

NEXT GENERATION GENIUS

Georgia Tech cultivates science and technology education for K-12 students and teachers

Story by Ben Brumfield

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42



As a GoSTEM Latinx science day, a student participates in a science demonstration in Spanish.

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Children learn how to make a simple electric motor in CEISM’s Horizons program at Drew Charter School Elementary Academy.

made of erector set parts, and puts her might and weight into the plunger.

“Always pump the air up to the same pressure every time,” Richter tells her. The compressed-air science gadget needs a consistent amount of force behind each launch.

Passion and test scores

Chyna is one of thousands of students benefiting every year from a palette of Georgia Tech K-12 outreaches so numerous they are hard to keep track of.

Some researchers dazzle young eyes at weekend sci-tech fests with laser experiments or underwater rescue robots. Others give schoolrooms vistas on nebulas thousands of light years away.

They stir wonder for science and awe for technology and push kids to reach for them. But the main focus is a bit less glamorous and a lot more committed to guiding classes through years of learning to raise grades and standardized test scores.

“We want long-term partnerships with schools so we make sure our efforts will actually facilitate change in the classrooms,” said Lizanne DeStefano, who runs a core Georgia Tech K-12 education and outreach unit called CEISM. “That takes prolonged engagement over time.”

Earth-shaking STEM

CEISM, pronounced seismic, like in an earthquake, stands for Center for Education Integrating Science, Mathematics, and Computing. Its mission is to raise exposure to STEM education — another acronym — which stands for science, technology, engineering, and math.

With the heft of 50 employees, including Ph.D. scientists, designers, engineers, and teachers, and with \$94 million in annual

funding, CEISM supports several Georgia school districts, the Boy Scouts, the Girl Scouts, and much more.

Its major funders are the National Science Foundation, the Goizueta Foundation, the Blank Foundation, and the Georgia Department of Education.

Its broader purpose is to take cutting-edge Georgia Tech research to the people. “We’re a knowledge transfer bridge,” DeStefano said. “We help the public to better understand the importance of science and technology in daily life.”

But children are the focal point. CEISM alone helps educate 11,000 children per year. “Our staff don’t sit in their offices much,” DeStefano said. “They’re out in the community.”

On the road again

CEISM’s Will Jimerson has driven 50 miles south from Atlanta to help out at Carver Road. He’s instructing some of Richter’s students using a catapult at the table next to hers. “You want to have a list of distances when you’re done, so you can average them later,” he tells them.

At Richter’s table, Chyna groans. “This is so hard!” She means the physical strain of the pump, not the mental strain. She’s a STEM success story, engaging with and responding to CEISM’s teaching methods as hoped.

“I want to be a pediatrician,” she said. “They do scientific things, and I like science, actually a lot.”

Breaking the fall

Chyna and her engineering classmates exemplify the mission of most of Georgia Tech’s K-12 outreach, which casts a particular eye on underserved students likely to lose interest in STEM or fall behind, then drop out of it.

The main outreach targets are public schools in areas where parent incomes are especially tight, and children often don't have opportunities to learn like students elsewhere. These schools also might not be able to afford some nicer equipment and instructional aids on their own.

Jimerson gestures to a device in the classroom corner. "That's a 3-D printer. Our grant funded 3-D printers for all middle schools and high schools in the county school system." CEISMC also created and donated the teaching texts, which are all over Carver Road's science classrooms. In fact, Richter has only ever taught engineering from CEISMC books.

Most likely (not) to succeed

A few halls away, in a seventh-grade science lab, students thumb through a CEISMC workbook on oil spills while they form teams for an experiment using tap water and cooking oil.

While she works over an aluminum tray with the oil-water mixture, Tiffany says she already knows she wants to be a scientist. "I got interested in sciences in the fifth grade."

Though many of the students in the science lab are white and male, it also has a good number of minority students and females, reflecting Carver Road's overall student body makeup.

To CEISMC, that's progress. One of its aims is to keep minority students and girls going in science, as both are very likely to turn away.

"We still see fewer girls interested in science than boys and far fewer African-American and Latino students in science careers," DeStefano said.

Chyna happens to be both female and African-American. She's also in her middle school years, a phase notorious for shedding math and science students.

The middle school wall

"Middle school is when we lose them," said Leigh McCook, who coordinates STEM outreach for the Georgia Tech Research Institute (GTRI).

GTRI is Georgia Tech's applied research organization, and it has access to lots of technology that makes kids say "cool!" — like lasers, underwater robots, and nanotechnology.

One GTRI program, called Direct-to-Discovery, uses a high-bandwidth teleconferencing system to connect students to megatelescopes halfway around the globe as well as cutting-edge Georgia Tech labs in their own state.

Like CEISMC, GTRI meets kids at science festivals and takes GTRI Road Kits to their schools to teach them about math, physics, and engineering.

Its K-12 outreach goal matches CEISMC's: Get children into STEM and point them toward college and a science or technology career. But GTRI also integrates business partners interested in helping with education.

GTRI has a dedicated year-long internship program called Project ENGAGES in four Atlanta public high schools, including one predominantly African-American boys school and one predominantly African-American girls school.

It brings underserved students into Georgia Tech labs to conduct research throughout the year and apply what they've been learning in science and engineering.

Puberty peer pressure

When kids hit middle school, science classes become more challenging, and many students hit a wall and turn away, said Mindy DiSalvo, a former principal who is an educational guide for GTRI.

It's more like three or four walls, for girls in particular. As

"I want to be a pediatrician. They do scientific things, and I like science, actually a lot."

a principal, DiSalvo watched them turn away from sciences in droves.

"First of all, they're just middle school kids, and they're more interested in social things. There's peer pressure." At one STEM event, only boys turned up, she recalled. "They told me that the girls were not there because they all went to cheerleading practice."

Also, middle schoolers aren't in one classroom all day with the same teacher, who knows their weaknesses along with their strengths to try to balance them out. Instead, pupils move from subject class to subject class, and the teachers don't get a full picture of what's going on with them.

"If we can hold onto them through middle school and engage with the teacher, we can see more of them sticking with sciences," McCook said.

That often means teaching the teacher. Richter, for example, teaches engineering but holds a degree in business management. Georgia Tech has helped her develop her subject-matter skills.

"They not only did a great job of explaining the goals of the curriculum, but they gave me the tools I need to teach my students," Richter said. "Things like 3-D modeling software and how to use a 3-D printer."

Meet Superteacher

In the past five years, CEISMC has trained around 2,000 schoolteachers.

Many have become classroom heroes, but high school science teacher Casey Bethel could rightly wear a Superman cape. He was selected Georgia's Teacher of the Year for 2017.

He's also a bona fide biochemistry lab researcher at Georgia Tech thanks to a CEISMC program called GIFT, short for Georgia Intern-Fellowship for Teachers.

He's now an expert on 3-D protein crystallography and has co-authored a research paper submitted to the prestigious research journal *Nature*.

That astounds him.



High school science teacher Casey Bethel is a bona fide Georgia Tech researcher in Professor Raquel Lieberman's lab. He's also Georgia's Teacher of the Year for 2017.

“Who would have thought this high school teacher might be published in *Nature*?” Bethel said. It makes him dream about going for his Ph.D. and researching full time, but for now he’s dedicated to his students.

About half the children at New Manchester High School in the Atlanta suburb of Douglasville come from low-income families, he said. “It’s not a Title 1 school, but it’s also not far from it.” About three quarters of the students are African-American.

Science sidekicks

As with the students they serve, many Georgia Tech programs target educators at underserved schools, and when they come into labs for a summer to work, work they do.

“Teachers are paid a living wage. It’s not charity,” DeStefano said.

When the school year starts back, Bethel will stride into class a real-life scientist. “The first few years, I had no idea what I was doing as a science teacher. It takes a lot of honesty to say that,” he said.

How things have changed for him. At Georgia Tech he co-authored a paper on engaging students in science that was published in the *Journal of Chemical Education*.

Georgia School Superintendent Richard Woods walked into Bethel’s classroom unannounced in May to declare him teacher of the year. Bethel nearly hit the floor, but his students went through the roof. “They were jumping up and down clapping and whooping,” he said.

In the fall, when Bethel returns to his classroom, he’ll have new STEM sidekicks. “I get to bring some students each summer to the labs for five weeks,” he said. “When they get back to school, they become advocates for science careers.”

People just like me

As another component of its STEM education outreach, Georgia Tech brings children from historically underrepresented minorities and ethnicities onto campus to get them accustomed to the idea that a university is a place for them.

These visits get Bethel’s students out of their typical surroundings, he said. “They come out of that and see that scientists are people just like them.”

With Hispanic students, the language barrier with parents can play a role, so CEISMC offers a Latino STEM day all in Spanish.

“What was really powerful was the parents,” DeStefano said. “The parents could easily participate, and the kids didn’t have to translate for them. The parents were so engaged. They asked questions like crazy.”

That’s rare. Usually, they are quiet because of language.

“Now, the children and their parents have experienced campus as a place that they belong,” DeStefano said.

These outreach programs are not just about recruiting future students for Georgia Tech. “We take a bus of students from Gwinnett County around to colleges in Georgia and outside of Georgia,” DeStefano said.

At GoSTEM, parents hear in Spanish about the possibilities a science education can offer their children.



BETHEL: ROB FELT; GOSTEM: ATLANTA SCIENCE FESTIVAL

When things go right

There is little doubt about Nick going to college, maybe only whether it will be Georgia Tech, MIT, or an Ivy League school. He's visiting Georgia Tech to boost his already stellar robotics skills at one of the many outreach opportunities open to all students.

Many who attend such publicly available seminars are high achievers.

Nick is captain of his school's robotics team, and with a competition coming up in three weeks, they're at Georgia Tech's Institute for Robotics and Intelligent Machines to sharpen their competitive edge.

"In the competition, there's an autonomous vehicle and also a driver challenge," Nick said. The winner gets a cash prize.

Nick's classmate Colette already has her takeaway from Georgia Tech's programmers.

"They give their robots tiny little commands, and then the robots decided how to use them," she said. "That's what we're kind of trying to do with ours."

Hot car alarm

Georgia Tech also gives budding engineering geniuses a chance to show off their inventions in the K-12 InVenture Challenge.

Some innovations are what one would expect from the research and development wing of a major corporation, like the car seat invented by a high school student who saw news reports about children dying in cars parked in the sun. Her seat sets off an alarm and dials 911 as the temperature in the car rises.

"You can see the next generation of scientists and engineers. You can see young students putting their creativity to amazing use."

CEISM's Sirocus Barnes gives instruction in an extracurricular science and technology class at Drew Charter School.



"You can see the next generation of scientists and engineers," DeStefano said. "You can see young students putting their creativity to amazing use and getting excited about their ability to create things and solve problems."

In another CEISMC public outreach, the Kids' Club, elementary and middle school students are learning about energy-producing technologies in a Saturday on-campus seminar. Most every question the teachers ask is met with a lightning-fast answer.

"The challenge is that they know more than you're expecting," said one of the teachers. "So, you try to get this line of inquiry going. But they already know everything."

These students are benefiting from a great education, and it shows. They're clearing the middle school wall like it's a runner's hurdle.

The early birds

The bricks to that wall are laid in elementary school, DiSalvo said.

"A generation of elementary school teachers say, 'I don't do science and math. I really don't do that,'" DiSalvo said. "Teachers will say, 'I have never been a biologist; I only teach a little biology.'"

Many of their students are then ill prepared for middle school science.

At two public elementary schools in Atlanta, CEISMC is planting the STEM seed early with dedicated programs called Horizons. One of the schools is Drew Charter School Elementary Academy.

Lea is not quite 3 feet tall and looks about 6 years old, but at Drew, she's trying hard to be the boss. She heaves herself into the teacher's chair and pretends to commandeer her school-mates as they file into a classroom for some extracurricular afterschool STEM.

Her squeaky voice is no match for the whooping of two dozen kids fueled by the knowledge that school will let out for summer in just a few days.

'Clap three times'

A man bellows warmly, "If you hear my voice, clap once; if you hear my voice, clap twice." The noise dies down, and after "clap three times," the room is silent. Little faces gaze up at CEISMC's Sirocus Barnes as he readies them for this week's lesson.

Three Georgia Tech undergraduate students have come with him to help the children learn about electromagnetism by building a simple electric motor.

They bend wires into heart shapes and spirals and balance them atop AA batteries perched on magnets. Then Barnes asks the class, "What's going to happen with the wire when I let it go?"

"It's going to heat up," a boy answered. True, but that's not what Barnes is looking for. Most of the little faces are stumped. Then eyes widen when Barnes lets go of the wire to show them how it rotates around the battery. "What's it doing?" he asks.

No answer, at first.

"I'm so confused right now!" moans Gania, one of the smallest girls in the room. She puts on a frolicsome grin, then muses, "I get confused a lot."

Horizons is working to change that for her and two-thirds of the students in the classroom, who make below-average grades. The extra instruction is designed to boost the performance of the bulk of the students.

Georgia Tech is committed to staying with them from first grade to early ninth grade, and plans to extend the program through high school are in the works.

During summer, the students come to Georgia Tech for booster courses. They also work in labs and learn how to swim.

The Horizons program is working. "Their achievement gaps



are reduced," DeStefano said. The kids are doing better in school and scoring higher on state-wide standardized tests.

A student gets hands-on experience in robotics with the help of a Georgia Tech engineer.

Ignoring pizza

In the classroom at Drew, a few hands shoot up. "The forces are moving the copper coil around and around," a girl answers.

"The electromagnet has forces that combine together to make the wire spin around, and the energy that flows through it is making it spin," a boy calls out.

Now, the kids are getting it, but brows are still furrowed. The new challenge lies not in the dexterity of mind but of hand. The wires are a bit thick for them to bend.

But they're so determined to finish making the motors that they ignore the aroma of pizza that has flooded the classroom for the past 10 minutes. The teachers end the lesson and serve up dinner.

Their parents will pick them up soon. On the ride home, the children can tell them all about electric motors. Parents who learned and remember the right-hand rule of electromagnetism in grade school might be able to follow along.

If they can't, they can take satisfaction in seeing their child get a better shot than they may have had at doing well in school — and in life. ○

Ben Brumfield is a senior science writer with Georgia Tech's Institute Communications. He is a former CNN.com editor.