Teaching and Outreach Statement

Education goes beyond the classroom, and my teaching philosophy builds on my own research, education, and teaching experience. Completing an undergraduate Capstone research project with my favorite professor, and later working in a first-rate interdisciplinary research group inspired me to go to graduate school, and later on to academia. In addition to the five teaching awards I have received at Pitt, I chose to experiment with my teaching and learn from the results; thus I am exploring, in a formal setting, student participation in the classroom. Last and first, had my father not pointed out, many years ago, the outstanding social impact of computing, I might not have gone to computer science at all. My approach to education integrates these experiences in four components: cross-disciplinary curriculum development providing opportunities for research; innovation in increasing student participation in the classroom; a cross-campus modeling and visualization research group (described in my Research Statement); and an intervention program to help increase diversity in computer science.

Cross-Disciplinary Curriculum Development

Computer Science (CS) education poses manifold challenges — from a misperception of the social impact of the field and its reduced practitioner diversity (ethnic, gender and otherwise), to evolving technologies and to its advanced heritage of math and engineering concepts. To overcome some of these challenges, the courses I designed or re-designed at Pitt emphasize community-service projects, teamwork, oral communication and hands-on experimentation. The courses address a sometimes-bimodal student distribution with ample extra-credit opportunities as well as peer-based undergraduate assistant help-hours (courtesy of my Visualization Research Lab), carefully crafted support code, and whiteboard proofs. Although each course covers different topics, they also offer opportunities for student research.

At Pitt, I have prototyped a new graduate course titled *Interdisciplinary Modeling and Visualization* (**2008** and **2009 CS Teaching Awards**), open to CS students and to students from other disciplines who are interested in collaborating with computer scientists. The course discusses computer graphics, modeling and visualization techniques used to solve scientific problems; occasionally the class includes gifted undergraduates. To give seniors a better chance at competing on the gaming and graphics job market, over the past five years I have gradually updated the Pitt *Introduction to Computer Graphics* undergraduate course, a nuts-and-bolts programming course featuring linear algebra and intensive computation. The course emphasizes modeling and simulation concepts; alumni place now in top gaming companies such as Sony Playstation. The results from this course are so unusually compelling, I was invited to talk about it at **ACM SIGGRAPH 2009**.

Investigating the alarming rate of solo final projects in the graphics course revealed a Pitt CS curriculum gap: most senior students lacked the skills necessary for teamwork (including scheduling and communication), as well as basic project management skills such as revision control or bug tracking. To help address this gap, in 2009 I designed and proposed, with the support of the CS Department, a new undergraduate course, *Software System Design and Management*. The course emphasizes large-project teamwork and oral communication, i.e. "soft" skills to help make Pitt CS graduates more competitive in the global marketplace and less susceptible to off-shoring. The proposal received a **2009 Pitt Provost's Innovation in Education Award**; followed by a **2010 CS Teaching Award** (top 4% in the School of Arts and Sciences) when I taught the course. Finally, to better prepare graduating seniors for the gaming industry challenges, I helped establish a Gaming concentration track in the CS Department. Most recently, I redesigned the *Principles of Videogame Design* (**2011 CS Teaching Award**) undergraduate course to emphasize the multi-disciplinary and teamwork nature of the game design process — which features collaboration among computer scientists, studio artists, and creative writers.

Innovation in Increasing Student Participation

In the immortal words of Confucius, *"I hear and I forget; I see and I remember; I do and I understand"*. Over the years I have come to understand that in learning, *"do"* can cover significant territory. In my graduate course I routinely ask the students to team up in small interdisciplinary groups, propose a scientific problem, negotiate,

implement, and evaluate a solution, then present — elevator-speech style — their work to the class. Final project proposals are peer-reviewed; the highest scoring proposals are "funded" and implemented, under cross-disciplinary supervision, as final projects. The project results are presented in public demonstrations. Unerringly, the graduate students *do* more, *understand* more, *create* more, and *have more fun* in the process than in a typical lecture-assignment setting.

Following this initial observation, I enrolled in the outstanding **Speaking Across the Disciplines** semester-long faculty seminar at Pitt; and then set out to consistently explore increasing student participation across the courses I teach. My courses now incorporate student short presentations, elevator pitches to bid for final projects and project partners, humorous yet technical skits [1] as a late-policy penalty, and peer-feedback — for presentations as well as teamwork. To guide the presenters, I provide rubrics for oral presentations, and have the class state compliments and points-for-improvement for each speaker. Through a successful collaboration with the Pitt Writing Center and the Oral Communication Lab (initiated in 2009; funded through my NSF CAREER and Innovation in Education Awards), I also have the students practice their presentations with an undergraduate Public Speech coach.

Not everyone participates in class in the same way. Remarkably bright students are sometimes too shy to speak; however, they will write. Wiki-style contributions, public praise for creative assignment solutions and insightful comments, and sometimes-explicit negotiation and feedback training further empower shy students. Students who see themselves as average or "impostors" [2] need encouragement, too. I believe that feedback and carefully designed challenges help build self-confidence; in turn, self-confidence improves performance [3]. For example, telling students they have solved, unknowingly, an ACM International Programming Competition problem as part of a well-timed in-class exercise (when, based on their reaction of disbelief, no doubt they would not have even attempted the problem had they known its source), works nothing short of magic on the class average final-exam performance.

To steer the courses, I use midterm and end-of-term questionnaires. The midterm questionnaire allows me to respond to concerns immediately and correct the course of the class if need be; this is particularly important given the diversity of backgrounds and interests in some of my classes. In addition to the course evaluations and questionnaires, the quality of final projects, demonstrated in public presentations, the improvements in student performance and retention, the number of students to join my research group, and job placement are also indicators of the course success (or of a particular experiment). Certainly, tapping into unsuspected pools of student creativity holds its own rewards.

Diversity Outreach

I have founded and am currently the faculty coordinator of the Pitt Women in Computer Science (WiCS) organization, whose primary goal is to increase the Pitt CS female undergraduate enrollment and retention. In 2007 the Pitt CS undergraduate female to male ratio was a worrisome 7%, compared to the University-wide 60%; and featured a defunct female-student club, despite departmental support. Over the next four years, I have recruited and trained three sets of WiCS student officers; to ensure continuity, each set features three active officers each year, yearly elections, and faculty coordination. Working as a team, we organize bi-monthly social and tech events [4], some including mentors from industry and academia, and some outreach, and we liaison with other women-interest groups.

In many ways WiCS works as a support group, through bonding and tailored interventions such as one-on-one mentoring, group meetings, goodwill outreach presentations, and site visits. WiCS and my research lab actively collaborate with K-12 organizations such as Gwen's Girls [5], talking to girls from at-risk neighborhoods about opportunities in computer science; as well as with the Pitt CS Technology Leadership Initiative [6], a program to provide under-represented and under-served diversity high school students with the opportunities, tools and motivation needed to pursue CS-related degrees. Our experience is that CS projects with clear, real-world applications help attract diversity students.

WiCS is thriving — membership has more than doubled over the past four years — and is currently attracting corporate sponsorship (Oracle and Northrop Grumman). I hope this growing set of outreach initiatives will deepen our understanding of diversity recruiting in computer science.

References:

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[4] Pitt Women in Computer Science, http://www.cs.pitt.edu/wics

[5] Gwen's Girls, http://www.gwensgirls.org

[6] Pitt CS Technology Leadership Initiative, http://www.cs.pitt.edu/tli