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Teaching Statement

Shashi Shekhar

My teaching philosophy has been shaped by memorable experiences with my own teachers in school and college. I fondly remember my Geometry teacher, Mr. Mangal Dev Pandey, who engaged us with fascinating stories complementing the textbook. He started with the advent of land surveying in ancient Egypt to track property boundaries across the Nile flood plain. Soon, Greek tales (e.g., Thales' prediction of solar eclipse, Archimedes' "Do not disturb my circles" tragedy) held our attention through discussion of theorems in the textbook (Euclid's *Elements).*

During college, I came across the "drinking from the fire hose" style of instruction but the teachers I remember most were different. At Berkeley, Prof. Richard Karp, whose *NP-completeness* notion transformed theoretical Computer Science and won a Turing award, was my major field advisor. His graduate classes were very popular as he could lucidly explain core ideas from terse publications. In addition, Prof. C. V. Ramamoorthy (my thesis advisor) used frequent colloquiums and student presentations to generate and evaluate bold new ideas, which could be developed into scholarly publications. He encouraged us to engage in current debates in our research area and explore new territory. I fondly remember his warning that it is hard to see far on a crowded beach. He truly believed in Einstein's proposition that "It is the supreme art of the teacher to awaken joy in creative expression and knowledge." He also instilled that belief in me.

At Minnesota, I have regularly engaged all my students in research and creativity, whether they belong to my research group or not. I routinely share current debates in our field and encourage students to choose projects with a potential to not only innovate but also to transform the thinking in our field. Even my undergraduate courses try to take students through steps of the literature survey, gap analysis, choice of novel hypotheses, and use of scientific methods to evaluate the chosen hypotheses. Students periodically present their preliminary results and engage in debate and communication via a peer review process. As the semester progresses, many students begin to appreciate ideas that had eluded them previously. Some students discover something genuinely new and experience the joy of discovery. They are permanently changed and evolve intellectually. This is the most rewarding part of engaging students in research for me. As a side effect, many course projects in my courses have resulted in

peer-reviewed (and highly cited) publications. In addition, almost all of my graduate advisees have co-authored and published research papers in selective peer-reviewed forums with me.

Mentoring the graduate and professional students is a responsibility I take quite seriously. Besides engaging them in research, I ask students to think about career preferences early in their degree programs and engage in activities towards becoming competitive in the job market at graduation. For example, my students interested in an academic career enroll in the *preparing future faculty* program and serve as teaching assistants. Students interested in industrial careers intern in companies during summer. Students interested in government careers spend summers at a government laboratory. They all investigate hard and societally important problems. Many apply for and receive competitive grants (e.g., Doctoral Dissertation Fellowship, Interdisciplinary Dissertation Fellowship). Most importantly, they engage in professional service and leadership. I am very proud to see all of my advisees (almost 75 now) succeed in the job market, and many of them rise to leadership positions in academia, industry, government and professional societies.

Even in ordinary classroom instruction, I like working closely with students while investigating creative new (and sometimes controversial) ideas from current pedagogical debates. It started with my selection to participate in the University's "Excellence in Teaching" program (1992-93) sponsored by the Bush Foundation. My mentor, Prof. Karl Smith (now an Emeritus Professor in Civil Eng.), introduced me to the radical idea of active learning to overcome student dis-engagement and boredom during long lectures. Soon, my lectures featured the think-pair-share exercises, where each student thinks about a short question for a minute, then discusses it with a peer for two minutes, and finally publishes it on whiteboard for a 3-minute class discussion. I tried it in my courses and students liked it. They said that the 6-minute *active group learning* exercises broke the monotony of long lectures, engaged them, and improved the social environment of classes.

In recent years, my son has opened my eyes to the world of Gen-Y and their love of social media (e.g., YouTube, interactive games). I wondered about the adequacy of my instruction methods for Gen-Y students, thinking about the warning from John Dewey: "If we teach today's students as we taught yesterday's, we rob them of tomorrow." Do we need to consider social media for teaching Gen-Y students? Some are investigating the idea of "flipped classroom" in Massive Open Online Courses (MOOCs). It appears to be an extreme form of

active learning, where class-time is devoted to discussions and problem solving after students have first completed a homework assignment to view pre- recorded video-lectures chunked into short (e.g., 10 minute) segments with in-video review quizzes. Fortunately, our MOOC proposal (with mentee Prof. Brent Hecht) was selected by the Provost's office in 2013. We co-developed and co-taught a MOOC on spatial computing and used the material for experimenting with a flipped classroom in an on-campus course in Fall 2014. Initial student feedback was encouraging, and we are waiting for more comprehensive evaluations.

Joy in creative expression has also fueled my interest in program development., I worked closely with Prof. R. McMaster to design a Masters in Geographic Information Science (MGIS) degree for professional students, who want marketable knowledge and skills in this emerging area. At the time there was a serious lack of pedagogical material because the area of spatial databases and spatial data mining were so new. I shared the opportunity with my students, who were very supportive. We co-developed a survey paper (1999), a textbook (2003) and an encyclopedia (2008) over a decade. Early drafts were used in multiple offerings of my courses so they could be refined with student feedback. These publications have since become primary teaching materials in GIS programs not just at Minnesota but worldwide via translations (e.g., Chinese, Russian) and foreign editions (e.g., India).

I also had the honor of leading an exciting new Interdisciplinary Graduate Education, Research and Training program sponsored by the National Science Foundation. With Prof. C. Neuhauser, we established a new interdisciplinary Ph.D. program for studying quantitative spatio-temporal issues across Ecology, Engineering and Computer Science in collaboration with two dozen faculty members across multiple colleges. We co-designed a course to sensitize each discipline about the research questions and values in other disciplines. For example, I developed lectures explaining the difference between Computer Programming and Computer Science using analogies of the difference between Land Surveying and Geometry (Thank You, Mr. Pandey!). We also coached students on interdisciplinary skills, e.g., using "continued conversations" to identify problems that can advance multiple fields.

This has been a joyful journey over the last 25 years. I have learned a lot from my teachers, my colleagues as well as my students and I am looking forward to future opportunities to improve graduate and professional education.