Introduction

In 2008, the National Science Foundation started an ambitious effort to have a new computer science curriculum taught in 10,000 schools by 10,000 well-qualified teachers by 2017 (CS10K Project). Training thousands of high school CS teachers as a part of CS10K to teach a new curriculum is a crucial step in meeting this demand. Scaling teacher training as needed by CS10K, however, is a daunting task. This effort requires us to deliver quality professional development opportunities for in-service teachers and conduct educational research to examine factors that influence professional development in CS to understand computer science teacher effectiveness. This white paper addresses these two areas (professional development and accompanying educational research) and introduces a framework for professional development that draws upon existing literature.

Developing Teacher Knowledge in Computer Science

Promoting professional development for in-service teachers is an important factor in improving computer science teaching practices. Because of the time and energy demands placed upon teachers, it is critical to effectively and efficiently provide high quality professional development opportunities. Our previous work suggests that developing teachers’ pedagogical content knowledge is an important step for propagating beneficial teaching practices (Cockburn, Yadav, Powell, & Diamond, 2010; Yadav, 2006). Historically, professional development has taken many forms, including in-service workshops and in-class coaching. However, these approaches are not directly scalable for CS10K given the need for extensive human, financial, and time resources. Furthermore, “one and done” professional development approaches that rely heavily on workshops without structured ongoing engagement are known to have limited success (Dickinson & Caswell, 2007).

In order to meet the CS10K goal of training thousands of teachers to teach the new CS curriculum, we need a multi-pronged approach that targets both computer science teachers and teachers from other content areas. Providing quality in-service teacher training has emerged as a critical need in our interaction with teachers and high schools. Teachers sometimes do not have sufficient content or pedagogical knowledge to offer rigorous computer science courses. Furthermore, technology or science teachers interested in teaching computer science have few opportunities to learn the subject. Hence, there is a critical need to develop teachers’ pedagogical content knowledge in computer science through professional development.

A recent landscape study on the state of high school computer science professional development provides a significant set of recommendations to improve teachers’ knowledge to teach computer science (Rand, Century, & Wilson, n.d.). Our work draws upon these recommendations to create a professional development program that:
1) is co-developed by university and school personnel based on the needs of the curriculum;
2) provides teachers with continual exposure to PD experiences for longer periods of time;
3) aligns the PD experiences to teachers’ instructional goals and courses; and
4) provides opportunities for teacher reflection.

One of the ways to deliver professional development is using online tools to advance teachers’ learning. They reduce the constraints of finances, time, and staffing. Researchers have advocated online professional development because of its potential to increase pedagogical content knowledge, sustainability, and scalability. In addition, online delivery fits within teachers’ schedules and increases their ability to network with other teachers (Dede, et. al, 2006). However, researchers should also consider some other important elements creating online learning communities: the deliverables should provide participants with opportunities to structure their goals, it should require them to work in groups to exchange information and share resources, it should allow for cognitive apprenticeships by pairing experts with less experienced learners to collaborate, it should offer authentic tasks and provide regular feedback, and it should also promote self-reflection while using different assessment methods such as the collection of participants’ work and excerpts of online discussions (Vrasidas & Zembylas, 2004). These recommendations guide the development of our Just-In-Time professional development program.

Just-in-Time Professional Development

The goal of Just-in-Time Professional Development (JIT-PD) is to develop in-service teachers’ pedagogical content knowledge (PCK) that is unique to teaching computer science (Yadav & Korb, 2012). The JIT-PD builds upon our prior work on a Methods of Teaching Computer Science course taught as a part of computer science supplemental licensure program at Purdue University.

Specifically, JIT-PD is designed to meet the following objectives:

1. Provide teachers with “experiences that allow them to think and act like computer science teachers” (Yadav & Korb, 2012).
2. Develop skills that “combine pedagogical principles with computer science content to improve the learning experience for their students” (Yadav & Korb, 2012).
3. Provide a variety of instructional strategies that promote student understanding and how to address student misconceptions of computing ideas.
4. Provide assessment techniques (formative and summative) for teachers to gauge student understanding of computing ideas.

The JIT-PD approach to these objectives is to engage teachers in learning experiences designed to expand teachers’ understanding of computer science, pedagogical tools, and assessment necessary to successfully teach a CS course. These experiences, which include lectures, learning activities, reflection, and discussion are designed to build teachers’
understanding of the computer science concepts as well as to showcase how to teach those concepts. Specifically, we provide teachers with background learning material through lectures and readings to develop a basic understanding of concepts. The teachers then engage in learning activities that are designed for them to apply their understanding to authentic tasks. These activities include: developing/refining lesson plans, examining examples of student codes, identifying student errors, etc. Finally, the teachers are engaged in a reflective dialogue with their peers surrounding the learning activities. We believe that teachers are more likely to benefit from the reflection and discussion as it helps them develop a clear and more elaborate understanding of teaching and learning. In summary, our professional development model pushes teachers to think about teaching computer science by having them put on two hats: one of themselves as students in computer science and another of themselves as teachers of computer science. This model is depicted in Figure 1.

![Figure 1: JIT-PD Model](image)

Preparing teachers is an important first step to expand computer science education in the K-12 schools; however, there is also a critical need to establish a scientific and shared research base that identifies best practices for teacher professional development in computer science. Educational research needs to be conducted to examine what aspects of PD are essential for improving teachers’ Knowledge, Skills, and Attitudes (KSAs) for teaching computer science. Given the need to train new teachers from other content areas in the teaching of computer science, we need to study how to prepare in-service teachers with little CS background to teach CS. More specifically, the following research questions are important:

1. What are the critical factors to developing teachers’ KSAs to teach computer science?
2. How do we prepare teachers to address student misconceptions of computing concepts?

**Implementation**

The designed JIT PD framework will be implemented in collaboration with Project Lead The Way (PLTW), [http://www.pltw.org/](http://www.pltw.org/). PLTW provides comprehensive curricula for engineering and biomedical sciences to 4,700 schools in all 50 states and the District of Columbia. PLTW is currently piloting a new course titled “Computer Science and Software Engineering” (CSE) which parallels the material covered in College Board’s CS Principles Course ([http://www.collegeboard.com/html/computerscience/](http://www.collegeboard.com/html/computerscience/)). We are collaborating with PLTW curriculum development and professional development staff to prepare for providing the Just-in-Time Professional Development to 20 pilot teachers in Spring 2014. The teachers have diverse backgrounds and varying experience in teaching computer science. PLTW’s existing infrastructure will be used as the platform for delivering the PD. All JIT-PD material developed will be made available publicly as will the results of our assessment.
Outcomes

The outcomes of this research will establish an evidence-based professional development program specifically designed to improve teachers’ knowledge to teach computer science. The diverse group of CS teachers involved in the project, in conjunction with multifaceted professional development activities, will allow the research team to isolate important factors critical to develop teachers’ knowledge to teach computer science and increase their teaching effectiveness.

References


