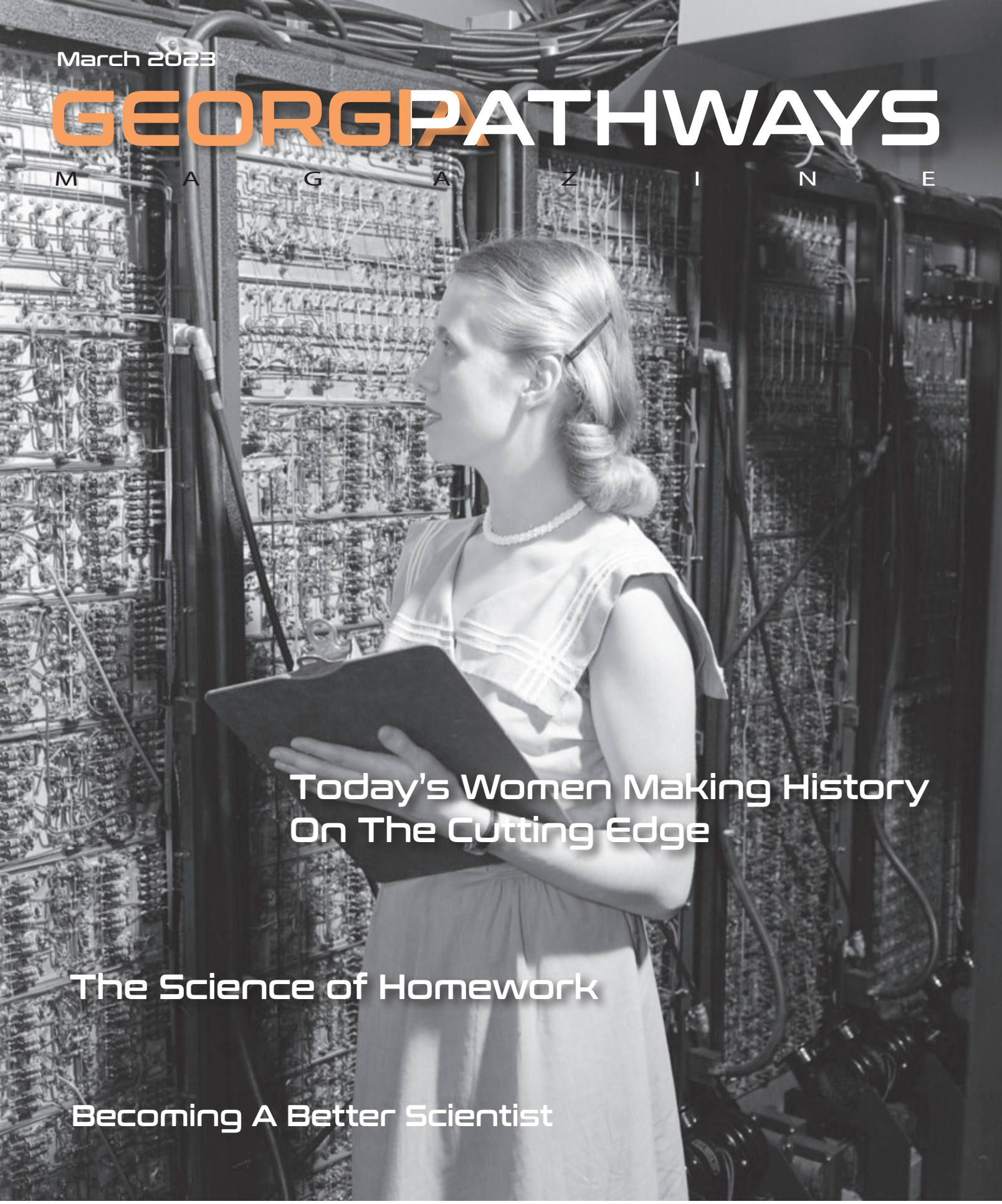
March 2023

GEORGIA PATHWAYS

MAGAZINE



Today's Women Making History On The Cutting Edge

The Science of Homework

Becoming A Better Scientist

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 STEAM 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 STEAM education in Georgia.

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Stephanie Seay / ORNL

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Welcome to the March 2023 issue of Georgia Pathways Magazine, in which we celebrate Women's History Month.

TAG
Technology Association of Georgia

I first want to shine a light on the progress that has been made to close the gender gap in technology throughout the state of Georgia. According to the Technology Council of North America, Georgia is leading the way among the 25 states with the highest growth rates of tech worker profiles. Notably, Georgia has the lowest gender gap at 38%. Despite this progress, there is still work to be done to ensure greater equality and inclusivity in the world of STEAM.

While women are well-represented in fields such as math and life science, they are still largely underrepresented in some of the fastest-growing and highest-paid tech careers. Women represent only 25% of computer professionals, and men continue to outnumber women in nearly every science and engineering field, with women making up only 28% of the science, technology, engineering and math workforce.

These statistics underscore the urgent need to foster interest in STEAM careers for young women and girls. TAG and TAG-Ed empower girls and women to excel in STEAM from the classroom to the boardroom by providing education, exposure and experience through programs including Pathways to Leadership, apprenticeship opportunities, Georgia STEM Day, high school internships, Day of Code and more.

In addition, the Center for the Study of Women, Science and Technology at Georgia Tech promotes the recruitment, retention and advancement of female students and faculty in STEAM fields. Furthermore, Women in Technology is committed to making Georgia the state with the highest percentage of women in the STEAM workforce by providing opportunities that champion women throughout their education and career. Lastly, the Georgia chapter of the Association for Women in Science champions the interests of women in STEAM across all disciplines, socio-economic strata and occupational focus.

For women, pursuing a career in STEAM not only ensures that future innovations better represent the needs of society as a whole but also opens the door to a wider availability of jobs after graduation.

For more information, please visit https://www.tagedonline.org/.

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.

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OAK RIDGE National Laboratory

Erica Prates:

Bridging science across scales with computational biology

By Stephanie Seay / ORNL

Erica Prates has found a way to help speed the pursuit of healthier ecosystems by linking the function of the smallest molecules to their effects on large-scale processes, leveraging a combination of science, math and computing.

Erica Prates is using her skills as a computational systems biologist to link the smallest molecules to their impact on large ecosystems. Credit: Carlos Jones/ORNL, U.S. Dept. of Energy

Prates is a computational systems biologist in Oak Ridge National Laboratory's Biosciences Division. She's using her interdisciplinary approach to develop hardier plants that can be grown on inhospitable lands to make clean jet fuels, to create healthier plants and improve carbon storage by exploring plant-microbe interactions, and to figure out how viruses affect human health.

"I integrate structural information on molecules into complex systems biology models," Prates said. "And I am fortunate to get to do so on the world's fastest supercomputers here at ORNL." She works to understand the three-dimensional structure of biomolecules, with a particular interest in proteins and interacting metabolites. "I help predict their structure and interactions using high-throughput methods that run on supercomputers. A molecule's structure is tightly related to its function and how it creates physical traits in an organism. Those traits then influence ecosystems on a large scale," Prates said.

If scientists can describe how information passes from genes to a cascade of molecular events that produce a given biological phenomenon, they can predict how genetic variation changes biological behavior, she added.

Versatile science

Prates studies a wide variety of subjects, including plants, microbes, viruses and species interactions. One of her main efforts is building a computational structural systems biology workflow that lets scientists identify protein targets that can be engineered to achieve biological traits of interest.

An example is her work identifying genes encoding proteins that can trigger desirable characteristics in plants for the Center for Bioenergy Innovation, or CBI, at ORNL. A key mission of CBI is developing improved non-food crops like poplar and switchgrass that have greater biomass yield and resistance to pathogens and pests. She is also learning the secrets of how microbes such as fungi use molecular signaling to talk to plants to support a healthy ecosystem for both. Those signals, known as lipo-chitooligosaccharides, or LCOs, are believed to govern the beneficial colonization of plant roots by fungus and may be involved in other important biological processes.

Prates played a role in ORNL's pioneering efforts to characterize all the proteins of the SARS-CoV-2 virus for insights into its evolution and the body's response to COVID-19. Prates and colleagues recently followed up their research with lab experiments

supporting their theories about the virus's pathogenesis. The team described how the virus inactivates an important protein in the body's immune system.

"This was very exciting work," Prates said. "Early in the pandemic there was this idea that the major target of the virus was lung cells. But then it became clearer that COVID-19 was a systemic disease, affecting the whole body." The team demonstrated at a molecular detail how the virus can dismantle NEMO, a protein in the host cell that is key for an effective immune response.

"One of the things I really enjoy about my work is the ability to migrate between very different systems." Prates said. "I was working with a lot of plants and microbes, and then at the onset of the pandemic suddenly started working with viruses. Proteins are proteins no matter whether the organism they influence is a virus, a human or a microbe. So it's easy and useful to migrate to these different subjects using the same tools. That's one thing I love about this job."

Encouraging words

Prates cites her mother's influence for her successful entry into a science career. "You have to be confident when you practice science," Prates said. "It was my mother who boosted my confidence every day growing up with messages that ran counter to an often sexist culture." She also cites the influence of a physician in the family who discussed science and medicine with her routinely from a young age. When her parents built her a doll house, Prates turned it into a play laboratory.

Prates earned her bachelor's, master's and doctoral degrees in chemistry from the University of Campinas, or UNICAMP, in Brazil. She first came to the United States with an internship at the University of Washington, and then spent a year at the National Renewable Energy Laboratory, or NREL, as a Sao Paulo Research Foundation Fellow researching biofuels.

In Brazil, Prates was no stranger to bioenergy. The nation is the world's second largest producer of ethanol. Renewables make up almost half of Brazil's energy mix, and about 70% of that supply is from plant biomass, according to the International Energy Agency.
It was at NREL, a key partner in CBI, that she became acquainted with ORNL and eventually joined as a postdoctoral researcher in 2018, hiring on as staff three years later.

"I've been very lucky in my career to have worked with very generous scientists who opened doors for me and made me feel empowered and capable,"

she said. She cited key mentors like Professor Munir Skaf, her doctoral advisor at UNICAMP, Gregg Beckham at NREL and Dan Jacobson at ORNL.

At Oak Ridge, Prates said she feels "lucky to be around very smart co-workers. The team that I work with directly supports my work in systems biology where you need to understand the connections between molecules, and often that requires people with very different expertise working together. It makes you talk a lot, this interdependence of a team where everyone might have a different approach." By having the same goal, the environment is more cooperative than competitive, she said.

She also enjoys the immense capabilities of working in a national lab environment, including the supercomputers at the Oak Ridge Leadership Computing Facility. "Just working here with Summit and Frontier is a big achievement already," she said.

Fearless and flexible

Prates advises young people interested in a career in science to "be fearless. It's important to be confident and creative. Don't give up, even on the ideas that at first may feel wrong. Be flexible and resilient. Just like Darwin's theories in nature, adaptability is key to success."

She also stressed the benefit of learning how to write. "You will write more than you expect to, and it's critical to be able to effectively communicate your ideas to others."

Prates's enthusiasm extends to her personal life as her family grows. "I'm very excited by the most important project of my life: the baby girl that I'm expecting," she said. "I plan to be very supportive of her in whatever she wants to do. I want to show her how the universe is complex and beautiful, as my inspirations did for me."

In her research as well as in parenting, she hopes to continue bridging the gap between the tiniest elements and the largest impact. "When you make this connection between the molecular world and the big picture, then you're learning which of the tiny gears can influence the entire system."

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. — Stephanie Seay

Credit: Carlos Jones/ORNL, U.S. Dept. of Energy

"How my academic training helped me become a better Scientist in industry."

by **Minal Mehta**
Research Scientist, AstraZeneca, Gaithersburg, Maryland

I was ecstatic when I first found out that I got an industry job offer in a major pharmaceutical company, a few months before I was defending my PhD dissertation.

The role was a great fit-- it was a lab-based scientist position, and the work I was doing was very similar to what I had pursued during my PhD and what I honestly enjoyed.

It all felt like a dream come true, as my career goal at the time was to get an industry research position, with a meaningful opportunity to have a wider impact through my work by helping to deliver medicines to patients faster through evidence-based scientific research. It was certainly not an easy journey landing this role-- I had heard from colleagues and friends how difficult it is to break out of the ivory tower without industry experience.

Towards the last six to nine months of my PhD career, I was frantically preparing to finish my dissertation, manuscript, complete the last big experiments, and on top of it to find a position relevant to my knowledge base, interests and skill set. I applied to over 80 job positions, only to be fraught by the emails I would get saying,

"Thank you for applying, but we will not be moving forward with your candidacy."

I did countless phone interviews, long in-person interviews for many jobs, and fortunately towards the last two months of PhD, I found a role that was a good fit, and received a job offer within one week of my interview. It was certainly a very stressful time but nonetheless the hard-work certainly paid off.

One of my primary concerns was whether I had the skills that allowed me to function and thrive outside of academia. I felt like I was pigeon-holed into a very specialized niche within my field that breaking out of it would seem difficult.

Through personal reflection and preparation, I discovered that I did have the knowledge, experience and skills that are useful for the industry roles I wanted.

One of the key skills we learn as PhD scientists is how to communicate our science well to others. This is paramount to success in every function across industries. Knowing how to organize your thoughts well, present them in a clear and concise manner, and telling a compelling story of your data and results is crucial for success.

In graduate school, we have to convince our advisors and thesis committees that our research and ideas are sound and promising, and are worth pursuing. This task is no different than when sales representatives have to convince their customers that their company's product is worth buying, or when lawyers have to procure clients for their services by marketing their legal skills.

Similarly, as an industry scientist in a discovery research group, I have to routinely deliver compelling presentations with strong scientific evidence to convince my colleagues and managers that the drug target is worth pursuing, allowing the timeline of the product development cycle to move forward, with the ultimate goal to reach to patients in need faster.

My PhD academic training helped me become well-prepared to shoulder this responsibility and improve on it every day.

As I continue to practice communicating my science with others, I became better at building professional relationships with my colleagues, peers, managers, upper management, and cross-functional teams, and larger networks. I also learned so much from them and their functions and feel very satisfied to meaningfully contribute to the organization as a whole.

Another key skill that is an incredibly valuable asset of a PhD scientist is their problem-solving mindset that drives them to solve complex problems with a sense of urgency and persistence. We become relentless in pursuing the research questions without fearing failure. In fact, we actually thrive in it, because we are not afraid to take risks and keep moving forward. This essentially drives the discovery research and innovation programs forward, because without someone actually doing the work to figure out if novel drug target are worth working on, these programs will stop and nothing will get delivered.

I routinely have to deliver on this as part of one of my performance goals. The best part is it is it all feels like solving puzzles. Every day is a different day, with different challenges and problems to solve. Figuring out what resources needs to be allocated to what projects, and how to design experiments strategically to answer the right research questions, are the skills we all learn in our academic training.

This is tremendously valuable in the industry context as well. I have the ability to find the answers to complex questions, to find novel and creative solutions, to generate new valuable data, improve on processes that may have become outdated, or require new fresh perspectives. I am able to critically reason research ideas, by applying my own knowledge and experience. At the same time, I am able to leverage my team's expertise, and efforts, and build on working together to bring the solutions forward.

In concluding, I hope that through the snippets of my experiences that I shared above, I was able to show you that you too are able to take leaps forward into applying to those dream industry jobs that you always wanted and be successful in your scientific careers outside of academia.

Perspectives:

Out-of-School STEM Programs Inspire, Empower, and Engage Children. Here's what K-12 can learn from them:

by Gemma Lenowitz

Even before the pandemic, it was common for teachers to grapple with the challenge of teaching students varying in mastery of academic skills, with as many as seven grade levels represented in one room. The pandemic has only widened that gap, particularly in math, with the most disadvantaged students experiencing the most difficulties.

A recent analysis by McKinsey found that students ended the year, on average, five months behind in mathematics and four months behind in reading. This gap is wider for historically disadvantaged students; children in majority Black schools have six months of unfinished math learning, and students in low-income schools have seven.

Closing these gaps is likely to involve more remediation and skill-based learning, including incorporating high-dosage tutoring into the school day. These efforts are vital to helping students achieve grade-level mastery, but they're not enough.

Now more than ever, children need to be inspired, empowered and engaged inside the classroom. And they need access to experiences that help them discover their innate capacity to drive their own learning.

Unfortunately, today's schools aren't often designed to facilitate those environments. But out-of-school programs are. Out-of-school, whether that's afterschool or summer, is often where children

discover, explore and fail without repercussions, engaging in the joy of learning for learning's sake.

This is especially true for science, technology, engineering and mathematics programs, which ensure that all participants see themselves as capable problem finders and problem solvers. Increased STEM interest and skills are often taken as signs of success for these kinds of programs, but the other skills children gain may be even more beneficial, specifically when it comes to social-emotional habits. These include improved communication, the ability to solve problems and work in groups, and the perseverance to stick with a difficult problem.

Out-of-school STEM programs provide a blueprint for engaging and inspiring children meaningfully, and getting them on track academically and social-emotionally.

In a hands-on invention program, for example, children develop self-awareness as they explore their identity as inventors, makers and innovators; social awareness as they give feedback to one another about their inventions; responsible decision-making in selecting the appropriate materials for their prototypes; self-management as they craft and deliver timed pitches; and relationship skills as they team up and co-invent.

This happens alongside building

STEM-specific skills, each reinforcing the other. Most powerfully, each success gives students the thrill of victory, reigniting self-esteem as well as genuine love of learning.

One of the best ways to bring the lessons of out-of-school STEM into the classroom is to involve educators who are the gatekeepers of how things are taught during the school day. While the enrichment value of STEM programs for children is widely recognized, little attention has been paid to the value and opportunity that STEM programs provide for teachers — including those for whom STEM is not a primary focus.

When classroom teachers visit out-of-school programs, they see children in an environment where they are empowered to use their imaginations, safely take risks and build their tolerance for ambiguity and failure. This is a powerful observational opportunity, one that is critical for teachers to develop an open mind about what learning can look like and a pedagogical approach that raises expectations for all students, versus focusing on children's deficits.

As former teachers and school administrators, we have witnessed the transformative power of afterschool programs for students and teachers. One instructor we worked with, who was a

librarian prior to the program, became a middle school STEM teacher because of her experience in out-of-school.

Facilitating and observing out-of-school STEM programs can provide teachers with professional development opportunities that help them build skills that will improve their ability to hook students' interest and engage them in authentic problem solving, versus applying a prescribed method to arrive at a single answer.

petri dish for invention education — teaching how to bring an idea to life and out into the world. When teachers have a safe space where they can solve problems alongside students through open-ended challenges with no one right solution, they can develop their skills in not just the subject area, but in empowering children to believe their ideas have value and that they are capable of engaging in difficult work.

There's lots of talk about the STEM

"They are empowered to use their imaginations."

In a STEM program, failure is not taboo — it is a celebrated part of the process. The insights gleaned from a motor not working, a part breaking or inconsistent trial results provide valuable data that can move a child toward learning persistence and, eventually, experiencing success. What if in-school STEM (and other subject) classrooms looked more like that?

The enrichment value of STEM programs for children is widely recognized. But little attention has been paid to the value and opportunity these programs provide another participant: teachers.

One reason STEM programs are so powerful for students, and can be powerful for educators, is that they are a

pipeline and the need for quality training for a robust, diverse and equipped STEM workforce. But the primary goal for STEM programs is not to guide every participant into a STEM career. Rather, it is for every child to have access to the tools of STEM and to find meaningful ways to enhance their dreams, goals and possibilities in ways that only STEM can.

STEM programs are a prime way to build the next generation of resilient, creative, problem-solving, solution-finding, inspired and innovative students — and teachers. They empower students and teachers together to cultivate their confidence, skills and joy of learning. That's why educators must do more to incorporate the lessons from out-of-school STEM into the classroom and ensure that access to high-quality out-of-school options like the National Inventors Hall of Fame education programs are available to all children — not only to those whose parents can afford extracurriculars. Survey data last year showed that for every child in an afterschool program, three more were waiting to get in.

Limiting the benefits of hands-on experiential STEM to out-of-school hurts students' futures. This year more than ever, we must envision the school day as an opportunity to engage and inspire. Lessons from STEM programs provide the blueprint to do so meaningfully, and to get students on track — academically and social-emotionally.

By **Breanna Bishop**
The U.S. Department of Energy
(DOE) and DOE's National Nuclear Security Administration

The NNSA announced recently the achievement of fusion ignition at Lawrence Livermore National Laboratory (LLNL) — a major scientific breakthrough decades in the making that will pave the way for advancements in national defense and the future of clean power.

On Dec. 5, a team at LLNL's National Ignition Facility (NIF) conducted the first controlled fusion experiment in history to reach this milestone, also known as scientific energy breakeven, meaning it produced more energy from fusion than the laser energy used to drive it. This first-of-its-kind feat will provide unprecedented capability to support NNSA's Stockpile Stewardship Program and will provide invaluable insights into the prospects of clean fusion energy, which would be a game-changer for efforts to achieve our goal of a net-zero carbon economy.

"This is a landmark achievement for the researchers and staff at the National Ignition Facility who have dedicated their careers to seeing fusion ignition become a reality, and this milestone will undoubtedly spark even more discovery," said U.S. Secretary of Energy Jennifer M. Granholm. "This Administration is committed to supporting our world-class scientists — like the team at NIF — whose work will help us solve humanity's most complex and pressing problems, like providing clean power to combat climate change and maintaining a nuclear deterrent without nuclear testing."

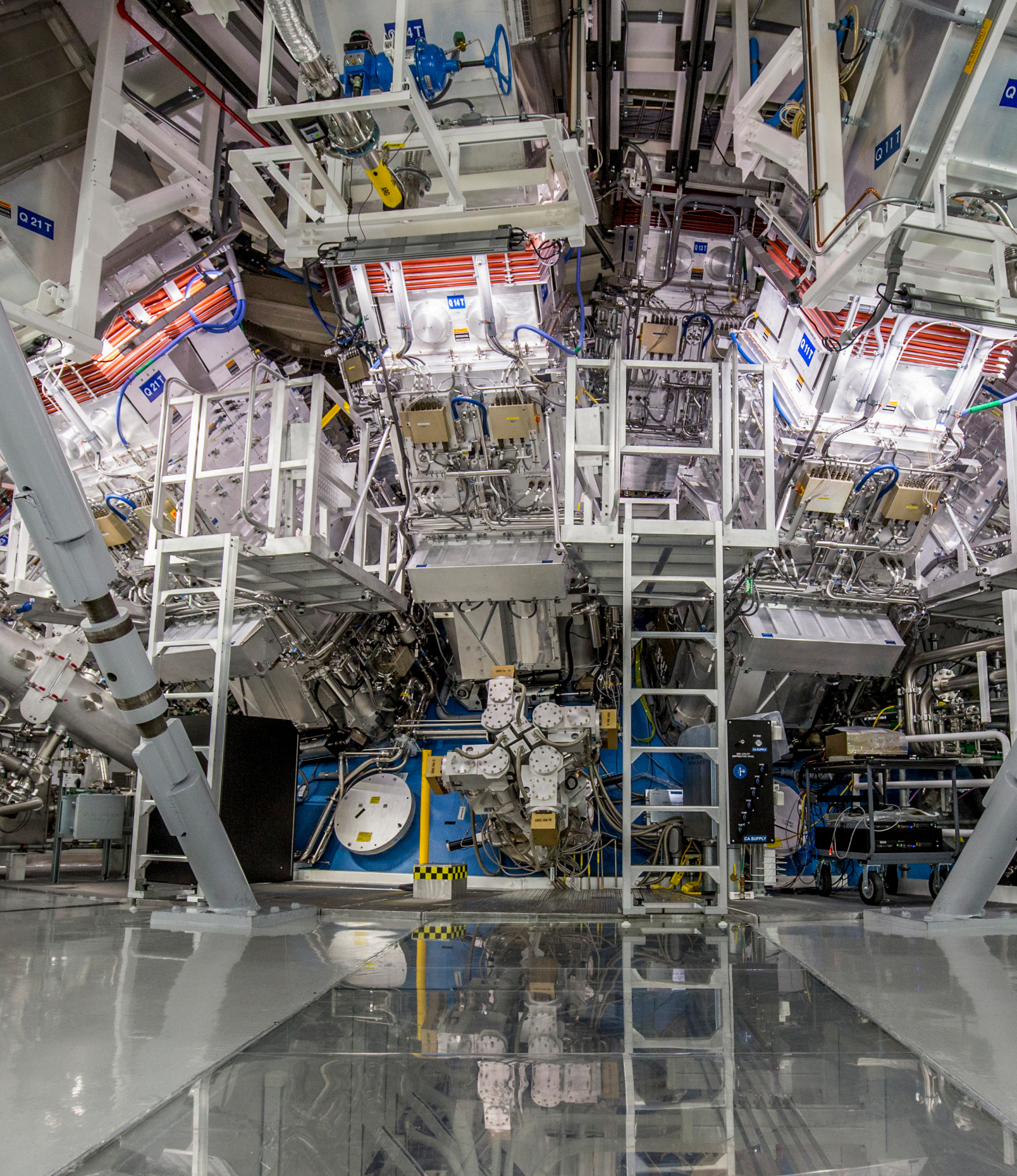


Photo: The target chamber of LLNL's National Ignition Facility, where 192 laser beams delivered more than 2 million joules of ultraviolet energy to a tiny fuel pellet to create fusion ignition on Dec. 5, 2022.

"We have had a theoretical understanding of fusion for over a century, but the journey from knowing to doing can be long and arduous. Today's milestone shows what we can do with perseverance," said Dr. Arati Prabhakar, the President's chief adviser for Science and Technology and director of the White House Office of Science and Technology Policy.

"Monday, December 5, 2022, was a historic day in science thanks to the incredible people at Livermore Lab and the National Ignition Facility. In making this breakthrough, they have opened a new chapter in NNSA's Stockpile Stewardship Program," NNSA Administrator Jill Hruby said.

triumph of science, engineering, and most of all, people," LLNL Director Dr. Kim Budil said. "Crossing this threshold is the vision that has driven 60 years of dedicated pursuit — a continual process of learning, building, expanding knowledge and capability, and then finding ways to overcome the new challenges that emerged. These are the problems that the U.S. national laboratories were created to solve."

"This astonishing scientific advance puts us on the precipice of a future no longer reliant on fossil fuels but instead powered by new clean fusion energy," U.S. Senator Charles Schumer (NY) said. "I commend Lawrence Livermore National Labs and its partners in our

"Monday, December 5, 2022, was a historic day in science"

"I would like to thank the members of Congress who have supported the National Ignition Facility because their belief in the promise of visionary science has been critical for our mission. Our team from around the DOE national laboratories and our international partners have shown us the power of collaboration."

"The pursuit of fusion ignition in the laboratory is one of the most significant scientific challenges ever tackled by humanity, and achieving it is a

nation's Inertial Confinement Fusion (ICF) program, including the University of Rochester's Lab for Laser Energetics in New York, for achieving this breakthrough. Making this future clean energy world a reality will require our physicists, innovative workers and brightest minds at our DOE-funded institutions, including the Rochester Laser Lab, to double down on their cutting-edge work. That's why I'm also proud to announce today that I've helped to secure the highest-ever authorization of over $624 million this

year in the National Defense Authorization Act for the ICF program to build on this amazing breakthrough."

"After more than a decade of scientific and technical innovation, I congratulate the team at Lawrence Livermore National Laboratory and the National Ignition Facility for their historic accomplishment," said U.S. Senator Dianne Feinstein (CA). "This is an exciting step in fusion and everyone at Lawrence Livermore and NIF should be proud of this milestone achievement."

This is an historic, innovative achievement that builds on the contributions of generations of Livermore scientists. Today, our nation stands on their collective shoulders. We still have a long way to go, but this is a critical step and I commend the U.S. Department of Energy and all who contributed toward this promising breakthrough, which could help fuel a brighter clean energy future for the United States and humanity.

This monumental scientific breakthrough is a milestone for the future of clean energy. While there is more work ahead to harness the potential of fusion energy, California scientists continue to lead the way in developing clean energy technologies.

How exactly does nuclear fusion work?

Simply put, nuclear fusion is the process by which two light atomic nuclei (nucleus of an atom) combine to form a single heavier one while releasing massive amounts of energy. Fusion reactions take place in a state of matter called plasma (a gas caused by the 2 nuclei separating), a hot, charged gas made of positive ions and free-moving electrons that has unique properties distinct from solids, liquids and gases.

To fuse on our sun, nuclei need to collide with each other at very high temperatures, exceeding ten million degrees Celsius (18,000,032 degrees Fahrenheit), to enable them to overcome their mutual electrical magnetic repulsion. Once the nuclei overcome this repulsion and come within a very close range of each other, the attractive nuclear force between them will outweigh the electrical repulsion and allow them to fuse. For this to happen, the nuclei must be confined within a small space to increase the chances of collision. In the sun, the extreme pressure produced by its immense gravity create the conditions for fusion to happen.

The amount of energy produced from fusion is very large — four times as much as nuclear fission reactions —

and fusion reactions can be the basis of future fusion power reactors. Plans call for first-generation fusion reactors to use a mixture of deuterium and tritium — heavy types of hydrogen. In theory, with just a few grams of these reactants, it is possible to produce a terajoule of energy, which is approximately the energy one person in a developed country needs over sixty years.

Stay with me now - this is a layman's explanation suitable for elementary students.

A "Newton" is the amount of energy needed for you to roll one Cantaloupe (2.20 pounds) across the floor, 3 feet in one second. You could actually try this in class or at home.

A newton is a unit of "**force**".
A joule is a unit of "**energy**".
The ratio is 1:1, so one newton of force requires on joule of energy.

How many joules of energy do you need to roll 2 Cantaloupes, 3 feet in one second? If you said, 2, you are correct.

The exciting reaction that happened on Dec. 5th delivered more than 2 million joules in a split second.

This is a very big deal.

We can celebrate another performance record by the National Ignition Facility. This latest achievement is particularly remarkable because NIF used a less spherically symmetrical target than in the August 2021 experiment," said U.S. This significant advancement showcases the future possibilities for the commercialization of fusion energy.

The challenges facing the world today are even greater than at any time in our past. We must accelerate the research to explore new pathways for the clean, limitless energy that fusion promises, and "you" can be part of it.

LLNL's experiment surpassed the fusion threshold by delivering 2.05 mega-joules (million) (MJ) of energy to the target, resulting in **3.15 MJ of fusion energy output**, demonstrating for the first time a most fundamental science basis for inertial fusion energy (IFE). Many advanced science and technology developments are still needed to achieve simple, affordable IFE to power homes and businesses, and DOE is currently restarting a broad-based, coordinated IFE program in the United States. Combined with private-sector investment, there is a lot of momentum to drive rapid progress toward fusion commercialization.

What's the big deal?

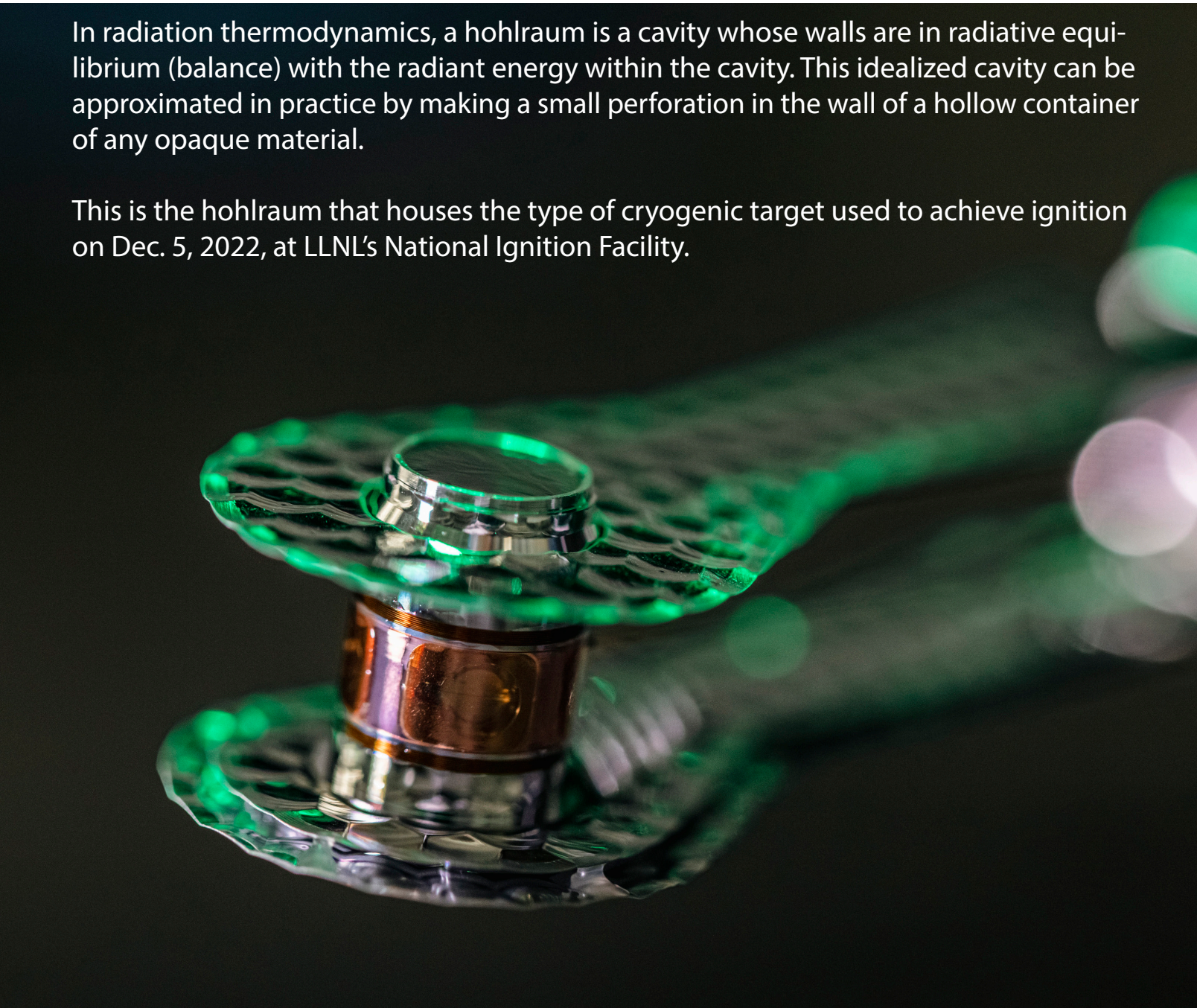
"We put clean energy into the reaction and got MORE OUT than we put in."

Imagine putting a one hundred dollar bill into a box and closing the lid. A few minutes later you open the box and pull out **$150** ! Would you be excited?

- no nuclear waste
- no radiation
- no harm
- no pollution
- the energy comes from water

In radiation thermodynamics, a hohlraum is a cavity whose walls are in radiative equilibrium (balance) with the radiant energy within the cavity. This idealized cavity can be approximated in practice by making a small perforation in the wall of a hollow container of any opaque material.

This is the hohlraum that houses the type of cryogenic target used to achieve ignition on Dec. 5, 2022, at LLNL's National Ignition Facility.



SMU®

TACKLING THE GREAT TEACHER RESIGNATION – *ONE TEACHER AT A TIME*

By Nancy George / SMU

Photo credit:Mary Cabanas, photo courtesy of SMU

College students like Mary Cabanas are in the pipeline to relieve the impact of widespread teacher resignations threatening U.S. public education. But what sets Cabanas apart is that she will enter a tough profession with her eyes wide open, thanks to determination, mentorship and training from SMU's Simmons School of Education and Human Development.

"Ongoing problems in education have been magnified by the pandemic and the political division in the U.S.," says Stephanie Knight, Simmons School dean. "And previous approaches to solving the teacher shortage, like alternative certifications, haven't worked."

Teachers need to develop knowledge and skills in the classroom early in their teacher education, Knight says. They also need higher pay and to be treated like professionals, which includes the opportunity to be collaborative and creative, Knight says.

Cabanas' trajectory as an education student may be a model for other students. She has taken collaboration with other future teachers into her own

hands, forming SMU's first student organization for education majors. But instead of taking field trips and hosting guest speakers, each week the Hilltop Educators meet to discuss controversial subjects in education, like book bans and school shootings.

The senior mathematics and education major has been planning to become a teacher since 8th grade. She worked in a classroom early, observing and even teaching a pre-K class as a future teacher intern in high school. At SMU, she is a recipient of the Noyce Teacher Scholarship, which commits her to teach math at a high-need school after graduation in exchange for a scholarship funded by the National Science Foundation.

Mentorship by Noyce Scholar faculty sponsors has opened other doors for Cabanas. On Saturday mornings, she can be found on campus assisting in an education research project comparing the effectiveness of using iPads vs. virtual reality to teach geometry. She also spent a summer researching best practices in math education by watching videos of math teachers and coding their teaching practices.

In addition, Cabanas helped analyze the effectiveness of demonstrating to students how workers use math in their careers.

"I'll take what I've learned from research into my classroom," Cabanas says.

Participating in education research gives Noyce Scholars the opportunity to be part of a larger academic community dedicated to bringing evidence-based practice to education, says Annie Wilhelm, one of Cabanas' Noyce Scholar mentors and an associate professor of teaching and learning at SMU's Simmons School.

"Research gives students the opportunity to connect what they are learning in class with the K-12 classroom," Wilhelm says.

Cabanas' motivation is personal – she wants to teach because teachers made a difference in her life. She moved with her family from Mexico to Texas and, as a 12-year-old middle schooler, faced the challenges of 7th-grade along with the task of learning English and settling in to Garland, Texas.

"My teachers saw my potential," she says. "As a newcomer, I was scared. It helped to know there were adults who were there for me."

Cabanas should find plenty of teaching openings when she graduates. Almost two in five teachers plan to quit in the next two years, according to a June survey of members of the American Federation of Teachers.

After graduating in May of 2023, Cabanas plans to begin work at SMU on her Master's degree in math education while completing her student teaching in fall of 2023. Her dream is to teach math at North Garland High School, where her teachers were so influential to her.

"I have to do this for the next generation," she said. *"If not me, who will?"*

The SCIENCE of Homework:

Tips to engage students' brains

Dr. Judy Willis

If you know a bit about the brain then you can plan homework to suit the needs of students as they develop. During early school years, for example, the brain is focused on getting to grips with the world around us. Memories and understanding grow when new information can be linked to things we already know. Homework that helps with this recognition can build literacy and numeracy skills.

When students reach adolescence, they become more independent and self-directed. There is shift away from rote memorization and single, correct responses. Learning goals are more likely to focus on reading for content and comprehension, revising, report writing, solving problems, investigating and independent or group work.

Well designed homework provides multiple ways for students to engage with what they are learning. They will then be able to use the facts they acquire to be creative and solve problems in class.

When to use online learning games for homework

Most teachers work hard to differentiate homework based on skill level, but with each new topic there may not be time to prepare individual tasks. Online games, in which pupils learn and test their factual knowledge, can be helpful when homework goals are about building a foundation of knowledge. This tends to be in the early years of school. Computer-assisted learning cannot replace good teaching: it is only from teachers that students can experience rich interactive learning and build conceptual understanding.

But using online learning games for homework tasks lets students gain the necessary level of factual knowledge and learn procedures that need to be memorized. This allows them to then progress in class to the richer subject content. Relieving teachers of essentially being drill directors means students get more class time to understand concepts and apply what they have learned.

Online games also help students to build skills to an automatic level at an appropriate pace for them. Games could be helpful in learning multiplication tables, spelling, remembering dates, names of rivers, foreign language learning, or getting to grips with grammar rules.

Well designed online skill games evaluate each student's ability as the basis for the questions or problems given. A good website for information about hundreds of available programs is *graphite*. You can browse by subject, grade level and skills, and see rankings of popularity with learners and teacher evaluations.

The importance of homework that students value

In later school years homework is more likely to focus on reading for understanding, revising and launching investigations. When students know that the effort they put into homework will enhance their participation and enjoyment of classroom learning, they become more motivated. Pupils also put more effort into schoolwork or homework when they are engaged in something that is relevant to their studies.

For instance, if the class is studying how to calculate area, good math homework may be to get students to measure parts of their room they want to change (e.g. walls to paint, windows for curtains, doors to cover with cork board for posting photos etc). Those who complete the homework will be able to make sketches to scale of their rooms on graph paper and determine area. Those who don't do the homework will not be prepared for this activity and will have to solve less interesting worksheet problems.

If the assignment is to read a chapter in a social studies or history book for discussion the next day, teachers can inform them that there will be a short quiz of the main points. Students who score high enough to demonstrate that they did their reading will have the rewards, or do independent projects of their choice and move on to new challenges.

How much time should homework take?

The amount of time spent on homework will always vary depending on the age of students and what task you have set.

After about 15 minutes of learning and practicing something - such as the Pythagorean theorem in math - the regions of the brain activated in spatial-numerical learning get fatigued and need to rebuild the neurotransmitters, such as dopamine, that ***get depleted.***

This is why teachers need to plan brain breaks in class time and for homework. It doesn't mean the child needs to run around or play a game. It just means another part of the brain (or body) should be doing the activating while the other area rests.

The restoration only takes a few minutes if the break is timely, but if they are pushed to stay with that same process for too long, stress builds, neurotransmitters drop way down and it will take twice as long to restore full efficiency to that area of the brain.

The good thing about getting students to do something that will enhance their classroom experience is that they are more likely to engage in it, so they don't mind spending time on it.

Online games for learning basic knowledge usually have set timings. You can assign a specific amount of time to be spent on the skill building program for homework and confirm students' compliance by checking the teachers' pages.

Make then

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Teaching

A Profession *Without* An Expense Account

A Look at the Way that Classroom Teachers Spend Their Own Money...
...on Other Peoples' Kids

Dr. Linda Karges-Bone

When was the last time you spent $23.00 on worms and you weren't headed out to the lake for a fishing trip? Ask third grade teacher "Carmen" of Berkeley County. She anted up to provide the worms for her compost pile, which was built by her faithful classroom volunteer, her husband. It was the only way to completely and effectively teach the rigorous state standards for science to a group of active, academically diverse youngsters.

These pupils have to see and touch science experiences in order to make them viable, especially since a number of them do not read on grade level and cannot rely on the textbook.

And what about reading? During the Martin Luther King celebration period when I visited her classroom, Carmen had an impressive display of books on Dr. King and other African-American history figures and events. Most of the books belong to her personal collection. She figures that the books in her classroom library are valued at about $2000; all purchased from her own account.

Carmen is not alone.

When I visit classrooms all over the country in my work as a university supervisor of
interns and as an educational consultant, I see hundreds of classrooms that are absolutely amazing. They are full of children's literature, packed with displays of science projects, strewn with colorful art projects, and buzzing with technology.

Much of the time, probably most of the time, the materials that make the lessons meaningful were purchased by the teachers themselves. And, here's an unscientific but defendable analysis. I believe that the classrooms in which one sees the highest test scores and the fewest discipline problems are those in which teachers have paid a price too, as one committed educator told me:

"I teach the way I want to; the only way I can."

As we consider budgets and ballots in the next election, how much longer can we ask teachers who are paid so little to contribute so much of their own meager salaries to educate "other people's kids?"

What the Experts Say:

The problem of teachers spending their own money on classroom necessities and enhancements is not new. I remember back to my first year of teaching (1981) which was also my first year as a married woman. My husband, the frugal engineer, was astonished to see that I had spent about 15% of my $11,000 salary on "teaching stuff." Those were the receipts that I had stuffed into an envelope, the ones that he saw.

The problem is national in scope and teachers are getting frustrated. In a NYCLU complaint, the American Civil Liberties union brought suit against the state, representing public school teachers who were routinely spending between $600 and $1000 per year to purchase basic teaching materials such as pencils and paper. In a press release, the Council of the City of New York Office of Communications reported that a City Council investigation found that New York City teachers spend an average of $426 out-of-pocket dollars for basic classroom supplies.

Council member Eric Gioia said: "Teachers already put their hearts and souls into the classroom-they shouldn't need to put in their paychecks too."

One first grade teacher, Marla Garnter, reports that she spends $500 to $600 a year on everything from Popsicles as a class reward to crayons and scissors for children whose families cannot afford school supplies. She notes: "It's those extras that make learning really fun and add that extra quality to the class."

A 2013 study found that K-12 teachers spent over ***1.6 billion dollars of their own money on classroom materials***. http://thejournal.com/articles/2013/07/01/k12-teachers-out-of-pocket-1-point-6-billion-on-classroom-tools.aspx

"The research was not conducted by a teacher advocacy group; rather it was conducted by an organization that represents the retailers that supply learning aids, classroom supplies, and other tools to educators, the National School Supply and Equipment Association (NSSEA). The study found that 99.5 percent of all public school teachers spent some amount of money out of pocket, with the national average for 2013-2013 coming in at $485 among those surveyed."

The average amount spent by teachers was $485, but a full 10% of those surveyed reported spending over $1000. Spending by teachers varies widely, according to experience, school affluence, and ethnic makeup of the school population. Another study, reported

in Forbes magazine, found that teachers spend closer to $500 each and that parents are actually contributing less to classroom supplies and materials.

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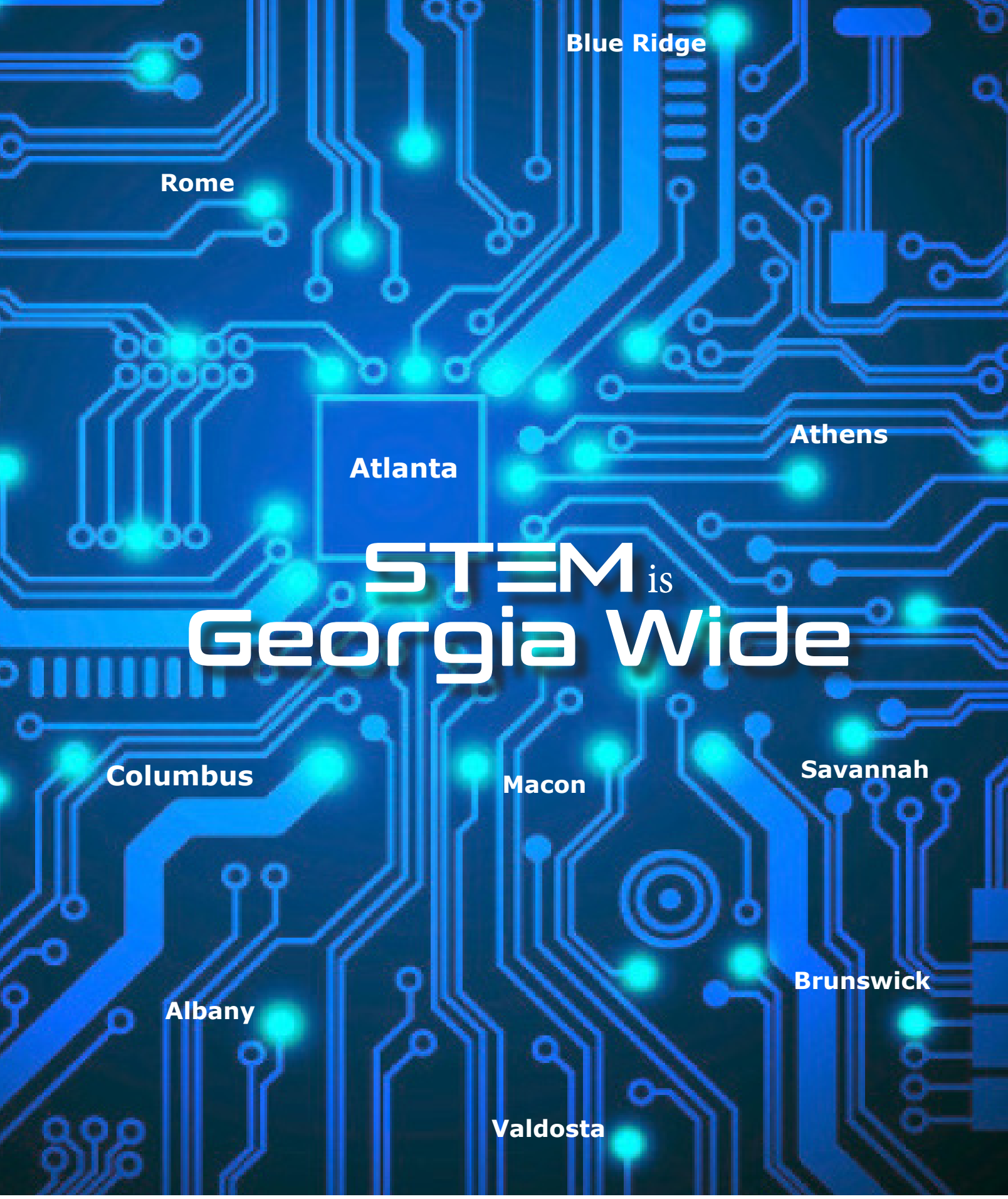

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