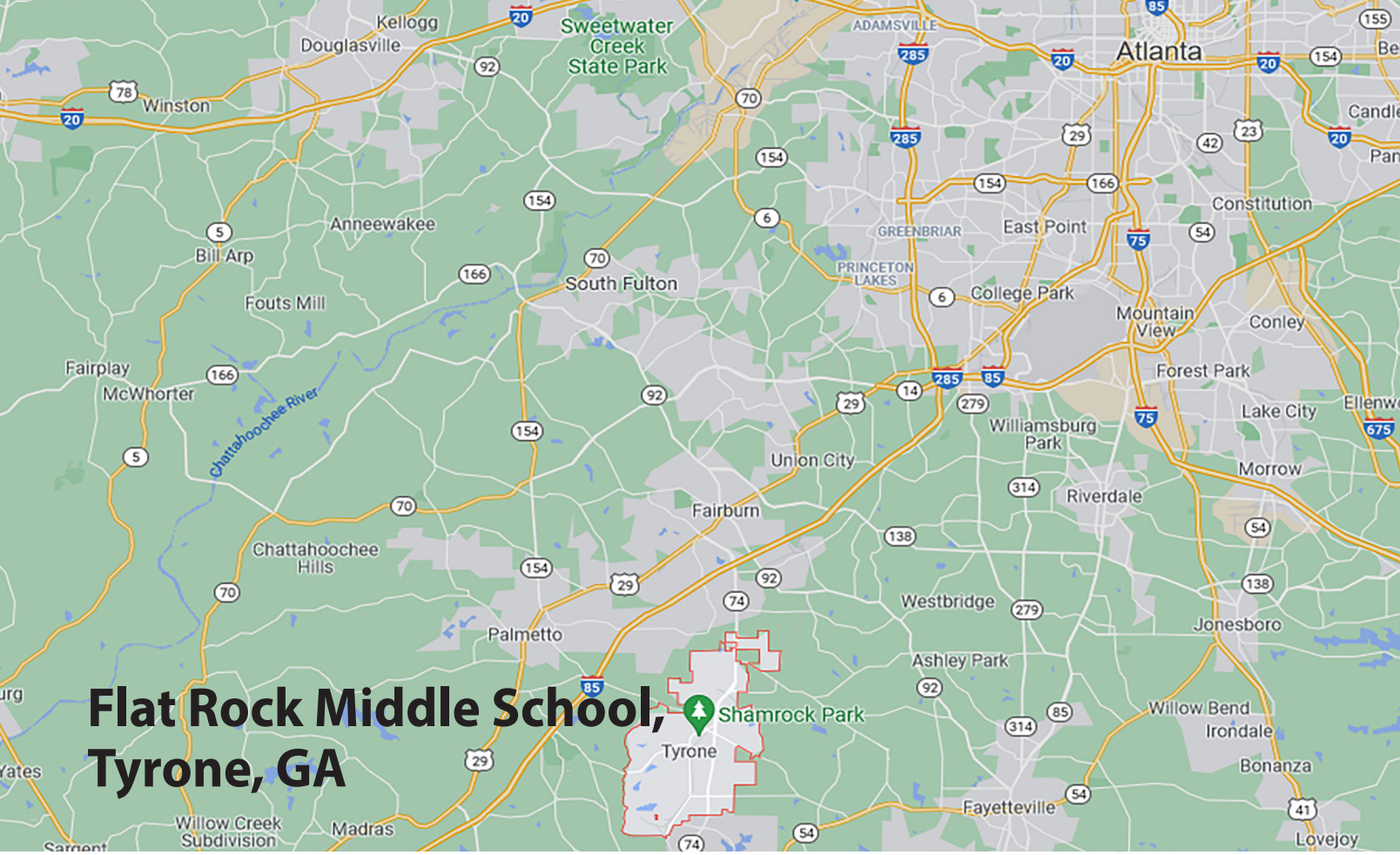
To enter the contest, students must submit by Jan. 25, 2022, an image of the robot design and a written summary that explains how the design is intended to operate on the Moon.

While students are not tasked to actually build a robot, they are asked to envision a robot design that is no larger than 3.5 feet by 2 feet by 2 feet and addresses three main design features: how the physical design of the robot will enable it to scoop/dig and move the lunar regolith, whether the robot will operate by moving large amounts of dirt per trip or transporting less dirt in more trips, and how the design and operation of the robot will meet the big challenge of lunar dust that is stirred up and can "stick" to surfaces when lunar regolith is moved.

Students can sign up individually or teachers can register their entire class. Entries will be split into two categories – grades K-5 and grades 6-12. Ten semi-finalists will receive a Lunabotics Junior prize pack and four national finalists from each category will win a virtual session with a NASA subject matter expert. The national winner from each category will be announced on March 29, 2022, and will be awarded a virtual chat for their class with Kennedy Space Center Director Janet Petro. For all contest and prize details, including education resources, visit: https://www.futureengineers.org/lunaboticsjunior

NASA and Future Engineers are seeking volunteers to help judge the entries anticipated to be submitted from around the country. U.S. residents interested in offering approximately five hours of their time completed over a 10-day period should register to be a judge at:

https://www.futureengineers.org/registration/judge/lunaboticsjunior



Community Partners Needed

By Sarah Thompson

It's 1:30 pm on a Monday afternoon at Flat Rock Middle School in Tyrone, GA. Parker has just finished a challenging schedule of academic subjects- Math, Science, ELA, and Social Studies, and now it's his favorite part of the day: STEAM Class. I greet him warmly at the door as he arrives at my STEAM Classroom. He walks in and meets with his teammates to review their task for the week. His class of 6th graders is charged with designing and managing a compost program for the school.

My name is Sarah Thompson, and I am the STEAM and Creativity Coordinator at Flat Rock Middle School. A veteran teacher and gardener, I approach Science and Technology education with a green thumb. My role at Flat Rock is to incorporate real-world opportunities into classroom lessons that spark creative connections between students and their academic subjects. I build elements into the STEAM Program that Parker and his classmates are learning in their 6th grade Science curriculum, including the water and rock cycle, into the Compost Program.

Parker and his team gather their equipment: a compost thermometer, gloves, and logbook, and head to the Food Forest. The sunlight shining through the exit door beckons them, and their faces transform into broad smiles as the class walks outside.

Flat Rock's Food Forest spans roughly a quarter of an acre and boasts an orchard, vegetable and pollinator garden, compost row, and aquaponic pond. In the STEAM Program, students connect concepts that they are learning in Science, Social Studies, and ELA, with hands-on work in the Food Forest. We're so fortunate at Flat Rock to have these areas on our campus. They are incubators for transformational learning and growth in our students! It's a happy place, where student-designed scarecrows polka dot the landscape for the "Scarecrows in the Food Forest '' showcase, and surprises can be found around every corner.

The plants in the Food Forest are as diverse as Flat Rock students themselves. There are old standbys like apple and pear trees, turnip and collard greens, and radishes. But plant markers give interesting facts about surprising plant varieties like Serviceberry trees, Gogi Berry bushes, Black Radishes, and Casperita Pumpkins. Garden signs and plant markers are written in the native languages of FRMS families: Spanish, Vietnamese, Chinese, Japanese, Wolof, Haitian Creole, and Telugu, just to name a few.

Classes are everywhere on this beautiful day. One teacher, Ms. Boykin, is smiling as her students follow a self-guided scavenger hunt in the Food Forest. Signs throughout the garden contain words that solve a mystery sentence. Other classes are setting out their Scarecrows for the upcoming exhibition, and still more are conducting science experiments in the sun.

Parker gathers shovels from the shed for his teammates. Today, they will be turning the compost piles and bins and monitoring the average temperature of the compost on Compost Row. They have learned that the compost needs to be hot in order to break down efficiently. He proudly notes, "Whenever we work in the garden, I feel successful." Another team monitors the compost tumblers to make sure there is an adequate balance of carbon and nitrogen. Still another team is shoveling and spreading seasoned compost into wheelbarrows to spread on the fall vegetables. Students in Parker's class have composted over 400 pounds of unusable fruits and vegetables from the cafeteria in the last four weeks alone, and proudly add that in addition to adding nutrients to the garden, they are also saving that amount from the landfill.

After a productive and fun work session, they head back to the STEAM classroom for a debrief. Parker's group shares the temperature average with the class, while another team updates the class with the most recent count of compost additions.

The students eagerly update their data tables in their logbooks, file them, and line up. They are already looking forward to the next day in the garden. " I don't really like closings, because that's when we leave, and I don't want to leave!" says Parker.

While Parker's 6th-grade class manages the Compost Program for the school, other grade levels tackle additional aspects of the Food Forest Program. 7th graders manage the plants of the Food Forest: weeding, harvesting, pruning, and watering. 8th graders care for the plants and fish and test water quality at the Aquaponic pond. In addition to their daily duties outdoors in the fresh air, Flat Rock Middle School students learn about STEAM careers and meet industry professionals.

Last week, they pitched their pickle recipes created in a previous lesson to Crystal Richards, owner of Pickle Puss Pickles.

Students learned about the history of pickling and created their own recipes using cucumbers, okra, carrots, and dill from the garden. Europeans, settlers in Georgia, even ancient Egyptians needed a way to make the summer harvest last through the winter. 7th-grade life science students learned about beneficial lactobacillus bacteria, and 8th-grade physical science students learned about acetic acid in vinegar and chemical changes that happen when vegetables are pickled. The Food Forest creates this natural bridge that we use to extend learning and form natural connections between disciplines in a fun and engaging way. The students have so much fun, they don't even realize they're learning. "I loved eating what we planted," says Parker.

It's no surprise that the Food Forest benefits the students in so many ways. Flat Rock Middle School uses the garden:

- To teach youth how food grows. Students spend time in the Food Forest during school and club hours. They design, plant, harvest, weed, water, prune and inventory the garden daily.

- To reinforce multidisciplinary academic learning. In the early Fall, students make pickles with cucumbers and spices harvested in the garden to learn about how Georgia settlers preserved food and then studied the beneficial lactobacillus bacteria created from the pickling process.

They write about their special pickle recipe. "Flat Rock Students involved in our school garden and nutrition program generally take pleasure in learning and show positive attitudes towards education. We hope that, in this pilot year of our Food Forest, students who have our school garden program incorporated into their science curriculum will score significantly higher on science achievement tests than students who are taught by strictly traditional classroom methods."

- To create awareness around environmental issues. Eighth graders test pond water quality several times a week and experience how environmental changes like heat, rain, or runoff can affect the pond ecosystem.

- As a tool for nutrition education lessons. Students make dishes like Butternut Squash Mac 'N Cheese, and learn how fast and easy it is to re-invent a favorite dish in a healthy way! Gardening in the urban school setting provides students access to healthy fresh foods in otherwise inaccessible neighborhoods. In certain communities where food deserts are prevalent, school gardens like the Flat Rock Food Forest provide a nutritional avenue for students and their families.

- As a way to connect with students' culture. Students make plant markers in their native languages.

The school invites Flat Rock families to plant fruits and vegetables that reflect their culture in their International Garden.

- To strengthen students' sense of place
- To introduce food systems
- To provide fresh food for cooking lessons
- To supply fresh food for our cafeteria
- To provide fresh food for families and/or to donate to the community
- For a school garden business

Flat Rock Middle School is looking for community partners to volunteer, garden supplies, or contributions to fund their mission. Contact Mrs. Thompson thompson.sarah@fcboe.org to learn more.

Sarah Thompson is the STEAM/Creativity Coordinator at Flat Rock Middle School in Tyrone, GA. She has over twenty years of experience and has presented on topics ranging from STEAM to gardening. She believes that hands-on learning through technical education is key to students' academic success.

Are your students, children, preparing to repair these "servants of mankind" as their near future career field?

Are they even interested?

Should they be?

What do they need to learn?

4 Ways to Make Lessons Come Alive Online

By Misti Bagley

As our isolation continues to sweep across the globe, communities are still adjusting to a new normal. For many students this means getting used to attending school from their homes. And for many teachers, this means transitioning face-to-face lessons to a virtual presentation.

Not surprisingly, so many of us are concerned about our students' ability to stay focused during this unprecedented time. After all, their computers are not only portals to the world; they can also lead to endless possibilities of distraction.

Knox Forest School

Knoxville's first forest school program

Over the years, I've honed my strategies for keeping students engaged online. As a career education teacher at an online school, I have valuable experience leading an online classroom. That's why I want to share four tips that will make your lessons come alive online and grab your students' attention.

Use Interactive Activities

Now that students are no longer sitting in front of you or their peers in a classroom you have to find new ways to encourage interaction. Fortunately, there are many activities you can incorporate into your lessons to foster an engaging and interactive learning environment.

First, consider starting your lessons by directing students to a discussion board. The questions I ask students as the class begins may not always be about the material (like their favorite book or movie) asking stress-free questions warms them up before we jump into the lesson. Collaboration boards also serve as a useful tool that allows students to view and respond to classmates' messages. Though they are not seeing each other face-to-face, these boards allow them to engage in shared discussions together.

Another helpful tool that I love to use are breakout rooms. In a brick-and-mortar classroom you would typically separate students into smaller groups and have them spread out and work together. It is just as easy online. You can place students in virtual meeting rooms where they can chat and brainstorm together and strengthen their team-building skills.

Encourage Engagement and Questions

Engagement is not easy, but it is a necessity. I have found that to increase engagement in the class, I have to ensure that students understand every lesson. By creating short instructional videos to walk through assignments, everyone can get on the same page and they can re-watch a segment until they grasp the main ideas or concepts.

Then, you can turn around to the students. Supplement your lessons with interactive activities that engage them in the material. For example, I occasionally create FlipGrid's to provide a visual component to lessons. Also, when students engage with the content, be sure to encourage questions and ongoing discussion. It can be intimidating for students to ask questions face-to-face, and for some students this anxiety only increases in a virtual setting.

Making Testing Fun … Yes Fun

Online school defies some of the traditional concepts we have when it comes to teaching. So, as you modify your lessons, consider unique ways to test students' knowledge of the subject. Make sure you are presenting the material in an applicable and identifiable way. Test their knowledge as you move along by including polls and discussion questions.

Another favorite is to include games that are relevant to the lesson. For example, I use PowerPoint based games like Jeopardy and Family Feud. These programs are already familiar to them and gets them engaged in the game from the start. Using an all-time student favorite, Kahoot, helps as well. The competition among students is fierce, but they learn the material at the same time in a fun and interactive way.

Embrace the Virtual World

Now that you have entered the virtual world, I encourage you to embrace it. It provides so many opportunities to enrich student's education. But also recognize that some students will need more guidance than others. As a CTE teacher, my students understand computer systems but not all students have that same background. Serve as a guide for those who need help. But not all students have to be STEM focused to thrive in an online classroom. There are plenty of online resources for teachers of all subjects to use to build their lessons.

It's possible that in a few months, some of you will return to a brick-and-mortar classroom while others will remain on the digital path. Either way, I urge you to consider the lessons learned and continue to incorporate that into your teaching plans moving forward. Online education can make your lessons come alive and really get students excited about learning. At a time when there is so much uncertainty in the world, helping students focus with engaging, informative lessons, is key.

Misti Bagley has served as an educator for nine years, four of which were in an online classroom. She currently teaches Software Programming and Development at Utah Virtual Academy.

To ***Motivate*** Students -

Ask Them Better Questions

By Dr. Richard C. Larson, MIT

What do these four questions have in common?

1. Can all the children of Lake Wobegon be above average?

2. On average, do your friends on Facebook have more friends than you do?

3. Do credit cards make you gain weight?

4. How do I estimate distances to nearby stars?

They are all math questions for high school students. They differ from typical school math problems in that they are phenomenon-based and stated as real-world problems, not as math exercises.

More and more educators these days are pushing for such phenomenon-based problems to engage the students, to get them excited about STEM, to advance their critical thinking skills, and to make math and science more fun.

A past research summary report from Toronto summarizes well the arguments in favor of phenomenon-based learning. According to the report, "a large majority of students find mathematics 'boring, mostly irrelevant and unrewarding.'" Phenomenon-motivated problems engage students more directly, offering relevance, opportunity for critical and careful thinking, and even joy. Many students who find math boring view it as merely a sequence of formulas and solution algorithms to memorize. Read a homework problem, recognize the pattern, match it to a recently learned procedure, and then mechanically "plug and chug."

But, as articulated in the Toronto report, mathematics is not plug and chug:

Mathematics involves learning to problem-solve, investigate, represent, and communicate mathematical concepts and ideas, and making connections to everyday life. … problem solving is a foundational building block for learning mathematics.

Let's go to Lake Wobegon, that fictional Minnesota town. Is it possible or impossible for all the students of Lake Wobegon to be above average? Imagine an active classroom, where the teacher becomes mentor and coach rather than lecturer.

First, Mike writes on the blackboard the mathematical definition of average, a sum of N numbers divided N. There is active discussion. Virtually everyone is saying, "No, it's impossible."

But how do we demonstrate that?

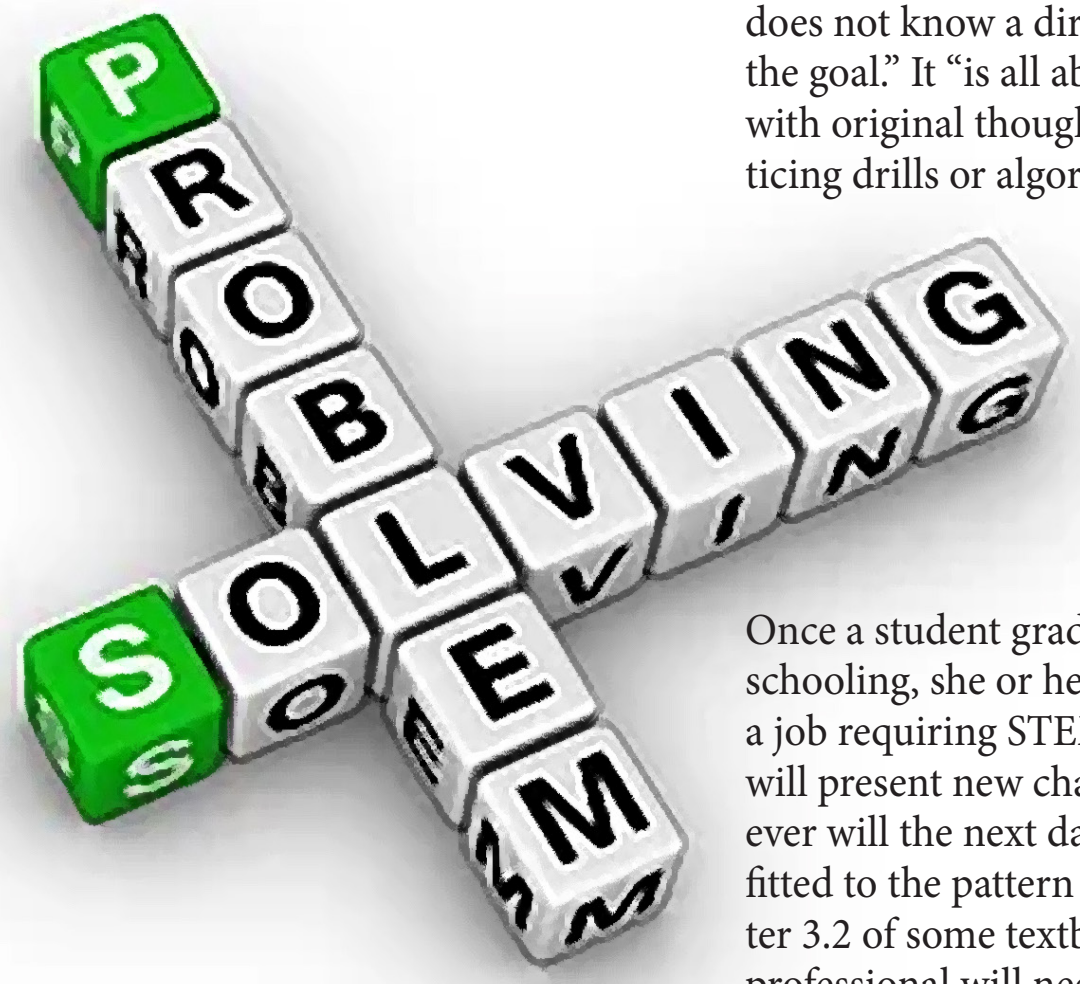
Eventually, Susan exclaims, "I've got an idea. Let's 10 of us stand in front of the blackboard and arrange ourselves in a line from shortest to tallest. We find the average and demonstrate that we can't all be taller than average!" The class cheers as they do the exercise and successfully show the result.

But then the teacher breaks into the class: "News Flash from the Lake Wobegon Chronicle, 'Every member of the senior class of Lake Wobegon High School has been accepted into an Ivy League university!'" Now, is it possible for all the seniors of Lake Wobegon to be above average? I leave it for the reader to imagine how the class responds.

A plug-and-chug approach to computing averages would not have engaged class so actively. Here, "the answer" — what we want students to discover — is not simply the answer to a problem, but rather the process itself, the process of investigation and creative critical thinking.

Math is not simply inputting data into a computational algorithm and recording the numerical result.

Returning to the Toronto report, in genuine problem solving the "solver is working on a question where the solver does not know a direct path to achieve the goal." It "is all about coming up with original thoughts, not about practicing drills or algorithms."



Once a student graduates from formal schooling, she or he will likely work at a job requiring STEM skills. Each day will present new challenges. Rarely if ever will the next day's challenge be fitted to the pattern found in chapter 3.2 of some textbook. The young professional will need skills to frame, formulate, and eventually solve that challenge. This requires knowing not only how to recognize patterns and use the "algorithms," but also, more fundamentally, the core ideas behind the algorithms. And the solution process may turn out to be an interdisciplinary one, perhaps involving — in addition to math — physics, chemistry, or even the humanities.

Next challenge:

"On average, do your friends on Facebook have more friends than you do?"

Wow, that's a puzzler! Perhaps the teacher would suggest dividing students into small teams and creating "friendship networks" within each team. The networks would have to reflect the randomness of actual friendship networks. We don't want everyone to be friends with everyone else — too boring!

The students work out a way to do this. Then they draw a picture of their group's friendship network. Then they have to decide exactly what the term "on average" means in this instance. To their surprise, they will discover, if they formulate the problem properly, that each and every friendship network in the class will have this counterintuitive property. We have experimental verification, but how do we prove it mathematically? That's a central question, and the process of discovery takes the students though a bit of graph theory and senior-level mathematics.

All four of these phenomenon-based questions involve active, inquiry-based learning. Two weeks later, or even two years later, students will remember these learning exercises far better than if the same material were delivered to them in a routine lecture.

Once more, the Toronto report:

The classroom needs to be a place of investigation by supporting unusual ideas and responses by students. … [It] should feel like a community where ideas can be discussed, developed, debated and understood. Students should feel that all ideas are welcome in the classroom, even those that are unconventional.

Richard C. Larson, *a member of the National Academy of Engineering, is Professor of Data, Systems, and Society at MIT.*

He serves as PI of MIT BLOSSOMS, an OER (Open Educational Resources) project that makes freely available, phenomenon-based, interactive video lessons for high school STEM classes.

OAK RIDGE National Laboratory

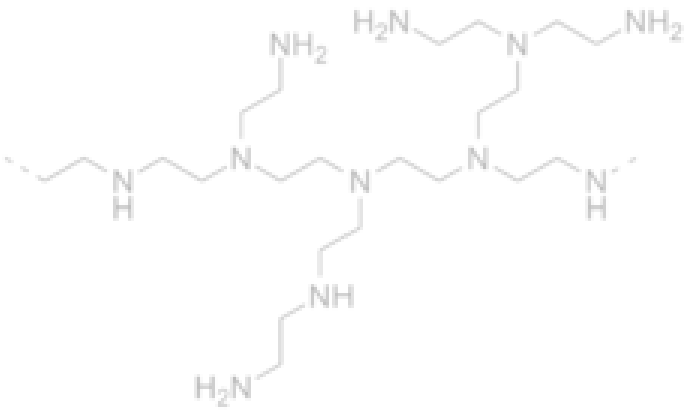
A Novel Polymer

By Ashley C Huff / ORNL

pol·y·mer
/päləmər/

noun / Chemistry
noun: polymer; plural noun: polymers

- a substance that has a molecular structure consisting chiefly or entirely of a large number of similar units bonded together, e.g., many synthetic organic materials used as plastics and resins.



Researchers at the Department of Energy's Oak Ridge National Laboratory designed a novel polymer to bind and strengthen silica sand for binder jet additive manufacturing, a 3D-printing method used by industries for prototyping and part production.

The printable polymer enables sand structures with intricate geometries and exceptional strength – and is also water soluble. The study, published in Nature Communications, demonstrates a 3D-printed sand bridge that at 6.5 centimeters can hold 300 times its own weight, a feat analogous to 12 Empire State Buildings sitting on the Brooklyn Bridge.

The binder jet printing process is cheaper and faster than other 3D-printing methods used by industry and makes it possible to create 3D structures from a variety of powdered materials, offering advantages in cost and scalability. The concept stems from ink-jet printing, but instead of using ink, the printer head jets out a liquid polymer to bind a powdered material, such as sand, building up a 3D design layer by layer. The binding polymer is what gives the printed sand its strength.

The team used polymer expertise to tailor a polyethyleneimine, or PEI (*Polyethylenimine (PEI) or polyaziridine is a polymer with repeating units composed of the amine group and two carbon aliphatic CH2CH2 spacers*), binder that doubled the strength of sand parts compared with conventional binders.

Parts printed via binder jetting are initially porous when removed from the print bed. They can be strengthened by infiltrating the design with an additional super-glue material called cyanoacrylate that fills in the gaps. This second step provided an eight-fold strength increase on top of the first step, making a polymer sand composite stronger than any other and any known building materials, including masonry.

"Few polymers are suited to serve as a binder for this application. We were looking for specific properties, such as solubility, that would give us the best result. Our key finding was in the unique molecular structure of our PEI binder that makes it reactive with cyanoacrylate to achieve exceptional strength," said ORNL's Tomonori Saito, a lead researcher on the project.

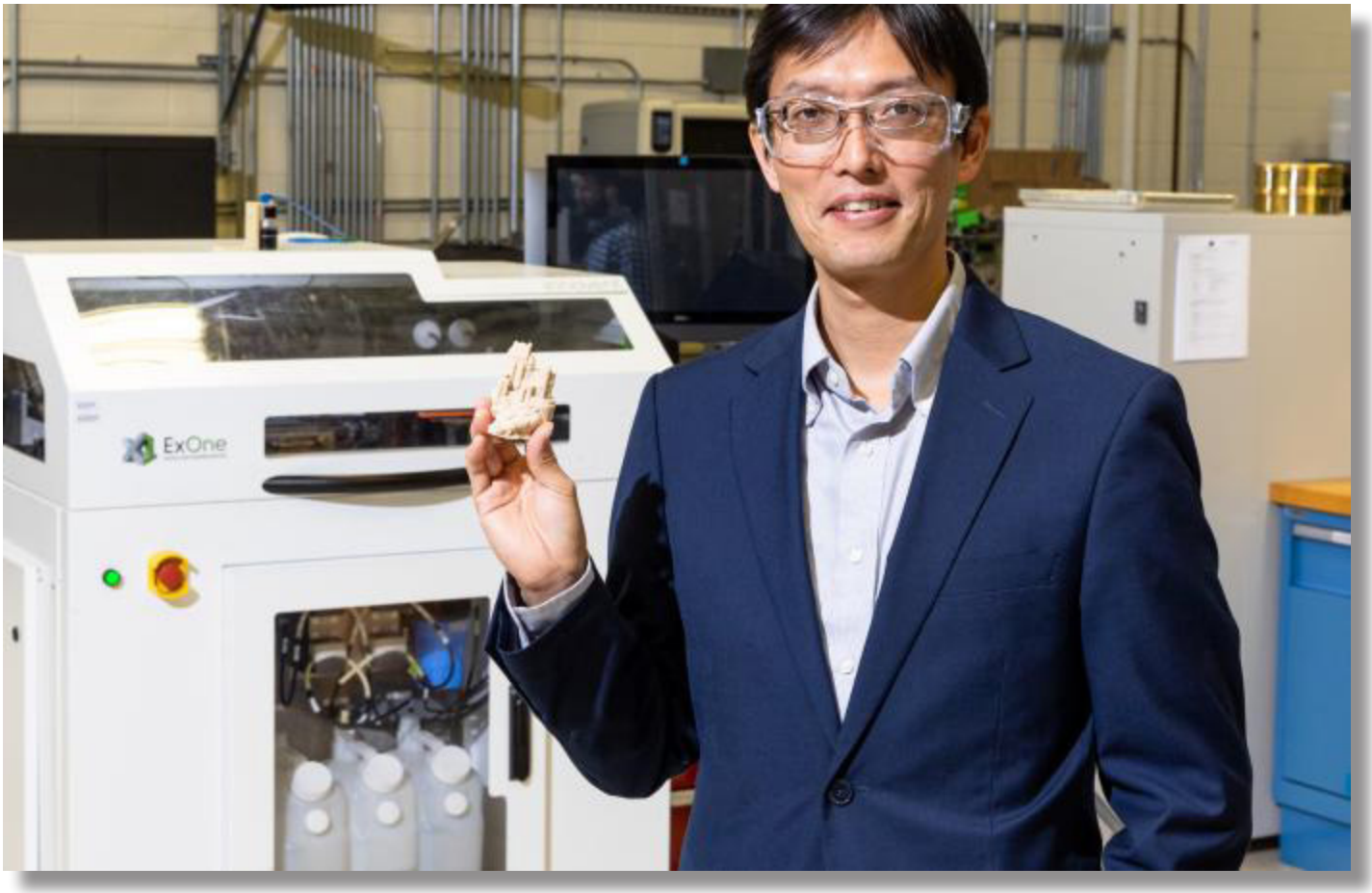
Parts formed with conventional binders are made denser with infiltrate materials, such as super glue, but none have reached close to the performance of the PEI binder. The PEI binder's impressive strength stems from the way the polymer reacts to bond with cyanoacrylate during curing.

One potential application for the super-strength sand is to advance tooling for composites manufacturing.

Silica sand is a cheap, readily available material that has been gaining interest in automotive and aerospace sectors for creating composite parts. Lightweight materials, such as carbon fiber or fiberglass, are wrapped around 3D-printed sand cores, or "tools," and cured with heat. Silica sand is attractive for tooling because it does not change dimensions when heated and because it offers a unique advantage in washable tooling. In composite applications, using a water-soluble binder to form sand tools is significant because it enables a simple washout step with tap water to remove the sand, leaving a hollow composite form.

"To ensure accuracy in tooling parts, you need a material that does not change shape during the process, which is why silica sand has been promising. The challenge has been to overcome structural weakness in sand parts," said Dustin Gilmer, a University of Tennessee Bredesen Center student and the study's lead author.

Current sand casting molds and cores have limited industrial use because commercial methods, such as washout tooling, apply heat and pressure that can cause sand parts to break or fail on the first try. Stronger sand parts are needed to support manufacturing at a large scale and enable rapid part production.



Tomonori Saito, a lead researcher on the project / ORNL

"Our high-strength polymer sand composite elevates the complexity of parts that can be made with binder jetting methods, enabling more intricate geometries, and widens applications for manufacturing, tooling, and construction," said Gilmer.

The novel binder won a 2019 R&D 100 Award and has been licensed by industry partner ExOne for research. The journal article is published as "Additive manufacturing of strong silica sand structures enabled by polyethyleneimine binder."

The work was sponsored by the DOE's Office of Energy Efficiency and Renewable Energy and used resources supported by DOE's Office of Science.

UT-Battelle manages ORNL for the Department of Energy'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 energy.gov/science.

Ashley C Huff / Media Contact
ORNL


"We're going back"
Georgia Pathways exclusive content in 2022

Why Healthy Teenagers Die

Dr. Judy Willis, M.D., M.Ed.

As a neurologist, teacher, mother, author, education professional development and parent workshop leader I have the gravest concern for teenagers. Teenagers are three to four times more likely to die during those years than at any other point past infancy, until they become elderly. The causes of death are largely attributed to their higher risk-taking and accidents. What may appear to be bad judgment or selfishness may really be an inability of their incompletely formed brains to think before they act.

Reasoning along with judgment, goal planning, risk assessment, consequence prediction, organizing, and prioritizing are the "executive functions" that are controlled from the last part of the brain to mature. Their mature bodies and growing independence are ready to go, but teens' prefrontal cortex has yet to literally "get it together". This is a set-up for disaster. Just when they are becoming sexually active, have access to drugs and alcohol, and begin to drive, teens neural network hubs for those judgment and risk-assessment controls are still childlike.

Bad Judgment from Child Brains in Adult Bodies

The prefrontal cortex has an anatomic location that enables it to integrate a wide array of neural circuits into a functional whole. This process of integration enables the prefrontal area to play a central role in complex mental processes that emerge as the child grows. The prefrontal region is crucial for social cognition (understanding the minds of others), self-regulation, response flexibility (taking in data, pausing, reflecting), and accurate self-awareness.

So as teens experience pressures from peers, parents, and society as they strive to create their individual identities, the prefrontal cortex, with its neural network of executive functioning and judgment, is not in place to guide them.

Without the prefrontal cortex's executive functions to inhibit impulses, weigh consequences of decisions, prioritize, strategize, separate fact from opinion, weigh the validity of information, and analyze risk, teens make

decisions based on emotional, reactive, rather than logical, reflective, responses. Until these networks are mature, things adults consider obvious and even dangerous may not be interpreted that way by the still incomplete frontal lobes of teenagers.

The Adolescent Growth Spurt.....It's Also In Their Brains

The brain's learning is coded in patterns and stored in neurons in the cerebral cortex. This outer brain layer, with the greatest density of information-storing neurons, is called gray matter because neurons are darker than most other cell structures in the brain.

Although the cortex is a relatively thin layer and comprises only about 17% of the brain's volume, if it were unfolded it would spread over 500 square inches.

The neurons are connected to one another by over one million nerve fibers in the adult brain, with each neuron making from 1,000 to 50,000 connections with other neurons. Most of these connections are dendrites, the branches that sprout from neurons to connect to neighboring neurons and carry information at speeds up to 300 feet per second.

Dendrites carry information as electric current into the neurons and axons carry information away. Myelin is the insulating coating that builds up around the most active axons. Throughout life the brain changes by both expanding and pruning these connections between cells, keeping the connections that are used the most and efficiently pruning away the unused ones.

One of the most active periods of brain reorganization occurs around two years of age, when a huge build up of neural connections is followed by a massive pruning that allows the strongest and most used connections to function more effectively. During adolescence, the frontal lobes undergo a second wave of reorganization and growth. This growth appears to represent millions of new synapses (connections between the brain cells).

Although it may seem like the more synapses and connections, the better, the brain actually consolidates learning by pruning away the least-used pathways, which in turn allows the brain to operate more efficiently. It is in the later teens and early twenties that a massive pruning of these excess connections begins and continues at a slow rate until the pruning tapers off in early adulthood.

Multit-ASKING for Trouble Teens from 16-20 have the highest fatality and injury rates, with motor vehicle crashes the number one cause of death from ages 15-20. There are about 8,000 teen motor vehicle deaths a year and 28% of teen drivers killed in motor vehicle crashes are intoxicated at the time of the accidents.

The brain's judgment development delay is not just problematic regarding excessive drinking and drunk driving. During this age period the driving risks are exceeded by poor decisions about seat-belts, talking on cell phones, and texting. Drivers are less likely to use seat belts when they have been drinking. Of the young drivers who had been drinking and are killed in crashes, 74% are unrestrained and 55% of passenger vehicle occupants who die are not wearing seat belts.

Driver inattention is the leading factor in most crashes and near-crashes. Nearly 80% of crashes and 65% of near-crashes involved some form of driver inattention within three seconds before the event. Driving while talking on a cell phone is as dangerous as driving under the influence of alcohol (four times more impaired than sober driving) and texting is eight times more dangerous than sober/undistracted driving. (Recall the accident on the California train where the driver was texting while driving, killing himself and about 25 others.)

Even adult brains sometimes cannot handle two simple tasks as easily as we think they should. For example, while seated in a chair rotate your right foot clockwise. Then draw the number 6 in the air with your right hand. Your right foot will change to moving counterclockwise. With teen judgment underdeveloped, their confidence in their abilities exceeds that of adults and puts them at greater risk for overconfidence when doing things that require focused alertness.

The Brain is a Pleasure-Seeking Organ

Dopamine is the chemical neurotransmitter most prominent in the brain's emotionally responsive and reactive limbic system; and dopamine is a pleasure surging chemical. Risk-taking itself increases dopamine levels and the associated pleasure response, as do many "recreational" drugs. Teen's "ungoverned" brains want to feel pleasure and may direct behaviors to pump up the dopamine surge artificially and temporarily by using drugs or engaging in risky behavior.

Addictive drugs such as cocaine and amphetamine cause a several-fold increase in dopamine levels in the brain.

"Risk-taking itself increases dopamine levels and the associated pleasure response, as do many recreational drugs."

The combination of this high pleasure response from dopamine joined with the immaturity of the frontal lobes increases susceptibility to illegal drug use, fast driving, dangerous biking or skate boarding activities, alcohol abuse, binge eating, sexual promiscuity, and other dangerous activities. Almost 20% of high school students surveyed reported having carried a weapon (gun, knife, or club) one or more days in previous 30 days.

What Can Parents and Teachers Do?

Parents and teachers can inform adolescents about the potential risks such as drugs, alcohol, sexual promiscuity, and eating disorders, and other risk-taking behaviors that do bring about a pleasurable dopamine jolt. But, to make the information stick, teens need knowledge about their own brains to add impact to those warnings.

Teens benefit from teachers' and parents' explanations of the brain's chemistry and physiology and by understanding their brain's susceptibility to high-risk behaviors. They can use this knowledge, while they develop their internal logic systems, to better defend themselves against dangerous temptations.

Judy Willis, M.D., M.Ed
WEB: http://www.RADTeach.com

GEORGIA PATHWAYS MAGAZINE

Content Invitation

Georgia Pathways™ STEM Magazine requests the privilege of including your content or the content of your students in upcoming 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 across Georgia.

If you have questions, please contact the publisher at:

wayne@tagonline.org

770.370.1905

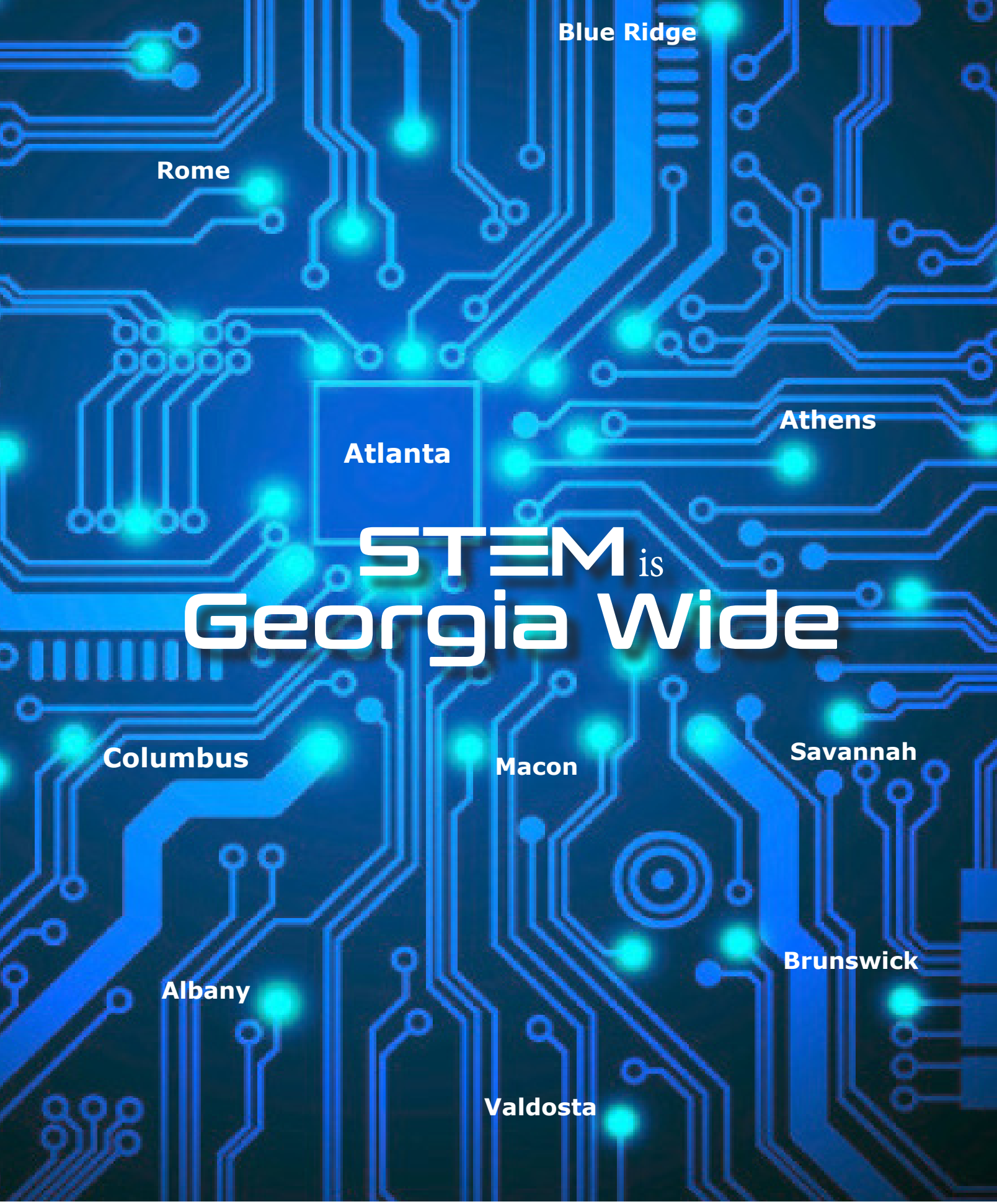
Content submissions:
- Word.doc format

- **Completely** revised and spell checked.

- Everything as an attachment.

- Unlimited electronic distribution to everyone in Georgia.

Advertising:
- Full page ads are available monthly at a very low cost.



TAG
Technology Association of Georgia

TAG TAG-Ed
Education Collaborative