Future directions in CS education research

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Professional lives amidst instability with the help of a crowd

The field of CS changes its face (some say revolutionizes itself) quite often. Accordingly, computer science (CS) education differs from other fields of science education, not only in its relative youth, but also in the extreme instability of the curricula and teaching methods (Roberts, 2004). CS Teachers have to adjust to the frequent changes quickly and be able to teach the new curricula effectively to their students. In this paper two future directions for research are suggested. Topic 1 concerns CS teachers' learning processes. It takes the growing interest in the field of (CS) teachers' knowledge a step farther. Topic 2 is derived from another aspect of a change in the professional lives of programmers, teachers, and students—the growth of their professional, supportive community. Owing to the prevalence of internet and web 2.0 tools, more professional interaction with more people is now possible, and the impact of certain professional practices and values should be researched.

Topic 1. CS Teachers' learning processes amidst frequent changes

In recent years there has been a growing interest within the CSER community in eliciting CS teachers' knowledge. This is not a trivial matter. In this paper I advocate a related topic that I believe the CSER community should pursue: those processes involving the growth of CS teachers' knowledge. The discipline of CS changes rapidly and accordingly, CS curricula change frequently. It is widely agreed that curricula should emphasize scientific principles, but that new paradigms evolve and change the face of CS curricula more frequently than in the classic scientific domains. The rapid technological development therefore changes the face of CS as well and these changes should be reflected in the curricula (e.g., mobile programming).

This means that CS teaching requires life-long learning competencies. Teachers should be able and willing to rapidly learn changing and new knowledge and process it quickly so that it will be teachable to their students, or using Shulman's terminology, they should develop relevant pedagogical content knowledge (PCK). PCK includes “the most useful forms of representation of those ideas, the most powerful analogies, illustrations, examples, explanations, and demonstrations—in a word, the ways of representing and formulating the subject that make it comprehensible to others.” (Shulman, 1986, p. 9). PCK also includes an understanding of conceptions and preconceptions that students bring with them to their lessons and the knowledge of the strategies most likely to be fruitful in fostering students’ understanding.

Models of teacher development usually conceptualize teacher learning as “growth”, the growth of knowledge, and more specifically, of PCK. Novice teachers are characterized by fragile PCK, which makes their teaching less flexible and attuned to their students' needs in comparison to that of expert teachers, whose PCK evolved throughout their experience (e.g., the model by Berliner, 2004; 2001). However, these models do not take into account situations involving dramatic changes in the knowledge
of the subject domain (aka content knowledge (CK)), which CS teachers face nowadays by frequent radical curricular reforms. This topic should therefore be further researched.

Preliminary work suggests that such a study is both feasible and beneficial. In a previous work we examined the learning processes of CS teachers having extensive experience in teaching procedural programming, who, owing to curricular reform, had to study and teach object-oriented programming. Using observations and interviews, we found that this situation creates a new hybrid state of teachers, which we term “regressed experts”. These teachers incorporate into their professional practice elements typical of novices as well as elements typical of experts. Namely, learning cannot conceptualize merely as a “growth” process, but rather as a sequence of retreats and growth processes. We also found that these teachers’ experience, although it was established when they taught a different content knowledge, serves as leverage to improve their knowledge and understanding of aspects of the new content (Liberman, Ben-David Kolikant, & Beeri, 2012).

The research questions that emerge in this reality are as follows: (1) what are the learning processes that CS teachers undergo at times of frequent, yet dramatic changes? (2) What can be done to foster and support these processes? In particular, what role should technology play?

**Topic 2: The reality of 'person plus crowd' and its effects on CS and CSE professional lives**

The internet and the ICT have changed our lives in many aspects. We live surrounded by information, resources, experience, and knowledge that other people share with us through the internet. The Internet facilitates and encourages students, professional programmers, and teachers to (search for and) build on other people's experiences and resources. They can, for example, use other people's experience to tackle errors and problems encountered, search to re-use or alter someone’s code instead of developing new code from scratch. Teachers and students can, for example, look for pedagogical demonstrations, simulations, tutorials, explanations, and exercises to improve the teaching or understanding of a certain topic.

The interaction with the crowd is multi-directional and the roles of people are fluid. One can produce a piece of a code and upload it, download other people's codes, use them, refine them and upload them. Linux is a prominent example of such a process. Teachers, too, have free wiki-like sites in which they can share educational resources and their experiences (e.g., Curricki).

Perkins (1993) asserted the importance of a person plus approach to thinking about one's knowledge, an approach that views the person and his or her surroundings as one system. This approach differs from the person solo approach, according to which, technology or any other means may be used in the learning process, but eventually, “it is the person solo who should have all the knowledge and skills in his or her hands rather than tucked away in easily accessible sources” (p. 132). Person solo is accustomed in traditional schooling. In CS education, however, a person plus approach is taken many
times, which is reflected, for example, in exams with open books or project-based learning.

Based on this idea, I proposed the term person plus crowd to emphasize a reality in which one is exposed to the crowd's knowledge—a wealth of knowledge, ideas, and resources. This reality impacts professional practices and values. This new reality of the professional life of person plus crowd provides many opportunities, and at the same time, is very challenging. It raises many important questions that the CSER community can and should address:

(1) How is the reality of person plus crowd reflected in the professional practices and capabilities of professional programmers and students, if at all? What are the differences, if any, between students (novices) and professionals (experts) regarding this aspect?

(2) How should CS education change, given this reality? What should we teach students to better prepare them for this aspect of their professional lives outside school?

(3) How can we utilize this reality to support teachers in their work? In particular, what conditions and support are required for establishing an active and fruitful life for the community of CS teachers?

References


