Designing and assessing ongoing professional development opportunities for high school computer science teachers

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Abstract: Findings from our research on teacher learning carried out in the context of a design experiment. We briefly discuss the need for ongoing professional development opportunities for high school computer science teachers, provide an account of our model, and share encouraging results from teachers' perceptions of what they have accomplished.

Introduction

Ongoing professional development opportunities for high school computer science teachers, building both fundamental content knowledge and corresponding pedagogy, are essential for a number of reasons including: (1) the critical role of the teacher in student interest, understanding, and success (AAUW, 2000; Darling-Hammond, 1998; Margolis & Fischer, 2002); (2) important decisions required of computing teachers, who are often individually responsible for designing entire technology programs as a result of a lack of common curricula or standards; (3) the wide range of expertise and training among computer science teachers, many of whom were originally trained in other disciplines (Schofield, 1995; Becker, 2000); and (4) the quickly developing nature of the content itself.

The current picture of high school computing education in the U.S. does not seem to include sufficient training opportunities for teachers. One of our collaborating teachers noted, "The problem is that once you get [into a teaching position], the learning stops." Research on the use of computing in schools shows that only a small proportion of teachers use computers in ways that may enhance various aspects of technological fluency (Becker, 2000).

Interdisciplinary design work

The professional development component discussed here is part of a larger multi-year effort to develop, implement, and assess a project-based computing curriculum and an affiliated model of professional development for public secondary schools in Bermuda. The project is a collaborative effort of a group of students and faculty from the Computer Science Department and the School of Education at Stanford, and Bermudian computing teachers. The computer science team provides the technical knowledge necessary to develop the curriculum content and extensive experience teaching computing concepts to college students. The School of Education team provides expertise in the design and study of the learning environment – involving learning theory and assessment strategies. The secondary school teachers provide observations and ideas based on their experiences in the classroom. By working together, the groups create a synergistic environment that has proven enormously valuable.

Professional development

Our model of professional development is consistent with research into teacher learning and new paradigms of teaching as an ongoing intellectual pursuit, focusing not on the mastery of static content but rather on the construction of meaning within a collaborative environment (Putnam & Borko, 2000; Darling-Hammond, 1998). The design of the professional development sessions is approached jointly by researchers and teachers. Collaborative activities based on student projects expand content expertise, while critical, reflective discussions around student work assess quality, standards, and student understanding, grounding the new knowledge in actual classroom instruction. The combination of new content with real-world experiences and specific teacher expertise facilitates teachers' construction of their own knowledge, practices, and ideas (Putnam & Borko, 2000). The explicit goal is to familiarize the teachers with the course material and to help them construct a conceptual framework within which to understand it. Our implicit goal is to create a community of teachers who learn from each other and share emerging ideas and information.

Since 1999, we have offered multiple contexts for teacher learning, including three 1-3 day sessions throughout the school year, a more intensive 1-2 week session during the summer, and ongoing support via email, telephone, and video-conferencing.

Assessment of teacher learning

Professional development theoretically should lead to changes in teacher performance, ability, and perceptions. It is difficult to document these changes, and traditional methods of teacher assessment, such as teacher and student test scores, do not reflect the complexities and variability of teachers' roles (Darling-Hammond, 1999). New methods must be explored that provide better insights into teacher development. One method we use is teacher reflections on changes in their own understanding and reports of how they have adapted original curriculum materials to meet student needs. Indicators of teacher development fall into these 5 main categories:

Growth of content knowledge. Though most of the teachers have no formal training in computer science, all perceive significant changes in their knowledge of fundamental curriculum topics, especially programming understanding and ability. Initial fears about teaching the subject are replaced with descriptions of self-expertise including "guru" and "whiz."

Perceptions of changing pedagogy. Specific new teaching methods are cited, as well as changes in overall awareness of the profession. One teacher notes that he no longer sees the students as a group, but as individual learners who may understand in different ways.

Sharing knowledge with other teachers in their department and teachers of other subjects. Informal collaborations suggest the formation of a community of learners sharing knowledge. Teachers report "no shortage of opportunities to teach people," ranging from inter-departmental workshops stemming from an individual interest, to helping a Mathematics teacher with spreadsheets or a Social Studies teacher with FrontPage.

Self-sustained learning in order to improve knowledge and skills. Teachers are building the confidence needed to independently develop their own learning. They describe using outside resources such as books or the Internet, and discuss time spent "playing with" a program, or "experimenting" with ways to introduce a new computer language to students.

Adaptation and innovation of course materials. To account for the variety of learners in the classes—including special needs students—teachers have reshaped and developed course materials to better serve the range of students. Teachers built a physical representation of the programming environment *Karel the Robot* using magnetic paint on their classroom walls, allowing students to design solutions using tangible manipulations before they begin to code.

Discussion

Though most of our teachers do not have formal training in computer science, ongoing professional development opportunities in multiple contexts enable them to exhibit indicators of success in teaching and learning. Results will be presented in a variety of formats, including interview transcripts and teacher work.

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