



Longitudinal Study of FUTURE STEM SCHOLARS

Building a Better Future STEM Faculty Executive Summary

The Longitudinal Study of Future STEM Scholars answered a question with implications for national efforts to improve undergraduate education: What are the short- and long-term effects of teaching development (TD) programs on doctoral students' teaching-related skills, knowledge, attitudes, and career choices?

Using surveys and interviews, we followed a cohort of STEM dissertators (initial N = 3,060) from three research universities as they completed their degrees from 2009 to 2013. We examined students' teaching experiences and TD participation during the doctoral program, their career pathways as long as five years after receiving their doctorates, and the short- and long-term effects of their participation in doctoral TD on their teaching knowledge, skills, and attitudes.

Findings from this seven-year study were gathered into a final report, *Building a Better Future STEM Faculty: How Teaching Development Programs Can Improve Undergraduate Education* (available at <http://lsfss.wceruw.org/>). Below is the report's executive summary, which focuses on ten key findings as well as recommendations to various stakeholder groups.

Key Findings

- 1. Nearly all doctoral students (94.9%) taught undergraduates during their doctoral programs.** Doctoral students spent the greatest amount of time as research mentors (median = 3 semesters), followed by their time in teaching/lab assistant positions (median = 2 semesters). Of all the graduate teaching roles we asked about, they spent the fewest semesters as instructors of record (median = 1.3 semesters).
- 2. TD programs at the three institutions we studied were diverse and offered by many campus units.** We found more than 77 different TD programs and courses. Based on a literature review and these programs, we created a framework of 12 core features of TD programs.
- 3. Participation in TD was commonplace, as most (84.6%) doctoral students engaged in at least one formal activity during their degree program.** Most respondents attended shorter activities like brief workshops and presentations. The four greatest barriers to participation were students' lack of time, the perception that TD was a low priority, lack of awareness of TD offerings, and scheduling conflicts. Women participated at higher rates than men during doctoral training, a trend that continued into their postdoctoral appointments and early-career positions.

4. **TD during the doctoral program had positive, significant effects for all participants, including those who do not take positions in academia after graduating.** Engaging in a moderate amount of TD—one formal course, for example—or more had a significant impact on the short- and long-term outcomes we measured. TD engagement increased STEM doctoral students' estimates of their teaching competence, bolstered their beliefs about their ability to perform as a college instructor, and increased their sense of community with their peers. Compared with their male counterparts, women benefitted more from their TD participation.
5. **Participating in TD programs during the doctoral program had no effect on students' time to degree completion, which was six years on average.** However, actual teaching experiences did increase doctoral time to degree. This finding challenges a common belief held by many faculty that TD participation delays students' timely progress to the doctorate.
6. **STEM doctoral students' interest in teaching undergraduates increased during their training, especially among those interested in faculty careers.** More doctoral students (56.2%) were interested in teaching undergraduates at the end of their programs than at the beginning (43.9%).
7. **STEM Ph.D.s followed career pathways to a variety of positions in and outside of academia.** Five years after earning a doctorate, more than half (56.1%) of all STEM Ph.D.s in our study were working in postsecondary institutions. Most Ph.D.s moved immediately into postdoctoral scholar positions after completing their degrees (62.8% at the first year and 56.6% at the second year after receiving a doctorate); a smaller proportion remained in this type of position after five years (18.2%). Within one year of earning their doctorates, 9.3% of students had secured tenure-track positions; by the fifth year after completing their degrees, 23.0% of students were in tenure-track lines.
8. **Higher levels of TD engagement during the doctoral program were associated with getting a tenure-track or non-tenure-track faculty position.** After controlling for other factors, high TD engagement (more than 55 hours) significantly increased the likelihood of moving into a faculty position within five years after completing the Ph.D., regardless of whether the participant completed a postdoc appointment. Higher levels of teaching experience during the doctoral program were also positively associated with getting a faculty position within five years of receiving a doctorate.
9. **Nearly half of STEM Ph.D.s (45.5%) were in positions with undergraduate teaching responsibilities within five years of receiving their degrees.** Of this group, about half (46.6%) taught as instructors of record, one third (36.0%) served as research mentors, and one quarter (24.2%) were guest lecturers.
10. **For STEM Ph.D.s 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.** Although TD type (specifically, formal courses) had a long-term positive impact on Ph.D.s' self-efficacy beliefs and teaching practices, its impact was mostly mediated by the higher levels of TD engagement. This finding is one of the first to identify long-term impacts for TD participation during the doctoral program.

Recommendations

Our findings have shown that TD engagement during the doctoral program is an effective way to prepare skilled STEM instructors. Because STEM Ph.D.s will teach undergraduates at more than 4,000 colleges and universities across the nation, investing time and resources in TD programming has great potential to transform undergraduate STEM education.

Getting people who are involved in doctoral education to take teaching development seriously remains a major hurdle, however. Overcoming faculty resistance and making teaching development a higher priority will require systemic change across national, institutional, departmental, and individual levels. To help stakeholders at all levels lower barriers to participating in doctoral TD, we offer recommendations for action based on our findings and previous research.

National Stakeholders

At a national level, research universities face external pressures from many sources: regulatory agencies, public and private funders, accreditors, peer institutions, employers, legislators, and the general public. Because external pressures can move universities to act, these stakeholder groups can influence whether and how universities provide more and better TD opportunities for future STEM faculty. We offer national stakeholders these change strategies:

- Require federal research grant awards (namely, those from the National Science Foundation and the National Institutes for Health) that employ graduate students and postdoctoral scholars to include TD in their mentoring and professional development plans.
- Advocate for national policy that elevates the importance of high-quality undergraduate instruction in STEM courses.
- Facilitate discussion among stakeholder groups about the importance of TD to faculty careers and improved undergraduate education.
- Advance lines of research on TD programs and participants that expand our understanding of how future faculty develop as effective teachers.

College and University Administrators

Presidents, provosts, deans, and other administrators shape the vision and mission of the institution, establish institutional policy, and distribute funding. This stakeholder group should acknowledge, support, and advocate for doctoral TD programs and initiatives. To this end, we recommend the following actions:

- Provide sufficient funding and support for doctoral TD programs and initiatives on campus.
- Facilitate campus-wide discussions about the importance of doctoral TD for graduate student professional development and undergraduate education.
- Collect and publish data from doctoral students about career interests, experiences, and eventual placements.
- Seek changes across the institution related to faculty reward structures and the adoption of effective teaching strategies.
- Create a map of campus-wide TD programs, organized by key features such as duration, intended audience, and expected learning outcomes.

Teaching Development Providers

Multiple campus units (e.g., graduate school, teaching and learning center, departments) provide TD programming to doctoral students and thus play a crucial role in the development of future STEM faculty. Given TD's positive effects on doctoral students, it should be a priority to lower barriers to students' participation. Based upon our findings, we offer the following recommendations:

- Increase awareness of TD opportunities through advertising and outreach.
- Offer multiple modalities of TD
- Gather more and better data about participant experiences and outcomes—and use it for improvement.
- Coordinate TD offerings for stronger and broader impact on doctoral students.

Department Chairs and Faculty

Academic departments—where disciplinary and institutional cultures intersect—arguably have the greatest influence on doctoral students' participation in TD. Our study found that the research-focused may prevent doctoral students from engaging in enough TD activities to gain significant, positive, and lasting gains. Negative attitudes about teaching—especially its importance relative to research—can be a barrier to students' participation in TD. To foster department cultures that truly value the formation of future STEM instructors, faculty members and chairs must assess and change their practices, processes, and values. We recommend the following actions:

Department chairs can...

- Encourage discussions of teaching development during doctoral student orientations and in students' individual program planning.
- Consider adding a required teaching seminar to the formal doctoral curriculum, perhaps in collaboration with a TD program.
- Provide opportunities to discuss teaching and learning from a disciplinary perspective.
- Reward and recognize effective teaching.
- Encourage faculty and advanced doctoral students to open their classrooms for students to observe effective teaching.
- Include periodic reporting on doctoral teaching development and experience in faculty meetings.
- Provide students with ample career planning information and opportunities.

Faculty advisors can...

- Communicate with students about teaching and its place in various types of faculty careers.
- Allow students to have time to participate in TD without fear of shame or reprisals.
- Help students integrate their research and teaching in mutually supportive ways to avoid TD being seen as only preparing graduate students for positions at non-research universities.
- Support students who are seeking community among others who have an interest in teaching.
- Help students gain access to authentic teaching experiences, especially as an instructor of record.
- Set a good example by supporting teaching and learning.

Doctoral Students

As our study showed, doctoral students greatly benefit from TD participation; they apply knowledge, skills, and attitudes gained from TD to undergraduate STEM courses. Their reasons for participating in TD are both intrinsic and instrumental. Yet, too few doctoral students participate in enough TD activities to enjoy their significant benefits. Here are some suggestions to increase doctoral students' TD engagement and outcomes.

- Communicate with faculty members, especially your advisor, about the role of teaching and TD in your career development.
- Participate in TD programs and teaching activities that allow you to learn about, practice, and reflect on undergraduate instruction.
- Find or create a community of like-minded peers and faculty members who work toward improving teaching.

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