July 2025

GEORGIA PATHWAYS

MAGAZINE

AI In A Changing World

The Power of Storythinking

Photonics and the Rise of STEM

Different Paths, Same Vision

The Technology Association of Georgia Education Collaborative (TAG-Ed) strengthens the future workforce by providing students with relevant, hands-on STEM learning opportunities and connecting them to Technology Association of Georgia (TAG) resources.

Formerly the TAG Foundation, TAG-Ed is a 501(C)(3) non-profit organization formed by TAG in 2002. Later, the organization's name was re-branded to TAG Education Collaborative to facilitate our role as the leaders for K-12 STEM education in Georgia.

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Welcome to the July 2025 edition of Georgia Pathways Magazine, a platform dedicated to exploring the forces shaping our state's innovation economy. For today's employers—large and small— success increasingly hinges on a workforce that is not only technically skilled but adaptable, visionary, and well-prepared for the fast-evolving demands of science and technology. This issue highlights how Georgia is advancing that future through strategic investments in STEM education and real-world application.

Today, we find ourselves in the midst of one of those moments, where artificial intelligence is not just reshaping our tools but transforming how we perceive possibility itself. As automation accelerates and generative technologies become woven into daily life, education and workforce pathways must adapt, not by replacing human capacity but by reimagining how we nurture it.

AI challenges us to ask better questions, think across disciplines, and reframe the skills we consider essential. It sharpens our need for creativity, adaptability, ethical reasoning, and systems-level thinking. And while technology is rapidly evolving, our opportunity is to ensure that people keep up with it, especially the next generation of problem solvers, designers, and storytellers.

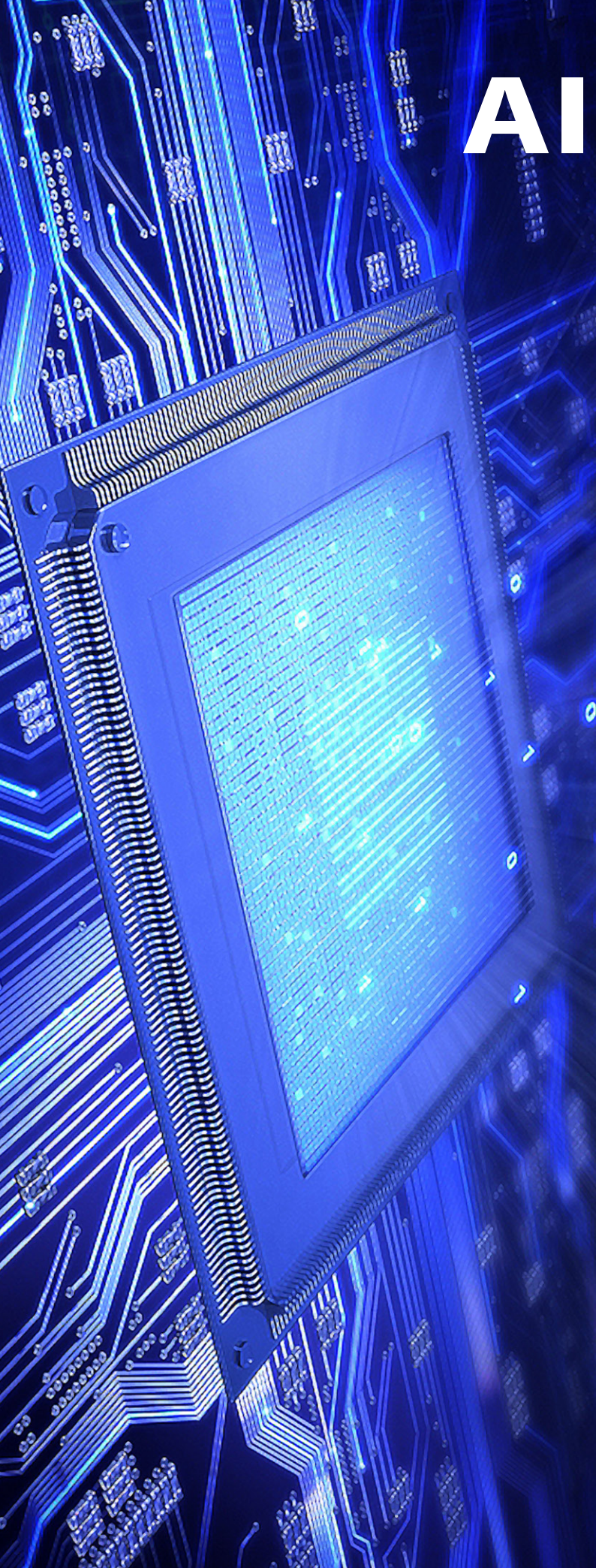
This issue of Georgia Pathways offers a compelling glimpse into the fusion of human ingenuity and technological advancement:

- "Illuminating Our World: Photonics and the Rise of STEM" explores how light-based technologies are revolutionizing fields from medicine to manufacturing—and inspiring the next wave of STEM curiosity.
- "The Power of Story Thinking" invites us to bridge creativity with computation, demonstrating how narrative insight can shape empathetic, impactful innovation.
- "Uniquely Talented STEM Problem Solvers" showcases diverse learners tackling complex challenges with resilience, imagination, and unshakable curiosity.
- "Four Models for Cross-Curricular STEM Integration" offers a practical framework for educators seeking to blur the boundaries between subjects and better prepare students for interdisciplinary futures.

Together, these stories remind us that technology alone doesn't drive progress—people do. And our most significant task, and privilege, is to ensure that every learner in Georgia can participate, create, and lead in an AI-enabled world.

Larry K. Williams
President
TAG / TAG-Ed

Larry K. Williams serves as the President and CEO of the TAG and the TAG Education Collaborative. 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.



AI In A Changing World

By Wayne Carley

AI is no longer just a technology, but quickly becoming intrinsic to every facet of our lives and business, in every industry. As AI rapidly becomes a natural part of how businesses operate, compete and grow, it will bring disruption to every industry and career path you are considering.

Disruption / definition:
- radical change to an existing industry or market due to technological innovation

- a significant interruption or disturbance to normal business operations.

Artificial Intelligence (AI) commonly refers to the ***simulation*** of human intelligence in machines that are designed to think and work like humans. AI learning machines (computers) have the ability to learn (accumulate information) from inputted experiences, make decisions (based on programmed parameters), and perform tasks that typically require human intelligence.

Every career choice you're considering will require you to interact with AI.

Advantages of AI

- Creation of new job opportunities
- Increased efficiency and productivity
- Improved accuracy
- Enhanced customer experience

AI is becoming increasingly important in today's world across all electronic applications and is revolutionizing most industries. A driving motivation is efficiency and productivity leading to greater profits. Common industries of significant size and popularity that are impacting your life and career path include:

- Healthcare
- Finance
- Education
- Energy
- Defense

and more.

The use of AI has already improved efficiency, reduced costs, and increased accuracy in various industries. With ChatGPT for example, the use of Generative AI has assisted human interactions to create new content, such as text, images, audio, and video, based on learned patterns from existing data.

It differs from traditional AI, which primarily focuses on tasks like pattern recognition and prediction. Generative AI models often employ deep learning techniques, learn from vast databases to generate unique suggestions that may

resemble, but are not identical to, the data being used or evaluated.

"It's a suggestion."

As a literary and communications tool, Generative AI has become extremely popular in suggesting alternative expressions of thought. This is showing great promise in customer service, targeting specific demographics who may respond differently to how information is communicated or presented.

In sales, how a product or service is presented verbally and in text, will often determine the response of the potential customer and their willingness to pursue the product or service. These suggested literary presentations, possibly more effective, boost sales in both volume and speed of transaction.

Not everyone in business is eloquent in their communications and no one knows

their business as well as themselves.

Students are an example of how AI has become popular, as they employ Chat GPT and similar AI tools to enhance their scholastic efforts. The controversy continues regarding the wisdom and ethics of this use, as some suggest that this tool is encouraging students to stop thinking for themselves and rely too much on artificial software to do their thinking for them.

Original creative thought that is developed during the educational years is an invaluable skill and contribution to most industries and society as a whole. However, studies are showing that ChatGPT is having a negative impact on student learning. Ali et al. (2024) found that ChatGPT in education still has several shortcomings, such as generating incorrect answers, triggering academic plagiarism, and causing students to become dependent on technology in an unhealthy way.

Outside of education, a wide variety of industries are benefiting from AI's advanced abilities in speed and accuracy.

Efficiency:
AI can automate tasks, optimize (by streamlining) processes, and improve how resources are used, leading to better efficiency. Companies such as Amazon, FedEx and data collection agencies (finance) are profiting from efficiency gains this AI algorithm provides. Faster means greater profits.

Decision-making:
AI-powered insights enable businesses to make more accurate and timely decisions, gaining a competitive edge. The faster a company knows what is working, selling or popular, the quicker they can ramp-up production and services or perhaps change direction completely.

Innovation:
The computer power used by AI can accelerate research and product development, reduce time to market, and encouraging continued innovation. This is being seen rapidly in the science and technology of healthcare and medicine.

Targeted Personalization:
AI quickly analyzes date collected from consumers to personalize experiences, improve customer satisfaction, and drive production and sales. You've seen it.

Cost Reduction:
Automation and streamlining business processes have always saved costs, going back to the roots in the industrial revolution. Will AI eliminate jobs? This is a fact of life, but others argue that it will also create new jobs. This remains to be seen, but those in the workforce pipeline need to be aware, trained and prepared for this reality.

Implementation:
Businesses need to carefully select AI technologies that align with their specific needs, vision and philosophy to ensure the integrity of their mission, training and integration of what may or may not be advantageous. The inclusion of AI tech is a reality for businesses to discover if it truly is an asset to their efforts or not. Each company will decide what's in their best interest.

Human Oversight:
AI can automate many tasks in many industries, but human oversight and validation are still necessary to ensure accuracy and minimize potential risks. Though humans are vital to AI's existence through the creation of computer algorithms for various applications, the value of people making decisions for machines cannot be ignored.

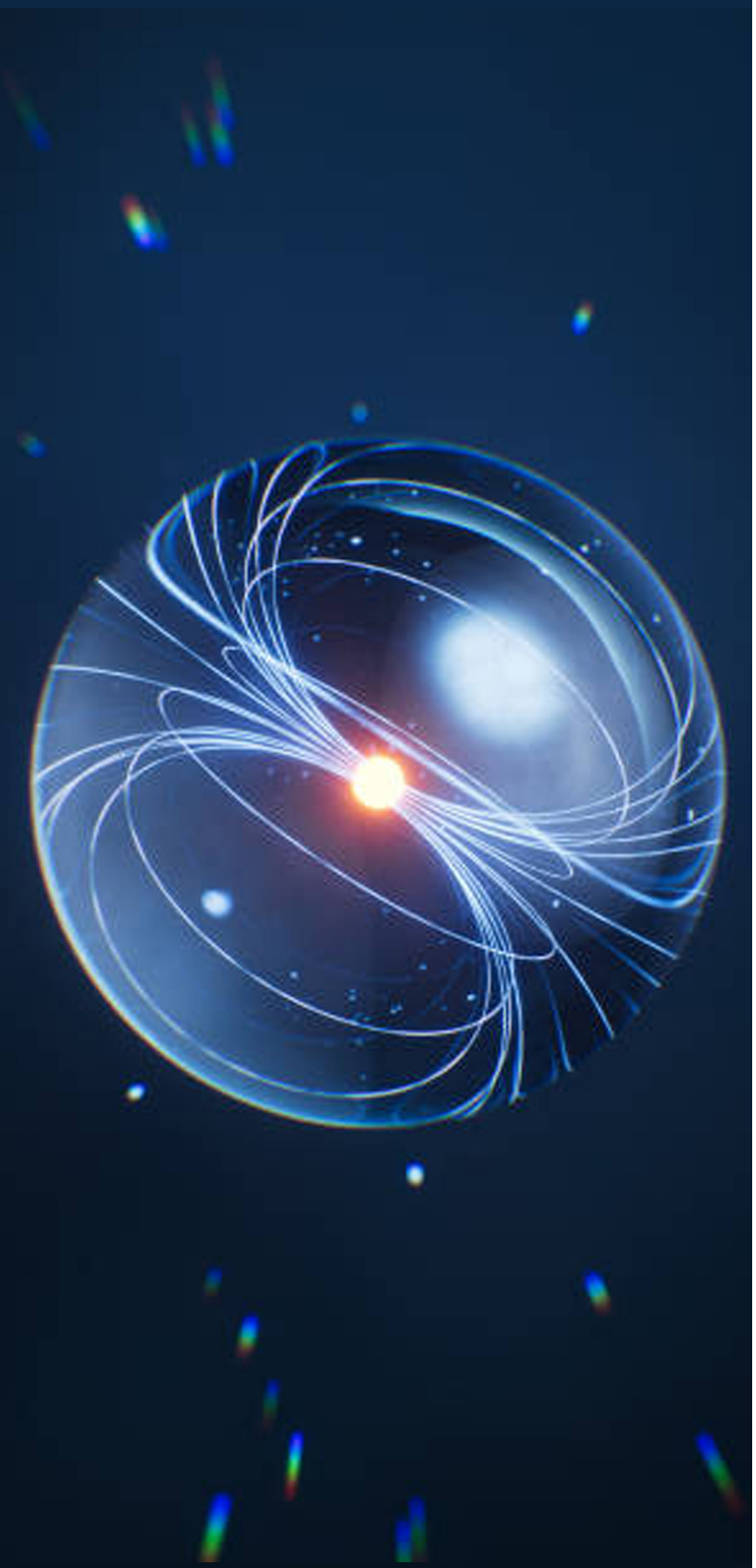
Where do you fit into this changing AI world?

The best news is that you're still in charge, making decisions about how to enable AI and shape its direction and setting the parameters of use.

As you engage with AI at school, work and home, it's reassuring to know that you're in control as long as you wish. The amount of interaction with these tools rests in your daily decisions. AI cannot do anything in your career or live beyond what you allow.

Perhaps more importantly, you will decide "how" AI is used - for good or evil. Understanding and staying abreast of AI applications and innovations will continue to be a necessary part of your changing world.

Illuminating Our World:
Photonics and the Rise of STEM



By **Sam Rubin**
President & CEO of LightPath Technologies

The year 2025 is shaping up to be a milestone for photonics, a field that now stands front and center in redefining our technological future. From medicine and defense to manufacturing and communications, photonics is making significant advancements, realizing capabilities that were once deemed far-reaching. At its core, photonics involves the manipulation of photons, the elementary particles of light, allowing us to employ light's dual wave-like and particle-like nature in transformative ways.

Both optics and photonics encompass the science and engineering of light. Optics studies the behavior and properties of light, while photonics focuses on harnessing and manipulating photons, the fundamental particles of light. This field enables diverse technologies, from precision measurement instruments like interferometers and spectrometers to advanced imaging systems like microscopes and telescopes. It also underpins laser technology used in manufacturing and medicine, and plays a crucial role in sensors, displays, and energy harvesting, extending far

beyond just optical communication.

This revolution in light-based technologies goes well beyond the fiber optic cables that structure global communications or the optical sensors embedded in everyday smartphones. It is now a foundational force powering innovation across industries, offering extraordinary speed, precision, and security. With rising data demands, global tensions, and the need for sustainable technologies intensifying, photonics is truly meeting and defining the moment.

Photonics Revolutionizing Medical Diagnostics and Treatment

Photonics is also transforming how we diagnose, monitor, and treat diseases. One of the most powerful tools in modern medicine is optical coherence tomography (OCT), a non-invasive imaging technique that provides high-resolution, three-dimensional views of biological tissue. Originally developed for ophthalmology, OCT has now expanded into cardiology, dermatology, and oncology, offering physicians the ability to detect diseases in their earliest stages when treatments are most effective.

Laser-based therapies like photodynamic therapy (PDT) are also making waves in the medical field. PDT uses specific wavelengths of light to activate photosensitive drugs that selectively target and destroy cancerous cells, bacteria, or damaged tissue. Because it can be highly localized, photodynamic therapy often results in fewer side effects compared to traditional chemotherapy or surgery, making it a promising option for patients and providers alike.

In surgical environments, lasers offer increased precision. Whether used in delicate eye surgeries, cosmetic procedures, or tumor removal, laser scalpels enable clinicians to cut tissue with minimal bleeding and trauma. As medical lasers continue to become more compact and affordable, their use is expanding into rural clinics and mobile health units, democratizing access to critical care.

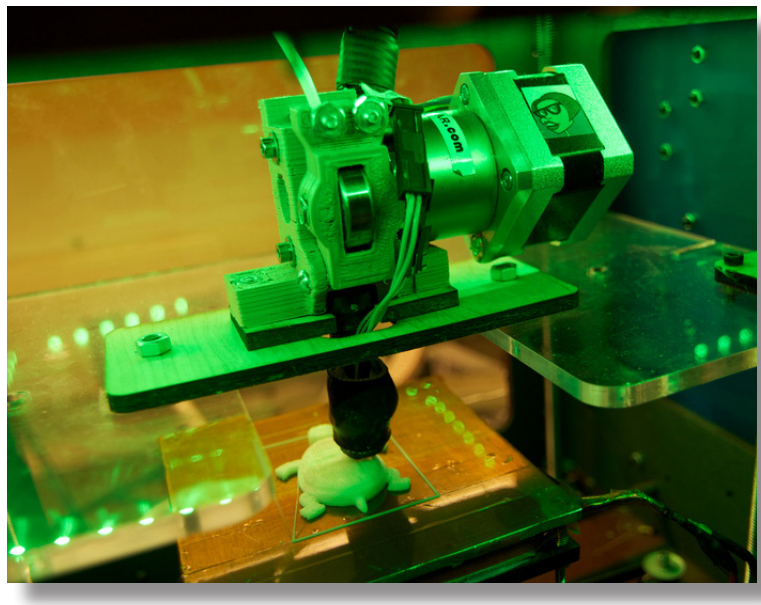
The Strategic Importance of Materials like Germanium

A critical material supporting this ecosystem is germanium, an element with exceptional optical properties in the infrared spectrum. Germanium-based lenses and windows are core components in high-performance thermal cameras, missile guidance systems, and other defense platforms. Yet, as global supply chains come under increasing pressure and geopolitical tensions raise the risk of material shortages, securing domestic expertise and production capacity has become a national imperative.

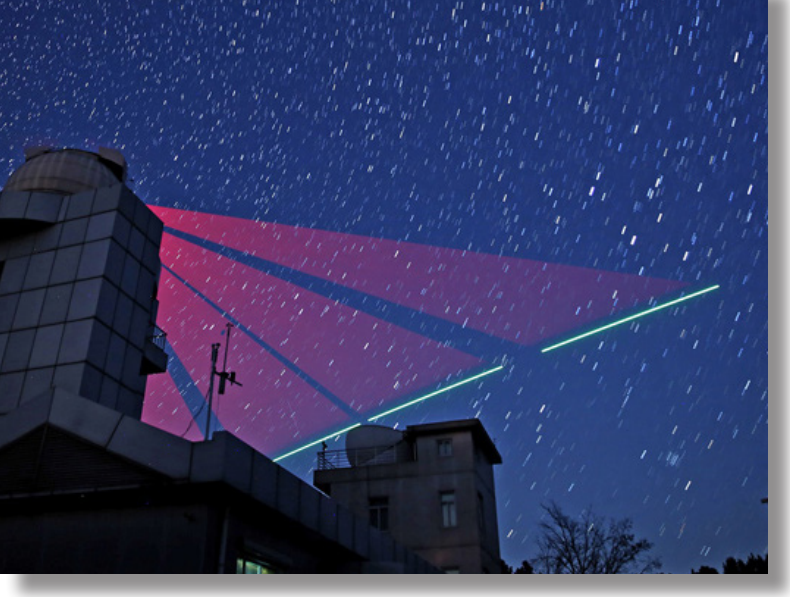
Companies across the U.S. are working to rebuild and strengthen the domestic industrial base for key optical materials and components. Efforts to develop synthetic alternatives, improve recycling technologies, and train a new generation of materials scientists are vital steps toward greater supply chain resilience and continued leadership in the infrared domain.

The Guiding Light of Photonics in Industry 4.0

In the manufacturing sector, photonics is enabling an unprecedented level of precision and efficiency. Lasers are now integral to 3D printing, micromachining, and welding, where they are used to fabricate complex parts with extreme accuracy. In industries ranging from aerospace to automotive, photonics tools are helping reduce material waste, improve structural integrity, and speed up production timelines.



Optical sensors are another important innovation, offering real-time feedback for quality control and process automation. These sensors can detect temperature changes, measure surface roughness, or identify defects invisible to the human eye. As manufacturers race to meet the demands of Industry 4.0 (automation, data exchange, and smart systems), photonics offers the tools to make factories smarter and more adaptive.



Photonics Illuminating the Quantum Sphere

Perhaps the most forward-looking frontier is quantum photonics. By leveraging the principles of quantum mechanics, researchers are developing technologies that push the boundaries of the possible. One standout application is quantum key distribution (QQKD), a method of encryption that is theoretically immune to eavesdropping. In an age where cyber threats are growing more sophisticated, QKD offers a fundamentally new level of data protection.

Quantum sensors, another promising technology, can detect minute changes in gravitational forces, magnetic fields, or motion. These ultra-sensitive instruments could change fields like navigation (offering GPS-independent systems), geology (detecting underground structures or mineral deposits), and space exploration (measuring cosmic phenomena with new precision).

Many of these technologies are still in the research or prototype phase, but the momentum is undeniable. Governments and private companies alike are investing heavily in quantum photonics, recognizing its transformative potential for communications, security, and scientific discovery.

A defining trend in photonics is the emergence of photonic integrated circuits, or PICs. These devices integrate multiple photonic functions, like lasers, modulators, and detectors, onto a single chip, much like how electronic integrated circuits revolutionized computing. PICs dramatically increase bandwidth and reduce energy consumption, making them indispensable for the future of data centers, 5G networks, and emerging applications like LiDAR systems in autonomous vehicles.

The use of PICs in data transmission is particularly important as we move into a world of exponentially growing data needs. Whether it's high-frequency trading on Wall Street or real-time video streaming in the metaverse, data centers require lightning-fast, energy-efficient infrastructure. PICs are helping meet that demand while reducing carbon footprints and lowering costs.

Ultrafast lasers and advances in nonlinear optics are also accelerating progress in telecommunications, materials

science, and biomedical imaging, offering new tools for researchers and engineers alike.

How Photonics is Strengthening National Defense

One of the most immediate and high-stakes applications of photonics lies in national defense. Defense systems are evolving with photonics at their core, developing next-generation technologies like high-energy lasers for precision strikes, quantum photonics for ultra-secure communications, and photonic integrated circuits that make advanced, compact, and efficient military systems a reality. These technologies are strengthening global security and maintaining critical advantages in an era of quickly changing threats.

For example, directed energy weapons, like laser-based systems capable of neutralizing incoming missiles, drones, or enemy infrastructure, offer a cleaner, more precise, and more cost-effective alternative to traditional kinetic weapons. Unlike bullets or bombs, lasers travel at the speed of light and don't require ammunition resupply. As research continues to improve beam quality and power efficiency, these systems are positioned to redefine the battlefield.

Precision-engineered infrared imaging systems also play a vital role in modern security strategies. Whether enabling night vision, enhancing surveillance, or improving target acquisition in complex environments, these technologies deliver top reliability for mission-critical applications. From wide-area reconnaissance to the targeting systems used in fighter jets and unmanned aerial vehicles, infrared photonics is essential for strategic awareness and response.

STEM Education as the Foundation for Photonics Advancement

But none of these innovations happen in a vacuum. At the root of photonics progress is a strong STEM education pipeline. As demand for skilled professionals in optics, photonics, and quantum engineering grows, educational institutions must rise to meet the challenge. Traditional programs in physics, materials science, and electrical engineering are vital, but so too is cross-disciplinary collaboration that includes biology, chemistry, and computer science.

Organizations and universities are launching specialized photonics training programs, industry-academic partnerships, and hands-on research opportunities to ensure students are not only academically prepared but also workforce-ready. Initiatives such as the National Photonics Initiative and

Lightwave Education Initiative are working to strengthen curricula and encourage underrepresented groups to pursue careers in light-based technologies.

The career opportunities tied to photonics span a wide spectrum of industries. Engineers and scientists working in photonics may specialize in optical design, laser development, biomedical imaging, or quantum technologies. Roles exist in defense, telecommunications, aerospace, semiconductor manufacturing, and healthcare, among others. Even sectors like agriculture and environmental monitoring are seeing growing demand for photonics experts, who help develop tools for precision farming and remote sensing. As photonics continues to underpin new technologies, professionals with expertise in this field are increasingly sought after for their ability to drive innovation.

Building an agile, well-educated workforce is critical to sustaining innovation and maintaining leadership in this field. Without a strong talent pipeline, even the most advanced photonics breakthroughs could struggle to reach real-world applications.

Strategic Investment for a Bright Photonics Future

To remain a leader of this global photonics revolution, the United States must invest beyond technology. It must create an ecosystem that supports research, entrepreneurship, and partnerships. This means increased funding for basic and applied research, targeted support for early-stage startups, and mechanisms that encourage collaboration between academia, industry, and government.

Smart policy is also essential to ensure that IP protection, supply chain security, and ethical standards keep pace with technological advancement. With the right infrastructure and incentives in place, the country can build an environment where breakthroughs can flourish in the lab and the market.

Conclusion

Ultimately, the promise of photonics lies in its capacity to shape a smarter, more connected, and more secure future. In 2025 and beyond, these technologies are paving the way forward. From the lasers protecting our skies to the quantum signals safeguarding our data, and the imaging tools that catch disease before it spreads, light is proving to be one of our most powerful allies.

As we continue to explore the vast potential of photonics, we are creating new possibilities for humanity, all while only beginning to understand the full impact.

About the author:

Sam Rubin is President & CEO of LightPath Technologies. As the CEO of LightPath Technologies, a Nasdaq-listed company and recognized leader in optics and photonics solutions serving blue-chip customers across industrial, defense, telecommunications, testing and measurement, and medical industries, Sam Rubin leads the company's strategic vision, execution, and performance. With 30 years of experience in the photonics industry, he has a deep understanding of the market, technology, and customer needs in this field.

Sam has a proven track record of creating and delivering growth, both organically and through mergers and acquisitions, improving operations, developing leadership teams, and building sustainable businesses in the US and abroad.

He has also co-founded and advised startups and served on the board of a non-profit educational organization. Sam holds an MBA from NYU Stern School of Business, executive education from Harvard Business School, a BSc in electrical engineering from Ben Gurion University, and multiple patents in the field of photonics. Sam's mission is to leverage his skills and expertise to drive innovation, value, and impact in the photonics industry and beyond.

To understand STEM...

...you must DEFINE STEM. You cannot define an acronym without defining each of the words the letters stand for.

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

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

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

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

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

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

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

The Future of STEM Education: Harnessing the Power of *Storythinking*

By Shelly A Munoz

STEM education has long been rooted in logic—a foundation of problem-solving, data analysis, and empirical reasoning. But as we look to the future, an emerging paradigm suggests that logic alone is not enough. Inspired by the groundbreaking ideas in Storythinking by Angus Fletcher, this article explores how storytelling offers a complementary way of understanding and solving problems, unlocking new possibilities for innovation, inclusivity, and creativity in STEM.

In Storythinking: The New Science of Narrative Intelligence, Fletcher explains how storytelling is not just a method of communication or entertainment but a distinct form of intelligence. He identifies storytelling as a cognitive skill that complements logical reasoning by engaging the brain's emotional and imaginative centers. Stories help us prioritize the exceptional, shift perspectives, and navigate conflicts in creative ways, making them a vital tool for solving complex problems and fostering innovation.

Traditionally, STEM has prized logic as the ultimate form of thinking. While invaluable, this perspective risks overlooking another powerful cognitive tool: narrative. Stories allow us to think in ways that logic cannot, bridging gaps in understanding, fostering empathy, and imagining futures that logic alone might never conceive. Here's how storythinking can revolutionize STEM education and what it means for the future:

1. Prioritizing the Exceptional

In STEM, patterns and statistical norms often dominate problem-solving. Data points that deviate from the mean are treated as noise. But storythinking flips this script by focusing on the unique, the exceptional, and the unexpected. It asks: What new possibilities do these outliers suggest?

For example, consider a student who approaches a physics problem in an unconventional way. Rather than dismissing their perspective, storythinking invites us to explore it. What insights might emerge if we treat their approach as a signal rather than noise? STEM education can harness this skill by encouraging students to imagine alternate futures, much like science fiction writers. By speculating on how anomalies might shape the future, students learn to think beyond the confines of the predictable.

2. Perspective Shifting

Empathy is not just a soft skill; it's a cognitive tool that drives innovation. Storythinking involves stepping into another's shoes, seeing the world from their perspective, and understanding the root causes of their behavior. This is invaluable in STEM, where collaboration across disciplines and cultures is essential.

Imagine an engineering team designing a new water filtration system for a remote community. Perspective shifting allows team members to see the problem not just through their technical lens but through the lived experiences of the community members. What challenges do they face daily? How might cultural norms influence the system's usability? By integrating this skill into STEM education, students learn to design solutions that are both technically sound and deeply human-centered.

3. Stoking Narrative Conflict

In STEM, conflict often arises between competing ideas, arguments, or theories. But storythinking encourages a different kind of conflict—one between actions and forces. It's about pitting two opposing physical causes against each other to see what unfolds, much like a novelist generates plot by creating tension between characters.

This type of thinking pushes STEM students to explore untested possibilities. For instance, instead of debating the merits of two alternative energy sources in the abstract, students might design and test competing prototypes to see which performs better under real-world conditions. The conflict doesn't aim for resolution but for originality—sparking innovative actions that might otherwise remain undiscovered.

The Brain's Natural Storythinking Abilities

The human brain is naturally wired for storythinking. We notice irregularities in our environment, shift perspectives to understand others, and engage in internal conflicts that generate new ideas. These innate capabilities, honed by natural selection, are key drivers of problem-solving and creativity.

Fletcher underscores how these skills can be developed and applied in fields like education, technology, and medicine. By fostering narrative intelligence, STEM educators can unlock students' full creative potential, helping them address complex challenges and imagine transformative solutions.

Connecting to Foundational Practices in STEM

The integration of storythinking aligns seamlessly with existing practices in STEM education, including:

Mathematics Practices (Common Core):

1. Making sense of problems and

persevere in solving them connects to storythinking's emphasis on exploring anomalies and imagining new possibilities.

2. Reasoning abstractly and quantitatively mirrors the balance between logic and narrative.

3. Constructing viable arguments and critiquing the reasoning of others ties closely to perspective shifting, as students consider alternative viewpoints.

Science and Engineering Practices (NGSS):

1. Asking questions and defining problems encourages curiosity about outliers and unique data points.

2. Developing and using models aligns with narrative conflict, as models test competing ideas or solutions.

3. Engaging in argument from evidence reflects the iterative, exploratory nature of storythinking.

Engineering Practices (NGSS):

1. ***Defining Problems:*** Similar to storythinking's focus on prioritizing the exceptional, engineering begins with identifying unique challenges and opportunities, particularly those outside the norm. Storythinking encour ages students to explore these anomalies as the foundation for innovation.

2. ***Optimizing Design Solutions:*** This practice resonates with narrative conflict. By testing competing design solutions, students explore multiple possibilities and refine outcomes based on real-world data and constraints.

3. ***Analyzing and Interpreting Data:*** While this may seem purely logical, storythinking integrates the human narrative behind the data, encouraging students to think about the broader implications of their findings and the stories they tell.

4. ***Engaging in Systems Thinking:*** Perspective shifting aligns with understanding systems and how individual components interact. Storythinking adds a layer of empathy, encouraging students to view these systems from the perspectives of various stakeholders.

Computer Science Practices (CSTA):

1. Fostering an inclusive computing culture integrates empathy and perspective shifting.

2. Collaborating around computing emphasizes teamwork and viewing problems from multiple angles.

3. Testing and refining computational artifacts mirrors the narrative conflict of pitting solutions against one another to find innovative outcomes.

A Vision for the Future

The future of STEM is interdisciplinary, inclusive, and innovative. By integrating storythinking into STEM curricula, we can prepare students to solve the challenges of tomorrow with both precision and imagination.

From prioritizing the exceptional to perspective shifting and narrative conflict, these skills equip students not just to analyze data but to understand the human stories behind it. They enable students to see not just what is, but what could be.

As educators, we have the opportunity to shape this future. By embracing storythinking and building on the practices of mathematics, science, engineering, and computer science, we expand the boundaries of what STEM can achieve—creating a generation of thinkers who combine the best of logic and story to build a better world.

Share this issue with your students, peers, parents and industry professionals you know. Make this a new monthly connection for curiosity, interaction, college prep and career development.

Many parents really enjoy this content as they too pursue their personal life-long learning goals.

Local industry and government leaders need to know about this resource as their future employees decide and prepare how to spend their careers.

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- **16%** Industry professionals
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Uniquely Talented STEM Problem Solvers:
How ADHD may provide just what we need.

By Jodi Asbell-Clarke, PhD

Visiting an eighth grade science class a few years back, I realized what we miss when we ask all students to sit in a chair, face the front of the class, and listen. I was co-teaching a lesson on heat and expansion that day, and while the teacher was still taking attendance, a boy named Caleb was bouncing around the class running his fingers along every wall. I held up a picture of a hot-air balloon and asked if anyone knew how it worked.

As the rest of the class was still chatting about other things, totally disinterested, Caleb walked in front of me, dragged his fingers across my face, and chanted, "The fire heats the gas. The particles spread apart. The gas expands. The balloon rises." This, by the way, is exactly how a hot air balloon works.

Unfortunately, rather than being encouraged to engage in a discussion on heat and expansion while he walked around the room, Caleb was shepherded to his seat and told to sit quietly while the teacher started the lesson. He had a minor meltdown, and as the class shouted over his outburst, he disengaged. We all missed out on ever learning what Caleb already knew.

Many of our best future STEM problem solvers are at risk of being marginalized in school and coming away from their formative years feeling unable to succeed or possibly stupid. Yet many learners who struggle in typical school activities may be extraordinary systematic thinkers, idea generators, or detailed problem-solvers.

Our educational systems often take a deficit-based view toward neurodiversity, and learners with ADHD or other executive function differences are seen as "broken" and needing to be "fixed." We provide accommodations to help every child learn in the way we deem "normal" or "standard," while we dismiss the very talents we need to nurture.

In our research at the STEM education R&D non-profit TERC, my team promotes inclusive learning environments in which students like Caleb and his classmates would be given the time and space to learn about heat and expansion on their own terms. They might build a model hot air balloon, or a thermometer, or a water filtration system. They might design a video game that uses the same principles, or create a video of an experiment where they study weather patterns in their community.

These are all ways to learn about heat and expansion. Moreover, in these types of projects, students learn how to plan, implement, test, and revise their plans according to how things go in real life. They learn how to take in new information, organize their ideas, and innovate as they go along. These are the skills we need all learners to build, especially our future STEM problem solvers.

For my book, Reaching and Teaching Neurodivergent Learners in STEM: Strategies for Embracing Uniquely Talented Problem Solvers, I interviewed neurodivergent employees in top global STEM companies and their employers, as well as neurodivergent learners, their educators, and their families. I wanted to learn what unique talents neurodivergent learners bring to the STEM workforce and how schools can better nurture those talents.

One woman interviewed, Anita, told me how her ADHD was what got her to run a successful virtual reality (VR) firm today. She is motivated by her need to move and her constant desire for novelty. Anita remembers being bored and disengaged in school, but she always had a lot of extra-curricular activities she was involved in. She was on several sports teams and she also ran a snack stand. Each year she started something new. She loved being in charge of her own business. What initially drove her was her desire for a new pair of skis each year, far and beyond what she could afford, so she started a sports equipment exchange program after school.

In university, Anita studied animation and started working at a game studio in a big city, while also keeping up with a strong physical regime as best she could. All that stopped during COVID lockdowns. Anita felt trapped in her tiny apartment, and many of her outlets were gone, so she moved across the country to a small city in a rural province where she could start an entirely new life. With help from friends who could do all the necessary paperwork, Anita started her own VR firm where she now employs a staff of 40. Anita credits her ADHD brain for being able to visualize the changes she wants to make. She sees what she wants and is then motivated to work hard for it.

She also says her brain still spends a lot of time going down rabbit holes when she is trying to solve a problem. She says she knows these are destination-less journeys–the endpoints are rarely significant, but it's down those rabbit holes where Anita says she discovers her best new ideas.

Many of the neurodivergent researchers, software engineers, accountants, cyber-security professionals, video game designers, and AI programmers I interviewed for my book said it is their neurodiversity that makes them so good at their job. They often see new ideas that others don't. They often find bugs in the software that no one else sees. They often see patterns in data that prompt the discovery of new solutions. Most neurodivergent people I interviewed said they didn't want to change their brains at all. They just wanted to change the way others look at them.

School environments need to change to embrace this creativity rather than stifle it. Teaching and learning activities should foster autonomy of thought and expression by allowing students time and space to work through their own conceptual knowledge using the representations, scenarios, and media of their choosing. To do this well, learning environments and activities must be specifically designed for inclusion.

Teaching and learning experiences must be differentiated for each learner, adapting to the unique physical, cognitive, emotional, and social considerations for each learner. This is not an easy task, but it is doable.

Our team at TERC helps teachers recognize the talents of their neurodivergent learners while also supporting their struggles. This emphasis on student-centered learning has been around since Dewey and Montessori, but it is very different from what most of our classrooms look like today. That needs to change lest we risk leaving behind a talented group of individuals who can contribute to our nation's urgent needs in STEM.

About the author:

Jodi Asbell-Clarke's academic background includes a MA in Math, an MSc in Astrophysics and a PhD in Education. Early in her career, Jodi dreamed of being an astronaut and went to Houston where she was an onboard software verification analyst for IBM during the first 25 missions of the space shuttle.

Later Jodi taught Physics and Astrophysics to some of the brightest students in the country at the laboratory school at University of Illinois. In 1993, she came to TERC and led several science education projects at TERC involving curriculum development, professional development of teachers, and educational research. In 2009, she co-founded EdGE with her colleagues to study how game-based learning can transform science education.

Different Paths, Same Vision:

Four Models for Cross-Curricular STEM Integration

By Dr. Angela Hairston, Dr. Jennifer James, Karie Ann Middleton, Nicole Murray, and David Simmons

STEM education is still a relatively new discipline, but educators have devised several innovative ways to implement STEM programs. Some include the arts (STEAM), while others add in agriculture (STEAMA). With so many possibilities for implementation, schools and districts often look for models and standards from certifying bodies to ensure quality programs. These certifications do more than offer formal recognition; they empower educators to promote students' deep thinking and connect learning to outcomes associated with success.

For example, among the STEM certification standards developed by Cognia®, a nonprofit specializing in accreditation and certification, are requirements for within-school opportunities and interdisciplinary frameworks. Those two standards ensure depth of learning by "de-siloing" STEM learning. STEM becomes embedded in pedagogical practice throughout an institution, and students can see how different disciplines interconnect. The interdisciplinary approach also encourages the use of instructional models – such as project-based and inquiry-based learning – that foster student engagement, analytical thinking, critical thinking, problem-solving, and creativity.

Our schools and districts have aligned with those two standards by integrating STEM principles across the curriculum. This practice has become popular, not only because of its effectiveness in establishing quality programs but also because of its flexibility in implementation.

As the examples below illustrate, we have each taken different paths to cross-curricular STEM integration. Yet, we all share a commitment to building programs that reflect the practices and characteristics of a rigorous, relevant, and age-appropriate STEM education.

How The Goddard School® Embeds STEAM in Early Learning

The Goddard School franchise system, a leading early childhood education provider serving nearly 100,000 young children at more than 640 schools throughout the United States, has used

inquiry-based learning to integrate STEAM into its early learning curriculum. At this development stage, children naturally question and investigate their surroundings, making it a perfect time to introduce scientific processes to solve problems.

STEAM activities are carefully designed to develop age-appropriate skills in identification, analysis, and problem-solving. For toddlers, something as simple as flipping a light switch on and off becomes a real-world problem that lets them learn about testing theories as well as trial and error. One child realizes that the light goes off every time the switch is pushed down, and the other children confirm that the same thing happens when they perform the action. Next, they investigate what happens when two switches control the same light bulb.

Preschoolers might be asked to build a bridge from one point to another on a carpet displaying a world map. When traditional blocks aren't long enough to span the distance, the children are encouraged to use their ingenuity to solve the problem with other items in the room, challenging them to think innovatively.

The inquiry-based approach empowers young children to formulate questions about what they want to learn and propose methods for finding answers.

With teachers' guidance, the children make decisions about the tools and resources needed for their investigation, fostering creativity. As the children collaborate in their investigations, they hone their communication skills just as those skills are emerging, creating a powerful foundation for their educational careers.

Another great advantage of STEAM education in early learning environments is that it offers children opportunities to foster grit. Engaging with new materials and concepts often means that children try more than once before they overcome a challenge. This process teaches them that failure is just a stepping-stone to success.

How Duplin County School District Integrates STEM in the Elementary Grades

At Duplin County Schools, a rural school district in North Carolina, counselors have developed the schools' career and college readiness plans around a STEAMA model (the second A stands for "agriculture") to provide personalized pathways for all students.

Different STEAMA focus areas are introduced to elementary students systematically. First-graders initially focus on science-based skillsets and careers. Eventually, they move on to technology, then engineering, arts, mathematics, and finally agriculture. The goal is to give students extensive exposure to all subject areas while helping them understand how the different areas connect with one another.

Each grade level participates in immersive experiences:

- First-graders attend an annual "Crayons on Campus" event at a local community college where they visit different departments, engage in interactive STEAMA activities, and begin to think about potential career paths.

- Second-graders attend an agricultural showcase called "Duplin Grows," where they talk with industry professionals and bring questions about agriculture back to the classroom for investigation.

- Third-graders and students in higher grades can participate in the district's annual STEAMA Fair, designing original projects and employing the scientific method or engineering design processes to solve real-world problems. Many Duplin students have advanced to regional and state-level competitions. Though the fair is an extracurricular activity, teachers provide classroom support for participating students.

Duplin's elementary schools encompass grades K-8, and all schools, including high schools, have makerspaces with 3D printers, Cricut machines, and various materials. These spaces enable students to conduct their projects and investigations, and problem-solve. The schools also have a STEAMA resource class that focuses on engineering and design problems and processes.

At every stage, educators ensure that students can see how what they are learning in math, for example, relates to what they're learning regarding health standards or literacy. Seeing how those subjects are interwoven ignites students' excitement for discovering more.

How Active8 STEM Academy Ensures No Teacher Works in Isolation

Founded in 2023, the Activ8 STEM Academy is a program of Danville Public Schools in Virginia. Serving students in grades three through six, the school emphasizes collaborative teaching in order to integrate STEM across the curriculum.

For example, when students are studying water filtration in science class, their English language arts class provides related reading materials, and their math class includes related measurement activities. This cross-curricular approach deepens student understanding.

Since instruction is so interconnected, Activ8 employs a distributive leadership model. In addition to taking part in weekly professional learning communities, every faculty member participates in multiple teams or committees. Information flow is supported through links in the faculty calendar system so everyone across the organization knows what's taking place.

To ensure that Activ8 educators have sufficient time for cross-curricular planning and collaborating, the district has increased the school's scheduling flexibility. Teachers can deliver additional instruction as needed during extra 30-minute "extension blocks." All content teachers for the grade level engage in each extension block. However, the subject teacher who arranged the block is responsible for ensuring that the others have the relevant information and knowledge.

Teachers regularly gauge students' intellectual engagement to ensure deep learning is occurring. The school uses Cognia's Effective Learning Environments Observation Tool® (eleot®) to evaluate whether students are exhibiting engagement, critical thinking, creativity, and communication. Some indicators include students using self-assessments, participating in rubric creation, or working collaboratively in teams.

This new school's integrated approach has yielded impressive results. Prior to attending Activ8 in 2023, students' average pass rate on benchmark assessments was below 50%. By the spring of 2024, the school pass rate for state reading and math tests was over 90%.

How Innovation Early College High School Redefines Instruction

Innovation Early College High School (IECHS) in North Carolina was founded as a partnership between Pitt County Schools and East Carolina University. Designed to give students the opportunity to graduate with up to 60 hours of university credits, the high

school uses inquiry-based instruction to facilitate project-based learning and human-centered design thinking processes throughout the curriculum.

All teachers go through professional development that has them experience inquiry-based learning firsthand. Participants engage in cycles of inquiry during which they work together to examine their current education practices as well as design and implement inquiry-based lessons. They also discuss what attributes would be observed in an inquiry-based classroom.

Teachers have described the professional development as the most impactful they've ever experienced because it immerses them in deep learning about their own teaching practice. As they experience that depth of learning, they are motivated to provide similar opportunities for their students.

The team of teachers who initially experienced the professional learning model is now responsible for guiding the rest of the staff through similar experiences. Teachers encourage a growth mindset in each other and in students. When inquiry-based projects don't work as planned, teachers help each other reflect on the experience and make modifications.

Helping Teachers Embrace STEM Integration

Since cross-curricular STEM integration is not typical in schools, the adoption of any model should include helping teachers adjust. Professional learning activities that explain not just the "how" but the "why" behind integration are extremely powerful ways to obtain teacher buy-in.

One example of such an activity is an "inquiry journey line" exercise for IECHS teachers, shared at a Cognia STEM Institute for professional learning. The teachers mapped their personal inquiry-based learning experiences as students onto a line representing their lifetime. As a result, many realized they had not engaged in meaningful inquiry from third through 12th grade. Seeing

that visual representation helped them reflect on how their current non-inquiry-based practices might be hampering student engagement. They became more motivated to engage in their professional learning cycles of inquiry.

Resetting the concept of what quality education looks like can seem risky, especially if students are already scoring well on high-stakes assessments. However, students must become adept at creative problem solving and decision making to succeed. Such skills have to be nurtured. Integrating STEM education into curricula from early childhood on, gives students a supportive environment and opportunities for cultivating those essential skills.

About the authors:

Dr. Angela Hairston is the Superintendent of Danville Public Schools in Virginia, and David Simmons is the Instructional Supervisor/Principal of the district's Activ8 STEM Academy.

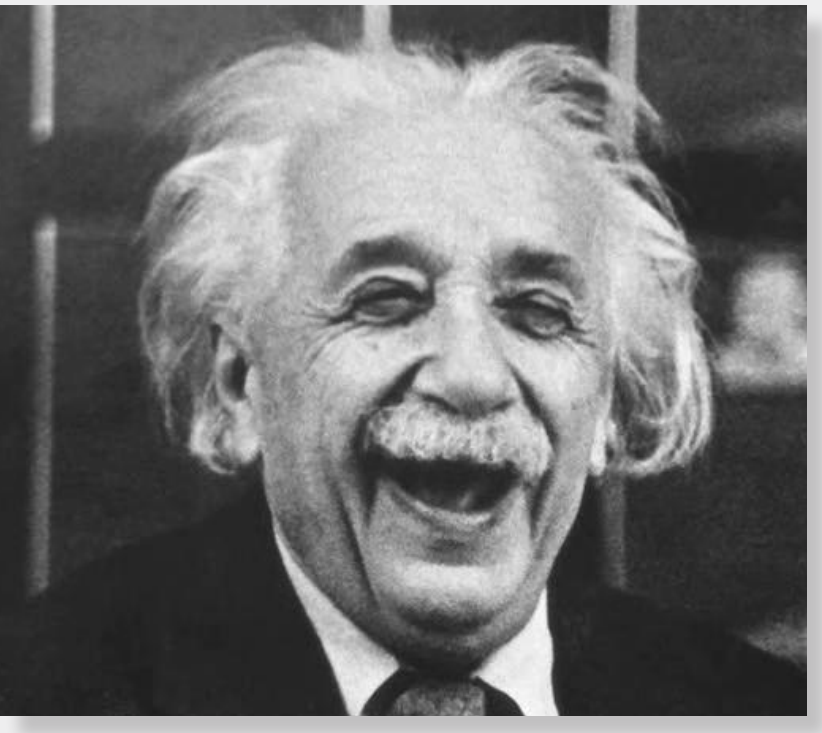
Dr. Jennifer James is Principal of Innovation Early College High School in North Carolina.

Karie Ann Middleton is Director of Early Childhood Programs at Goddard Systems, LLC.

Nicole Murray is Chief Officer for STEAMA Curriculum and Instruction/Professional Development at Duplin County Schools in North Carolina.

So, you want to be a

Mathematician



According to the U.S. Bureau of Labor Statistics there are only 3,500 mathematician jobs in the U.S.

- with good growth expected between now and 2028. That is not a lot of jobs in math, but let's look at this in more depth.

- Mathematicians conduct research to develop and understand mathematical principles. They also analyze data and apply mathematical techniques to help solve real-world problems.

- Mathematicians typically need at least a master's degree in mathematics. However, some positions are available for those with a bachelor's degree.

- Businesses always need mathematicians to analyze the increasing volume of digital and electronic data.

DATA....*that's the key*. What is the most needed STEM career in America?

Statisticians

There is a growing shortage.....

Definition of statistics -

: a branch of mathematics dealing with the collection, analysis, interpretation, and presentation of masses of numerical data.

: a collection of quantitative data (or relating to how much there is of something : of or relating to the quantity or amount of something.

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- Price: $750

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AI Skills: The New Currency in Today's Job Market

The AI revolution is here. Ever since ChatGPT arrived on the scene in late 2022, artificial intelligence has been reshaping the way we live and work. What does that mean for tech professionals looking to compete in a changing labor market?

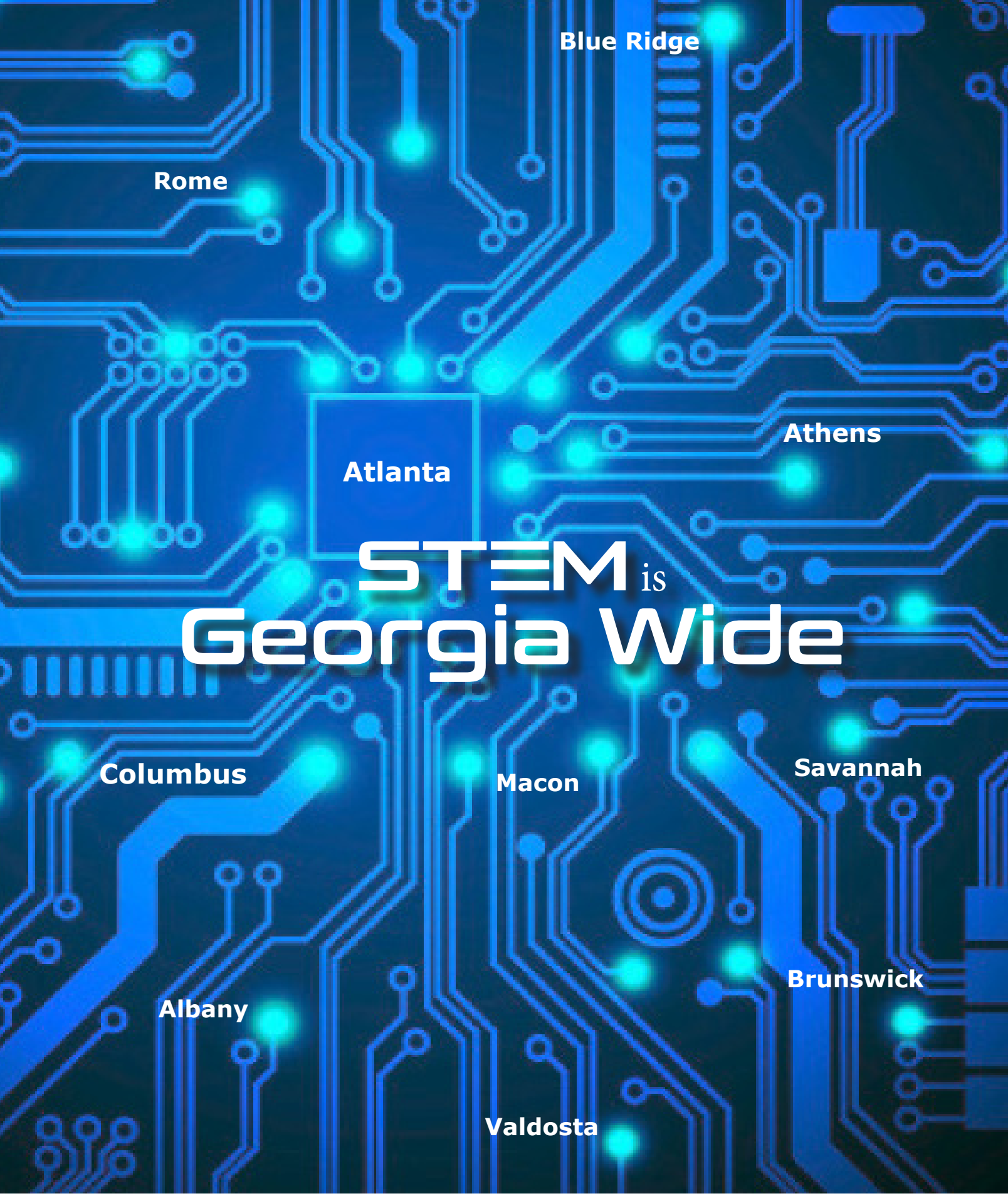
TV pundits and talking heads love to get riled up about whether robots are coming for our jobs — but the truth is that AI will probably create more jobs than it eliminates. And one thing's for sure: understanding how AI works, and mastering AI skills, will be the key to success in tomorrow's ever-changing world of work.

New research shows that a growing number of companies are asking for AI skills in job descriptions — including non-tech roles. And a survey of HR professionals released last month shows that job candidates with AI skills ask for more money during the interview process — and tend to get it once they're hired. Simply put, AI is going to be underpinning nearly every job out there. That's why staying ahead of the latest in AI development is so important.

Building AI skills doesn't just mean learning how to engineer prompts for ChatGPT. It's everything from programming to data modeling and analysis to mastering concepts like machine learning and natural language processing. And if there's anything certain in our fast-paced economy, it's that building AI fundamentals today will translate to career opportunities tomorrow and beyond.

That's where SkillStorm comes in. In partnership with TAG, we offer Microsoft Azure AI courses that are instructor-led, career-aligned tech certification courses and will help you build the AI skills that employers need. From the basics of AI and machine learning to a comprehensive understanding of how to design, deploy, and maintain AI solutions, you'll learn everything you need to accelerate a career in the economy's hottest fields.

It won't be long before all kinds of jobs, all across the economy, require AI skills. And starting now is the best way to accelerate your ascent up the career ladder. Build those skills today and you'll lay the foundation for opportunity for years to come — and set yourself up for success in an AI-driven future of work. Register today to get started with a career in tech.



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