

Teaching Statement

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I've been teaching astronomy, 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 have expertise and specialize in large enrollment introductory courses.

Enrollments in my online science-quantitative "Energy in Everyday Life" course, which are offered exclusively to ASU students, are currently ≈ 1000 students each per offering.

Enrollments in my online "Introduction to Solar Systems Astronomy" course, currently range between $\approx 3,000$ and $\approx 10,000$ participants per offering. This is largest college credit eligible astronomy course in the world, and in the summer of 2015 was the first college credit eligible MOOC in the world. This course is part of the ASU + EdX "Global Freshman Academy", a first-of-its-kind collaboration that offers a full slate of university freshman level online 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 (I assure you) personalized.

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 education research is focused in student-centered active learning solutions that advance the world of digital learning for all students. My efforts led to the prototyping and deployment at scale of a new digital learning tool, called "Discovery Challenge". The tool is currently used in my two online courses described above.

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. ASU education researchers are assessing the multiple courses that deploys Discovery Challenge to test hypotheses and ensure efficacy of the digital learning tool.

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 science; (3) for students to learn how to better 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

I suspect that Rich Townsend (UW Madison), Lars Bildsten (UCSB), Bill Paxton (UCSB), and I will generate a new, outside-the-box, graduate level textbook on Stellar Evolution with MESA within the next few years. If it has a success about equal to what MESA itself has achieved, it will be a home run.

I am also one of the Directors of the annual MESA Summer School. The School is aimed at graduate students and postdocs, who are interested in a week of extensive hands-on labs to gain familiarity with using and developing MESA, and learning how to better 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. Over 200 participants, teaching assistants, and instructors have graduated from the MESA Summer School. Every year there are about 50% more applicants than openings, suggesting the demand by the astronomy 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; graduate students and postdocs spend most of their time setting up, running, and interpreting MESA models in small groups. By having one master-level teaching assistant at each table of three students, we ensure hands-on participation and energetic interactions. The now over 200 graduates are creating their own MESA user infrastructure at ≈ 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.

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