Student Learning Goals

My primary goal in teaching is to nurture students into becoming (1) *competent* in the core technical foundations of computer science, (2) *confident* in applying this knowledge to new scenarios, even those outside of computer science, and (3) *cognizant* of opportunities to apply and articulate this knowledge in a broader societal context. In my own area of security, I specifically aim to help students build a *security mindset*:

> Security professionals... see the world differently. They can't walk into a store without noticing how they might shoplift. They can't use a computer without wondering about the security vulnerabilities. They can't vote without trying to figure out how to vote twice. They just can't help it. (Bruce Schneier)

By developing a security mindset, students learn to (1) correctly identify the assumptions underlying a system and how violating these assumptions may cause a system to behave in unexpected ways (confidence), (2) deftly apply this process to systems they encounter in the real world (confidence), and (3) reflect on how security affects the world around them and how to explain this interaction to both technical and layperson audiences (cognizance).

Classroom Practices

To effectively guide students towards competence, confidence, and cognizance, I strive to provide an educational environment that is explicitly inclusive of a diverse set of students. I achieve this goal by following a three-step learning process in my classroom: (1) establish a common foundation of a problem setting and relevant terminology and background on which to build a new concept, (2) guide students in actively learning the new concept in a safe environment, and (3) assess student learning outcomes through code, written prose, or spoken presentations. Below, I explain how I create this environment in my classroom, drawing on examples from my past teaching and course design experience.

In order to contextualize the course material in the real world, I organize my courses around a single, intuitive scenario that serves as a motivating example for each of the course topics. As an example, an introductory security course would center around the security challenges one faces when sending a picture to a friend via a mobile messaging app. In doing so, I also help build competence, confidence, and cognizance, since anchoring new concepts to existing knowledge in this way promotes long-term retention of the material and illustrates how the skills I teach can be applied to new scenarios in a broader context.

To establish a safe, inclusive classroom environment from day one, I begin a course by learning the names and gender pronouns of all my students; in my experience, this process takes a week for around ninety students. To help build students' confidence, I also tell students that with the right help and effort, I believe that they can all succeed in my course, and that struggling with the material is completely normal. To further signal a commitment to provide a safe learning environment, I also tell students that they can provide feedback or suggestions for the course at any time. I have used feedback to remove learning activities that were unhelpful for students and to spend more time on topics that students found difficult.

In order to help a diverse set of students build competency in the course material, I survey students' existing knowledge through the use of a self-assessment questionnaire, which provides me information on what background needs to be reviewed in class and individually by students. I use this information to assemble a set of foundational lectures that serve to establish relevant background, such as definitions, problem settings, and solution frameworks that students will use in the remainder of the course. For example, in an introductory security course, I may begin by presenting the different definitions of security, followed by the mathematics underlying basic cryptography, but review the C programming language only if questionnaires indicate that most students lack a strong background in C.

I follow my foundational lectures with a mix of in-class activities, engaging students with a wide range of learning styles. In lectures, I help build student competency by walking students through fully worked-out examples and asking them to try explaining concepts to one another. I use in-class lab sessions to build confidence, providing them with a new problem and helping them work through difficult conceptual leaps or operational challenges such as installation difficulties. I use discussion-based mini-projects to build cognizance, presenting students with a prompt such as "Explain to your grandparent which unlock method (e.g., fingerprint, password) they should use on their new smartphone, justifying your reasoning in a way that they can understand." These mini-projects follow the "jigsaw method," in which I assign 3–5 readings to distinct groups of students. Groups that read a given article have separate discussions, and then the class forms groups of students where each student has discussed a different reading. Each group then collaboratively synthesizes a prose response to the prompt. The use of this method allows diverse students to work closely together, further promoting diversity and inclusivity in the classroom.

To further develop the competence of all students, I provide a learning environment in which students of diverse backgrounds can safely ask for help with difficult material. I use course sites with an online forum that allows anonymous posting, and encourage students to ask questions and provide feedback publicly and anonymously. The use of anonymity minimizes bias that I or other students may have towards the student's post, and also protects students struggling with the material from appearing less adept to their peers. As another example, as a teaching assistant in Switzerland, even though my courses were taught in English, I spent several hours per week learning the multiple dialects of German spoken there so that in one-on-one questions, students could use their native language to more clearly express their questions.

To provide me with rapid feedback on student learning, I give frequent low-stakes quizzes. To develop long-term competence in the material, these quizzes use spaced repetition, in which questions revisit past concepts after increasingly longer time intervals. This approach also avoids the pressure on students that a small number of high-stakes exams creates. I assess students' overall competence, confidence, and cognizance at the end of the course through a project that assesses their technical, written, and presentation skills. In a security course, this project would be to implement a lab exercise that extends a topic seen in class, to present the exercise to the class, and to create a website that showcases the project. For example, in my past network security course, a group of students implemented a lab exercise to intercept a network connection using weak cryptography and leverage this vulnerability to log into a server.

Future Directions

I am excited that I will be co-instructing a newly-developed course in blockchains and cryptocurrency in Spring 2018 at Carnegie Mellon University. The course focuses on the technology, policy, and economics underlying cryptocurrencies, and will provide me the opportunity to further practice developing competence, confidence, and cognizance in a relevant and rapidly changing field.

In parallel, I also plan to develop my own courses, based on existing courses at my institution and on student feedback. As a teaching assistant, I collected regular feedback in my previous courses. While this feedback has characterized me as a clear, easy to understand, approachable, and caring teacher, it has also highlighted ways that I can improve course activities such as my quizzes. I plan to use this feedback to design courses more helpful for student learning, improving an introductory security course I designed as a project for the Future Faculty Program at Carnegie Mellon University.

As a professor, I also plan to continue work towards increasing diversity in several areas of computer science. During my graduate studies, I assisted in the initial planning stages of the Student Summer Research Fellowship at ETH Zurich, which supports undergraduate and graduate research internships with the aim of increasing diversity in computer science. I plan to continually improve my own courses to be inclusive towards a diverse set of students, as well as work towards establishing research and mentorship programs similar to those at ETH Zurich to kindle a passion for computer science in ever broader demographics.