Teaching Statement

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My teaching philosophy, shaped by my own experiences, pedagogical research, and best practices, is grounded in three key principles: **providing diverse learning modalities**, **supporting student growth through controlled challenges**, and **teaching students how to learn**. In the following sections, I describe how these three principles shape my teaching approach, then I will discuss my mentorship approach.

My Teaching Approach

Providing Diverse Learning Modalities

I believe that implementing multiple representation modes promotes learning by providing different conceptual entry points for students. Research demonstrates that employing multiple instruction modes, e.g., visual, kinesthetic, and discussion-based, can lead to improved student achievement, persistence, and motivation [1]. Active learning activities in particular have been demonstrated to reduce failure rates by 33% compared to traditional lectures [2]. To accommodate different learning styles, ***I will prioritize the use of multiple learning modalities, including active learning activities, in my lectures***. For example, when introducing synchronization mechanisms, students will complete think-pair-share activities: individually tracing execution paths to identify critical sections, comparing synchronization points with partners, then presenting alternative strategies (mutex, semaphore, monitor) to the class.

This priority is influenced by my experiences as a teaching assistant (TA). My formal pedagogical training began with the course 15-890 Computer Science Pedagogy taught by Michael Hilton and Françeska Xhakaj, where I learned evidence-based teaching methodologies. I was so inspired by what I learned that I then TAed the course. Serving as an infrastructure TA, my role was to organize and compile the course materials on a website so instructors at other universities could access and use the materials [3]. These responsibilities included attending classes and taking detailed notes to create weekly lesson plans, a process that I found extremely beneficial for helping me reflect on my own teaching strategies and philosophy– it also provided a unique opportunity to learn how to teach people how to teach.

This foundation prepared me for TAing 17-313 Foundations of Software Engineering taught by Michael Hilton and Andrew Begel with an enrollment of 100+ students. I selected this course to gain experience teaching large-scale software engineering and to continue learning from Michael's pedagogical expertise. I prepared and delivered recitations, extended and updated supplementary materials for several assignments, and hosted weekly office hours. The course employed diverse learning modalities, e.g., pair programming, lectures, and group discussions, demonstrating how varied instructional methods maximize student engagement in large classes. ***This experience reinforced my commitment to multi-modal instruction***.

Growth Through Controlled Challenges

Educational research establishes that psychological safety, i.e., the belief that one can take risks without judgment, is essential for learning, leading to increased engagement and improved outcomes [4]. ***When students feel psychologically safe, they're able to engage with controlled challenges that support deep learning***. Combined with structured scaffolding that provides graduated support, students can tackle increasingly complex challenges while maintaining confidence [5].

To encourage intellectual risk-taking, I create environments with clear evaluation expectations and prompt feedback. I normalize mistakes as integral to the learning process by recalling when and how I learned a specific topic and the challenges I faced when engaging with students facing challenges, additionally demonstrating that the state of 'not knowing' is a normal part of scientific learning and discovery. For example, when students come to me frustrated with segmentation faults, I share my own debugging stories and emphasize that even experienced developers spend hours tracking down similar issues.

Addressing the Impact of Generative AI on Student Growth and Challenges

Generative AI (GenAI) has had a profound impact on software engineering as an industry and academic pursuit. Traditionally, ***students grow through controlled challenges, but GenAI is rapidly changing what is a challenge for students in learning environments***. For example, an exercise on implementing the quick sort algorithm that once required algorithmic thinking no longer does if students choose to use GenAI tools to solve it. Because of this, many students are not being challenged, so they are not growing.

This is a significant challenge for us as educators and something we need to recon with as a field. While I cannot pretend I have a solution mapped out yet, ***I believe in order to address this challenge we as educators must reflect on our approach to assignment and assessment design.*** By returning to core learning objectives and asking ourselves what students truly need to learn, we can identify the core competencies students need and redesign course materials that authentically measure deep understanding, critical thinking, and learning objectives rather than outputs that can be easily generated.

Teaching Students How to Learn

I believe one of the most important things an educator can teach students is how to learn. To become self-directed learners, students must develop metacognitive strategies including the ability to monitor and adjust their learning approaches [5], processes that most students do not naturally engage in [6].

I myself had a cannon experience in an Introduction to Artificial Inteligence course where I learned how to learn. When I struggled with Q-learning implementation and was convinced that I was doomed to fail the course, Professor Doucette demonstrated how to decompose complex topics into manageable components. Through multiple office hour sessions, he taught me how to learn challenging topics through systematic decomposition, a transferable metacognitive learning strategy that I have fallen back on countless times.

As an instructor, ***I will incorporate strategies for developing such metacognitive skills into my courses and 1:1 student interactions***, e.g., through the use of early performance-based assessments that provide students with sufficient practice and feedback, as well as through the use of demonstrations of how to decompose complex concepts into manageable tasks.

As an example of how I've done so in the past, in 17-313 office hours, I modeled metacognitive strategies when debugging with students. I would verbalize my problem-solving process: 'First, I'm examining the stack trace to identify where the crash occurred. Now I'm forming a hypothesis about why this pointer might be null. Let me test this assumption by...' ***This think-aloud approach helps students internalize systematic problem-solving approaches.*** I also ask them to articulate their debugging strategy before diving into code, reinforcing deliberate practice over indiscriminate trial-and-error.

My Mentorship Approach

I have had the privilege of serving as primary PhD mentor to 12 undergraduates, resulting in seven peer-reviewed publications including one that received first place at the ICSE'22 Student Research Competition. The majority of the students I have mentored have been through my departments' Research Experience for Undergraduates program (REUSE) which provides transformational opportunities to students who would not otherwise have the opportunity to engage in academic research experiences. Because I believe a good testimonial is priceless, I have interwoven messages I have received from former mentees into this section where relevant to add color and the additional perspective of student voices.

As a mentor, I believe that it is my responsibility to **help students accomplish their goals**, and as someone who has recently had to do a lot of soul searching to figure out what my own long-term goals are, I know that figuring out what you want to do is not always easy. I aim to help my students not only come up with ambitious long-term goals that align with their passions, but ***help them break down those goals into actionable steps*** and support them through each one.

Each student I have worked with has had different goals, background, and skill sets that I have worked and support and foster. Some students come in with a research background and a clear goal to publish, others have never done academic research before (which was the same position I was in when I was a REUSE student in 2018). As a mentor ***I prioritize meeting students where they are at, and supporting their individual growth and development***, whether that means teaching them how to read academic papers

or demonstrating advanced statistical modeling techniques. One student shared, *"coming out of my first year of college, I had very little idea how to read papers, identify key ideas, or structure a project, but she broke down the process in a way that was clear and approachable. A specific memory that stands out is how she walked me through reading research papers effectively—teaching me how to critically evaluate methods and results instead of getting lost in the details.…The supportive and collaborative environment she created made research feel exciting and accessible, and her mentorship has been a major influence in my decision to pursue a Ph.D."*

While I adjust my mentorship approach based on the needs of each student, I always follow the same fundamental principle: be an active, engaged, and accessible mentor. When working with new students, I schedule frequent check-ins (reducing the frequency if that aligns with what the students need). I also have a literal open door policy– my office door remains open at all times (unless I am in a meeting), and I have a candy jar strategically placed on a bookshelf right by my door to encourage drop ins. I also have a very cute senior toy poodle named Chanel, who I bring into the office on quiet days– she is also a great way to encourage students to stop by! One student shared how this active engagement and accessibility impacted their experience: *"As soon as I arrived, she focused on making me feel both welcomed into the space and comfortable with asking any questions related to my research focus and general Ph.D. student life. I especially appreciated how she was able to meet me where I was in my undergraduate journey, always breaking concepts down to an understandable level and walking me through processes step by step. This attitude helped me to feel more confident in my skills over the course of the program, and I left with a solid idea of what my place in academia could look like."*

As a mentor, I also believe that **one of the most important things you can give your students is a sense of belonging**, which can help increase effort and decrease negative distracting thoughts [7]. One way I have worked to build a sense of belonging is by advocating for my students' desk assignments to be as close to mine as possible. In my experience, it is a great way to make students feel more comfortable reaching out with questions and also enables me to provide better, more timely, individualized support.

For example, in summer of 2021, there were three open desks in my office, which all three of my students opted to work at. They enjoyed it so much that they told other students about it, and soon I had a fourth student taking up residence at the round table in my office (which was the only flat surface left)– it really warmed my heart to create a space where students feel welcome and comfortable and that is something I take pride in to this day. Furthermore, supporting a welcoming environment fostered effective research collaborations that paid off: All three projects were successful and led to peer-reviewed publications. This accessibility makes a tangible difference as one mentee reflected, *"Courtney was kind enough to share her office with me for 10 weeks, a proximity that allowed me to frequently bounce ideas and questions off of her. She was extremely patient and knowledgeable, and she was quick to refer me to other experts or sources if she didn't know the answer."*

Another strategy I employ to support a sense of belonging is being candid about my own challenges when students share their own, normalizing not only the experience of such challenges but also modeling strategies for persistence and resilience. For example, one student who was new to research expressed frustration with the difficulty she was having focusing while reading papers and performing research tasks, so I shared by own stories of how I could relate to those challenges, being a neurodivergent researcher myself. While I thought the story ended there, years later that student shared some insight on how my candor impacted her, *"[Courtney was] the first person to openly speak with me about having ADHD in the academic world. Thanks to hearing about [her] experiences, I finally got diagnosed and started treatment. My work and focus has been greatly improved as a result of [her] help."*

As a professor, I will continue my efforts to help students feel a sense of belonging by **mirroring the positive role models I have had**, including my own advisor, Christian Kästner, who hosts weekly lab reading groups, lunches, and end-of-semester social events, e.g. mini golf. As a student, having these opportunities to interact regularly with my labmates has been invaluable and has strengthened my own sense of belonging– it's also a great way to network. I look forward to doing the same thing for the students in my own lab someday soon.

Course Preferences

I am qualified to teach foundational programming or computer science courses, and courses on Software Engineering topics. I am particularly well suited to teach the following courses: Software Engineering, Empirical Methods, Web Development, Data Visualization and Communication, and Programming for non-CS majors.

I am also interested in developing a graduate seminar on the intersection of AI and software engineering, examining both how AI tools are transforming development practices and how we can build more reliable AI-enabled systems. Having taken and TA'd CS Pedagogy, I would also welcome the opportunity to mentor graduate students in developing their teaching skills, potentially through a pedagogy course or teaching practicum.

References

[1] C. C. Johnson, J. B. Kahle, and J. D. Fargo, "Effective teaching results in increased science achievement for all students," *Science Education*, vol. 91, no. 3, pp. 371–383, 2007.

[2] S. Freeman, S. L. Eddy, M. McDonough, M. K. Smith, N. Okoroafor, H. Jordt, and M. P. Wenderoth, "Active learning increases student performance in science, engineering, and mathematics," *Proceedings of the national academy of sciences*, vol. 111, no. 23, pp. 8410–8415, 2014.

[3] M. Hilton, F. Xhakaj, C. M. Miller, and C. Garrod, "15-890 computer science pedagogy," http://cs-pedagogy.github.io/.

[4] A. C. Edmondson and Z. Lei, "Psychological safety: The history, renaissance, and future of an interpersonal construct," *Annu. Rev. Organ. Psychol. Organ. Behav.*, vol. 1, no. 1, pp. 23–43, 2014.

[5] S. A. Ambrose, M. W. Bridges, M. DiPietro, M. C. Lovett, and M. K. Norman, *How learning works: Seven research-based principles for smart teaching*. John Wiley & Sons, 2010.

[6] J. H. Flavell, "Metacognition and cognitive monitoring: A new area of cognitive–developmental inquiry." *American psychologist*, vol. 34, no. 10, p. 906, 1979.

[7] D. L. Schwartz, J. M. Tsang, and K. P. Blair, *The ABCs of how we learn: 26 scientifically proven approaches, how they work, and when to use them*. WW Norton & Company, 2016.