Online curricula for monitored, closed-lab first-year CS courses

We propose to design, evaluate, and disseminate a new approach for teaching introductory computer science courses. Using a web-based learning environment, we can take advantage of recent research on learning and incorporate successful strategies for teaching diverse students.

**Intellectual Merit.** We have tested our approach at U.C. Berkeley since summer 2002. We will implement this approach in first year programming and data structures courses. It features:

- A diverse set of activities, including case studies, collaborative problems, comparison of solutions, video explanations from varied instructors, brainstorms, simulations, and projects that provide more and timelier opportunities to learn
- Collaboration and group work that enhance understanding and engage students as both producers of solutions and critics of alternatives
- A suite of support mechanisms that help students keep up with course assignments and sustain consistent participation
- Activities such as mentoring and just-in-time-tutoring that help all students and especially underrepresented groups, including women, have more success
- Embedded assessments and data on student interactions that enable instructors to use a fine-grained knowledge of student conceptions and progress to customize instruction
- A comprehensive learning environment that enables instructors to allocate limited time where it can be of best use: efficiently diagnosing student needs, iteratively customizing the course materials, and improving TA training

We will design and test professional development workshops for this approach, document curricular customizations that faculty make, and evaluate student learning and instructor workload using internal, external, and expert review processes.

**Broader impacts.** We propose to extend our approach to the full range of cultural groups and educational contexts important for ensuring a diverse workforce in technology. We will tailor techniques proven successful at Berkeley to students in community colleges, minority-serving institutions, and liberal arts colleges. At regular workshops we will design research to determine which aspects of the instruction succeeds and to communicate these successes widely. We will collaborate with instructors from diverse institutions to customize the instruction to the curriculum and expectations in their departments. Our research suggests that a diverse set of activities meets the needs of more learners than the more limited activities in traditional courses. In addition, the detailed information available to instructors enables them to guide students in a more timely and effective way. Our experience suggests that this pedagogical approach helps instructors use their time effectively and does not demand more time for teaching.

To evaluate our efforts we have secured the participation of leading computer science instructors to review and critique our materials. In addition we will benchmark progress prior to instituting innovative approaches and compare the new cohort of students to the benchmark group. We will also conduct comparison studies using the learning environment to randomly deliver compelling alternatives to groups of students. We will analyze the rich, embedded products of students and follow the trajectories of a randomly selected and diverse group of students over a several year period. We will also observe and assess the varied instructional techniques used by instructors and identify promising practices. We will test these ideas by encouraging all the participating instructors to try techniques that succeeded in other institutions and to evaluate their effectiveness. We will develop a coherent, tested set of practices that can be used widely.