

I have long advocated that the most important thing you can do is ask a student to struggle and the most challenging lesson I am still learning in my career as an educator is *how* to ask a student to struggle. This is because the face of who I teach is constantly changing. For myself, I have grown from a public school algebra teacher, to a graduate teaching assistant, and finally to a college professor of practice. Even at the collegiate level, the demographics and environment have evolved multiple times; in response to all changes, great and small, I have to adapt my answer to the question: How do I provide the appropriate amount of scaffolding so that my students feel confident to grow independently as learners?

During my time teaching at Virginia Tech as a GTA, I developed a philosophy based on productive struggle. My teaching statement at the time detailed a learning process of my own, during which I had to realize as a first-time teacher at the collegiate-level, that feeding answers, and giving rote questions on homework assignments, was hindering student learning. I had to redevelop my objectives to focus on the learner. I had to reprogram my desire to help as much as possible, and to sometimes let students answer their own questions. I had to put in the effort and time to write assignments that encouraged synthesis over recall. These are all obvious statements to a more seasoned educator, but it was a genuine lesson for me at that point in my career that now comes as second nature. In fact, I recently wrote an essay for a pedagogy how-to book for new graduate teaching assistants that is firmly rooted in this early version of my teaching philosophy, but I am also constantly re-identifying and redefining productive struggle.

After two years as a computer science (CS) professor of practice at Lehigh University, I developed a more mature pedagogy and as a direct result, a multifaceted teaching philosophy. It is still grounded in productive struggle but now includes more formal elements of inquiry-based learning (IBL), while still allowing me to deliver the traditional lecture I feel most comfortable giving (for now). So, while I have begun to incorporate IBL in my classrooms, it started with a major shift in my perspective on the importance of discovery-based learning, with gradual changes made in implementation. I firmly believe that it is important for both the student and the teacher to feel comfortable with pedagogical methodologies. Integral to this is that the teacher should be intimately familiar with the approach before fully incorporating any such progressive techniques. My current curriculum delivery uses these traditional lectures, with frequent, and appropriately placed, key questions, along with independent work that includes open-ended prompts (sometimes with purely speculative corresponding answers).

This integrated IBL/traditional lecture classroom environment began as my proposal for the Creative Inquiry Faculty Fellowship I held at Lehigh University during the 2019-2020 school year. In the fellowship I aimed to identify key concepts introduced in early classes of a prerequisite chain, that are foundational in higher-level courses. I chose to focus on the mathematical concepts first learned in CSE140: Discrete Structures and Algorithms relied heavily upon in CSE340: Design and Analysis of Algorithms; both of which I regularly teach. With the breadth of information covered in CSE140, and with many concepts being fairly easy to learn independently, I adopted an online textbook in which I could track student completion of reading assignments. In this way, students were held accountable for completing their at-home reading. From there, I was able to focus on the major concentrations of the course at a higher level of cognitive demand that encouraged students to synthesize the information, not simply regurgitate it. Where, in the past, homework assignments were essentially end-of-the chapter exercises, my colleague and I wrote homework assignments that required the students to develop justifications for and in defense of their solutions. Our exams were written with a cognitive demand that was intended to make the rigor of CSE340 less of a “surprise”. We even pulled some concepts from the CSE340 curriculum so students were introduced to them earlier. I was tasked with teaching a 120-student class when integrating IBL into the curriculum, but walking into my classroom (or more aptly named, lecture hall), you would never know. Throughout my entire lecture, students from all over the room would talk to me and each other, in what was truly a symbiotic group of learners, myself included. I never require raised hands for contributed comments, which could have been disastrous with this many students. But given this independence to think and speak freely, students quickly learned appropriate times to interject perspectives and questions, and ultimately they guided classroom discussions that were organic, yet stayed within the boundaries of the daily lecture objectives.

As we all know, the current academic year is very unusual. Remote teaching and learning introduces another type of struggle that I was wildly unprepared for, but had to learn to mitigate. Going remote halfway through the spring 2020 semester allowed little time to become a great online teacher. But knowing that the next academic year was likely to be virtual as well, I was motivated to learn best practices when teaching in a remote environment. Over the summer, and in a lower-risk, smaller-classroom environment, I was able to test different strategies for administering homework assignments and exams online. I practiced the technique of writing rigorous questions for

open-book exams, and worked to build a culture of community in the virtual classroom. Community is usually built on campus, but a virtual community is a hard thing to define. I assumed there was some complex methodology to this. As it turns out, the solution (for me) was to be more explicit in letting students get to know me. When we gather in groups, we implicitly learn about each other and our mannerisms. In a virtual environment, I realized I had to make time to humanize the woman on the screen. Every lecture, I took a few minutes - and sometimes more - to talk about something other than coursework; something I had recently done or planned to do. A new restaurant I was getting take out from or a funny story about my dog that many knew from past semesters. I was open with them about my own struggles with virtual teaching. And slowly, they started to do the same. I learned about what Las Vegas looked like with no people. One student shared his passion project to develop an app to help people who want to take community action connect. I “met” a lot of pets.

Having had this time to practice the fundamentals of online teaching, my main objective this fall semester teaching CSE340 was to continue to accommodate students’ unique, virtual experience, while still holding them to the same intellectual expectations as previous, in-person classes. Many of the students in the class had taken CSE140 described above, and so there were very few unknowns when relying on their background knowledge. They were also familiar with my style of teaching and the types of assignments I give. I worked with the same colleague again and we had the help of two exceptional teaching assistants. Anytime we encountered a challenge, or even when we were just managing daily tasks, there were four informed voices coming to a consensus. And when only one of us could respond to an issue, that individual always had the full support of their colleagues. The students certainly benefitted from this strong support at the top, and the trickle-down effect was we had 150 students who on average were comfortable with the level of independence we were requiring of them in a remote learning environment in an already demanding course. Students consistently answered each other’s questions on Piazza; sometimes with a level of rigor that rivaled an instructor response. They engaged in Zoom lectures as much as they did in an in-person lecture. They took an active role in giving us meaningful feedback and truly constructive criticism on the structure of the course during the semester, and we respected them by making reasonable changes in response. This is not to say we did not have instances where individual students struggled (and in ways that are not related to my theme of productive struggle) or that I did not make any mistakes. But, it was clear that the majority of students took ownership of their learning. In this semester, my students, my colleagues, and I redefined productive struggle in a virtual learning environment as one that is properly scaffolded by good teamwork and open communication.

At this point in my career, I am preparing to move into a role that will require me to teach graduate students, in particular mentor them as Masters and Ph.D. students. While this is a new role for me, the work I have done up to this point positions me as someone who has learned to adapt to the environment. I will regularly refer back to the major shift in perspective I had to make when going from a teaching assistant who was told my daily topics and what had to be on the exams, to a professor who has the authority to deliver the curriculum in any way I see fit. I advised four undergraduate independent studies or projects so far at Lehigh, and so I will lean on the lesson learned that not all students are independently motivated, but this does not mean they are not intellectually curious or incapable. Sometimes varying levels of stimulation and structure from a mentor is necessary; but eventually the truly curious will no longer require as much direction as they previously did. And I will lean on my most recent lesson learned: that good teamwork is crucial to the success of the individual.

Most importantly, I will remind myself what my advisor said to me early in my own graduate career: *Sometimes we don’t know what the question is until we’re done answering it.* He taught me that research isn’t a prefab assignment cooked up by textbook writers. It is an often-ever-changing frontier that we have to learn and relearn to navigate our entire careers. That sometimes, with stars in our eyes, we set a horizon only to push it back several times as we seek to find our next research question. My advisor had me write in a journal regularly - anytime I had a thought or an idea, he encouraged me to write it down, or work it out, with the intention to keep me constantly thinking about my research. I now have dozens of journals and notebooks filled with work that is waiting to be the next question. Some may be dead ends, others (especially the early ones) may be trivial. But, I also included my perceptions of the work I was doing. At times I was kind to myself, and others I was quite unforgiving of my weaknesses or misunderstandings. For me now, the point is not that I have thousands of journal pages that will become published work; rather that I have years of documentation of the mind of a developing graduate student as I transition into my next role and seek to define the new meaning of productive struggle at the graduate level.