

# Reforming K-12 Computer Science Education ... What Will Your Story Be?

By Chris Stephenson and Cameron Wilson

## *It Takes A Community*

Education reform is, above all else, about community, engagement and commitment. And breaking the status quo is more than just curriculum reform programs, teacher development, facts and arguments. These are important and matter, but individuals and their stories matter more. We begin with the stories of three individuals that reflect what building a little community, getting engaged and committing to a vision can do to strengthen K-12 computer science education for all students.

**Baker Franke.** In 2011, a snowstorm buried Chicago, bringing the city to a standstill. With no power and dying laptop Baker Franke, a local high-school computer science teacher, sat in his apartment insistently hitting his e-mail's refresh for signs from the outside world. One click brought an interesting e-mail into his inbox asking if he would be part of a panel on Capitol Hill to explain why K-12 computer science education mattered and what policy makers should do about it. Baker affectionately called this e-mail the "bat signal." It brought him before a national audience and helped initiate a chain of events helping reform K-12 computer science education in Chicago's schools.

**Joel Adams.** Three years ago, Joel Adams, professor of Computer Science at Calvin College attended a session on Advocacy at a CCSC Conference. This session inspired him to question why secondary school students had so few opportunities to take rigorous computer science courses when the data showed a tremendous demand for jobs in computing-related fields. He picked up his phone and made an appointment

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with his local Representative in the United States Congress where he pointed out that the lack of K-12 Computer Science Education was startling given the unprecedented demand for computer science graduates. The Representative responded by championing support for Computer Science Education Week [1] within the U.S. House of Representatives, and three years later this initiative<sup>1</sup> is helping create a platform for discussing the opportunities and issues in computer science education and leading to hundreds of events worldwide.

**Tammy Pirmann** As a high school computer science teacher in the School District of Springfield Township, Pennsylvania, Tammy Pirmann wondered why students in her district were required to take an outdated computer technology course and yet had little opportunity to take computer science courses. She began working with her principal, and then her district coordinator, and finally with her school board on a proposal to develop a new requirement to replace the outmoded technology course. Now all students in her school district are required to take a computer science course.

Beyond being standouts among the thousands of dedicated and outstanding computer science educators worldwide, these three stories represent the start of a growing trend within our community of educators. People are getting involved directly and deeply in their local communities with the vision of improving K-12 computer science education. Motivated to ensure that students have access to computer science education and are getting the skills and knowledge they need for 21st Century jobs, these individuals are seeking reform to both curriculum and the policy environment that envelopes teaching. They are acting as agents of change at a time when change is desperately needed.

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## *Evidence of Progress*

But change typically can only occur when there is opportunity and the community is mobilized toward a greater goal. As we survey initiatives within the computing community and the larger educational landscape, our opportunities to catalyze reform have never been better. Consider just a few of the following major events that have happened in the past three years:

- The National Science Foundation launched a new program called Computing Education for the 21st Century to help seed the overall CS10K Teachers effort [7];
- The Computer Science Teachers Association released the revised *K-12 Computer Science Standards* [2], providing the definitive framework and foundation for K-12 Computer Science Education;
- ACM, CSTA, Microsoft and Google (to name just a few key partners) launched a major new K-12 advocacy coalition called Computing in the Core [3] that now has 13 partners;
- Google has provided initial funding for a partnership between ACM, Google, CSTA and NSF to begin developing models to scale up the work around Computer Science Principles;
- The British Government is replacing its existing use-focused Information and Communication Technology (ICT) curriculum with computer science curriculum;
- The community strongly rallied around a new approach for AP Computer Science through the Computer Science Principles course now being piloted at high schools and universities across the United States;
- Educators have successfully piloted a new introductory course for high school computer science -- Exploring Computer Science -- in the Los Angeles Unified School district and that model is now being adopted in Chicago;
- Reforming education to include critical 21st Century skills and knowledge to stay globally competitive is on the lips of most national leaders from around the world; and

- The job opportunities and impact computing has on our daily lives have never been larger. Computer science degrees are now the highest paid of any degree among graduating undergraduates.

Now we face the harder task of leveraging these events and mobilizing the entire computer science education community to work toward reform. This mobilization can focus on many issues from curriculum reform to new teaching methods and programs but the bottom line is that none of these reforms can be sustained without changing the policy landscape for K-12 computer science education.

### *A Very Decentralized Approach*

In the United States, this landscape is very complex because decision-making is highly decentralized with numerous power brokers, agendas, and outside advocacy groups all driving or, at times diverting, education reform. The framework for K-12 education policy starts with the federal government through the Elementary and Secondary Education Act (also known as the No Child Left Behind Act), but this is only a framework as most decision-making on policy is vested in the state and local level. For example, while the U.S. Department of Education distributes billions of dollars in education aid across the United States, it cannot tell states specifically what courses to teach or how to teach them. Moving to the state level and local level you quickly find that, while there are some commonalities among the states, the centers of power, issues, and landscape differ from state to state.

Policy governs what is taught and how to teach it at the K-12 level. More importantly, it governs what resources are allocated to teachers and courses, and determines a school district's or state's priorities. Any discussion around reforming or expanding computer science education must start with a conversation about how computer science fits within the existing policy landscape.

One of the few areas where we can begin to look at how computer science does or doesn't fit into the policy landscape is state standards and assessments, teacher certification, and whether computer science is part of the core curriculum -- that is, that it "counts" as a core graduation credit from secondary education. In 2010 ACM and CSTA released *Running on Empty: The Failure to Teach K-12 Computer Science in the Digital Age* [4]. This report examined the state standards and graduation requirements for computer science education in all 50 states and found bleak results. Roughly two-thirds of the states have very few computer science education standards for secondary school education and almost all states treat high school computer science courses as simply an elective course and not part of a student's core education. For some sense of scale of how deep computer science exposure is the K-12 space, 22,176 students took AP Computer Science across the US in 2011 while 340,000 took an AP Calculus exam. Our numbers are an order of magnitude smaller. While we can build great courses and develop wonderful teachers, without policymakers making computer science a priority and giving us a seat at the table with other core subjects, our impact will be marginal.

### ***A Mobilizing Strategy***

As the computing community grapples with how to significantly expand K-12 computer science education, we must keep these lessons in mind. They also point toward a strategy for mobilization that must be locally driven and built from the ground up. We need our own "boots on the ground". This is where you can become the next CS reform success story. We offer the following basic guidance for taking some concrete steps toward advocating for computer science education:

"Imagine if we had 200,000 or 500,000 students graduating from high school every year who have taken computer science, as well as calculus." Marissa Mayer, Vice President, Consumer Products at Google.

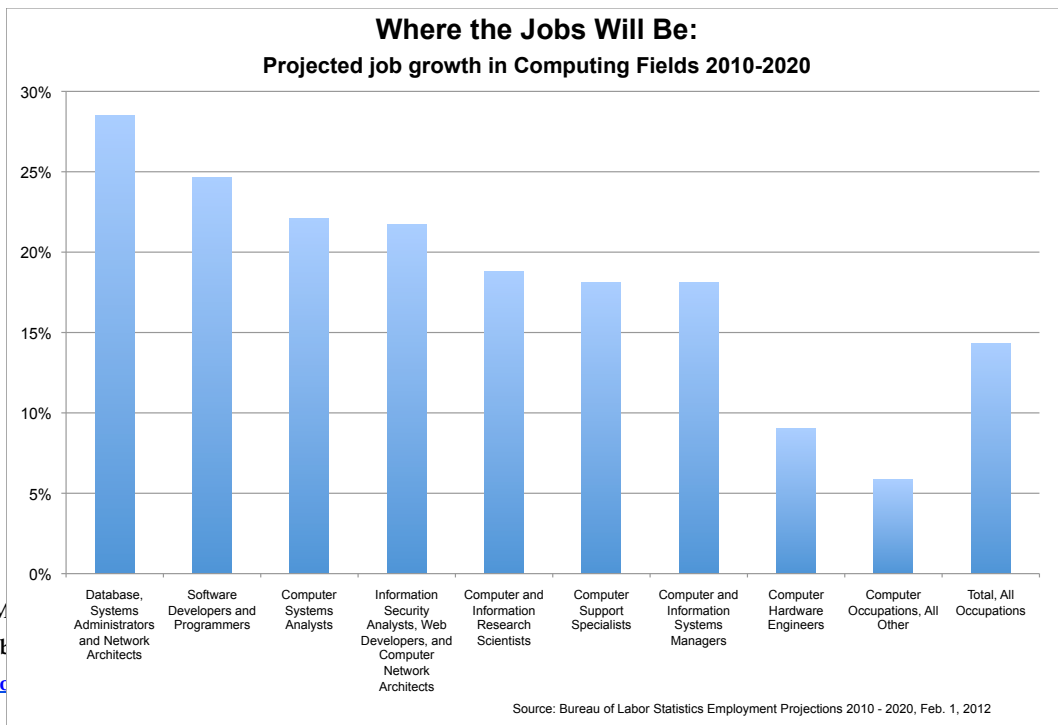
**Do Your Homework** -- Successful advocacy efforts start with researching two basic questions: 1) what does the policy landscape look like related to computer science locally (i.e. how does computer science count in your school, what are the teacher certification requirements, are there state laws or regulations encumbering education, etc.)? And, 2) Who is in charge of making education policy decisions and at what levels (i.e. are the important barriers or opportunities with the State Department of Education, your local school board, the higher education system, etc.)? These question can seem daunting at first, but often you can find administrators in schools and State Departments of Education who can start to provide answers and locally elected officials can also serve as intelligence gathering resources.

**Gather Your Arguments and Stay on Message** -- Once you have some sense of where to target advocacy, you should begin to create a simple set of arguments that you can repeat over and over again to various audiences. The community's most powerful arguments resonate around jobs or access to critical knowledge. For example, computer science education will enable students to be better prepared for the projected 1.5 million job openings in computing-related fields over the next ten years (Figure 1). Or, students who take the AP Computer Science Exam are almost eight times as likely to major in computer science than students that do not take AP CS [8]. There are numerous resources you can

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explanation of computer science education (CSTA's *K-12 Computer Science Standards*) and additional tools for advocacy on CSTA's, Computing in the Core's, CEdWeek's and NCWIT's websites.

*Figure 1. Where the jobs will be; source U.S. Bureau of Labor Statistics*

**Recommend Reform, Don't Just Complain** -- When engaging in policy reform you clearly have to point out what the problem is (computer science is an elective, there is no teacher certification, students have no access to courses, etc.), but the conversation cannot stop there. You have to recommend what you would do about the problem. *Running on Empty* contained the following policy reform recommendations for state and local governments:

- Create a well-defined set of K–12 computer science standards based on algorithmic/computational thinking concepts, such as those found in CSTA's K-12 Computer Science Standards
- Count computer science courses toward a student's core graduation requirements either as a computer science credit or as a mathematics or science credit;
- Develop courses, such as Computer Science Principles or Exploring Computer Science to implement new computer science standards;
- Develop assessments for computer science education;
- Categorize computer science courses as academic courses;
- Expand professional development opportunities and recruit new computer science teachers;
- Expand access to computer science courses for under-represented populations; and
- Create flexible certification programs for computer science education grounded in the knowledge of the field.

**Look For “Messaging” Opportunities** -- While you should target your advocacy at decision-makers that matter to your context, repeating your key messages and

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recommendations across as many platforms and to as many external groups as possible is also valuable. There will be also times during the year when you may be able to highlight key facts, developments, and recommendations relevant to computer science. One such opportunity is to plan something for Computer Science Education Week, which is December 9-15. The CSEdWeek website [1] has an event planning tool kit to plan your engagement.

**Build a Community** – K-12 educational policy reforms that achieve real, sustained change must be solidly grounded in the realities of K-12 educational system and no one knows the system better than computer science teachers. Over the last few years CSTA has built a vibrant community of teachers engaged in support and advocacy work through its CSTA local chapters and Leadership Cohort [6] program. If there is a CSTA chapter or Leadership Cohort members in your state, begin by tapping into these communities. If there is no CSTA chapter in your area, consider starting one (CSTA has a Chapter Liaison who can help you do this). Suggestions from a community of educators are often much more convincing than ones that seems like one person’s opinion.

It is also important to reach out to the local business community, especially to businesses who depend on the computing workforce. Policy-makers and politicians are often very receptive to policy reforms that could mean jobs for their students and constituents.

**Find a Champion** – A lesson that we can draw from our three stories at the beginning is that finding a champion that is external to the community matters a lot. Champions can come in many forms (a principal, a parent, a state department of education employee, a school board member, a politician, etc.) but ideally they are an “insider” to whatever policy context you are working on, can help shepherd reform, and are willing to spend the political capital necessary to achieve shared goals. Champions will naturally develop over time through your engagement, but it can take time and persistence. You need to connect



with them on the things that they value and make computer science education part of their story of leadership.

**Engage, Assess, Evaluate, Repeat** -- There is no silver bullet, no one-size fits all solution to policy reform. You need to engage with policy makers, make your arguments and recommendations, then evaluate the results and continue to repeat the most effective messages and solutions. Profound systemic reform can only be achieved through sustained engagement by a dedicated and informed community. It takes planning, a great deal of effort, and patience. A sense of humor (or at least an appreciation for the absurd) is also exceedingly helpful.

With numerous community-wide initiatives coming to fruition at a time when the need for K-12 computer science education has never been greater, the stage is clearly set for expanding access to this critical subject. However, we need to mobilize our community to communicate why computer science education matters, what the issues are and how to reform it to many different audiences including parents, businesses, educators, and, most importantly, policy makers. These communities must understand that no other discipline will open as many doors in the 21st Century, regardless of a student's ultimate field of study or occupation, as computer science. At a time when computing is driving job growth and new scientific discovery, it is unacceptable that roughly two-thirds of the entire country has few computer science standards for secondary school education, few states count computer science as a core academic subject for graduation, and computer science teacher certification is deeply flawed. These are national failings and ones that we can ill afford in this digital age. The question for our community now is: what role will you play in changing K-12 computer science education in answering this call to action? Our next great success story can start with you.

## ***References***

[1] Computer science education week, [www.csedweek.org](http://www.csedweek.org)

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### **Categories and Subject Descriptors**

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