It was seven in the morning, and I was biking to campus when it started to rain.

That summer, I oversaw the academic content of the Young Scholars Program—a math camp for highly talented high school students—and, on that rainy morning, I was on my way there to teach. As I continued to bike, I reflected on the format the number theory instructor had chosen the day before, and I mulled over how I would introduce complexity theory the following week. The rain picked up, and I considered how the students should be grouped and how to best encourage my teaching assistants. I was soon drenched and covered in wet gravel coming up off the road, yet I realized that in that moment, there was nothing I would rather be doing than going in to teach.

George Pólya gave the lovely description, “a mathematics teacher is a midwife to ideas,” which I feel is an apt metaphor for the constructivist teaching approach I have adopted. In particular, I believe in a teaching style that firmly gives students ownership of their learning through active engagement, well-crafted questions, and committed mentorship.

For me, teaching is a highly student-centered process built around dialogue and student-driven exploration. My class sessions typically consist of me acting as facilitator while students either work together in small groups or present their ideas to the class. For example, to introduce Google’s PageRank algorithm at the Young Scholars Program, I gave the students seven or eight hundred beans and showed them how to use these to model internet traffic in a network I drew on the board. The class was split into groups, which each performed the simulation. Students recorded each group’s final bean distribution on the chalkboard, and we briefly discussed general findings as a class. I then put the students back into groups to pursue any questions that came to mind, and within ten minutes, most students had independently discovered the notion of a limiting distribution and also figured out how to compute it.

When I teach, I strive to engage with my students’ natural curiosity. In office hours, students play with brightly colored mathematical oddities from my desk, and in class, they regularly vote on what to discuss next. To explore divergent series, my calculus students balanced stacks of dominoes on the edge of their desks and were amazed to see how far they could push them. My probability students passionately debated the Monty Hall problem and made projects that answered “throughout all of human history, have there ever been two shuffled decks of cards that happen to be in the same order?” And my liberal arts students spent days tying knots, coloring maps, doodling compass constructions, creating puzzles, drawing friendship graphs, arranging toothpicks into fractals, cutting Möbius strips, and playing nim tournaments.

In a teaching approach such as mine, asking well-crafted questions is crucial. Although generic questions—such as “well, what do you think?” or “what would that mean?”—are often effective in getting a student to reason through an idea, posing questions for assessments or initiating discussion requires careful planning. One template I particularly like is the following.

Alice thinks $X$, but Bob thinks $Y$. Who's right and why? What's wrong with either argument?

What I like best about this format is that it lets me directly address rather nuanced aspects of student understanding. In the language of Bloom’s taxonomy, questions like this bring students
beyond the superficial modes of comprehension (e.g., memory and application) to the deeper processes of analysis, evaluation, and creation. Moreover, I find the phrasing “who is right” particularly effective in helping students develop intuition and reflect on their conceptual understanding. For the same reason, if a student is unable to articulate some argument, I like to use a tactic of feigning to disagree. This has the effect of immediately eliciting an animated reaction, and frequently the student is readily able to argue exactly why I’m wrong.

I believe that providing personalized instruction and committed mentorship is an essential part of the education process. By the second day of class, I typically know each student’s name, major, and career aspirations, and throughout the course I use this to craft individualized questions and examples. Outside of class, I typically offer six to ten office hours a week, and these are consistently well attended by both current and former students. Beyond the experiences in traditional courses, I have also mentored students in various formal research projects and in directed reading programs. Because my area of specialization—probabilistic combinatorics—lends itself so well to undergraduate study, these student projects are often closely related to my own work, and I look forward to mentoring more undergraduate researchers in this field.

Of all the classes I’ve had the opportunity to teach, I am most grateful for the new course I developed—*Math as a Creative Art*—which was an honors class for liberal arts majors. The title alludes to a 1973 public lecture by Paul Halmos, in which he addresses the problem that “educated people don’t even know that my subject exists.” In this spirit, I decided to create a course where liberal arts majors could get a taste of—and ideally appreciation for—proof-based mathematics. I wanted a forum where non-mathematicians would encounter deep mathematical ideas, and I wanted a socially-conscious curriculum where students of all backgrounds would discuss not only Euclid and Cantor, but also Turing, Germain, and Ramanujan.

The implementation of the course was better than I could have hoped for. Students reacted positively to the format, and the discourse was rich and vibrant. The weekly reflections and final projects encouraged students to explore their own mathematical ideas, and in fact two of my students—both humanities majors—were each able to publish the mathematical results they had discovered in class. I later presented reflections on this course at MathFest 2016.

I’ve had a lot of varied teaching experience, and I’ve loved all of it. I’ve been an instructor for numerous classes, and I developed and taught an entirely new course at my university. I’ve presented my pedagogy and combinatorics research at national conferences, and I’ve helped my students get published. I’ve led research programs for high school students and independent study courses for undergraduates. I’ve volunteered to teach first-generation college students aspiring for graduate school and to tutor low-income middle school students struggling to pass seventh grade. Whether it’s facilitating a class discussion on Hilbert’s hotel, mentoring a student in office hours, or simply engaging the business major sitting in the back of the class, I find something profoundly and uniquely gratifying about this wonderful way to live.

Remark: Much more information is available on my website including syllabi, exams, student evaluations, and detailed slides for my MathFest 2016 presentation on Math as a Creative Art.

www.math.rutgers.edu/~prd41