Type 1: Using Instructional Design Techniques to Create Distance CS Education to Support In-Service Teachers

Project Summary

Even the best of modern computer science pedagogical practices conflicts with the professional development needs of high school teachers. Our best practices involving systemic design principles or contextualized approaches still require students to spend time struggling with programming. A CS student’s struggle is often inefficient because a significant percentage of her time is spent dealing with extraneous tasks, such as syntax problems. Cognitive tutors have been used to teach computer programming efficiently and effectively, but not practically—students who learned to program using cognitive tutors have learned to write code, but not learned to design, implement, and debug software. The needs of teachers go beyond writing code, to being able to teach computer science concepts and to address student misunderstandings.

We are proposing a middle ground between current best practice and cognitive tutors: The use of instructional design and educational psychology research findings to develop improved computer science teaching materials for CS concepts and programming. Our goal is (a) to teach more effectively those CS concepts that can be taught without programming, and (b) to improve the efficiency of programming activity so that less time is spent on extraneous issues. Our hypothesis is that many of the best ideas from instructional design and educational psychology have rarely or not yet been tried in computing education. Through a design-based research approach, we plan to develop materials and apply them to improve educational practice. We will aim our efforts at high school teachers learning computer science who are time-constrained (thus needing greater efficiency), adult learners (thus better at metacognition, and able to be better informants on our designs).

Intellectual Merit: We propose to use worked examples with practice informed by instructional design principles to produce materials for in-service teachers for use in learning computer science. The example presentations will be informed by the modality principle of multimedia design. The content of examples and practice will be informed by a structure-behavior-function (SBF) model of knowledge. The structure and order of examples and practice will be informed by cognitive tutors research. We will be developing new best practices in computing education especially for distance learning and self-study. We will measure learning outcomes of CS content, student satisfaction with the instructional media, and efficiency during programming assignment sessions.

Broader Impacts: The techniques that we will be developing for our high school teachers can be used by other high school teachers, or other CS students, even for informal learning. We will be establishing models and design guidelines for creating other high-quality learning materials informed by education research. Evaluation of these materials will inform the computing education research community about the impact of applying these instructional design principles to computing education. We are explicitly interested in taking the results of the instrumented practice activities and using it to scaffold new computer science teachers in creating effective classroom activities.

Issues of Underrepresentation: We will use our materials with high school teachers in our current professional development programs, who are mostly members of under-represented groups, teaching in “majority-minority” schools. We plan to expand our testing with other professional development efforts around the state of Georgia, which similarly serve mostly under-represented minority teachers. We will measure number and performance of their students.