Transforming High School Computer Science: CS / 10K Project

If we are to maintain a globally competitive IT workforce that leads in innovation, there is no stage in the academic pipeline more crucial than high school. Students do begin to lose interest in computing much earlier, but engagement programs for K-8 will not be effective if we drop those students for their high school years. Likewise, revitalized college computing programs cannot have a significant impact if too few students show up at their doors. And there are too few students showing up now. Since 2000, HERI data shows that the percentage of incoming college freshman intending to major in computer science has decreased more than 70%; for women, the figure is closer to 80%. In 2008, intended majors in CS dropped to a 25 year low.

High schools are key, yet they often fail to teach rigorous, academic computing. Many schools offer IT courses only as Career and Technical Education (CTE). Often, though not always, these courses are limited to basic computing literacy, and are not taken by college-bound students. With the exception of the Advanced Placement (AP) CS course, few high schools offer any computing courses with college preparatory status.

The AP CS is a rigorous college prep course, but it is taught in less 10% of our high schools, and even in those schools, it is not optimal. AP CS is programming-centric, and inaccessible to students with no prior experience. It does not focus on the fundamental concepts of computer science, and it does little to teach the breadth of application or "magic" of computing. Consequently, in 2008 only 15,537 students took the AP CS test, as compared to the 222,835 who took Calculus AB or the 108,284 who took Statistics. AP CS had the worst gender balance of any of the AP tests: only 18.6% of the test takers were women, in comparison to Calculus AB at 48.6% and Statistics at 50.7%. Only 12.4% of the AP CS A test takers were underrepresented minorities.

Clearly, high school computing needs to change. We are serving too few of our students well. We propose

> **CS/10K Project Goal**: *To develop an effective new high school curriculum for computing, taught in 10,000 high schools by 10,000 well-qualified teachers by 2015.*

New High School Curriculum

The new curriculum will feature two courses: an introductory course for all students (college prep as well as CTE) and an entirely new AP CS course.[1] Both of the new courses will be rigorous, both will develop computational thinking skills, both will cover fundamental concepts of computer science, and both will expose students to the breadth of application and "magic" of computing. The AP imprimatur will give us a single point of national leverage.

The College Board, with funding from the National Science Foundation (NSF), is developing the framework for the new AP course. It will not be programming-centric, but will focus on the underlying principles of computation involving problem solving, abstraction, algorithms, data and knowledge creation, and programming, as well as the limitations of computation, and its breadth of application. The course will expose students to related issues of society, culture, and ethics. It will be engaging, accessible, inspiring, and rigorous. It is intended that the course carry college credit, if not placement, at the undergraduate level.

The curriculum for the introductory course, does not need to be as prescribed. Instead, we will create a framework, a set of exemplars, and course materials. One of those exemplars will be the

[1] The existing AP CS A test, with its focus on programming, will still be offered by the College Board.

new Exploring Computer Science (ECS) course that is being taught now in the Los Angeles Unified School District.[2]

10,000 Teachers in 10,000 Schools

Curriculum, however, is not the biggest challenge. The biggest challenge will be scaling teacher training to reach 10,000 teachers. Few of our high school teachers have a formal CS background. We will launch an unprecedented preparation program, working with in-service as well as pre-service teachers in both traditional and alternative certification programs. We will pair face-to-face training with extensive, state-of-the-art online support that includes curricula, materials, and social networking. We will provide high-quality, ongoing professional development. To accomplish this, we will need to call on the resources of university faculty, undergraduate and graduate students in service learning programs, and IT professionals serving as citizen scientists.[3]

We will need also to gain entrée into the schools. That will not be easy. It is obvious that many schools are struggling with extremely tight budgets, but what may be less obvious is that many schools simply don't have a place for academic computer science. CS does not carry math or science credit in most states. As a result, it is often impossible to fit computing into the already full schedules of college bound students. Changes in the classification of computing as well as standards and teacher certification will be necessary in many states.

With all of the attention and resources currently flowing into STEM (Science, Technology, Engineering, and Mathematics) education, it would seem like a great time to be pushing for increased efforts in computing, but that is not necessarily the case. There is no "C" in STEM. Computing, which spans all of STEM, is left out of most discussions of STEM education. We also need to change that.

Progress to Date

Initial phases of this project have already begun with NSF support. The design of the new AP framework is underway. The LAUSD ECS course, developed with support from Microsoft and Google, has been awarded both college preparatory and CTE status in California. With support from Google, a working group has been created to develop a framework for the introductory course, and a meeting of education leaders – directors of science and mathematics in from school districts – began a draft plan for the national roll out of the new curriculum. Two demonstration sites – Los Angeles and Atlanta – have begun pilot programs to create and scale teacher training, support, and professional development. The Computer Science Teachers Association (CSTA) and the ACM have been involved in all these efforts and will continue to be close collaborators.

Partnerships for Progress

In its entirety, the CS / 10K Project will require building substantial collaborations beyond NSF. We are seeking to build a consortium of partners – government agencies, community groups, private foundations, and industry leaders – to assist in all aspects of the effort. The time is right for this effort, but it will need the active support of the entire computing community.

For further information, contact Jan Cuny, Program Officer, National Science Foundation (jcuny at nsf dot gov)

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[2] ECS was developed under the direction of Jane Margolis, Todd Ullah, Joanna Goode, and Gail Chapman.

[3] National Lab Day provides university faculty and IT professionals a great place to start their engagement with local K-12 schools: www.nationallabday.org