Teaching Statement

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I've been teaching astronomy (mainly), physics, and math since about 1990. Past institutions include UC Santa Cruz and the School of the Art Institute of Chicago. Currently I teach two online courses per year at Arizona State University (ASU) and a session at the annual MESA (Modules for Experiments in Stellar Astrophysics) Summer School at UC Santa Barbara.

Undergraduate Education

I specialize in large enrollment introductory courses. I've been teaching strictly online since 2009, with the courses coordinated by ASU's EdPLus. Enrollments in my online "Introduction to Solar Systems Astronomy" and "Energy in Everyday Life" courses, which are offered exclusively to ASU students, are about 1000 students each per offering.

I am also the instructor of the largest college credit eligible astronomy course in the world (`https://www.edx.org/course/introduction-solar-systems-astronomy-asux-ast111x-2`). Enrollments currently range between 10,000 and 15,000 participants per offering. My course was the first one out the door (thus the first college credit eligible MOOC in the world) as part of the ASU + EdX "Global Freshman Academy", a first-of-its-kind collaboration that offers full university freshman level courses for credit. The ASU + EdX partnership was established to provide quality higher education opportunities to anyone, anywhere in the world. These opportunities are accessible (open to everyone, everywhere), cost-effective (earn college credit credit at a fraction of the cost), and personalized.

Independent of the above, my development of a new digital tool has been submitted for an institutional level Online Learning Consortium (OLC) Digital Learning Innovation Award. Some background is prudent. The Bill & Melinda Gates Foundation granted OLC funding to support the use of digital courseware to improve student success, especially among minority, first generation and other disadvantaged student groups. With a focused lens on increasing the number of underrepresented students who complete general education or gateway courses, the Award aims to build awareness, assess readiness, and provide guidance on the use of digital courseware. With online environments as the platform for digital courseware, the grant furthers the reach of OLC's mission through the continued expansion of online learning for students.

While many technology innovations and learning management systems utilized in education have revolutionized mass delivery through efficiencies of scale, our targeted student population often requires personal interaction and mentoring to create a high-touch experience. My OLC submission is focused in student-centered active learning solutions that advance the world of digital learning for all students. My efforts to prototype and deploy a new digital learning tool, called "Discovery Challenge", led to the Digital Learning Innovation Award submission mentioned above. The tool is currently used in my "Energy in Everyday Life" online course and will be used in my ASU + EdX online course "Introduction to Solar Systems Astronomy" in Spring 2017.

Discovery Challenge addresses the critical gap in online learning often only met in traditional, on-ground classrooms. Learning quantitative material often emphasizes exact answers. Discovery Challenge enables students to master complementary skills – learning that an order-of-magnitude estimate is not merely good enough, it is often more useful than an exact answer. Discovery Challenge, combined with guiding documents and learning strategies, motivates and engages online learners to exercise creativity on large-scale problem solving. Logic, reasoning, critical thinking, digital information seeking, and building learner confidence all contribute to more effective lifelong learning skills – necessary in today's global marketplace. Challenging students to solve large-scale questions through curiosity-based exploration has been demonstrated to significantly boost student achievement on course-based learning outcomes. In addition, use of Discovery Challenge boosts the skills of at-risk learners – those likely to drop out or fail courses – and increase retention. The ASU team is conducting research on multiple courses that deploys Discovery Challenge to further test hypotheses and ensure efficacy of the digital learning tool.

Simply said, my goals for undergraduate education are: (1) for students to have fun. Do not underestimate the pedagogical value of enjoyment in reaching learning outcomes! ; (2) for me to communicate the excitement of modern astronomy, physics and general science; (3) for students to better learn how to communicate their ideas and results to other people. The strong appeal of astronomy by the public – as evidenced by recent media and movies – is a tremendous aid in reaching these goals.

Graduate Education

In October 2016 I agreed/contracted with Princeton University Press (PUP) to produce a pragmatic graduate level opus on stellar evolution featuring the popular software instrument MESA. My co-authors in this adventure, Rich Townsend, Lars Bildsten, and Bill Paxton, and the PUP editor, Eric Henney, are excited about producing a quasi-living and new type of graduate textbook on stellar evolution — with a pronounced emphasis on *evolution*, and other under-appreciated modern topics.

I am one of the Directors of the annual MESA Summer School. The School is aimed at advanced undergraduates, graduate students, postdocs, and faculty members who are interested in a week of extensive hands-on labs to gain familiarity with using and developing MESA, and learning how to use MESA to advance their own research. Topics vary from year-to-year, highlighting MESA's growing science capability, and are led by leading experts in their respective fields. Recent topics include gravity-mode oscillations of massive stars, transport by waves, magnetic fields in stellar evolution, massive star explosions, and massive star binaries relevant to interpreting LIGO's recent discoveries of gravitational waves (e.g., `http://cococubed.asu.edu/mesa_summer_school_2016/`) Over 200 participants, teaching assistants, and instructors have now benefited from the MESA Summer School. Every year there are about 50% more applicants than openings, suggesting the demand by the stellar community for future MESA Summer Schools has not waned or saturated.

A MESA Summer School is not your standard astrophysics summer school. Participants are expected to master material prior to arrival. About 30% of the time is spent in a lecture format; students spend most of their time setting up, running, and interpreting MESA models in small groups. By having one teaching assistant at each table of three students, we ensure hands-on participation and energetic interactions amongst the participants, teaching assistants, and lecturers. To increase community buy-in from the $\simeq$33 participants per year and their advisors for the week long event, we do not subsidize participant travel or local accommodations. The now over 200 graduates are creating their own MESA user infrastructure at $\simeq$50 institutions around the world, which accelerates research and discovery. These metrics suggest that MESA is having a significant impact on education and likely to become the standard stellar astrophysics instrument for the next generation of researchers and educators.

MESA-Web is a cloud resource aimed at lowering the barrier to using MESA for graduate education. Despite being a beta-version prototype that was released in June 2015, MESA-Web has already run over 1000 jobs for education projects at over 40 institutions in the USA. These statistics suggest MESA-Web has significant growth potential for graduate education. Driven by the stellar community's enthusiastic support for MESA-Web we anticipate extending single star evolution to encompass additional input physics, enable binary star calculations, and develop the capability for students to model supernova and other explosions. Also in response to community input, we will build new capability that allows graduate student nuclear physics experimentalists to easily test the impact of a new, measured nuclear reaction rate.

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