Today's complex problems demand more (and better) computational thinkers

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Note: This column is part of a series written by researchers, staff, and collaborators at the Santa Fe Institute and published in The Santa Fe New Mexican. *Read the article in The New Mexican* here.

It is amazing that in a world progressing so rapidly in technology, the U.S. supply of computer scientists should be in such a state of crisis. The National Bureau of Labor and Statistics estimates that there will be 1.5 million computer science jobs in the U.S. by 2018. Of those, we will be able to fill less than 30 percent with U.S. graduates. We, as a nation, are not producing enough computer scientists to meet the current demands in our country's job market, much less its future demands. And, unlike other areas of science and engineering, the number of computer science graduates is not increasing yearly to help us meet this demand.

As our kids head back to school in a week or two, many will be ending a summer thoroughly or partially engaged in computers, smartphones, and games. It's ironic that while nearly every elementary, middle, and high school student can use a computer as a consumer to do things like explore the internet, create a document, or play a game, few are preparing to create new tools to push the technology further and use computers' vast power to address the complex problems facing the world today – climate change, ecological distress, the spread of diseases, financial unpredictability, and more.

How can it be that our children, who are so interested in all things technological, do not have an interest in being part of that technological development? Perhaps they don't understand they CAN be part of it. While other countries include computer science as part of their core curricula at an early age, in the U.S. it is only a small part of our educational requirements and frequently merely an elective. Nearly all successful computer science college majors report exposure to computer science in high school and earlier. Because the requirements for that exposure are minimal in the U.S., it should be no surprise that we are not producing enough computer scientists. The question is how do we interest our kids in becoming computer scientists.

The Santa Fe Institute has been involved in educational outreach for quite some time. The major focus of this has been exposing a broader audience to complex systems science. The beauty of complexity science is that it takes some of the worlds biggest dilemmas and transforms them into problems that can be investigated and, perhaps, understood. Not only is complexity science powerful, it is approachable. It takes seemingly impossible problems and breaks them down into individuals following relatively simple rules. When you see a large flock of birds moving as one and wonder how they do that, a complexity scientist sees a group of individual birds each following a set of relatively simple rules (move as my neighbor moves, stay close to my neighbor but not too close, and avoid predators). SFI has applied this powerful idea to some of the worlds most difficult and pressing problems. Over the last 10 years, a growing part of the Institute's work has been focused on sharing its science more broadly, and specifically sharing it with New Mexico students. These educational outreach programs have been popular and successful.

Today, the Institute is building on the success of these programs with the creation of a new Learning Lab, which will help non-scientists understand the kind of research being conducted at SFI, with an emphasis on students in grades K through 12. Irene Lee, an educational researcher with the Institute's Education and Outreach group, will direct the Learning Lab. I'm happy to be a part of this effort as a program coordinator for some of the outreach efforts.

The joy of teaching complexity science concepts to primary and secondary school students stems directly from its accessibility to these students. Students can explore a large variety of complex issues through computer modeling and simulation. Even young learners can understand how to apply simulation in basic ways, especially when the topics are familiar to them -- exploring ecosystems by creating colorful underwater worlds of fish, predators, and plankton, developing a better way to evacuate a building, or seeing how a forest fire spreads, for example. The students not only experiment with existing models but also learn to develop their own unique computer models. No longer is computer

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SFI PEOPLE IN THE NEWS

2014-11-11 - Congrats to SFI External Professor Carlos Castillo-Chavez, selected to receive the 2015 SIAM Prize science something monopolized by a few select students to address obscure issues; nearly every student can use it to address problems that excite them individually. Complexity science allows the student to see that it is relatively simple for them to be involved in computer science.

Previously, SFI’s complexity science education outreach programs have featured curricula tailored for specific age groups. Project GUTS (Growing Up Thinking Scientifically), for example, targeted middle school students in a weekly afterschool program centered around problems – ecosystems, traffic patterns, social networks, etc. -- that can be addressed through complexity science. GUTS y Girls served middle school girls in a monthly weekend workshop exploring the application of technology and complexity science in fun and new ways.

The Learning Lab is continuing and expanding these programs to reach additional audiences. Its New Mexico Computer Science for All (NM-CSforAll) program, for example, is a statewide professional development program for teachers, part of the National Science Foundation’s effort to prepare 10,000 U.S. teachers to teach computer science by 2015. NM-CSforAll’s approach is unique among those being explored by the NSF. It focuses on computer modeling and complexity science as a gateway to computer science education. NM-CSforAll’s program is rigorous, requiring teachers to complete more than 200 hours of professional development to be eligible to serve as learning coaches for a dual-credit computer science class offered within high schools. This fall more than 150 students around New Mexico will receive both high school and college credits for successful completion of the course, run in conjunction with the University of New Mexico. The curriculum developed for the course will be available nationally.

SFI’s Learning Lab has its sights set on bigger and better future programs that would develop new approaches to complexity science education and evaluate their effectiveness while expanding the horizons of students and allowing them to explore issues of interest to them. The ultimate goal of these programs is to share complexity science with a new generation, while at the same time enticing young people to expand their computational thinking skills and pursue careers in computer science and other science, technology, engineering, and math disciplines.

In a world with so much new territory to explore, it’s an exciting time to be a science teacher. It’s an even more exciting time to be a science learner. I hope you’ll join me and the Santa Fe Institute as we help redefine this country’s computer science education systems – and, we hope, the prospects for our children and grandchildren. For more information about the Institute’s Learning Lab and education programs, visit www.santafe.edu/education.

Maureen Psaila-Dombrowski is the program coordinator for NM-CSforAll and the Growing Up Thinking Computationally program at the Santa Fe Institute. She holds undergraduate and graduate degrees in chemistry, physics, and nuclear engineering, including a PhD in nuclear engineering from MIT. Her current work and passion is sharing the joys of complexity science modeling and computer science with children of all ages.