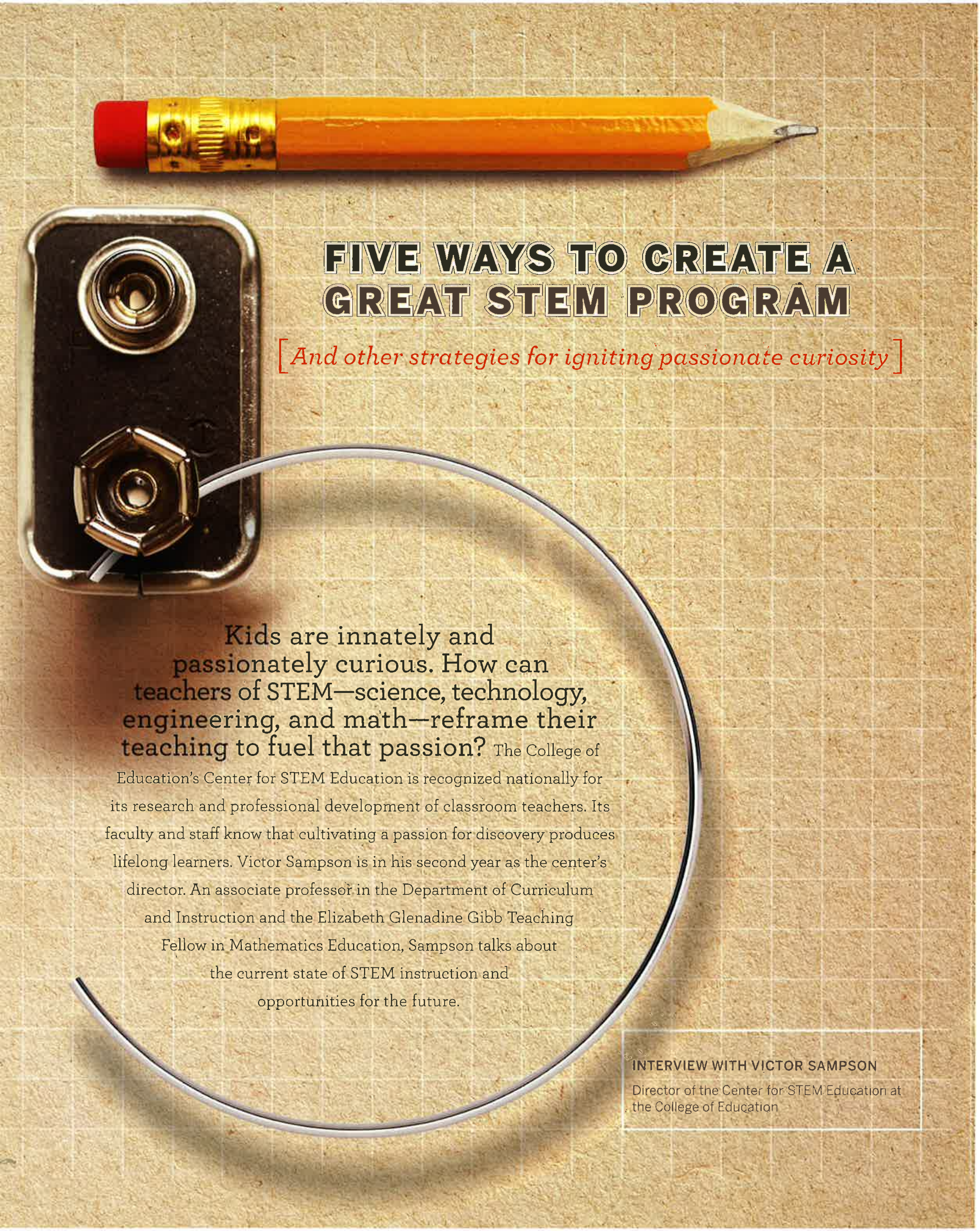

FIVE WAYS TO CREATE A GREAT STEM PROGRAM

[And other strategies for igniting passionate curiosity]

Kids are innately and passionately curious. How can teachers of STEM—science, technology, engineering, and math—reframe their teaching to fuel that passion? The College of Education's Center for STEM Education is recognized nationally for its research and professional development of classroom teachers. Its faculty and staff know that cultivating a passion for discovery produces lifelong learners. Victor Sampson is in his second year as the center's director. An associate professor in the Department of Curriculum and Instruction and the Elizabeth Glenadine Gibb Teaching Fellow in Mathematics Education, Sampson talks about the current state of STEM instruction and opportunities for the future.

INTERVIEW WITH VICTOR SAMPSON

Director of the Center for STEM Education at the College of Education

HOW CAN TEACHERS IMPROVE STEM EDUCATION?

Victor Sampson has identified five ways we can change how classroom teachers interact with students.

1 | Create an environment where everyone is teaching and learning. This is more than semantics. It is one of the fundamental problems with how we think about schools. Teaching and learning co-occur. If we remove the dichotomy of teaching and learning, we can recognize that students can also teach each other.

Students can teach the teacher. In my own teaching experience, for example, I would often ask a student to help when I had a problem with technology. The student taught me the solution. An effective learning environment supports all of these relationships.

2 | Encourage students to investigate questions in their own way. Students should have more voice and choice in STEM subjects. I advocate an approach where a teacher poses a scientific question to students in middle or high school, such as, "How is the strength of an electromagnet affected by the number of turns of wire?" Students have to design an investigation to answer the question, collect and analyze data, and support an answer with evidence.

It's OK for students to fail at first. When an experiment doesn't go the way you thought it would, it's a wonderful opportunity for students to learn.

3 | Let students follow their unique interests. Students should explore topics that are meaningful to them. Meaningful topics are those that students themselves are curious about: Are genetically modified foods safe to eat? How do I contribute to climate change? What does it mean that my neighborhood is a "food desert" and why does that matter?

These require scientific and mathematical knowledge to answer. Furthermore, they are open-ended, in that an answer to one part of the question inevitably leads to another question.

4 | Encourage collaborative learning across disciplines. STEM fields are no longer isolated from each other. Breakthroughs are often the result of collaboration. As but one example, the paper reporting on the first discovery of gravitational waves has more than 100 authors. STEM is a social endeavor, and we should represent that to students as they carry out investigations. Ideally, students should see themselves as part of a community of learners and scientists, engineers or mathematicians.

5 | Assess, Assess, Assess. What works? What doesn't? Assessment provides invaluable guidance.

Q How has teaching science and math changed in the last 50 years?

In many ways it hasn't. In a lot of classrooms, students still sit at a desk, listen to the teacher and take notes. Then they'll be asked to read a chapter and answer questions about it. They are consumers of knowledge rather than creators of it.

It's the same with math. Students watch a teacher do math problems and then work on their own problems. Lost is the responsibility of students to engage with deeper principles. In other words, students are not held responsible for negotiating meaning in these situations.

Q How is the Center for STEM Education's research translated into strategies for teachers?

The center includes a professional network of teachers called the Texas Regional Collaboratives (TRC). The TRC has grown to reach more than 10,000 teachers across Texas annually. More than 60 of these collaboratives are set up across the state and enable us to move ideas quickly to teachers.

We attend state and national conferences for educators. Center faculty have presented our work at the National Science Teachers Association annual conference, the National Council of Teachers of Mathematics annual meeting, and the Conference for the Advancement of Science Teaching.

I have presented at the Texas Education Leadership Association annual meeting, another important avenue not only for disseminating our work, but also for improving STEM education. If we want to improve STEM education, we need to work with school boards, superintendents, principals, and educators.

> Our good work with schools and teachers opens doors for us to create and pilot innovative curricula and then conduct research on students' learning using that curricula. — VICTOR SAMPSON

Q When teachers use the center's strategies, how do outcomes change?

Learning increases in science and nath. We have evidence they also make ains in other subjects. For example, tudents who learn through the argument-riven inquiry (ADI) approach I developed ith collaborators show significant gains in cience proficiency.

Q What is Argument-Driven Inquiry?

Argument-Driven Inquiry (ADI) is n innovative approach to laboratory struction based on current research bout how people learn science, and cludes recommendations for making b activities more meaningful. ADI helps tudents learn how to participate in the ractices of science, and use core ideas nd crosscutting concepts of science to nake sense of natural phenomena. ADI ves students an opportunity to learn how read, write and speak in the context of cience. Current research indicates that hen teachers incorporate ADI into the cience curriculum, all students—including nose who tend to be at a disadvantage traditional science classrooms—nake substantial gains in inquiry skills, nderstanding content, and the ability write in a scientific manner. It has the otential to make science classrooms nore equitable and more effective.

Q Why is the Center for STEM Education important?

We are a hub for all parties interested improving STEM education: teachers, chools, districts, policy makers, state ducational leaders, and private industries elying on a STEM knowledge base.

We research STEM teaching and arning, evaluate other programs designed to improve STEM education, provide professional development for educators, and then share findings from these activities so that others benefit from our work.

We collaborate across the UT campus and are currently working on projects with faculty in engineering, computer science, and psychology, to name a few.

Richard Crawford, a professor in the Department of Mechanical Engineering, is working with Stephanie Rivale, Todd Hutner and me on a project recently funded by the National Science Foundation (NSF). We are investigating a promising approach to integrating engineering into science classes. We want to create a curricular framework to help students learn science content, scientific practices, and engineering practices at the same time.

Catherine Riegle-Crumb, associate director for STEM education research in the center, works with Chandra Muller, a professor in the Department of Sociology. The NSF is funding their research on ways to increase the number and diversity of undergraduate students entering and completing STEM majors. This is important research, and I am very excited to see the results of their project.

We are also a national leader in STEM education. For example, Dr. Riegle-Crumb just finished a two-year term as president of the Sociology of Education Association. I'm an associate editor of the *Journal of Research Science Teaching*, the leading journal in science education. Carol Fletcher, who is our deputy director, works with people across the U.S. on ways to increase the number of computer science teachers in schools. These are indicative of the respect that the broader STEM education community has for the work we do.

Q What's your next challenge?

We are very much focused on the need to improve computer science education.

We need to provide professional development to current teachers in both the content and pedagogy of computer science. We are well-positioned to meet the needs of the teaching force in Texas, thanks to Dr. Fletcher, who oversees these efforts. The center has gained a reputation for the high-quality professional development we provide.

Personally, I'm focused on changing the nature of STEM learning environments for students for whom English is a second language. This is particularly important in Texas. There is a shortage of STEM teachers who speak a language other than English, and this tends to result in learning environments that are not very equitable or inclusive.

I am working on a grant with Rebecca Callahan, an associate professor of bilingual/bicultural education in the College of Education's Department of Curriculum and Instruction, to study ways science teachers can use the ADI approach. We want to help teachers provide a more language-rich learning environment for emerging multilingual students so these students can learn science at the same time they are developing skills in reading, writing, and English.

We have to find ways to improve teaching and learning in STEM with respect to the language needs of our students.