TEACHING STATEMENT

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"The mind is not a vessel that needs filling, but wood that needs lighting." — Plutarch

Teaching and mentoring begin with finding ways to connect with each student. This personal connection, starting with learning names in the early weeks of a course, facilitates sensing the contour of a student's understanding. With a notion of the extent of their understanding, I plan the next tangible step towards the learning goal and execute the plan.

My pedagogical approach is comparable to the way a robot navigates to distant goals by layering a *global planner* with a *local controller*. The global planner finds a sequence of waypoints through the expected terrain that leads to the ultimate goal, while the local controller (a *sense-plan-act loop*) guides the system from waypoint to waypoint while recognizing and overcoming obstacles. Likewise in teaching, the higher-level learning objectives are decomposed into modules or waypoints over a whole semester. On a daily or weekly basis, I try to actively sense the students' understanding, plan the direction toward the learning goals, apply an action to take an incremental step toward those goals, and then sense again to determine if progress is being made. This kind of *hierarchical feedback control* enables robots (and teachers) to make incremental progress toward larger goals in spite of changing circumstances.

The foundation, though, is making a connection with students. Feeling connected to students and helping guide their journey through adversity to eventual achievement is, for me, a splendid reward for the effort of teaching and mentoring.

My mentoring and teaching experience consists of instructing as a Graduate Teaching Assistant (GTA), informally mentoring several grad students, and formally mentoring two undergraduates in research over the past two years.

Undergraduate Research Mentorship. I enjoyed working with Becca Horzewski during 2016 when Becca was a Junior. Becca worked in the lab part-time ($\approx$ 10 hours/week) and was beginning to learn how to design and populate custom embedded systems. While attempting to solder small electronic components, Becca overheated and damaged several tiny fragile LEDs (0603 format, $\approx 1mm$) and sought my assistance. I asked Becca to describe what was happening, and I made several suggestions. After a while, I found Becca was still not succeeding. I recognized a disconnect between my description of the solution and Becca's interpretation of my description. I tried another approach. I instead had Becca try again while I gave step-by-step suggestions. Becca made small, guided adjustments *while learning by doing*. During that afternoon, Becca learned to solder while bracing her wrist on the work surface, and I learned that some students learn more effectively by *performing a task* rather than by *listening how to perform a task.*

I also enjoyed mentoring Lambros Karkazis, who worked part-time during the Spring semester and full-time during the Summer of 2018. I met with Lambros several times per week. I noticed he was using the editor `Vim` but employed only basic commands. He seemed so engaged when I showed him a shortcut, so we started making a habit of ending every meeting with an exchange of `Vim` tricks. Since our research involved repetitively searching and editing files, I made a plan for Lambros to find and demonstrate a new command, macro, or plugin for our regular meetings that he could use to accelerate our research experiments. I would also show him tricks and shortcuts until we found one he had not seen. In this way, Lambros quickly became adept at automating the editing process of adding physical unit type annotations. With the saved time, I involved Lambros in collecting data and creating figures. Within a few months, Lambros started contributing meaningfully to our research efforts and became a co-author of a paper at ASE'18 [C-9].

Graduate TA Experience. I am the graduate teaching assistant for SOFT-260, a Sophomore-level software engineering class in UNL's new software engineering major. My activities include one-on-one tutoring, leading two sections of two-hour labs (46 total undergraduate students), grading weekly homework and quizzes including proofs and programming assignments, creating histograms of the students' grades, and organizing the efforts of five undergraduate teaching assistants. Because the course and labs are new, I summarize feedback from students and undergraduate TAs for the professors and provide suggestions on how to make improvements.

Occasionally during office hours, multiple students will arrive simultaneously. Initially, I queued them up and tried to give them equal one-on-one time, but sometimes there was not enough time to address them all. Eventually, I learned to ask them upon arrival what kind of problem they're working on, and have students with the same kind of questions help each other until I can get to them. I noted that these students now employ some of my tactics ("What have you tried?") and sometimes together they discover a clue they missed individually.

During labs, I'm in continual contact with students as they engage with structured, practical applications of classroom knowledge and concepts. This interaction requires a quick assessment (sensing) of a student's understanding and misunderstanding followed by making a plan of one or more actions: a clue, nudge, discussion, question, recalling class notes, gentle cheerleading, or an analogy (I try to find multiple analogies for every concept). I love to see students persevere and 'get it,' and sometimes that happens after I think they're not going to get it. I especially enjoy it when they can successfully transmit their understanding to fellow students.

Based on what I've learned from the lab sections, I would prepare several micro-presentations for the whole class to refresh material relevant to that day's lab. I would also create review sections to cover background material to fill common gaps in students' understanding.

Feedback from Students: *"John Paul is a really good presenter. It is obvious that he knows the subject and communicated it well. He is entertaining and truly interested in the audience feedback." "Really good speaker. Deep understanding of the topic ... easy to understand." "Overall—awesome presentation." "Better than most professors."*

Contributions and Commitment to Diversity. Diversity can take many forms, at least including racial, socio-economic, gender, gender identity, sexual, neurological, and age. I have contributed to diversity by belonging to UNL's ACM-W chapter 2014–18 ("Computing For All")—I helped research prominent CSE women graduates and made digital posters for their colloquia. Our efforts contributed to Dr. Patricia E. Wirth being the first woman inducted into the UNL-CSE "Computing Hall of Fame." I also volunteered in the summers of 2015–16 for the "Bright Lights" middle-school robotics programs for girls as outreach to help bolster the STEM pipeline. I endeavor to be an active contributor and stalwart ally in promoting diverse backgrounds and perspectives and helping to remove artificial barriers to academic success. In group discussions, I will ensure that all voices have an opportunity to contribute. As faculty, I plan to actively recruit, support, and mentor students from underrepresented populations.

Evidence-Based Learning Techniques. As a GTA and mentor, I incorporate concepts from cognitive science and research-based learning techniques. These help structure my interactions with students, focus attention, and scaffold technical material into bite-sized, chewable chunks. I'm inspired by the Simon-Initiative[1] because I'm especially interested in how continual feedback on teaching techniques can be used to iteratively improve educational results. Some of the techniques I've found useful:

1. Clearly stating the **learning objectives**.
2. Recognizing various **motivational barriers**—*"Why should I care?"* is different from *"I'm not good at this."* is also different from *"I haven't eaten today."*
3. Encouraging students to write about their understanding, because writing is supposedly a **collaboration between working memory and long-term memory**.
4. Presenting tasks that require **sustained focus**.
5. Presenting **mutually reinforcing visual and audible stimulus** during lectures.
6. Helping students to **classify problems** in addition to just problem solving.

I plan to incorporate these techniques into future classes and mentoring by, for example, meeting individually with each student early in the semester to discuss learning goals and identify motivations. Scaling this approach for large classes (> 100 students) is difficult, but might be mitigated by having students meet individually with GTAs. I also plan on having research mentees write summaries of the key ideas in their research, including how these ideas connect to the research questions and the next steps in their research.

Conclusion. Overall, I want to become a memorably good teacher and research mentor. I have a passion for teaching and mentoring and am excited to continue on this journey. I seek to be mindful of students' diverse backgrounds and needs. I will continue to improve in several areas, including sensing what students know and how well they are learning, planning courses in modular units, and learning how to recognize what actions will best benefit particular students.

I can teach at both the **undergraduate level**: *Software Engineering*, *Compilers*, *Data Structures*, *Embedded Systems*; as well as the **graduate level**: *Program Analysis and Software Testing*, *Current Robotic Research*. I am interested in building an advanced course that merges SE and Robotics because the robotics engineers of tomorrow will require a deeper understanding of the promise and perils software engineering. So far, my experience indicates that I will be effective as both a research mentor and lecturer, and I look forward to the opportunity to do both.

[1] `https://www.cmu.edu/simon/index.html`