# *Teaching Statement*

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I heard it from across the MIT lobby in which we held office hours: "S&%t. That's beautiful. Wow... f$#k!" Ten minutes ago, this student was stuck on a problem on probability generating functions. I had encouraged her to talk with a classmate who appeared to be on the right track. She'd gotten it, and had shared the thrill of discovery with twenty rather taken-aback classmates, graduate students, and postdocs in the lobby. Her voice sticks with me, a vivid reminder of the joys of problem-solving. Math offers us a language, and with it a power to understand and control. Find the right words, feel the power, and you might just find yourself spouting profanities in a public lobby.

The guiding question of my teaching is: *how can I make the experience of discovery and empowerment accessible to* all *students?* I ground my answers to this question in actively inclusive teaching practices and evidence-based assessment of their effectiveness. These answers are the foundation of two quarter-long (ten-week) courses in computing and data science that I designed last year at UCLA. Each course meets students at very different stages of their learning journeys. I'd like to reflect here on how I implemented these courses, how I assessed their success, and what I'll carry forward into my future teaching.

## ENCOURAGING GROWTH.

PIC16A is an introductory course on computing and data science in the Python programming language. This course meets students in a fragile place. In my first entrance survey, many students—and disproportionately female students—felt frustrated and discouraged by the prerequisite course. One student, whom I'll mention again and call Valerie, entered my classroom feeling that "*there's a lot that I don't understand, but I cannot figure out what to ask or where to begin*." She wasn't alone. I posed myself a mandate: PIC16A would nurture students feeling beaten down by previous computing experiences, and it would narrow gender disparities in motivation and interest. I pursued this mandate through three primary interventions.

**Intervention I: Active Learning and Student Agency.** Active learning—as opposed to traditional lecture-based formats—is known to improve student performance and narrow achievement gaps [1, 2]. To make time for active learning, I required students to attend small-group Discussion activities and released them from the obligation to attend scheduled lectures. I offered them short prerecorded videos from which to glean key concepts, combined with small quizzes to ensure they didn't fall behind. This allowed me to center active group work as the fundamental core of the course. All students, including students in non-US timezones, could access the material in exactly the same way on a schedule that worked for them. I encouraged students who wanted extra support to attend the now-optional scheduled lecture periods. I used these periods to help students work through examples, review challenges from recent quizzes, and present optional background content.

**Intervention II: Nurturing a Growth Mindset.** Many of my students entered the course with a fixed mindset: "some people are good at programming, and I'm not one of them." I wanted to nurture a growth mindset [3]: "I can learn, improve, and achieve things I'm proud of." I designed almost all assignments as scaffolded mini-projects, with a satisfying product or insight waiting for the student upon completion. Many students were surprised at how quickly they could grapple with complex, relevant problems:

- By the end of Week 3, students had programmed a simple Markov language model and related it to popular autocomplete features in modern technology.
- By the end of Week 7, they had implemented logistic regression from scratch.
- By the end of the course, they had worked with a group to complete a complex machine learning project, including exploratory analysis, feature-selection, modeling, and critical discussion.

Reflecting on her experience, one student wrote:

> *My confidence has skyrocketed since taking this class. Coming from a low income community I felt extremely behind in the STEM field when I entered UCLA, and thought that any career with coding would just be a pipedream. Once I finished. . . my project it made me realize that I could actually do these things, and if I work hard and continue with my coding I could do it for a living.*

**Intervention III: Learning Micro-Communities.** Being a student can be an lonely experience in the best of times, and the COVID-19 pandemic has only exacerbated isolation. To promote both peer learning and student mental health, I instituted small, persistent groups in which students work on both in-class and out-of-class assignments. These groups acted as miniature learning communities [4], forming a fundamental part of both the educational value and social fabric of the course. One student wrote:

> *The best thing about [the class] is my group! Discussion sections are one of the highlights of my week! We also have scheduled a time every Sunday where we work together on the homework. It's so refreshing to have contact with new people in these crazy circumstances.*

In other times, I would aim for the entire class to act as a single, cohesive, learning community. In the reality of remote learning, the formation of effective and supportive micro-communities is one of the process outcomes of which I am most proud.

**Evaluation: Narrowing the Gap.** In Winter '21, encouraged by qualitative student feedback and inspired by a recent course I'd taken on evidence-based pedagogy, I designed a simple evaluation of the course's effectiveness in increasing student confidence and narrowing the gender gap. At the beginning and end of the term, I asked my students to rate their agreement with a series of propositions related to interest and confidence in programming. I found improvements along most questions, with greater improvements for female students. For example:

- "If I wanted to, I could have a career that involved machine learning or data science."
  70% $\mapsto$ 87% agreement among women, 82% $\mapsto$ 88% among men.
- "I can often understand what task a program achieves by reading the code."
  55% $\mapsto$ 90% agreement among women, 71% $\mapsto$ 94% among men.
- "I feel comfortable explaining my thought process to others."
  57% $\mapsto$ 94% agreement among women, 85% $\mapsto$ 100% among men.

On the basis of these and other outcomes, my course model has been widely adopted by instructors of PIC16A. The model reached over 400 students across six sections in academic year '20–'21, and will reach over 500 more across eight sections in '21–'22.

## The Next Step

PIC16B, the next course I designed, is an advanced survey of computational and data science in Python. As such, PIC16B meets students at a very different moment in their learning journey. These students have already taken PIC16A. They are confident, fluent in basic concepts, and eager to explore complex projects and potential careers. For these reasons, I felt that the highly structured design from PIC16A would not be appropriate. Instead, I built the course around a long-term project. Activities helped students pitch ideas, meet like-minded classmates, and organize group project proposals by the end of Week 3. Regular check-ins helped groups move at a consistent pace. I asked groups to write about the tools they were teaching themselves along the way. I planned lectures around project interests, focusing on topics that I knew would be especially challenging for students to navigate without guidance. At the end of the quarter, I was deeply struck by the ambition and quality of the projects that my students produced. One group had built a machine-learning model to classify images of dogs by breed. A second had created an interactive opinion-dynamics visualization. A third had scraped a complete data set from a state criminal court system. One member of this group will collaborate with me in Fall quarter on research to analyze the data for racial disparities. One student wrote from PIC16B wrote:

> *I learned so much from this quarter... The project is difficult but I'm really surprised that we were able to accomplish what we have. It's a unique experience.*

Another felt simply that *"this was the course in which I 'grew up.'"* One student's growth particularly impressed me. At the end of PIC16B, Valerie—who entered PIC16A feeling lost and unsure how to get help—told me that she would begin a job in natural-language processing after her graduation.

## Teaching Outlook

The day I stop growing as a teacher will be the right day for me to retire. I am always looking for ways to improve myself and offerings. My plans for the coming year include greater emphasis on algorithmic bias in PIC16A and a move to specifications grading [5] in PIC16B. I am a member of the MAA Project NExT Gold '21 cohort, and I'll be bringing what I've learned from my peers and mentors into my classroom.

While aspects of my current teaching practice reflect my portfolio of Python computing courses, I believe that the same principles—active learning, growth mindsets, learning communities, equity focus, and independence at the right time—are also fundamental to inclusive, effective pedagogy in computer science more broadly. I plan to grow as a teacher-scholar across the computer science curriculum.

I am able to teach a range of courses in programming, theory, data science, and machine learning. I look forward to continuing my journey as an inclusive teacher of data science and quantitative problem-solving. Along the way, perhaps I'll hear another student swearing in the lobby, and smile.

## References

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