Teaching Philosophy and Interests

Overview

"When is my teaching a success?"

The answer to this question is a window into a professor's values. The answer exposes the thinking behind one's choice of pedagogy, textbook, topics, problem sets, and classroom activities. I consider my teaching a success when students emerge from my courses with long-lasting mastery of physical processes, improved scientific and quantitative reasoning, and feelings of ownership of their education. When these objectives are met, learning science becomes an empowering process that gives students the confidence and ability to tackle challenging future problems and to assess their own level of expertise. I pursue excellence in teaching as diligently as I seek excellence in research. I am eager to adopt best practices from my peer instructors. I apply ideas from the education research literature. I listen to my students in order to create an environment where they can reach their full potential. Additionally, throughout my career, I have incorporated changes to my teaching to increase diversity and inclusion in STEM. (Letters from faculty and students speaking to my teaching effectiveness are in Appendix T.1).

I believe emerging scientists today, more than ever before, need a broad set of skills to tackle pressing societal issues and disseminate their research across disciplines. *[3-4 sentences: why my approach is a good fit for this school]*

I am interested in teaching [*which of the courses currently offered*]. I would also welcome the opportunity to create new courses depending on departmental needs and specifically courses where I could incorporate my own research into my lessons: stellar evolution, stellar populations, astrophysics in the local Universe, and computational astrophysics.

Below, I discuss the themes that have emerged from my teaching experiences: how I have taught toward long-lasting mastery, the importance of increasing diversity and inclusion in STEM, and my lifelong pursuit to always improve.

Toward Long-Lasting Mastery: Teaching Beyond the Course

I use the term mastery as a step beyond critical thinking, as the ability to consider a problem and choose an efficient track to its solution. Maintaining the level of mastery beyond the duration of a course is especially important for physics majors: individual physics courses may suggest to students that there are conceptual boundaries between related physical processes, advanced topics build off of intermediate ones, and critical thinking in physics often requires students to link several overarching concepts together.

It is part of my role as an instructor and mentor to promote long-lasting mastery; to teach beyond the course. To do this, I have added guides to homework assignments for navigating practice problems (see Appendix T.3) and have taught the importance of examining the limits as well as the typical values for a given concept. In class, I incorporate wait-time. Students have time to think independently and deliberate with those around them when I ask questions. I encourage critical thinking and help bring to the awareness of the students the steps to reach the correct answer, not, for example, only rewarding the first raised hand with the correct answer. I encourage the use of office hours, often structuring part of them to attract students who may not be able to fully articulate their confusion. For every lesson I give, or homework that I assign, I have followed three rules to facilitate the commitment to long-term memory using the famous "three R's," reception, retention, recollection. I expand upon my experience with each "R" below.

Students more easily *receive* new information by being active participants and accessing their prior knowledge. When I structure my courses around active engagement, more open-ended and thought-provoking questions are raised and students often go over-and-beyond on their assignments. In my first semester as the primary instructor of the astronomy laboratory course at San Diego State University, students spent in-class time on what many consider "busy work," submitting completed worksheets at the end of class and never looking back on any lesson again. I realized my students could achieve perfect scores without necessarily understanding the material. By the time I left, I had rewritten the manual with open ended questions and hands-on exercises. My students wrote proper lab reports and I enjoyed reading their reflections on them in their final portfolios (a sample of changes I made to the manual is provided in Appendix T.3). Aside from the qualitative evidence that my students were gaining more from an engaging course, upon my introduction of new design and content, my course evaluations jumped from average to nearly a full point above average (on a scale from 1-5) with respect to the six other instructors of the same course (see Appendix T.2 for my teaching evaluations).

Retention is improved when students have had a chance to reflect upon what they have learned. When teaching discussion sections as a teaching associate at the University of Washington, I would give "mini-lectures" that gave students a chance to reflect on the main points of the prior lecture. Each concept within a lesson would end with a summary multiple-choice or "think-pair-share" question and each homework problem required a written comment interpreting the result. My favorite sources for review questions have been Green's "Peer Instruction for Astronomy" and Slater's "Learner-Centered Astronomy Teaching."

Organization of new information is very important for *recollection*, though, learning styles vary. To meet my educational objectives, I use at a minimum three forms of teaching, visual (image, drawing, or plot), auditory (vocal), and written (short summary text), allowing the students to be in the "driver's seat" as much as possible.

As an example, one of the lesson objectives I created as the primary instructor for the Pre-Major in Astronomy Program (Pre-MAP[1]; see next section) seminar was to give first-year students a positive initial experience comprehending an astrophysics journal paper. I selected Brown et al. (2004) on the discovery of Sedna to access their prior knowledge (*reception)*. Students were familiar with the demotion of Pluto to "dwarf-planet" status, and were interested to know this was the primary source that spurred the debate. I assigned the paper with a reading guide, a glossary of jargon, and comprehension questions (*reception*). In class, students went over the questions in self-selected groups (*retention)*. I then divided the class to discuss in detail one of the proposed origin scenarios and to draw a comic strip to illustrate it (*retention)*. After, I shuffled the groups such that each student would teach to their group a different comic strip origin scenario (*recollection)*. As a summative assignment, students wrote their own popular science-level article relating the paper to the "Pluto controversy" (*recollection)*.

Increasing Diversity and Inclusion

I believe education is an excellent weapon against ignorance, bigotry, and poverty. Following that

[1] http://depts.washington.edu/premap/

simple tenet, I have served on the board of the University of Washington (now, Pacific Northwest) Louis-Stokes Alliance for Minority Participation, and created two educational programs targeted to increase underrepresented middle school students' enthusiasm in STEM. As a graduate student, I joined Pre-MAP, a graduate student-led program to increase the retention of students traditionally underrepresented in STEM majors (low-income, minority, female, or first-generation in college) by fostering a student community and facilitating faculty-student relationships through research experiences.

When I arrived at Pre-MAP, it consisted of a keystone seminar, where incoming Pre-MAP students were taught scientific programming, had a research experience, and took a yearly field trip to build community. However, qualitative evidence showed upper level Pre-MAP students were underperforming compared to the rest of those in their major. In three years, I led the staff to completely turn that statistic around by strengthening the programmatic support and mentoring and advising students.

Community building and student support are important to persistence in STEM (Seymour Hewitt, 1997). Therefore, I started a yearly welcome potluck to introduce the astronomy department to the incoming Pre-MAP students. The potluck included a research talk by an advanced Pre-MAP student. I organized research talks and lab tours across campus to expose students to similar paths in STEM. Lastly, I added to the curriculum an assignment to interview a faculty member to help students approach faculty and find mentors.

Most Pre-MAP students entered college a year behind their physics major peers in mathematics. I met with students to teach metacognition, study habits, time management, and test taking skills to help them reach their potential faster than by trial and error.

A Lifelong Pursuit
Green's "Building a Better Teacher" confirms that that my lifelong pursuit to improve my teaching is an essential part of being a successful academic. I have used two main mechanisms in pursing excellence in teaching: soliciting feedback from educators and students, and continuing my education as a teacher.

Engaging with fellow teachers and educational professionals is an integral part of my teaching philosophy. I fostered a teaching and learning community at SDSU Astronomy by creating a private web forum and semester debrief meetings for fellow teaching associates. I wrote the curriculum and started teacher training for new graduate student teaching associates in the Astronomy department at the UW. Upon leaving an educational post, I share my work with my successor to allow for feedback exchange, welcoming valuable perspectives. For each course as the lead instructor at UW, I created a curriculum guide that I shared publicly, some that have been used at major universities. During each course I teach, I request formative evaluations so I can improve my teaching in real time and to suit the evolving needs of my students.

Though my two post-doctoral positions have been research-focused, I have been preparing for future teaching by studying research-based pedagogies. I have taken online educator training while becoming a certified computing skills instructor with Software Carpentry[2], I have co-instructed "The Science of Teaching Science," a course on science teaching pedagogy at Harvard University, and in

[2] http://software-carpentry.org

collaboration with Dr. Philip Sadler and the Harvard-Smithsonian Center for Astrophysics Science Education Department, I have begun to apply my astrophysics statistics training on education research by studying the effects of role models on the decision of high school students to pursue STEM career.

With new insight into science teaching pedagogy, I have identified subtle changes to my approach that would lead to more successful learning outcomes. For example, my focus on teaching toward mastery and the three "R's" would be enhanced in introductory courses by having students first confront their misconceptions (Sadler, 1998; Aarons, 1990). The active learning strategies I have applied in introductory courses may be cumbersome with the rigorous schedule of advanced classes. Instead, I would design courses following principles from "How Learning Works" (Abrose et al., 2010). For example, to balance lectures, students would work occasional problems in class to help them practice integrating new skills and recognizing when to apply them. I would also design assignments to draw on novices teaching novices to counter the "expert blind spot." I look forward to discovering how my pedagogical approaches can be further adapted to better serve my students.

"Has my teaching been a success?"

Becoming a successful teacher, as I have defined it, is a lifelong pursuit. I can count many moments that were a result of successful teaching. I have observed long-lasting mastery when a struggling first-year student eventually became an excellent physics teaching associate. I have seen improvements in my students scientific and quantitative reasoning when they deftly answered professors' questions during a student research symposium poster session. I have witnessed success when a student took charge of their education: after failing their midterm, they applied metacognitive study strategies from my lessons and scored among the top of their class on their final exam. I am empowered as an instructor and mentor by these kind of examples of my students' dedication. I am eager to continue this lifelong pursuit at *[school]*.

References

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