

Educating Biomedical Engineering Graduate Students about Teaching (Work in Progress)

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Work in Progress: Educating Biomedical Engineering Graduate Students About Teaching

The goal of this paper is to describe how to help BME graduate students and postdoctoral fellows, our future faculty members, develop better skills and perspectives about teaching than current STEM faculty have, and thereby improve STEM undergraduate education. We briefly review mechanisms for graduate students and postdocs to learn about teaching through the Center for the Integration of Research, Teaching, and Learning (CIRTL.net), with the goal of raising awareness of the options available. We then discuss evidence that teaching development (TD) programs benefit STEM PhD students. The research we cite is STEM specific, and some has been obtained from BME students. Finally, we discuss how members of the Biomedical Engineering Division of ASEE can play a role in professional development of BME graduate students and postdocs in the area of teaching.

The overall status of teaching preparation, and some of the impediments to obtaining it, were captured succinctly in a brief article by Derek Bok, the former president of Harvard, who was speaking about PhD students in general (Bok, 2013):

“The most glaring defect of our graduate programs, however, is how little they do to prepare their students to teach. Doctoral candidates have long had the chance to assist professors in large lecture courses by leading weekly discussions among small groups of undergraduates. Yet only a minority of those assistants report that they receive adequate supervision by the faculty member in charge of the course. In fact, professors often tell their graduate students not to spend much time on their teaching duties, lest it distract them from the all-important task of writing a thesis.”

Within STEM fields, ineffective and/or insensitive teaching practices are a major reason why undergraduates leave these fields, resulting in high attrition rates in engineering and science at many universities (Geisinger and Raman, 2013; Pascarella et al., 2011; Santiago and Hensel, 2012; Tanner and Allen, 2007). There is ample evidence that engineering courses that implement evidence-based methods like active or project-based learning improve student retention and performance (Bullard et al., 2008; Felder et al., 1998; Knight et al., 2007; Martin et al., 2007).

Two beliefs limit education about teaching: First, many current STEM faculty members, at least at the research institutions that are training all the future STEM faculty, do not view teaching as something that *can* be learned. Second, teaching is not something that *should* be learned. They consider time spent on teaching development to be detrimental to one's productivity and future prospects for jobs and funding. Neither of these is a valid argument. With the variety of teaching methods available, and the strong diversity of the college population, even future faculty with excellent intuition about teaching still have a great deal to learn (e.g. Ambrose et al., 2010; Bain, 2004; Bransford et al., 1999; Brown et al., 2014). Graduate school is an ideal time to begin to learn about teaching, because the pressures are usually less than in early faculty careers. Teaching also helps graduate students to become better researchers (Feldon et al., 2011).

The Center for the Integration of Research, Teaching and Learning (CIRTL.net), a consortium of 43 research universities (36 with BME programs) was created to address the need to improve undergraduate STEM education, and its strategy is to enhance the preparation of future faculty. CIRTL has local programs that differ at each university, but also has programs that can be accessed by anyone. CIRTL offers two 8-week MOOCs about teaching through EdX that are designed for asynchronous engagement. The instructors of the MOOCs encourage the formation of local MOOC-centered learning communities (MCLCs) of students enrolled in the MOOC at each university, facilitated by a leader. CIRTL provides a MCLC facilitator's guide to assist leaders. Second, CIRTL sponsors weekly "CIRTLcasts," one hour sessions that do not require registration, and focus on many topics in teaching.

There is considerable evidence from a variety of sources that teaching preparation is beneficial to STEM graduate students. The most comprehensive study on the impact of teaching development (TD) programs is the Longitudinal Study of Future STEM Scholars (Connolly et al., 2016), which studied graduate students from three large institutions. The goal of this work was to answer the question "What are the short- and long-term effects of TD programs on doctoral students' teaching-related skills, knowledge, attitudes, and career choices?" The three most important results are captured in the executive summary: "1) TD during the doctoral program had positive, significant effects for all participants, including those who do not take positions in academia after graduating. 2) Participating in TD programs during the doctoral program had no effect on students' time to degree completion, which was six years on average. 3) For STEM PhDs who taught undergraduates, higher levels of TD engagement during the doctoral program had positive effects on their self-efficacy beliefs and teaching practices after completing their degrees."

We have similarly positive data from a CIRTL-based STEM TD program at our university, called [Mentored Discussions of Teaching](#) (Baiduc et al., 2015), but wanted to know how biomedical engineering students specifically viewed participation in TD programs. We did an online survey of our BME graduate students and postdocs who are now alumni and who had done some level of TD. We asked alumni because their perspective provides a better sense of whether teaching development is beneficial in the long run. Twenty-five were invited to complete the survey, and 12 (4 postdoctoral and 8 PhD alumni) responded. This small sample is diverse in terms of current occupation: 4 are currently postdocs, 4 are tenure track faculty members, 2 are in other academic positions, and 2 are in industry. No matter what their current job is, they are either currently teaching in a formal or informal context, or plan to teach in the future. Significantly, both alumni in industry indicated that they were teaching, reinforcing the idea that teaching is a component of many careers that BME PhDs will find themselves in. We asked how they obtained information about teaching while they were at our university. Eight indicated that their knowledge "came mainly through programs of CIRTL and/or the Teaching Center," and two indicated that it "came mostly from mentoring and/or supervision when I was in a teaching or TA role." This is understandable, because these two had only taken part in the one day conference for new teaching assistants. The other two indicated a combination of formal programs and informal mentoring. All indicated that their experiences had been useful in helping them know what to do as teachers in the future. Half of the respondents would have done more

TD programs if they had the chance to return and none would have done fewer.

Comments included the following (the last one from a student in the MOOC and MCLC):

“These programs allowed me to learn best teaching practices... Additionally my teaching statement was ... regarded highly during my faculty application process.

... allowed me to explore and learn about pedagogy, which I had never studied before. I also gained mentoring and teaching experience, which positioned me well for my current job. I would not have been qualified for my first job ... without these programs and opportunities.

The Teaching Center program ... clarified my thinking on what it is we are trying to do when we teach, expanding critical thinking, moving up the levels of learning, rather than dissemination of information. This was a critical foundation for me ...”

Despite having been a TA several times in graduate school... I had little-to-no training on how to actually teach. This class was packed with useful information! There wasn't a single moment that felt like I wasn't learning something. And it was all so applicable... The weekly discussions were fantastic. Having an experienced, knowledgeable professor, who cares about education, engaged in discussing the lessons with us helped us ... consider how some of the lessons would apply to our specific classes.

This is a small and selective sample. But we also know that our junior faculty members often wish they had more knowledge about teaching.

In the biomedical engineering division of ASEE, we rarely think about impacting the graduate students who will become future faculty. Development of graduate students is often left to the laboratory mentor, who may or may not have any interest in the development of teaching knowledge and skills in his or her graduate students. However, many teaching track faculty members encounter graduate students in their role as teaching assistants. We suggest that this provides teaching faculty with an important opportunity to the foster competence and confidence of graduate students in teaching. As we have illustrated, teaching development programs are not a distraction, but a benefit. They provide perspectives and knowledge for all graduate students, including STEM students, and for BME students specifically.

For faculty members who are not at CIRTl institutions, there are CIRTl programs for students nationwide. Faculty members can play a role by serving as leaders of a MOOC-centered learning community, or by mentoring their teaching assistants in teaching, or by connecting them with the local teaching center. Faculty members at CIRTl institutions have these opportunities as well, but have the even easier job of pointing students and postdocs toward CIRTl at their universities, and encouraging them to participate.

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