April 2021

GEORGIA PATHWAYS

MAGAZINE

Pharmacology
One degree – many choices

Women In Georgia

A.I. and Genetics

New treatments for Parkinson's disease

TAG
Technology Association of Georgia

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Education Collaborative

The Technology Association of Georgia Education Collaborative (TAG-Ed) strengthens the future workforce by providing students with relevant, hands-on STEM learning opportunities and connecting them to Technology Association of Georgia (TAG) resources. Formerly the TAG Foundation, TAG-Ed is a 501(C)(3) non-profit organization formed by TAG in 2000. Later, the organization's name was re-branded to TAG Education Collaborative to facilitate our role as the leaders for K-12 STEM education in Georgia.

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It's already April, and time for one of our most influential TAG events. As technology continues to advance at a blinding pace, as well as the associated Georgia careers, the Georgia Technology Summit (GTS) is once again in the national spotlight. Bring together and engaging more than 1,200 prominent technology, business and thought leaders, the focus will revolve around the most prominent and relevant trends that are emerging.

GTS is an invitation to engage with the tech community, and provide an opportunity to learn, meet, and discover new ways for your company to get involved, develop relationships, and identify potential partnerships. GTS will showcase nationally recognized speakers who are "in the know", and the perfect resource for tech professionals to stay up to speed on trends. We always include content sessions, hot tech demos, and Georgia's most innovative tech companies that are revolutionizing business. As one of TAG's annual meeting, GTS also offers attendees a chance to engage with TAG's 20+ tech professional societies, representing leaders and leadership opportunities in key sectors.

From entrepreneurial journeys to conquering state and global markets, technology trailblazers will share how they define purpose, build diverse teams, and inspire this generation and the generations to follow. Consider registering for the 2021 Georgia Technology Summit.

TAG
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Engagement usually drives outcomes, so as innovation emerges from breakthrough ideas and diverse and inclusive cultures, leaders create innovative cultures that drive successful and entrepreneurial organizations. Georgia Pathways STEM Magazine is the perfect platform for tech exposure and imagination for the thousands of

Georgia's educators, students, parents and industry professionals, as they consider career paths and educational choices. Influence and exposure to existing and innovative technology is a power tool to spark imagination and educational direction when considering career choices and needed skills.

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.

Women in Georgia: *Then* and Now

Interview by Jennifer Rainey Marquez

Professor of sociology Deirdre Oakley put together a report last year titled, "How Far Yet to Go? The Status of Georgia 1970 and Today." Commissioned by the American Civil Liberties Union (ACLU) Foundation of Georgia and coauthored with sociology Ph.D. candidate Ifeanyi Ukpabi, the report was meant to initiate a conversation about the status of women in Georgia and strategies for achieving greater equality and well-being for women in the state.

"The story of women in Georgia ends up being about inequality and race, which are areas that I look into a lot," says Oakley. "The intersection of inequity and race and gender resonates with the rest of my research."

For Women's History Month, we spoke with Oakley about where women have made gains, where they lag behind and the policies that can help improve women's lives across the state.

Your research shows both progress and persistent lags for Georgia's women since 1970. Was there anything you found that surprised you?

One thing that really stood out for me is that 41 percent of businesses in Georgia are owned by women, making us second in the nation for female-led businesses. And a third of these businesses are owned by women of color. It's interesting because if you look at the pay gap between women and men in Georgia, we don't do well.

What I found is that this statistic has nothing to do with gender. It has to do with the way that laws and policies are set up in Georgia that are business friendly. This is a place that attracts entrepreneurs, and it just so happens that not all entrepreneurs are men. However, it shows that there's an opportunity to put policies on the books in Georgia to support women-owned businesses.

The report notes women have made significant gains when it comes to education. For example, more women in the state complete bachelor's degrees or higher than men.

Not only that, but women in medical school increased dramatically. Morehouse has more women pursuing medical degrees than men in recent years. And as a result of that, in 2019 the nation's three leading medical organizations — the American Medical Association (AMA), the American Academy of Pediatrics and the American College of Physicians — were all run by women doctors from Georgia. Patrice Harris was also the first Black woman to become head of the AMA. It's a testament to women's levels of achievement, particularly women of color, in the medical/healthcare space here.

You note there are ways in which women in Georgia lag behind women in other states. What would you say is the most significant?

To me, the biggest issue is that Georgia has no paid family-leave provisions beyond federal leave, which is unpaid. Research shows that in states that have more family-friendly reproductive health policies, because reproductive health goes well beyond pregnancy, women are more upwardly mobile. They have better opportunities in terms of jobs and earnings, they have better access to healthcare and better-quality healthcare, they have more childcare support.

Without those policies in place, women's education, career, health and wellbeing trajectories can be stymied.

I believe it would even have an impact on the state's maternal mortality rate, which at 40 deaths (and 62.1 deaths for Black women) per 100,000 births makes Georgia one of the most dangerous states in the country for pregnant women.

Deirdre Oakley

Across the U.S., the social and economic repercussions of the COVID-19 pandemic have disproportionately affected women. Do you think the pandemic has set women back in Georgia for the long-term?

I think it's too soon to tell. A lot of these impacts also intersect with socioeconomic status, education level and race. One area that I'm concerned about is healthcare access.

Pre-pandemic, only 83 percent of women in Georgia had health insurance, making us 48th in the nation.
I'm also curious to see how this impacts the pay gap, which is already significant. The report found that if employed women in Georgia were paid the same as men, their poverty rate would be reduced by nearly half and poverty among employed single mothers would drop by more than two-fifths. Now a lot of organizations have instituted pay freezes, which means there's no ability or attempt to close the gap.

What gives you hope or optimism about women's wellbeing in Georgia going forward?

The increase in the number of women who are in the state legislature is a big one. In the late 1970s, less than five percent of our state legislators were women. By 2019, more than 30 percent were women, more than any other state in the South.

That's particularly important because you have women who are helping to set the state's legislative agenda and weighing in on the policies that could affect them.

How are you continuing this research into women's experiences in Georgia?

Going forward, I'm paying a lot more explicit attention to gender in my research, because these findings reinforce the need for policy change in Georgia.
One area I'm interested in exploring is Black- and woman-owned businesses in Georgia and their impact on the surrounding communities' health and well-being. I'm also interested in how Black female entrepreneurs experience structural racism as business owners.

The other thing I'm really interested in is the maternal mortality rate. Black women are disproportionately affected by it, but it crosses socio-economic levels. I want to dig deeper into the root causes and the policies that would have the biggest impact in addressing the issue and resolving the racial disparity.

"What students need to know this month."

By Wayne Carley
Publisher

The articles, activities and videos in this resource can often be entertaining, but possibly not meaningful to you in regard to your future, as far away as that might seem. Best case is, as you read an article of interest, you might be curious, but can you use it today? ***How does it fit into your life where you are now?***

Both teacher and student should be reminded about the difference and value of "entertainment" versus "education". They are rarely the same in meaning or retention. An entertaining activity that's fun and engaging, but has no meaning in our living this week, might have been better used.

Gaming is a good example of how you use science, as defined, when you play your favorite. Since we have "multiple" lives in our game, we are in a constant state of memorization about where the bad guys are, where other dangers are that would take one of our limited lives and how to get past them to progress to the next level.

This is definitely a systemic accumulation of information or knowledge which happens to be the definition of **science.**

So, as you are "constantly, and systematically accumulating *(collecting)* knowledge" about the level you're on, you are scientifically playing your game in order to advance. This doesn't stop throughout your game since each level has its own unique obstacles, challenges and levels of difficulty that will have to be scientifically approached, memorized, used and responded to, if you want to succeed.

Interestingly, there is little difference in how your playing your game and that job in your future as it applies to the systematic accumulation of knowledge. You will certainly want to succeed there too through lots of knowledge accumulation, and one of the most important skills you'll use to do that is the same skill that got you to level 21 in that Xbox or Playstation game you love.

Who knew that you were already in STEM training for your dream career as you duck for cover on level 7. One more thought; let's try and avoid the "Grand Theft Auto" behaviors at work!

One Pharmacy Degree
5 Fulfilling Career Possibilities

By Heidi **Fuchs**

From hospitals to drug stores, a degree in pharmacy opens doors for jobs in so many settings. At Touro College of Pharmacy, we'll make sure you are prepared no matter what path you choose. You can even start our PharmD program before you've completed your undergraduate studies, putting you on the fast-track to a career as a pharmacist.

Once you've earned your Doctor of Pharmacy degree (PharmD), there are plenty of ways you can put it to use working as a pharmacist. The pharmacy profession today goes way beyond simply compounding and formulating medications. Tomorrow's pharmacists have many more career options than ever before. With people living longer and the ongoing discovery of new drugs, the number of prescriptions expected to be dispensed will multiply exponentially.

With the globalization of the pharmaceutical industry and of pharmacy practice, almost every country is experiencing similar problems with health care costs and access.

The pharmacy profession is recognized as a key solution to addressing these issues. Many pharmacists now work directly with patients, often collaborating with doctors and other healthcare professionals to create drug treatment plans that work safely and effectively. Some pharmacists also use their PharmD degrees to work in an entrepreneurial setting finding new pharmacological treatments and cures.

With the rising costs of healthcare, many patients are reluctant to visit doctors or ask medical questions. Because pharmacists are so accessible, they have the opportunity to play important roles in the community. Not only do they offer advice about medications, they also counsel patients and provide information about managing their symptoms or which warning signs can indicate bigger health problems. In many states, pharmacists directly affect public health by recommending and administering vaccines.

Whether you dream of teaming up with doctors to develop patient treatment plans or working at a biotech company to develop new drugs for countries around the world, check out these five exciting career opportunities for pharmacists.

#1 Ambulatory Care

As healthcare transitions to chronic disease management across the patient care continuum, the demand for ambulatory care pharmacists has rapidly increased. As highly trained members of the interprofessional team, Ambulatory Care Pharmacists are well positioned to see and treat patients in a clinical setting, physician's office and care organization. These pharmacists often focus on patients with multiple chronic conditions and are referred to the pharmacist for medication management of their conditions.

Qualified pharmacists can become authorized to provide collaborative drug therapy management services which include prescribing medication and ordering laboratory tests.

#2 Pharmacogenomics

This relatively new field combines pharmacology (the science of drugs) and genomics (the study of genes and their functions) to develop effective, safe medications and doses that will be tailored to a person's genetic makeup.

Imagine a trip to the pharmacy to fill a blood pressure or cholesterol prescription and leaving with a medication tailor-made just for you, no worries about side effects or whether the medicine will work. Using the ever-increasing amounts of genomic data collected from large populations to evaluate various approaches to disease, drug application and develop-

ment, researchers now better understand how an individual's genetic make-up influences response to diseases and the drugs that treat them. As a result, the field of pharmacogenomics has emerged as an entirely new personalized approach to medicine.

#3 Specialty Pharmacist

A specialty pharmacist may work in a variety of practice settings in roles that include dispensing, medication therapy management, patient advocacy and therapy compliance.

Pharmacists with a desire to work with orphan drugs or to treat patient populations with complex or rare diseases pursue this area of practice. Specialty pharmacists are unique in that they coordinate many aspects of patient care and disease management including patient counseling and education, medication safety, use and adherence, handling and storage and, when possible, financial assistance for medication costs.

#4 Informatics Pharmacist

Pharmacy informatics are improving medication use and patient safety by making it easier for prescriber's to reduce patient risk by providing layers of data related to prescribing habits, patient compliance, drug equivalents and cost-savings potential.

Pharmacists in this field are tasked with the integration of information, technology and data related to the medication use process. Informatics can be used to make smart pumps even smarter, to gain better control over prescriptions for controlled substances, for e-prescribing, telepharmacy, bedside bar coding and inventory management. Informatics Pharmacists are experts in human factors, patient safety, and the use of technology to optimize the care delivery processes and effectively communicate patient care activity.

#5 Clinical Pharmacist

Clinical pharmacists work in hospital settings, making rounds with doctors and nurses. Looking at patient records, your job will be to recommend the safest and most effective medications – and be on the lookout for negative reactions or potential drug interactions.

A big part of a clinical pharmacist's responsibilities is to help a patient navigate medical transitions, such as being admitted or discharged from the hospital, so medications aren't duplicated, forgotten, or incorrectly dosed.

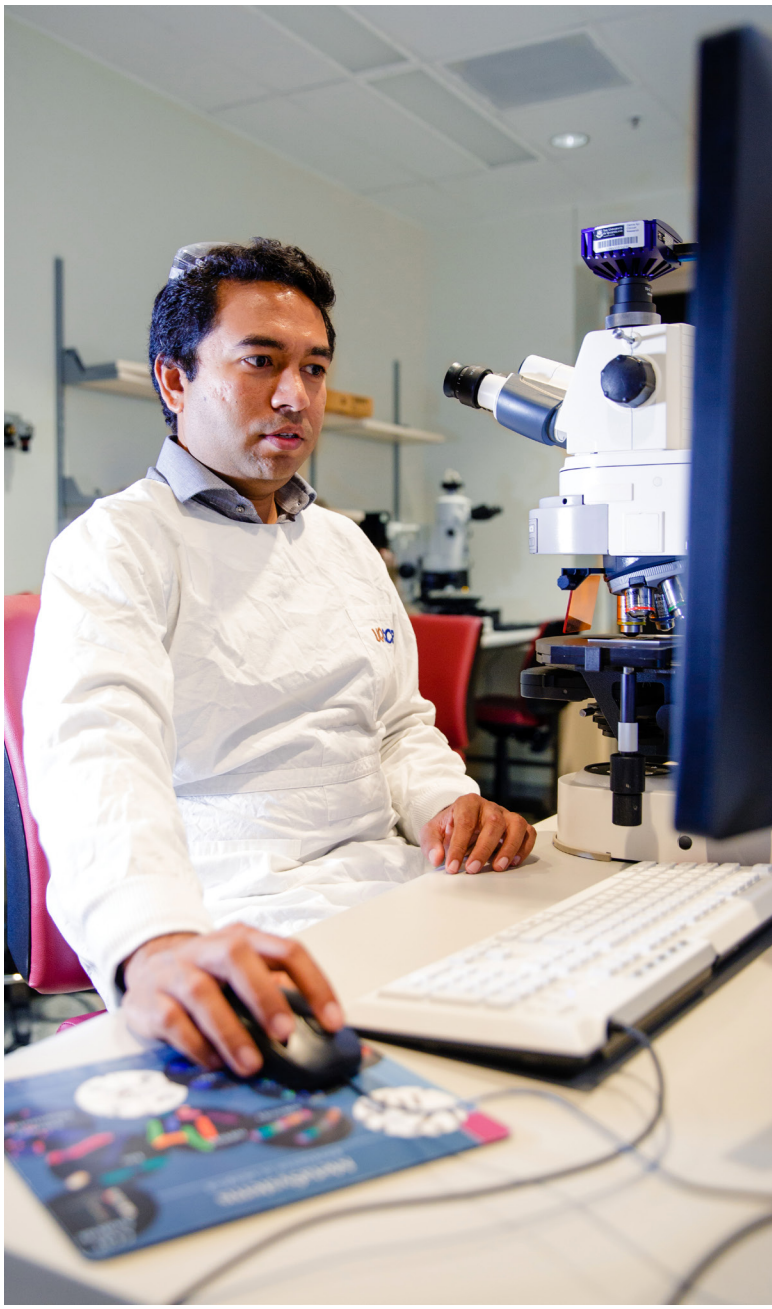
You also may team up with doctors on Collaborative Drug Therapy Management (CDTM), essentially taking over drug-related patient care by ordering lab tests, adjusting dosages, and monitoring the effectiveness of medications.

MICROBA

Mining the Gut Microbiome

to develop new treatments for Parkinson's disease

Two Australian groups – Microba and The University of Queensland (UQ) – have joined forces to develop new treatments and biomarkers for Parkinson's disease by investigating changes in the gut bacteria of those with the disease. Parkinson's disease is the second-most prevalent neurodegenerative disease worldwide, with around 10 million suffering from the disease. Parkinson's is characterized by the loss of brain cells that produce dopamine which is accompanied by a spectrum of debilitating symptoms affecting movement, gut function, and cognition.



Current treatments only help to manage symptoms of the disease, but do not slow or stop its progression. There is therefore an urgent unmet clinical need to develop new treatments that can alter the disease course. This development of new treatments is hampered, in part, by the lack of definitive biomarkers to enable early detection of the disease and before there is significant irreversible loss of dopamine producing neurons occurs in the brain. Emerging research increasingly points towards the gut microbiota playing a role

in the development of Parkinson's, with evidence showing that changes in gut function often come many years to decades before the onset of symptoms such as tremors.

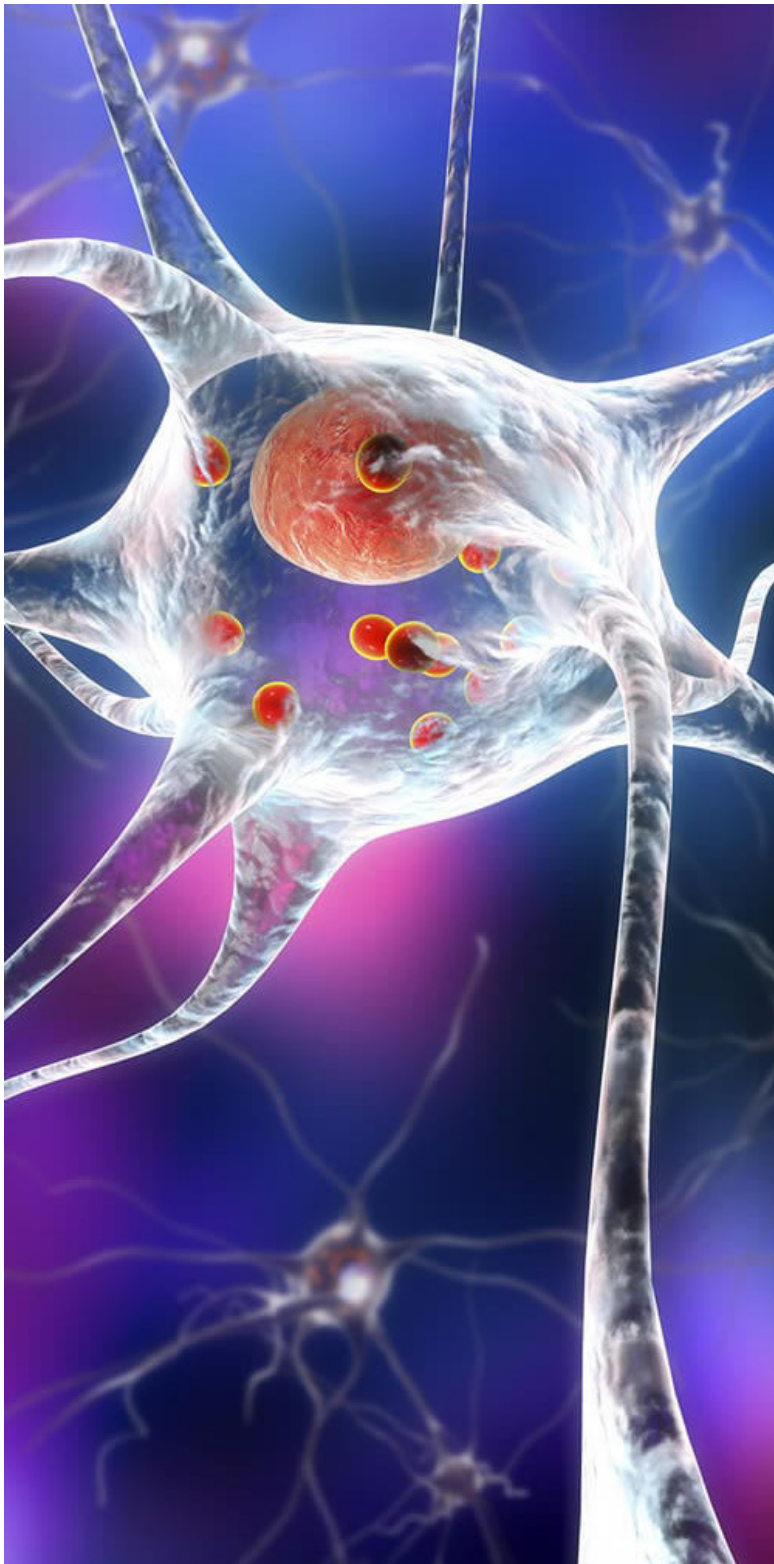
Australian-based biotech company Microba have partnered with Parkinson's researchers at The University of Queensland to unravel the links between the gut microbiota and brain.

Microba's expertise in analyzing the gut microbiome with leading sequencing technology, called metagenomics, will be used by the researchers to study functional changes in the microbiome at high resolution. The joint research program will involve a combination of human studies in Parkinson's patients and work in animal models.

Dr Richard Gordon, a Parkinson's researcher at UQ's Centre for Clinical Research (UQCCR) is leading the project. His team are working on understanding the underlying causes and mechanisms linked to the progression of the disease, such as persistent inflammasome activation and changes in the gut microbiome.

"The microbiome represents a new frontier in our understanding of Parkinson's. With Microba's expertise we hope to gain unprecedented new insights into the functional role of the microbiome in the disease process. We will use these to guide our quest for new treatments and biomarkers for early diagnosis," he said.

The State Government of Queensland provided funding for the partnership's first clinical trial, which is set to commence in 2021 at multiple sites. These trials will determine if a new treatment can restore beneficial gut microbiome species and improve symptoms such as constipation in people with Parkinson's disease.



UQ Associate Professor John O'Sullivan, a neurologist based at the Royal Brisbane & Women's Hospital is the clinical lead for the microbiome trial. He believes a better understanding of the complexity of the microbiome in patients with Parkinson's disease is fundamental to utilizing it for diagnostic or therapeutic goals.

"I'm pleased to collaborate on this project that represents a unique opportunity for patients with Parkinson's disease to contribute biological samples for research that can translate to novel interventions that may modify the course of disease for themselves and future generations."

Microbial ecologist Professor Gene Tyson is the Co-founder of Microba and supports this project as an important step towards advancing research on the gut microbiome in neurodegenerative diseases.

"We believe that this partnership will uncover disease-related signals in the microbiome that have not been seen before. We are excited to apply Microba's leading measurement and analysis tools to enable discovery in this debilitating disease," he said.

Working together, the two groups hope to see a future where Parkinson's sufferers have access to earlier diagnosis and potential treatments to stop the disease in its tracks.

"Our initial studies using Microba's powerful analytical tools have already yielded exciting new clues into what the gut microbiome changes that we see in Parkinson's patients could mean for the progression of the disease," said Dr Gordon.

"Our ultimate goal is to gain a deeper understanding of the complex changes which occur in the microbial ecosystem of the gut in Parkinson's disease and use this knowledge to develop more effective treatment strategies to slow its progression."

MICROBA

How To Make A Hoop Glider

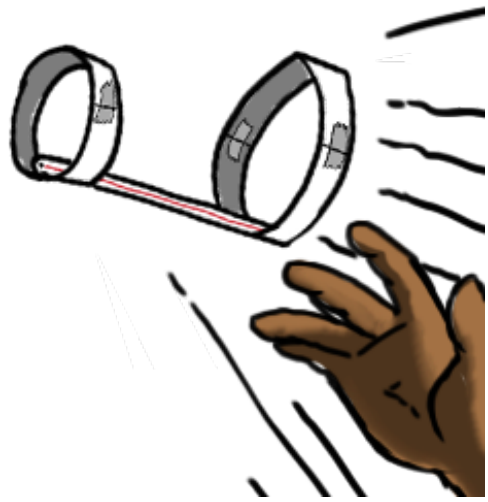
Materials Needed:

- light card stock or paper

- scissors

- one straw

- tape



Directions:

1. Cut two strips from your paper. The length will determine the flight response. This is a good opportunity to experiment with different lengths and compare results.

2. Tape one end of your strip to the other, creating a circle. Repeat with the second strip of paper. Make the trailing or back circle larger then the front.

3. Tape each circle to opposite ends of the straw.

4 Now testing begins as you throw the plane. Document each change in flight as you change the design.

Lesson:

The two sizes of hoops help keep the straw in balance as it flies. The larger diameter hoop creates drag
(air resistance) and the smaller hoop in front keep the hoop airplane straight.

Since objects of different sizes and weights generally fall at the same speed, the hoop plane will keep its "upright" position.

Schools' Usage of Ebooks and Audiobooks Surge

Remote / hybrid learning leads to exceptional growth in reading through Sora reading app

By David Burleigh

In a year riddled with challenges, the move to remote and hybrid learning has accelerated the adoption of ebooks and audiobooks in the classroom. As a result, OverDrive Education, the leading digital reading platform for schools worldwide, reports a record number of K-12 schools have made the digital shift in 2020.

Now, 44,000 schools in 71 countries – an increase of 80 percent over last year – allow students to borrow and read their school's ebooks and audiobooks through the Sora student reading app. Tens of millions of books have been borrowed by students through Sora in 2020, nearly triple the total in 2019. Digital adoption has steadily increased for several years but it has accelerated significantly this year because of the pandemic.

"During the past five and a half years, Napa Valley USD has circulated over 97,000 digital materials from OverDrive Education and the Sora app," said Kate MacMillan, Coordinator Library Services at Napa Valley USD in California.

"Of that amazing number, 24 percent of these circulations occurred during the last eight months. Watching these numbers escalate gave my office a clear idea of the collection map and the foresight to increase our digital budget to meet the needs of our students during this pandemic."

Margaret Gaudino, School Library Media Programs Coordinator at Montgomery County Public Schools in Maryland, added, "Our district's Library Media Centers began leveraging online resources from the very beginning of the pandemic and these digital resources continue to be vital during distance learning. With the one-to-one implementation of student devices in our district, along with the increased purchase of ebooks, we can say with certainty that all of our students have equitable access to high quality reading materials. A bonus result is the students' opportunity to leverage accessibility tools within Sora."

Data shows that students read more with Sora. In addition to easy 24/7 access to assigned readings and other digital materials, students can also use the app's built-in feature to connect Sora to their local public library's digital book collection. Ebook and audiobook checkouts increased over 460 percent when students connected Sora to their local public library, compared to the same period in 2019. This integrated feature expands students' access to more digital books, providing additional age-appropriate choice reading options for students.

"School demand for digital books has surged along with the pandemic, and our teams have put forth tremendous effort to meet this need," stated Angela Arnold, General Manager of OverDrive Education. "We realize what a critical time this is for educators and students.

The good news is we are all beginning to understand how digital reading can make a powerful impact on student engagement. With Sora, teachers have more insight about how students read than they would have with print."

The top five titles borrowed from K-12 schools in 2020:

1. Diary of a Wimpy Kid by Jeff Kinney

2. Harry Potter and the Sorcerer's Stone by J. K. Rowling

3. The Ninjabread Man by Katrina Charman

4. The Lightning Thief by Rick Riordan

5. From the Top by Lincoln Peirce

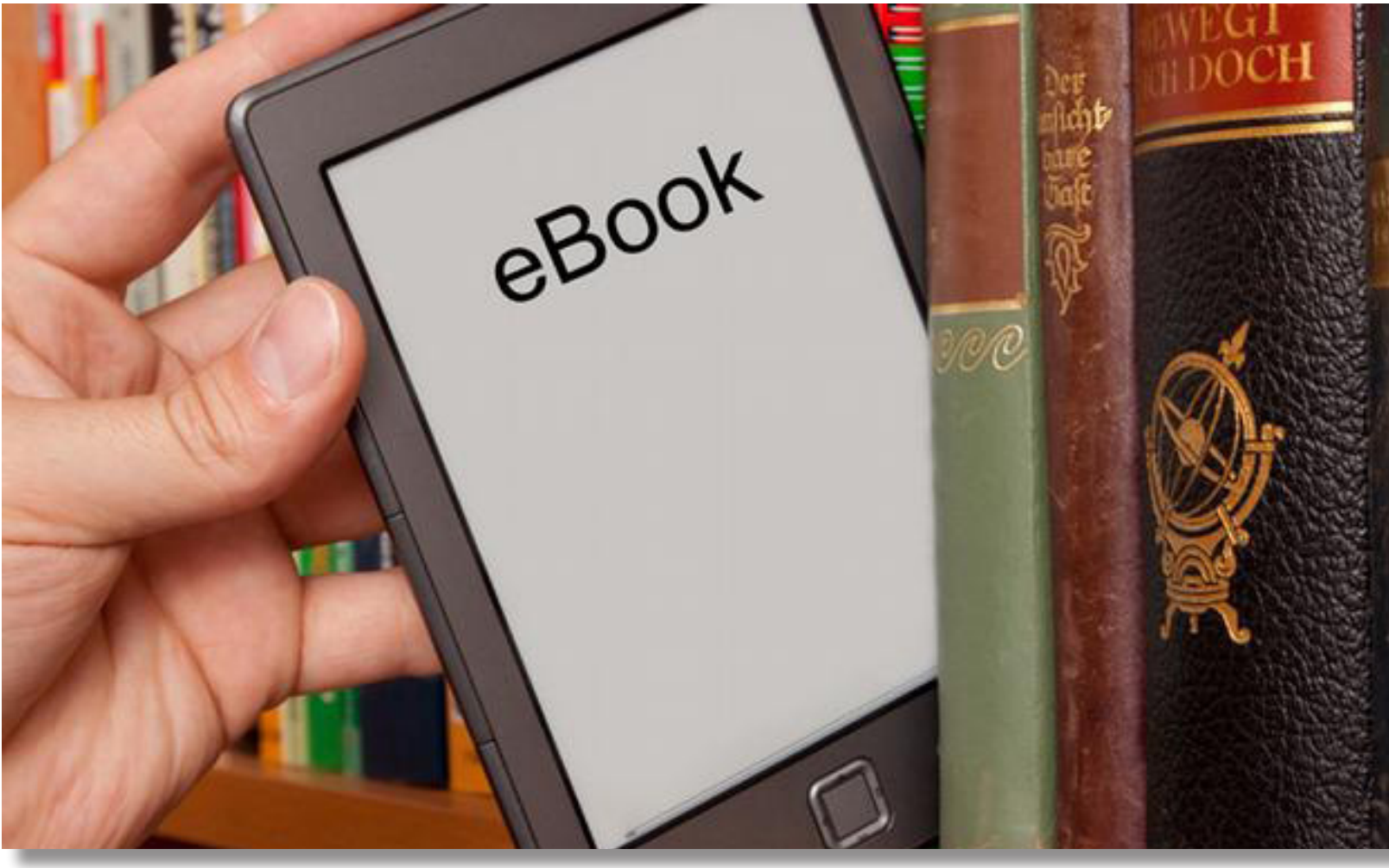
The top five fiction subjects (ebooks & audiobooks) borrowed from K-12 schools in 2020:

1. Comic and Graphic Books/Humor
2. Fantasy
3. Picture Book Fiction
4. Historical Fiction
5. Mystery

The top five nonfiction subjects (ebooks & audiobooks) borrowed from K-12 schools in 2020:

1. Biography & Autobiography
2. History
3. Sociology
4. Nature/Science
5. Reference

To learn how schools are leveraging Sora to raise test scores and reading rates with digital books, engage teen readers, boost digital book usage and more, visit https://company.overdrive.com/iste-presentations.



To understand STEM...

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

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

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

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

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

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

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

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

Artificial Intelligence
Deciphers Genetic Instructions

By Prof. Dr. Julien Gagneur
Professorship of Computational Molecular Medicine
Technical University of Munich

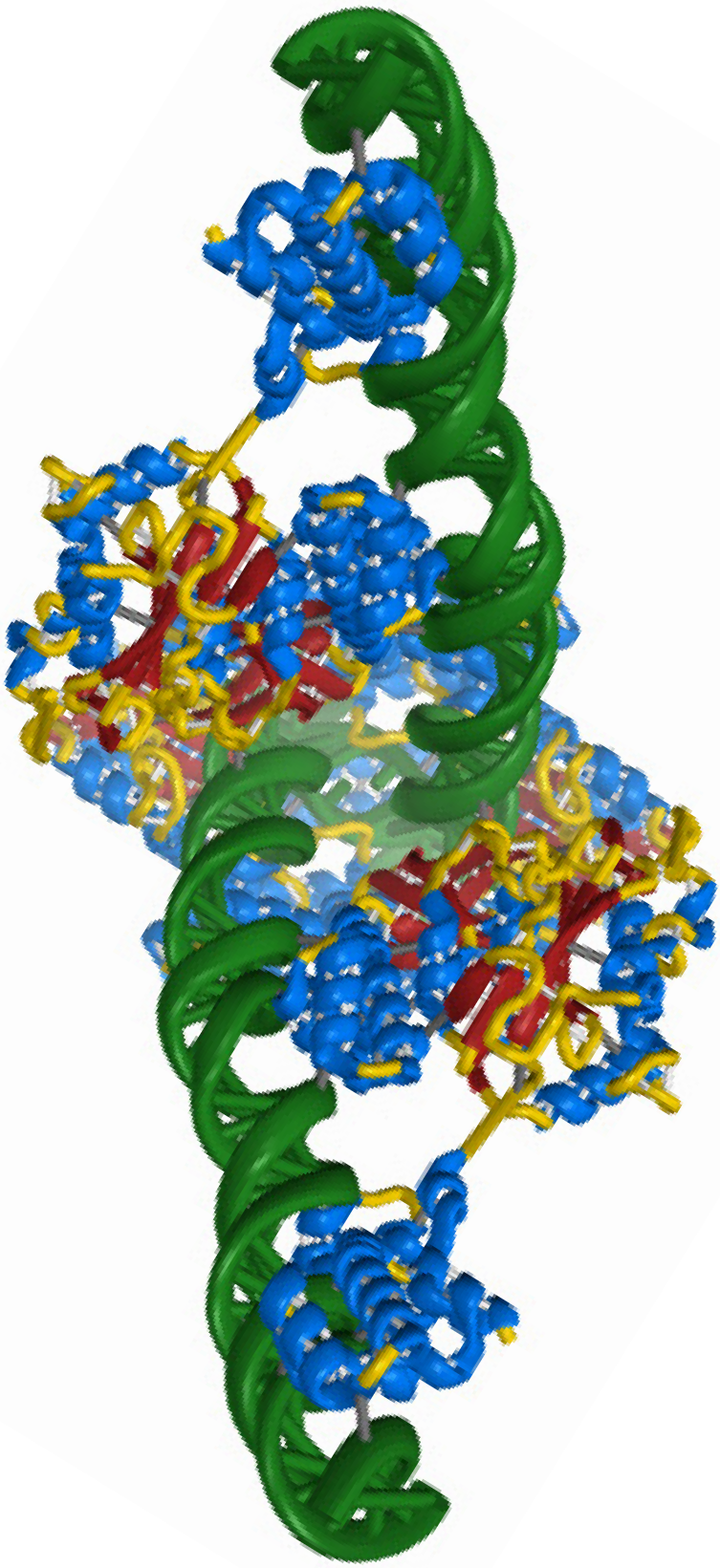
Deep learning algorithms reveal the rules of gene regulation.

With the help of artificial intelligence (AI) a German-American team of scientists deciphered some of the more elusive instructions encoded in DNA. Their neural network trained on high-resolution maps of protein-DNA interactions uncovers subtle DNA sequence patterns throughout the genome, thus providing a deeper understanding of how these sequences are organized to regulate genes.

Artificial intelligence algorithms are extremely powerful at fitting massive and complex datasets. But their interpretation, rationalizing how the machine performs specific predictions when presented a given input, is notoriously hard. This black box behavior hampers wide acceptation of AI in medical diagnostics, where justifications matter, and restrain their utility in natural sciences where understanding mechanisms is the goal.

Now, an interdisciplinary team of biologists and computational researchers from the Technical University of Munich, the Stowers Institute for Medical Research and the Stanford University has shown that applying neural networks, such as those used for facial recognition, together with newly developed model interpretation techniques can be used to decipher complex instructions encoded in DNA.

One of the big unsolved problems in biology is the genome's second code, its regulatory code. The DNA bases encode not only the instructions for how to build proteins, but also when and where to



make these proteins in an organism.

The regulatory code is read by proteins called transcription factors that bind to short stretches of DNA called motifs. However, how particular combinations and arrangements of motifs specify regulatory activity is an extremely complex problem that has been hard to pin down.

DNA binding experiments and computational modeling going hand in hand.

The key was to perform transcription factor-DNA binding experiments and computational modeling at the highest possible resolution, down to the level of individual DNA bases. The increased resolution allowed the team not only to train highly accurate neural network models, but also to extract the key elements and patterns from the models, including transcription factor binding motifs and the combinatorial rules by which they function together as code.

“Neural networks are black boxes, but they can be interrogated digitally. So, with a large number of virtual experiments we figured out the rules the neural net learned” says first author Dr. Žiga Avsec, member of the group of Julien Gagneur, professor of computational molecular medicine at the Technical University of Munich. Together with Anshul Kundaje, professor at the Stanford University, he created the first version of the model when he visited Stanford as a guest scientist.

Applied to master regulators of stem cell differentiation and confirmed experimentally by CRISPR genomic edition, the approach revealed complex rules involving a precise positioning along the DNA double helix and specific ordering of events.

"This was extremely satisfying," says project leader Julia Zeitlinger, investigator at the Stowers Institute and professor at the University of Kansas Medical Center, "as the results fit beautifully with existing experimental results, and also revealed novel insights that surprised us."

A pattern becomes visible: how Nanog binds to DNA

For example, the researchers found that a well-studied transcription factor called Nanog binds cooperatively to DNA when multiples of its motif are present in a periodic fashion such that they appear on the same side of the spiraling DNA helix.

"There has been a long trail of experimental evidence that such motif periodicity sometimes exists in the regulatory code," Zeitlinger says. However, the exact circumstances were elusive, and Nanog had not been a suspect. Discovering that Nanog has such a pattern, and seeing additional details of its interactions, was surprising because we did not specifically search for this pattern."

"This is the key advantage of using neural networks for this task. A classic computational model is built on hand-crafted, rigid rules to ensure that it can be interpreted", says Avsec. "However, biology is extremely rich and complicated. By abandoning the need to interpret individual parameters, we can train much more flexible and nuanced models that capture any biological phenomena, including those yet unknown."

A powerful bottom-up approach

This neural net model – named BPNet for Base Pair Network – is a powerful bottom-up approach similar to facial recognition in images, where a neural network first detects edges in the pixels, then learns how edges form facial elements like the eye, nose or mouth, and finally how facial elements together form a face.

Instead of learning from pixels, BPNet learns from the raw DNA sequence and learns to detect sequence motifs and eventually the higher-order rules by which the elements predict the base-resolution binding data.

Both the Zeitlinger Lab and the Kundaje Lab are already using BPNet to reliably identify binding motifs for other cell types, relate motifs to biophysical parameters and learn other structural features in the genome such as those associated with DNA packaging. To enable other scientists to use BPNet and adapt it for their own needs, the researchers have made the entire software framework available with documentation and tutorials.
"This work is a technological tour-de-force," says Julien Gagneur. "It combines

deep learning modeling of genome-wide assays down to single-nucleotide resolutions, together with advanced explainable AI techniques allowing to interpret what "the black box" has learned. The methodology will help biologist studying the full regulatory grammar."

Publication:

Base-resolution models of transcription factor binding reveal soft motif syntax
Žiga Avsec, Melanie Weilert, Avanti Shrikumar, Sabrina Krueger, Amr Alexandari, Khyati Dalal, Robin Fropf, Charles McAnany, Julien Gagneur, Anshul Kundaje, and Julia Zeitlinger nature genetics, Feb. 18, 2021 – DOI: 10.1038/s41588-021-00782-6
https://www.nature.com/articles/s41588-021-00782-6

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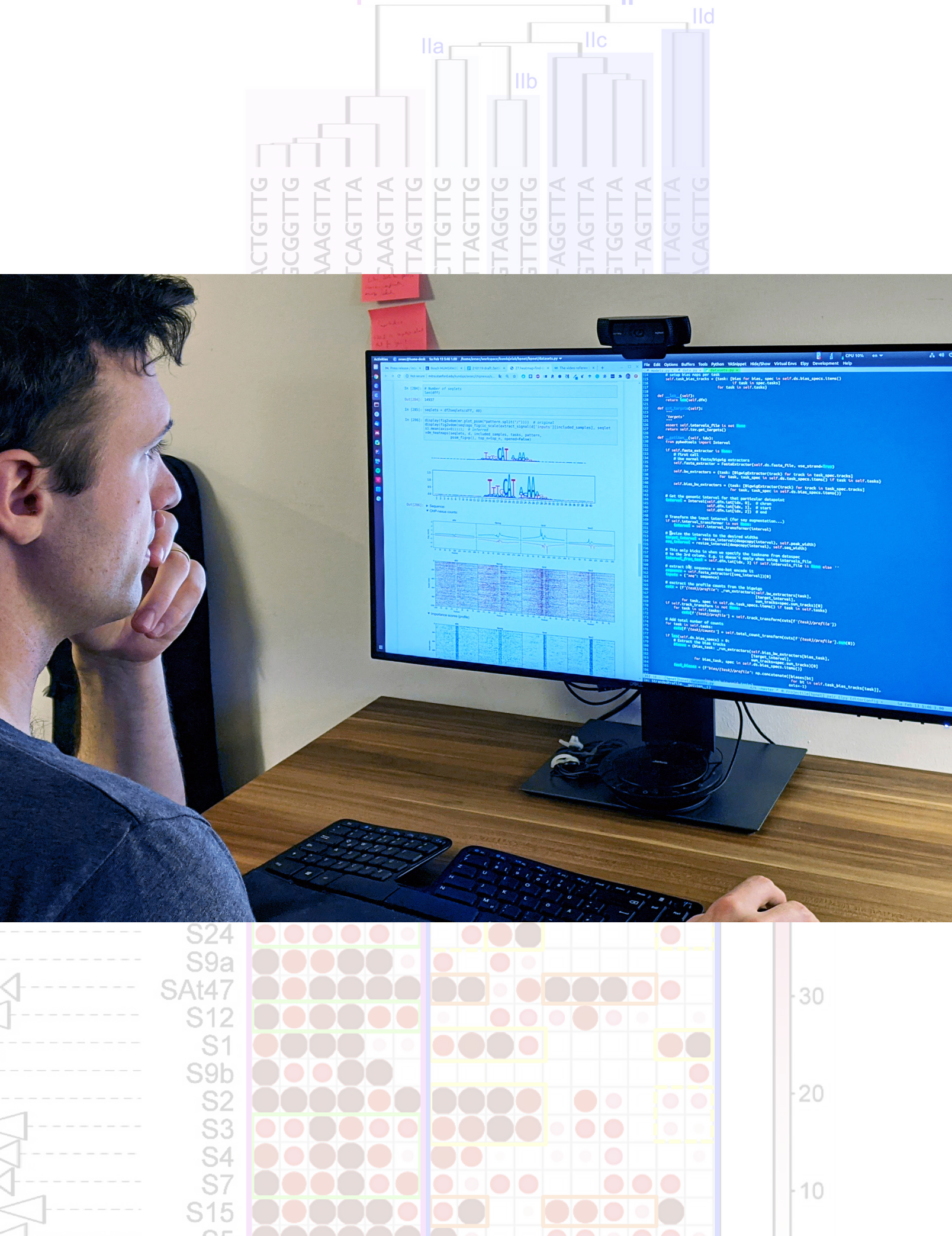
The Technical University of Munich (TUM) is one of Europe's leading research universities, with more than 600 professors, 45,000 students, and 11,000 academic and non-academic staff. Its focus areas are the engineering sciences, natural sciences, life sciences and medicine, combined with economic and social sciences. TUM acts as an entrepreneurial university that promotes talents and creates value for society. In that it profits from having strong partners in science and industry. It is represented worldwide with the TUM Asia campus in Singapore as well as offices in Beijing, Brussels, Mumbai, San Francisco, and São Paulo. Nobel Prize winners and inventors such as Rudolf Diesel, Carl von Linde, and Rudolf Mößbauer have done research at TUM. In 2006, 2012, and 2019 it won recognition as a German "Excellence University." In international rankings, TUM regularly places among the best universities in Germany. www.tum.de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Highlighting for Understanding of Complex Text

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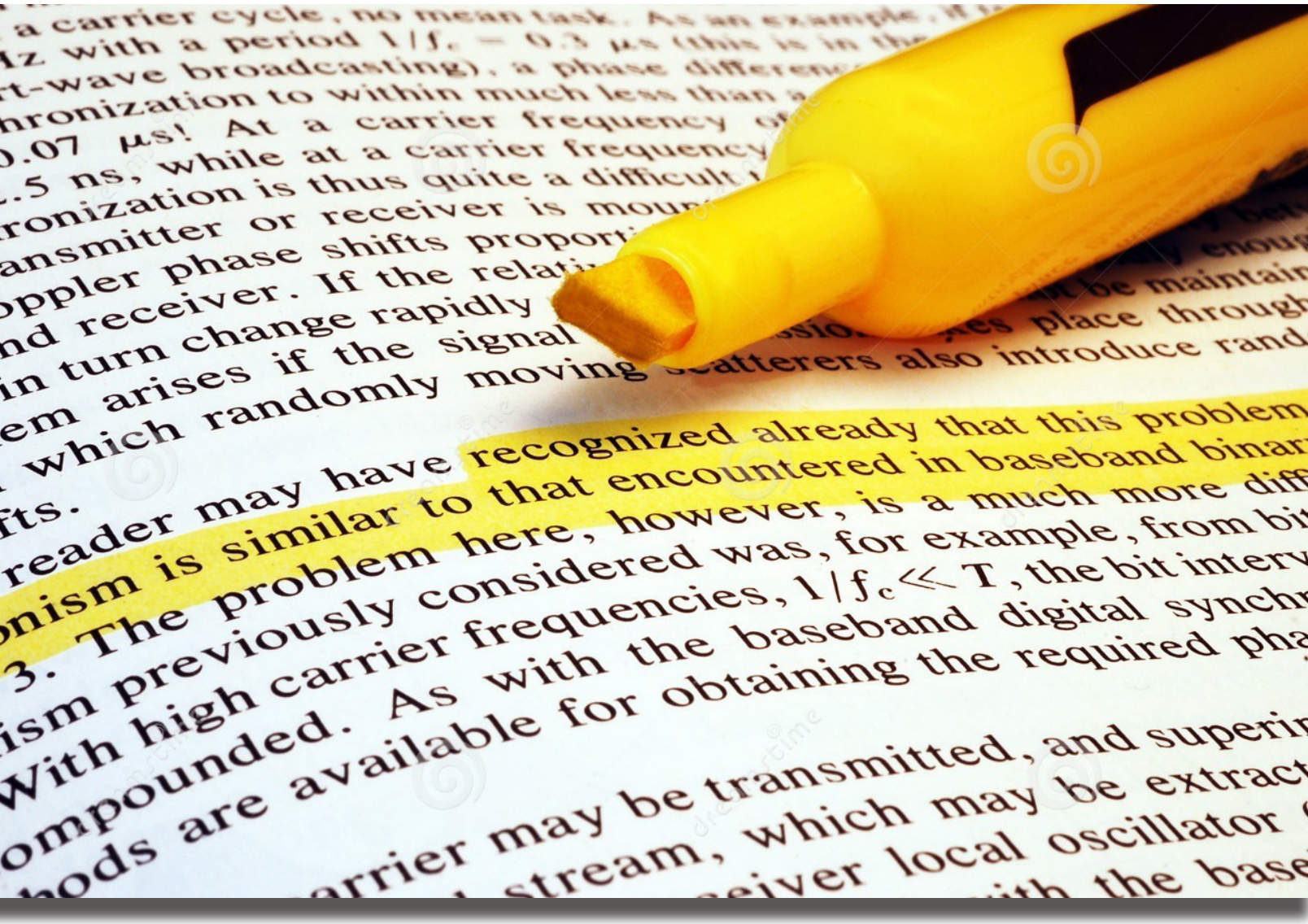


Most teachers enjoy challenging their students and extending students' critical thinking skills. Few joys compare with seeing a student grasp the big picture, connect and relate previous learning to something new, and discover the satisfaction of an "Ah-ha" moment.

However, with larger classes and more material to cover in less time, it's not always possible to engage in Socratic methods with empirical or inductive dialogue to bring students up to their potential as high level thinkers. But brain-based research and colored marker pens can help teachers provide the necessary scaffolding and guide their students with to develop their powers of interpretation, analysis, and abstraction.

Many students are limited in their prior experience in higher cognitive analysis of complex written text. They have either been taught to the standardized test or are products of the digital-audio-visual era with its emphasis on immediate gratification without encouraging critical feedback. Sheridan Blau teaches in the departments of English and education at the University of California, Santa Barbara, where he also directs the South Coast Writing Project.

He believes that, "Over-instruction or giving predigested interpretations to students results in a limited conception of what competent readers go through to produce meanings from what they read.

Most student readers function largely as welfare recipients in the economy of literary and other academic interpretation and instruction. We want to give students the experience of successfully interpreting difficult text, and liberate students from interpretive welfare.

The goal is to build in students a greater tolerance for difficulty or failure. Confusion represents a high state of understanding. The act of interpretation doesn't occur in reading unless you feel something is wrong – something makes you uncomfortable. From there you seek and reach a new perspective and the richest parts of the understanding and connection with the material."

As part of the South Coast Writing Project, Blau demonstrated a teaching technique to the fellows in the writing project that I have subsequently applied to help students connect with and critically interpret not only literature, but also information in philosophy, psychology, and history texts.

Blau's comprehension of text strategy reflect the way competent readers move haltingly and recursively toward the satisfactory interpretation of difficult text without "interpretive welfare."

To demonstrate the strategy, Blau gave the member of the workshop copies of a challenging, obscure poem that not a single member claimed to fully interpret after a single reading.

He next directed participants to use three different transparent colored markers, read the poem three more times, and each time underline any text we didn't understand. In his instructions, he noted that strong readers pay more attention to what they don't know because they think that what they notice, but don't quite understand, is worth pondering.

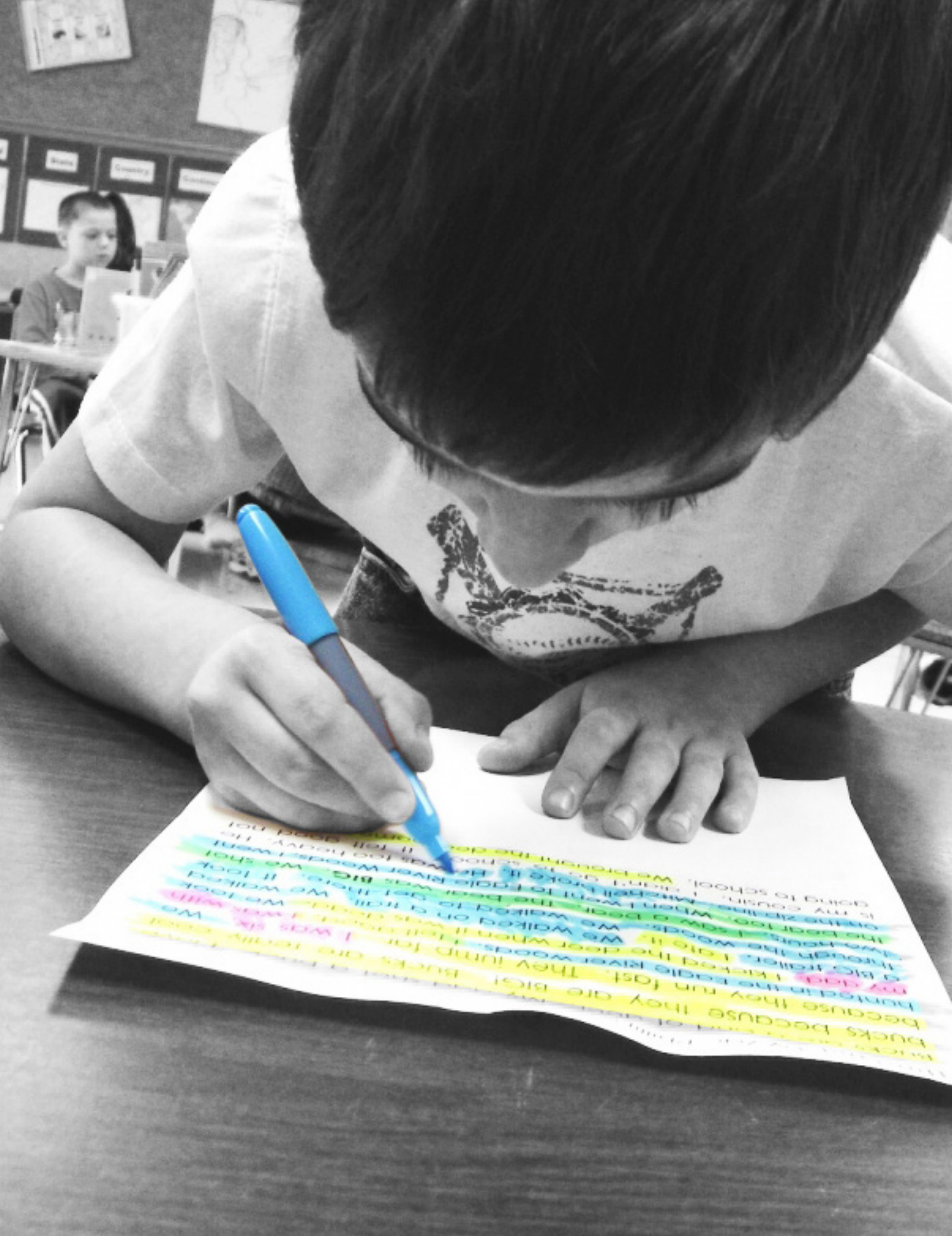
Not surprisingly, the participants discovered that they understood more of the poem each time they read it. The process of underlining focused attention on the phrases they would have skipped as "too hard." They persevered because they were obliged in color to return to these lines. They found themselves enjoying the "feel"of the markers, the positive reinforcement of each insight, and the discovery that solving one piece of the puzzle helped them when they returned to earlier points of confusion.

The exercise went beyond simple reading and rereading, because there was the active, visually enhanced process of increased time spent with the complex lines by virtue of slowing down to highlight them. In addition, looking at the decreasing amount of text underlined with each color was encouraging and built confidence. That experience provided a set of self-management skills , concentration, persistence and courage— in the face of intellectual difficulties. By extrapolation I have used the colored pen technique to light the way for students to reach higher levels of thinking, abstraction, and conceptualization regarding the material they read in other subjects where interpretation is important.

As one would expect, the scaffolding afforded by the colored markers eventually becomes unnecessary, because as students become adept at the process, they are simultaneously developing their higher levels of thinking, abstraction, and conceptualization. They discover that they can achieve the same degree of understanding by focused re-reading.

The end result is that they learn the material they need, but not because it is processed through superficial rote memory from notes or lectures that predigest the material, but rather through their own relational and conceptual thinking utilizing their higher-level executive function skills.

What's Happening in the Brain That Moves the Hand That Controls The Marker?



Perhaps what may sound like a "gimmick" this may garner the appropriate respect and attention from skeptical readers when they understand the science behind how this technique is promoting learning. Behind the colored markers, the technique works like this:

Executive functions, centered in the orbito-frontal portion of the frontal lobes, include higher reasoning, abstraction, synthesizing, critical analysis, comparison/contrast, and judgment. As brain research has found, this processing results in the learned material becoming part of long-term memory available for retrieval and subsequent critical thinking connections far beyond the classroom. The brain is divided into lobes, each with many functions, each interconnecting to the other lobes through nerve pathways or circuits.

Areas in the frontal and temporal lobes are integral in executive attention – alerting the rest of the brain to pay attention or respond to stimuli. In learning, the stimuli are the bits of sensory information students see (through their eyes or by internal visualization after reading text), hear, feel, smell, touch, or experience through movement.

There are even more specialized brain regions that have been revealed through neuro-imaging and brain mapping while subjects are in the process of moving information from sensory data to these centers of executive function.

When new information is actively learned and stored, the first areas activated (lit up by increased metabolism seen on PET or fMRI scans) are the somatosensory cortex areas, one in each brain lobe, where input from each individual sense (hearing, touch, taste, vision, smell) is received and then classified or identified by matching it with previously stored similar data.

Next in the sequence of memory storage is the limbic system, comprised of parts of the temporal lobe, hippocampus, amygdala, and prefrontal cortex (front part of the frontal lobe).

Studies of the electrical activity (EEG or brain waves) and metabolic activity (from specialized brain scans) show the synchronization of brain activity as information passes from the somatosensory cortex sensory processing areas to the limbic system.

For example, bursts of brain activity from the somatosensory cortex are followed milliseconds later by bursts of electrical activity in the hippocampus and then other parts of the limbic system before being passed along to the executive function centers. This is the one of the most exciting areas of brain-based memory research because it offers educators a view of the brain while it is processing new information. This provides empirical evidence with which to evaluate the techniques and strategies that stimulate and those that impede communication between the parts of the brain when information is processed and stored.

Engaging in the process of learning actually increases one's capacity to learn. Each time a student participates in an academic endeavor, a certain number of neurons are activated.

When the action is repeated, such with a new color marker during each re-reading, these same neurons respond again. The more times one repeats an action the more connections are made from the new memories to previous related knowledge.

If previously stored, related memories can be activated, or brought back on line, they travel back to the hippocampus and nearby regions of the temporal lobe where they are connected to the new information. The brain then makes the conscious connection between these stored memories and the new information.

When students process information through multiple sensory intake centers in their brains (visual reading, auditory reading out loud or with a partner, color stimulation of the highlighting, and the positive emotional connections to past "coloring" activities when coloring meant childhood fun, the information to be

learned is connected to multiple senses and positive emotions. This excites more of the brain, increasing stimulation of executive function centers.

Part of this process is due to the brain's plasticity. When new information is input using several sensory systems, the brain's plasticity builds additional dendrites to form more networks of information communication. For example, offering the information visually will set up a dendrite/neuron connection with the occipital lobes, the posterior lobes of the brain that processes visual input. Subsequently or simultaneously presenting the same material by sound will build an auditory dendritic circuit with the temporal lobes.

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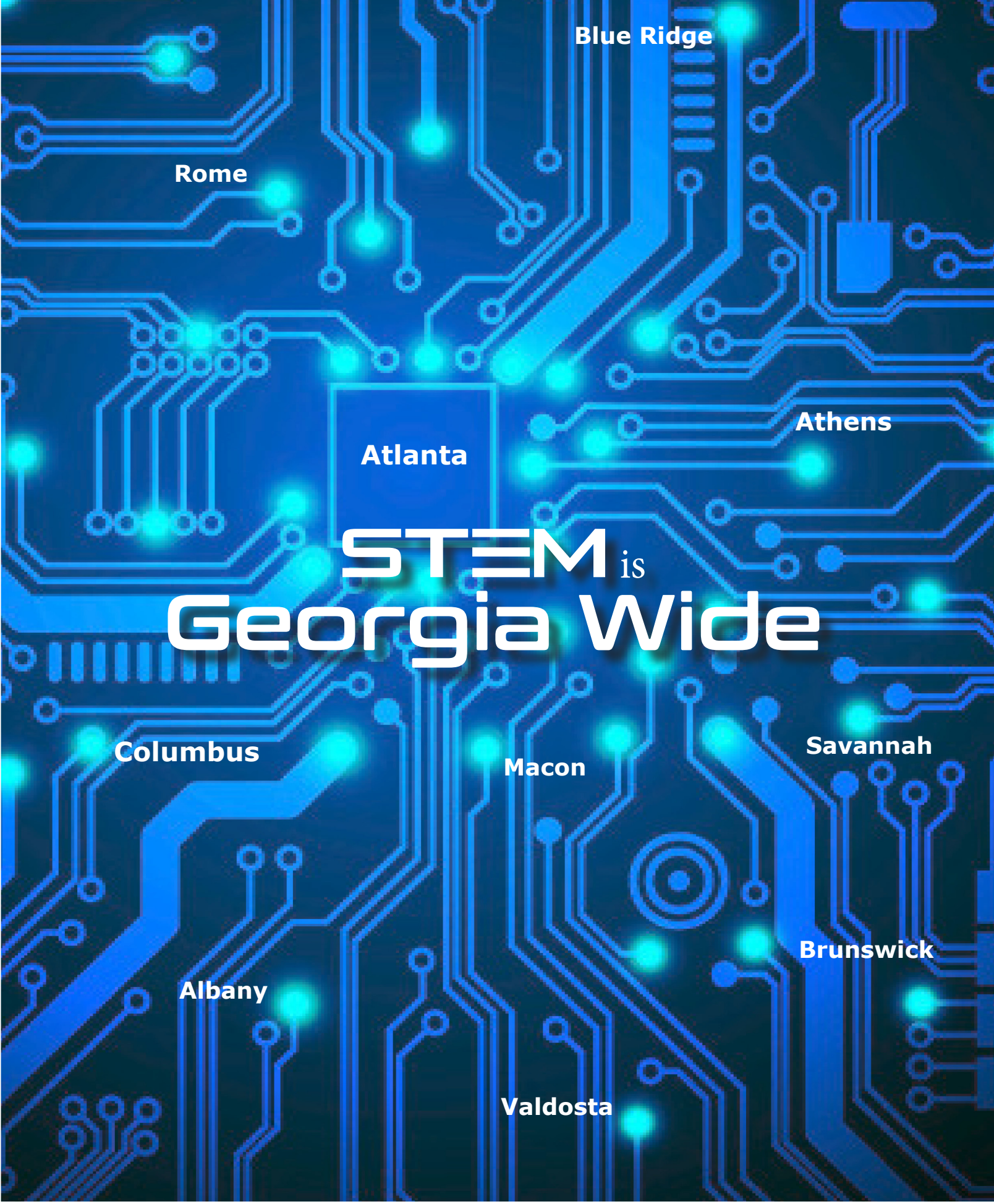

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