Statement on Teaching

Michael D. Shah, Ph.D. | www.mshah.io

Over the past 6.5 years working as a teaching professor, and the previous six years of working as a graduate teaching assistant, I have had many teachers, colleagues, and experiences that have shaped how I teach well over a decade. In brief, my teaching style is to create a safe, low stress environment for students to actively learn, collaborate, experiment, and focus on motivating students. The reality of my experience is I can teach to students, but in order for students to learn, I have to excite them so they will discover and synthesize the content I present. Perhaps one of my best tricks as a teacher is to get students to emulate me – that is, teach each other, forcing students to break material down into small pieces, question their own understanding, and self-reflect on what they actually know as they attempt to transfer knowledge to colleagues.

In this statement I have organized my teaching statement around a few core ideas:

1. It is important that I develop the material I teach.
2. Students are my target audience, and learning needs to be student focused.
3. Teaching effectively takes careful thought--my teaching philosophy
4. Reflection and evaluation is important

With these core ideas in mind, I will present my teaching statement and invite you to also think about the quotes below.

I forget what I was taught. I only remember what I have learnt.
- Patrick White

The secret in education lies in respecting the student.
- Ralph Waldo Emerson

Developing the Material I Teach

Almost every course that I have ever taught has had some portion of the course materials developed from scratch by me. This is not because I think I am the best at every topic, but rather that I need to create course materials to match my personality, presentation style, take opportunities (i.e., calculated risks) to improve the material, and be authentic to students. Students I believe can see when materials have been solely adapted from another source and it can make them disengaged if they do not see the instructors personal touch on the material at the least (especially in relation to cost of tuition). My enthusiasm for the courses I teach has often been commented on in my course evaluations as an example of evidence that my initiative to develop the course materials is important. When I develop the materials, I feel invested in the course, and more invested in sharing with students materials I can be proud of.

When I first began teaching however, it was very difficult to create multiple courses from scratch (and even to this day creating new courses is an immense intellectual effort). However, the benefit of this is that it has forced me to look over the course learning objectives, evaluate any previous materials relationship to these objectives, and help build a stronger foundation for a course that can later be shared amongst other faculty to further innovate on in their own style. To date of the 52 total courses at Khoury College that I have taught, I have developed 45 of the course materials. This means that I have created at 86% of the material (i.e., assignments, labs, lecture slides, website, exams) from scratch. The other 14% of the materials would

come from talking with instructor about ideas for assignments, reviewing a syllabus from a past iteration, reviewing the course charter, or otherwise discussing courses at a professional venue at an educators forum.

Owning the material importantly asks me to engage with the course, and often relearn topics or engage with a specific topic more deeply than I previously had. This important discovery process requires me to 'learn as if I were a student' and this becomes an important time for me to document my own learning process (e.g. where I struggled, what was unclear, and what analogies helped my understanding). I find that frequently redeveloping and creating learning materials has helped me create courses that are approachable and also allow individual students to have more unique insights for students as they discover the foundations of a topic for themselves.

Now, during my time at Northeastern, I have developed courses from scratch in Computer Systems, Programming in C++, Building Games Engines, Computer Graphics, Offline Rendering in Computer Graphics, Applied Computational Geometry, Human-Computer Interaction, Foundations of Software Engineering, Discrete Math, and a Teaching in Computer Science seminar. The courses I more regularly teach (Computer Systems, Foundations of Software Engineering, Building Game Engines, and Computer Graphics) have been borrowed by other instructors which I consider a testimony to the success of the courses I have built. Owning the material forced me to get invested, be responsible, and iteratively improve and share the material over time. Now I have collaborators at Northeastern and other institutions working to make the best course possible for students, and it all started with taking personal responsibility to own the learning materials.

Some quantitative evidence of the discussion above to summarize the materials I have created and my initiatives in curriculum development are found in the table below.

- Number of courses taught: 52
- Courses in which I created at least 75% of the materials: 45
- Brand new courses developed: 5 (4 completely new, 1 redesigned from scratch merging two half semester courses together)
    - While the courses were developed and proposed by me, I however have consulted several higher rank faculty during this process to ensure the course fits into the curriculum (e.g., For CS 4910 – Introduction to Non-Interactive Rendering techniques, considerations of where the course would fit as an elective, or perhaps a subsitute for traditional Interactive Computer Graphics).
- Nearly all courses are taught incorporating a 'flipped model'
    - Most class sessions are 70% lecture, and 30% in-class lab.
    - By redesigning the courses from scratch, I have been able to design from the bottom-up courses that include active learning exercises.
- Some portion of my course materials have been provided to 26 different instructors across the entire Northeastern University network.
- I know of at least one instance where other institutions (Kent State) have adapted my Game Engine Course materials.

Student Focused Learning

As an associate teaching professor and dating back to my first teaching experiences as an undergraduate teaching assistant, I have enjoyed the challenge of teaching to students who have a variety of backgrounds (whether culturally, economically, or experience level), and this has always benefited me by challenging my expertise in the subject and my ability to connect content to students at levels ranging from beginners to experts, to pure cs majors or non-majors. Below I describe my experience in how I think about teaching and making sure that the boss (i.e., the student—who many would otherwise think of instead as the customer) is the center of attention and engaging in the learning process.

My style of teaching to students is to engage with students and be interactive and support hands on learning activities with my students. Through my experience (undergraduate teaching assistant all the way to a teaching professor), I have found students learn best when they are actively engaged with in-class activities and labs that reinforce the key topics students are learning. Active learning gives students a chance to make decisions, fail, try again, and eventually synthesize and apply their knowledge in the real world while I get to observe in class. Active learning gives me an opportunity while teaching to adjust (i.e.. take the temperature of the room) to the students pace of learning. Within these active learning sessions I often ask students to engage in 'think', 'pair', and 'share' sessions. Pausing and giving students time to consume content at their own pace is important during the 'think' portion—and I will often mirror the students taking time to think as they are thinking. The 'pair' portion is where students get a chance to teach other students—a great trick for forcing them to really reflect on how much they know when they explain something to a peer student. And finally the 'share' portion is where we reinforce a classroom culture where we are all learning, discovering, transfer, and synthesizing knowledge together. In the classroom I have also used this 'think', 'pair', and 'share' technique including myself. For example, I often will perform live coding, where students and I program together, making mistakes, learning how to fix them, and asking 'what if we try this' questions using a 'think aloud' technique while teaching.

I believe strongly in the importance of positive learning interactions with students inside the classroom so they feel ready and excited to continue learning outside of the classroom in the real world. Inside the classroom, I start this learning experience by learning students names as soon as the first day of class to help establish trust with students that they matter and are the focus. In order to further have positive learning experiences I come organized and present transparently what materials they are expected to learn, but I also allow creativity for students to expand on the material that engages them the most (e.g. often having 'going further sections' in assignments that are optional). Showing students that there is more beyond the evaluation often helps encourage their creativity and curiosity, especially when they are given the option to do so on their own initiative. A classroom is somewhere I believe is a safe space for all students to learn, fail, retry, succeed, and express and develop new ideas in computer science. To continue focusing on student learning I further engage in mentoring students and creating opportunities for them to continue pursuing topics they are passionate about. This includes making myself actively available to students for directed studies or to serve as an adviser and mentor for materials that sparks their interest.

In order to quantify my student focused learning, I want to provide some evidence related to the number of students I have supervised and some of their outcomes. Every student that I have supervised I have also had them in class at least once.

- I have supervised (and in one case co-supervised) 31 total independent studies, masters projects, or masters thesis with 26 individual students.
- 3 Students who served as research assistants (Mark Aldrich (Tufts), Yuyou Fan (Utah), and Zachery Casey (Boston University)) have gone onto computer science Ph.D. programs at tier 1 research institutions.
    - 1 other student is at the MIT Media lab and currently applying to Ph.D. Programs.
- 100% of my graduated students have gone on to find employment (1 while also completing a masters degree)

Teaching Effectively Takes Careful Thought--My Teaching Philosophy

When teaching, I constantly remind myself that we are teaching other human beings—we have limitations. A 3 hour and 15 minute course for example, is not going to leave students engaged the whole time regardless of how entertaining one is as a lecture. I also think, it is worth thinking about what type of education happens outside of the classroom. I believe that education does not exist only in the classroom, and by helping students achieve their goals in the classroom, they will take that excitement and curiosity

into the world and apply their skills. Courses that have heavy programming components, need to have in-class components where students can work together and have the instructor and teaching assistants available to guide and reward exploration of computer science. I focus strongly on this rewarding of thinking out loud, and do not penalize for making mistakes—thus trying to create a safe environment for learning. Another part of my teaching philosophy is to never randomly call on students. It does not in my opinion create a safe learning environment (instead it only creates stress), and if students are not participating that is feedback to me that I need to get them more engaged or try something new.

Teaching for a variety of classes has showed me that different courses must be structured to fulfill students learning of the material. As an example I have run several series of programming workshops for non-programmers which serves as a reminder to always be thinking about who my audience is, and how to target material that can be effectively learned from. I make assignments and perform lectures using examples that explain why the work is relevant to students learning the material presented. Students must be able to engage in hands on experiences in computer science, so that they retain the information. As a teaching professor, I engage students by building in questions during my lecture at rapid intervals, and encourage small group discussion (Again: “think”, “pair”, and “share”). During lab assignments, I will often pair students together, so they can practice pair programming. Again, each class however cannot be taught the same—it takes careful thought about what dynamics will allow for a safe and rewarding learning experience for the students.

The teaching techniques that I have learned however came through experience and professional development as a teacher. I participated in Northeastern’s CATLR’s Teaching Inquiry Fellowship where I deeply investigated how to improve my courses and improve student outcomes. One project in which I investigated as a result of this was to create student feedback teams, and survey student within my class and garner feedback through small discussion sessions. I was also able to build course content for an institute known as the Blue Waters Institute in which utilized student feedback teams during the development of the content. Thus the learnings from this experience have been utilized both in the classroom and in the professional world.

Reflection and Evaluation is Important

Taking time to think and reflect as an instructor is important. Sometimes this thinking happens during the middle and at the end of a semester during formal evaluation. But in this statement I want to reflect on my journal all the way back as an undergraduate where I began as a teaching assistant for Programming Languages and Data Visualization. I was good at seeking further opportunities to teach by engaging in teaching once a week for three of my four undergraduate years ranging in courses from 3D modeling and animation and web programming courses. In part, this felt crucial as an undergraduate when applying for Ph.D. programs, to begin developing teaching and communication skills as well as improve my knoweledge. Through graduate school I continued to serve (sometimes voluntarily) as a teaching assistant for: Introduction to Data Structures, Algorithms, Operating Systems, Concurrency, Computer Game Development, Computer Graphics, and Human-Computer Interaction. As I volunteered to help others instructors, it helped reinforce my knowledge, and that was so motivating to me (A concrete example of this is when I updated our computer graphics course during my Ph.D. course to invert our lectures and have ten in-class lab sessions that I could supervise and engage directly with students). And as I reflect on these experiences that lead me to my time at Northeastern (2017-present), one thing that was missing was the feedback loop to students beyond just ‘grading’ by the rubric.

Teaching is one of the most self-fulfilling human experiences where everyone who participates benefits, but in order to benefit the student they do need feedback so that they can improve. I have experienced teaching through tutoring sessions, holding office hours, coursework, workshops (conferences or volunteering at MIT), computer laboratories environments, teaching large (80+ students) and small lectures, and one on one mentorship with both undergraduate and graduate students during my teaching career in higher education. Throughout all of these different experiences, it has been important to set goals, establish what those goals are, and give students a way to check their progress. A letter grade and a point

deduction provides feedback, but it does not however further students to engage with the material. Directed feedback telling students in addition to where they fell short, what resource they may reference to improve, and in addition, what they have done well I have found to work very well.

My philosophy here is that it is important to "respect the student". My lowest TRACE score (internal rating system) throughout my time at Northeastern University has been 4.2/5.0. The range of courses I have taught goes from 1000-level freshman courses taught at 8:00am to 7000-level Ph.D. level courses. What I have learned is, it is important to learn from the student (survey early in the semester to get their feedback, and at the midterm), and to provide students actionable feedback (both on what they missed, and what they did well). Northeastern students I have found respect being evaluated on the rubric (listing items as core material, intermediate, and advanced level), setting clear expectations early in the course, being provided curated resources, and having assignments rooted in real world problems.

Closing and Plans for the Future

As a Professor, I would like to continue teaching a range of courses in computer systems, building game engines, software engineering, and computer graphics as that is where my research, industry experience, and teaching has consistently been focused. I always remain open to teach other courses (as an example I have recently developed a new applied algorithms this past Spring). My previous industry experience in these areas gives me a large depth of knowledge I can pull from to build new courses to fit with the university's current curriculum and continue providing students pragmatic experiential learning.

My teaching statement spans my career through undergraduate until now, because I believe it is important to always reflect on what has and has not worked. I continue to participate in interdisciplinary workshops at my current institution (as a teaching inquiry fellow), because the learning never ends, and I can confess I have always been enthusiastic to teach and share with others. By reading this teaching statement, I hope you can understand some of my core ideas, my reflections, and the direction I am heading. As always I am excited and would continue to have the responsibility and privilege to teach. This teaching statement was written guided by my heart with careful reflections in my mind focused on student outcomes.

It is one of the most beautiful compensations of this life that no [one] can sincerely try to help another without helping [themselves].

- Ralph Waldo Emerson

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