Educating our Future Scientists

TACC teaches advanced computing knowledge and skills to students of all ages

The use of advanced computing systems ("supercomputers") has become crucial in conducting scientific research. Supercomputing is pervasive in research and development in traditional scientific disciplines, and is increasingly important in many commercial sectors, national security, and the entertainment industry. Scientists, engineers, economists, architects, financial modelers, filmmakers, and many other professionals now apply advanced computing technologies in ways imagined, but not possible just five years ago.

Where are these future scientists and supercomputing-savvy professionals? They are sitting in classrooms all across the world. In Texas alone, K-12 students are more than four million strong. To enliven these budding and expanding minds with early, engaging experiences in the STEM (science, technology, engineering, mathematics) disciplines, centers like the Texas Advanced Computing Center (TACC) are developing a variety of scientific computing programs, curricula, and materials for students in grades K-12 and all the way through graduate school.

Brad Armosky, TACC's Education & Outreach Coordinator, is committed to the center's mission to enhance research, education, and society through the application of advanced computing technologies. Through engaging and practical education programs, Armosky's goal is to move people forward in terms of their computing knowledge and skills, ultimately helping each person learn effective ways to apply advanced computing in their chosen field. Some people may be novices, while others may have expert skill sets, but everyone is capable of learning at any stage.

In the following Q&A session, Brad talks about how he wants to inspire the public, students, and teachers to learn more about how advanced computing enhances their everyday lives.

How does advanced computing affect our lives?

To me, the impact of advanced computing is in how it changes people's lives. Just ask yourself, 'What new decisions do I make as a result of learning more about advanced computing?' Perhaps it's realizing that advanced computing plays a vital role in automobile design, which saves thousands of lives each year, and choosing a safer car as a result. Or, realizing that a supercomputer enabled a researcher to analyze new data that led to a huge improvement in a drug for treating Alzheimer's disease. This is the kind of awareness and impact we want people to understand about the relevance of advanced computing to society, not just equating it with huge supercomputers.

Whom are you trying to reach with TACC's education programs?

The audience for our education programs is broad. Most people may know about computers in general, but be completely unaware of advanced computing and how it benefits them on a daily basis. Our education programs target students from kindergarten through graduate school, as well as science and math teachers, university faculty, and industry professionals.

Tell us a little about the role of K-12 education with regard to the STEM (science, technology, engineering, mathematics) disciplines.

Until now, advanced computing has been too complicated for K-12 students and teachers because it wasn't user friendly and practical. Now, however, portals and science gateways offer engaging, practical ways to teach and use advanced computing. It's up to us to understand how the education system works and to help teachers and administrators develop courses

and materials, so they can teach math and science that is enabled by advanced computing in creative ways. Let's face it, its 2007, and petaflop machines are coming. In the next 10 years, it will be difficult to do much math and science at all without having a clear idea of how to use advanced computing technologies.

So, how do you engage, prepare, and attract this crucial group of students to STEM careers?

We take advantage of the existing education infrastructure and enhance it in ways that support math and science educators. Teachers need inspiration and help from the outside and that's where TACC steps in — we have expertise in advanced computing, we have experience translating it into meaningful curricula, and we have a center where kids can see and touch the machines and translate that experience into 'yes, I can do this.' You say "supercomputer" to a kid and they think it's cool…just the word is cool. If we do it right for K-12 students, they will develop the problem-solving and critical thinking skills necessary for careers in the STEM fields. We hope many of them will apply advanced computing skills using actual data and real-world problems by the time they get out of high school. There are more than four million kids in the Texas school system right now — there's your job pool.

What happens when high school kids today enter into a university? Are they greeted with the advanced computing courses they need?

Currently, many undergraduates can get into a research group, but they won't find specific advanced scientific computing courses. University courses that prepare students to use advanced computing resources are relatively rare in university curricula. TACC is hoping to change this with four core courses that will soon be offered to undergraduate students through the newly formed Division of Statistics and Scientific Computing at UT Austin's College of Natural Sciences (see TACC Scientific Computing Curriculum below).

Our overall goal is to develop curricula that will impart a broad, contemporary knowledge of scientific computing to students in all of the scientific disciplines. So, when cross-disciplinary research teams get together, they can quickly get on with using advanced computing systems, be it at TACC or across the National Science Foundation's TeraGrid project.

What are science gateways and portals, and how do they relate to the education effort?

Portals are the software brokers for accessing and using advanced computing systems — they make it easier for users to access and use these resources. Science gateways are portals, with a more friendly face, but they are no less powerful. They help novice users get specific and big computing jobs done, too.

Here's an analogy — online banking, mortgage calculators, online video editing. You can do these things via the World Wide Web. But if you want to quickly build a molecule, make and experiment with nanostructures, or explore the universe with terabytes of current data from many different telescopes across the whole electromagnetic spectrum, you can use a science gateway.

Science gateways and portals will play a large role in educating students about advanced computing. Just as the World Wide Web exploded in 1994, science gateways and portals will expand and become the red carpet into advanced computing for kids in grades 6-12, and for their teachers. We just need to make sure that science gateways and portals are user-friendly and have effective graphical user interfaces.

This is where the TeraGrid comes into play. TeraGrid makes it easy to find and use these portals and science gateways. And TeraGrid has a growing set of resources that people can learn about and use.

You seem passionate about your job and advanced computing. Why do you enjoy it so much?

Mainly because advanced computing really does "power discoveries that change the world." That's not just TACC's tagline — it's real. Advanced computing is a powerful means of problem solving and at the same time it empowers our imagination. Supercomputing feels like driving an exotic, high- performance car…you have so much potential power available to you.

I now play a game whenever I watch science documentaries, TV magazine shows, or read articles in Reader's Digest. I look for the hidden supercomputer. Sometimes it's easy to spot — they'll say something like "computer simulations have allowed us to…"; other times, no credit or mention is given. The article

focuses, as it should, on the people doing the science and making the discovery. But people need to understand that without advanced computing, that discovery would not happen.

Advanced computing is as much about the people as the machines and software — there's an awe-inspiring symbiosis. And kids in school right now can choose to be part of it.

TACC's Education Programs in a Nutshell

Advanced Computing Training Classes
Students, faculty, and researchers at universities, research laboratories, and private sector companies are encouraged to attend TACC's training classes in high performance computing, parallel computing and programming, distributed and grid computing, and scientific visualization. Classes are free for academic and government attendees, and take place at TACC's main building at The University of Texas at Austin's J.J. Pickle Research Campus. Learn more at http://www.tacc.utexas.edu/services/training.

Summer Supercomputing Institutes
Graduate students can jumpstart their thesis research with this intensive and comprehensive week-long workshop that integrates all of TACC's training content. Attendees will have the opportunity to apply advanced computing on complex problems, produce meaningful results, and develop relationships with scientists and researchers in the real world. Learn more at http://www.tacc.utexas.edu/summerinstitute/. Future summer institutes will enable undergraduate students to learn advanced computing early in their academic careers in preparation for graduate school or professional careers, and offer high school students an introduction to the excitement of research in computational science in advance of making decisions on colleges and majors.

Scientific Computing Curriculum
Senior TACC scientists teach a set of four scientific computing courses at The University of Texas at Austin. The course topics have some overlap with TACC's advanced computing training classes (above), but provide an even more formal, comprehensive education in the theory and (especially) practice of using advanced computing technologies. These classes prepare students to use advanced computing resources as they are used in computational, applications-driven R&D in both academia and industry. TACC makes these course materials available to any university that wants to develop and offer new courses, or use all or part of the content in their own existing courses.

Introduction to Scientific and Technical Computing
Distributed & Grid Computing for Scientists and Engineers
Parallel Computing for Scientists and Engineers
Visualization & Data Analysis for Scientists and Engineers

TACC Tours
Local community groups, education organizations, home school organizations, and K-12 teachers and students are welcome to explore TACC to discover how they can apply advanced computing to enhance science, benefit society, and take mathematics and engineering to levels that match their imaginations! During the tour, you will visit the ACES Visualization Laboratory, machine rooms (where the supercomputers and storage systems run), and talk with TACC staff. You will have the opportunity to learn how people, science, and technology work together to make things better, faster, and more powerful!

Project "IT" Girl '09
Girlstart is a non-profit organization created to empower girls to excel in math, science, and technology. Founded in 1997 in Austin, Girlstart has established itself as a best-case practice leader in empowering, educating, and motivating girls to enjoy and become more proficient in math, science, and technology. TACC is collaborating with Girlstart on a three-year journey with 60 girls to accomplish the following goals:

Increase girls' interest and competency in science, technology, engineering, and math.
Increase girls' interest in pursuing STEM education and career paths.
Prepare girls and their families for college.
Through this program, IT Girls are asking big questions and defining their own projects to answer them. They are developing important problem solving and project management skills while applying technology throughout the process. The program empowers the IT Girls to pursue career-related interests in a variety of fields, such as industry, the arts, science, and engineering.

Teacher Professional Development
TACC is adapting the San Diego Supercomputing Center's (SDSC) successful TeacherTECH program to serve Texas teachers. In collaboration with SDSC, TeraGrid, The University of Texas at Austin, and the Texas Education Agency, TACC will share the program and help other advanced computing resource providers develop their own TeacherTECH programs. Learn more at http://education.sdsc.edu/teachertech/.