Cultivating Intellectual Agency

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Overview

I can teach computer graphics and geometric computing through the graduate level, and I can teach courses involving introductory theoretical computer science and applied mathematics at the undergraduate level. I am interested in the challenges of teaching CS1 to student populations with different goals and backgrounds, and I believe I could effectively teach CS1 courses oriented to artists, scientists, or engineers.

I gained most of my teaching experience working as a teaching assistant. I have lectured and led recitation sections in addition to grading. I reinforced my TA experience by taking a course on academic teaching, and over several years I read a body of research literature on computer science education.

The core of my teaching philosophy is that students learn by spending large amounts of time working intently on tasks relevant to skill development. An instructor can foster that process of sustained, effective study by helping students develop a credible sense of intellectual agency: they can solve the math puzzle, they can make the technique work, they can pick out the crippling glitch, they can modify existing theories, they can reject flawed ideas... The conviction that knowledge is not merely a commodity produced by other people serves as the seed of innovation.

Courses I am prepared to teach

My research background focuses on modeling 2D and 3D shapes, so I would be happy to design and teach graduate courses involving solid modeling, CAD/CAM, and geometric aspects of computer graphics. Provided time to prepare, I would also be comfortable teaching general computer graphics, rendering, physical simulation, and image processing.

At the introductory undergraduate level, I can teach courses focusing on logic and mathematical methods, such as introductory theory, discrete mathematics, or proof technique. Because of my background in digital media, statistics, optimization, and differential equations, I can teach programming courses oriented toward artists, scientists, and engineers. Drawing on my experience as a teaching assistant for Georgia Tech's computer science ethics and professionalism course, I could also teach a course on the social implications of computing.

Teaching experience

In my sophomore and junior years at Brown, I served as the head TA for a combined graduate and undergraduate course on theoretical computer science. At Georgia Tech, I served as a teaching assistant in the following courses:

- Introduction to Educational Technology, Fall 2001
- Computers and Society, Spring 2001
- Computing for Engineers, Summer 2004
- Computers and Society, Summer 2006
- 3D Complexity, Spring 2008
- Computers and Society, Spring 2010

I jointly led recitation sections for Computing for Engineers, and I designed and delivered lectures for 3D Complexity (a graduate level course taught by my advisor) and Computers and Society. I completed a three-hour course on academic teaching offered by the College of Computing, which addressed topics such as lecturing technique, instructor ethics, and course policy design. I also independently studied research literature on education by reading papers distributed through the College's Learning Sciences and Technologies mailing list over a period of several years.

Engaging students in the classroom

As both a student and an instructor, I have learned that it is easy for classroom discussions to assume the following form:

> INSTRUCTOR: *Is* $|y|^{\frac{4}{3}}$ *smooth?*
> CLASS: *...[awkward silence]...*
> INSTRUCTOR: *Susie, what do you think?*
> SUSIE: *Um... yes?*
> INSTRUCTOR: *No. Its derivative is continuous, but it is not smooth. What about* $\sin\frac{1}{x}$*...*

There are excellent reasons to avoid this kind of exchange:

1. The answer to the instructor's question may not be obvious, but he provides his students little time to think it through.
2. The precise meaning of "smooth" may be unclear, given that it has multiple technical meanings as well as intuitive meanings from everyday English.
3. When Susie guesses the wrong answer, the instructor immediately provides the correct answer and moves on to the next problem with minimal explanation.

The instructor does his own example a disservice by failing to communicate its significance to his students.

Because the world provides us with innumerable technical problems, a professor's role is not to teach answers as much as it is to demonstrate methods suitable for finding answers. Many of these methods may be domain-specific, but good teaching also promotes general-purpose intellectual strength and flexibility.

In practice, this means taking the time to talk through problems in class. It means working with unorthodox approaches students propose; giving students time to reflect on what they are proposing before explaining why they are wrong; and allowing students to think out loud, with a shared understanding that people make mistakes when they think out loud. It also means managing the discussion's pace and intervening when it becomes stuck or unproductive.

In talking through problems, students reveal which aspects of the course attract their attention. Discussion also generates loose ends that offer opportunities for follow-up. While respecting the advantages of a stable syllabus, I favor reshaping the course throughout the semester in response to students' participation. This expresses to students that they are part of the course, and not simply pushed through it.

Developing expertise through assignments

Assignments offer students the chance to test and expand their disciplinary understanding by working for longer periods of time and with greater concentration than is possible in class. The best way for an instructor to ensure that students invest time and energy into assignments is to ensure that assignment completion produces something students value. Ideally, this value extends beyond getting a grade or obtaining a degree. Instead, assignments should reflect what we value in research: utility, beauty, efficiency, simplicity, economic impact, technical impact, and so on.

Students benefit if the value of their work is easy to communicate. Projects in computer graphics and geometric computing naturally produce media: interactive graphics, sound, images, and even 3D physical objects. Because anyone can experience these end products, they are suitable for impressing roommates, grandparents, and prospective employers. This provides students with an incentive to perfect their work beyond what the course requires. It also broadens the scope of evaluation to include the quality of the work as perceived by the student's social world.

"Official" feedback - grades and written comments from professors and TAs - should consistently remind students of the context of their academic work. Ideally, students pursue an education so that they can expand their abilities and learn to make valuable things. These are long-term goals. While projects and courses quickly reach closure, feedback needs to look to the future: *If you were to seriously pursue this project, what would the result look like? If you really want to understand differential equations, here's what you need to do...*

Cultivating intellectual agency

A technically competent person who is not taking pains to be clear can confuse almost anyone with unambiguously correct propositions. Unfortunately, this can lead students to conclude that knowledge is made by other people - people unlike them, who even speak a different language. Our job as computer science educators is to convince them that this is not the case. We teach them the initial pathways to expertise, and prepare them to continue as far they care to go.