**Learning How to Prepare Computer Science High School Teachers**

Few secondary school students in the United States have access to high-quality computer science. There are only 2,000 teachers of computer science at the Advanced Placement level, for more than 25,000 high schools in the United States. Some 14,517 students took the AP Computer Science Level A exam in 2010, compared to 194,784 students who took the Calculus AB exam and 134,871 who took Biology in 2010[[1]](#footnote-1). A recent report by the Computer Science Teachers Association (CSTA), *Running on Empty[[2]](#footnote-2)*, shows that across the 50 states, less than 35% of the recommended high school CS learning objectives are part of state curricula. Some states do better than others, but in most states, students are unlikely to find any computer science in their high schools.

That’s a problem for all of us. High school students who don’t see computer science hold negative stereotypes about the field. Those stereotypes hurt us in enrollment, and in having an educated public that understands and values computer science.

The US National Science Foundation has set a “CS10K” goal, to have 10,000 high school teachers ready to teach computer science at the Advanced Placement level in 10,000 schools by 2015. Where are we going to get all those teachers? How are we going to prepare them to teach computer science? My colleagues and I at Georgia Tech work in *computing education research*, an interdisciplinary field that studies how we educate about computer science and how to make that education better. We have been working in teacher preparation and studying the results of our interventions. Here are some of our lessons learned.

**Operation: Reboot**

One solution to teaching all those teachers about computer science is to start with people who already know about computer science. Barbara Ericson is running a program, *Operation:Reboot*, to help IT workers, unemployed by the recession, to become high school computer science teachers. She is currently working with her third cohort of candidate teachers. Barb’s ingenious plan produces new computer science teachers and improves existing ones.

New candidate teachers (former IT workers) start in the summer with professional development. They then go into the classroom in the Fall, team-teaching with a business teacher. (In Georgia, as in most states, computer science is classified under career and technical education, and is often taught by business teachers.) Barb teams up an IT worker who needs to learn how to run a classroom, with a business teacher who knows how to run a classroom and needs to learn more CS. They can learn from one another. The result of the collaboration is two well-prepared high school computer science teachers. She pays a stipend to a model computer science high school teacher to mentor the pair.

*Operation: Reboot* has had some success. The project has produced new and well-prepared computer science teachers. The mentoring model has been especially successful. The model teachers are rarely in the same district as the team-teaching pair, so the cross-district mentoring serves to spread good ideas on how to teach computer science.

Few Operation:Reboot teachers are in the classroom today. The recession that put the IT worker out of work has also hurt secondary school budgets, and computer science is not a priority in high schools. Overall in Georgia, the number of jobs for high school computer science teachers has fallen. When there is an opening for computer science, there are newly-unemployed, experienced teachers to take that slot, who are preferred to the brand new teachers coming out of Operation: Reboot. Most candidate-teachers from Operation: Reboot are actually employed back in the IT industry, where there are now more jobs and the pay is better.

**Developing CS Teacher Identity**

Education researchers who study teachers know how important it is for teachers to develop a sense of identity as a kind of teacher, e.g., a science teacher or a reading teacher. A teacher who self-identifies as a “science teacher” is more likely to be retained (over 46% of STEM teachers quit teaching in their first five years), to seek out professional development opportunities, and to join a community of fellow science teachers. Most teachers’ sense of identity comes from their certification, e.g., they are certified as a “mathematics teacher.” That’s where our problem starts. Few states have computer science certification.

Lijun Ni is a PhD student in our Human-Centered Computing program. She has been studying how high school teachers come to identify themselves as “computer science teachers.” She has been tracking teachers engaged in a professional development activity called a Disciplinary Commons. Developed by Josh Tenenberg and Sally Fincher, a Disciplinary Commons leads a group of teachers through an academic year in a process of self-reflection on what and how they teach. Our Disciplinary Commons for Computing Education (DCCE) was led by a high school teacher (Ria Galanos) and a university faculty member (Briana Morrison)—both master teachers. Lijun interviewed and observed a set of high school teachers over the year as they participated in the DCCE experience. There were teachers who taught CS but didn’t necessarily see themselves as CS teachers.

Teachers aren’t necessarily eager to label themselves as computer science teachers, e.g., to link their performance evaluations to how well they do in CS, and to seek out professional development in CS. A Calculus teacher takes professional development to learn how to teach mathematics *better*, but the *subject* and the *notation* stays the same. A CS teacher has to keep learning the subject, because it changes. They have to learn new languages, as they go in and out of style. It is hard to be a CS teacher.

Lijun found that DCCE did help develop the teachers’ sense of identity as computer science teachers, even without certification. She found that participating in a *community* of teachers was critical. Through the DCCE experience, her participants found others who were teaching the same computer science content that they were, and realized that they had teaching methods to contribute which others valued. What’s more, the DCCE participants were inspired by the master teachers who led their group, and having role models did a lot to encourage them to learn to be *better* computer science teachers.

**Teaching Teachers On-Line**

Probably the most likely place to get all those computer science teachers is by helping existing high schools teachers re-train, much like the business teachers in Operation: Reboot. How are we going to teach all those teachers the computer science that they need for CS10K to succeed? One possible answer is with on-line courses.

Another Georgia university has just started an effort to help high school teachers by having them take on-line courses originally developed for their MS in Computer Science program. Klara Benda, another HCC PhD student[[3]](#footnote-3), interviewed students currently taking those on-line courses. These students were full-time professionals by day. She wanted to figure out what the issues were in learning computer science in an on-line setting by students who are themselves full-time workers, before the existing, full-time high school teachers arrived.

She found that the on-line computer science courses mirrored the pedagogy of face-to-face computer science classes. CS classes offer lectures and book reading assignments, then expect students to work their way through novel programming challenges interacting with some development environment. Our pedagogy is a kind of apprenticeship for students learning to become software developers. The focus on learning through practice in authentic settings might make sense when the goal is to create software developers. But for a full-time worker and part-time student who wants to learn key CS concepts? As one of Klara’s participants said, “There were times that it would take me hours to find one comma out of place or find that one something that was wrong, so I didn’t mind sticking with it but it just got to the point where I just didn’t get it.” How many full-time professionals will be okay with wasting hours to find a misplaced semi-colon?

**Conclusion**

The United States needs more high school computer science. That means we need more high school computer science teachers who are well-trained, valued, and part of a supportive community. NSF’s CS10K goal is a tremendous challenge, and we frankly don’t know how to get there. Computing education must change for different audiences, like future high school computer science teachers. How will it change? What should it look like? We need more education research that is informed by understanding computer science—how computer science is taught, what the current practices are, and what is important to keep as we change practice. We need more *computing education researchers*, to help meet the workforce needs in our technology-based society.

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1. <http://apreport.collegeboard.org/sites/default/files/downloads/pdfs/AP_RTN_2011.pdf> [↑](#footnote-ref-1)
2. <http://csta.acm.org/runningonempty/roemap.html> [↑](#footnote-ref-2)
3. Working with my colleague, Amy Bruckman. [↑](#footnote-ref-3)