

Teaching Statement

For the past decade, I developed of algorithm visualization technology for computer science education. In order to make informed choices in the development process, I have studied the literature on educational research and learning theory, and I have conducted empirical studies that explored the viability of various alternative approaches to using the technology as a pedagogical aid. My strong interests in educational technology, educational research, and learning theory reflect an underlying belief in the importance of designing effective educational experiences for computer science students. In my own teaching, this belief translates into a teaching approach with three guiding principles: active learning, consistent feedback, and a willingness to experiment.

Active learning. Above all, my past research into computer science education has taught me the importance of actively engaging students as they learn computer programming and algorithms. In a comprehensive review of past experimental studies of algorithm visualization effectiveness (Hundhausen, Douglas, & Stasko, in press), I found that *active learner involvement* was the single most important contributor to successful learning episodes involving algorithm visualization technology. Students who used algorithm visualizations as part of an active learning process—for example, by making predictions regarding future algorithm operations, constructing their own input data sets, or constructing their own visualizations—consistently outperformed students who merely viewed visualizations passively.

In my own teaching, I have applied this research result by designing courses that stress problem solving and structured exercises, and downplay traditional lectures. For example, in my “Introduction to Computer Science” course (“CS 1”), I have recorded all of the course lectures as streaming videos, which I make available on the web. I tell students that, if they wish to, they may view these lectures at their leisure, preferably in small groups so that they can stop the video frequently to pose and answer questions.

Recording lectures frees up regular class periods for learning activities that get students more actively involved. For example, in a typical week, I dedicate one of the class periods to “concepts,” and the other to “programming.” In the “concepts” class, I pose study questions and problems on the board, and I divide the class into groups in order to discuss the questions and problems. Near the end of the class period, I ask a leader from each group to present the group’s findings. Students finish the class by taking a quiz that covers the concepts that were discussed. In the “programming” class, by contrast, I begin by posing a sample design problem, for which I interactively present an exemplary Java solution. Next, I pose a programming problem related to the one whose solution I just presented. I then strategically break students up into groups of three, attempting to match stronger students with weaker students so as to encourage peer mentoring. Groups have about 45 minutes to write a collaborative paper-and-pencil solution, which they are required to hand in by the end of class. I subsequently comment on and grade their solutions.

Inspired by the instructional model used in architecture, I envision taking “active learning” even further in the standard, junior-level algorithms course. In particular, in my CAREER-funded research, I will develop a *studio-based* algorithms course in which the construction and discussion of visualizations are the central activities of the course. In such a course, students will use algorithm visualization technology to construct their own visual solutions to algorithm design and analysis problems. In a variety of regularly scheduled review sessions, they will present their solutions to instructors and peers for feedback, discussion, and evaluation.

Consistent feedback. A second guiding principle in my teaching is that an educationally effective course requires consistent student and instructor feedback. I strongly believe that instructors ought to seek feedback from students on a regular basis, and that they ought to use that feedback to improve the course immediately—while the feedback can still make a difference in the present semester. Conversely, I believe that students deserve consistent feedback from their instructor with respect to their progress in the course, so that they can make any necessary adjustments that will enable them to get the most out of the course. In my own teaching, this principle manifests itself in two ways. First, I administer anonymous questionnaires regularly throughout the semester. To show students that I am taking their feedback into consideration, I present to them a feedback report that summarizes their responses, and lists specific changes that I will implement in light of those responses. Second, I adopt a “one week turnaround” policy, which stipulates that all coursework will be graded and handed back within a week after it is due. To support this policy, I maintain web-based gradebook that students can log into to access their current scores, current percentage, and current letter grade.

Willingness to experiment. A third guiding principle in my teaching is that educationally effective courses arise out of experimentation, not necessarily out of tradition. In other words, to design a course that is effective, instructors ought not be bound to traditional instructional activities such as lectures and closed-book tests. Rather, instructors ought to enlist their full creativity to devise learning activities that work, and they ought to be willing to continually refine them through regular student feedback. In my own teaching, I have enlisted this principle in my development of completely on-line versions of our department’s “CS 1” and “CS 2” courses. Because of the obvious limitations of the on-line medium, I have had to develop non-traditional learning activities for these courses. For example, for each learning module, I have created an “overview” that previews the module and its essential content, states learning objectives, proposes group learning activities, and poses discussion questions to be discussed on-line. Students are required to discuss these questions, pose their own questions, and to answer others’ questions, in on-line discussion boards; such participation is worth 10 percent of their grade. In addition, I have devised a series of collaborative, problem-based laboratory exercises that can be done outside of a closed laboratory. Finally, to keep these courses on track, I have successfully solicited student feedback through an active on-line discussion forum dedicated solely to that purpose.