Creating a Cooperative Environment for Graduate Studies and Career Preparation

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The purpose of graduate education in the STEM disciplines is to prepare students for careers requiring specialized knowledge and skills. However, most of the formal education in graduate school is focused on increasing subject area knowledge, in both breadth and depth, and critical thinking. While these abilities are certainly key to success in jobs requiring advanced degrees, there are many other knowledge and skill sets that are not part of formal graduate training. Students, then, must rely on other means to gain experience in grant writing, establishing productive collaborations, teaching, and lab management. Often these skills are modeled by graduate mentors, but the end result is haphazard, inconsistent, and often fraught with poor habits. For instance, many mentors, particularly in the biomedical science, abhor teaching undergraduate students. That faculty's mentees, then, are likely to dislike teaching or are forced to pursue it in secret.

The end result of this patchwork training is twofold. Firstly, when graduates pursuing academic careers start their own labs as an assistant professor, they struggle to balance their academic work with mentoring, management, teaching, funding, and service duties. The second effect is that graduate training only prepares students for academic research positions. Graduate students interested in non-academic or non-research careers are, in reality, left to fend for themselves.

The goal of my proposal is to create a model of graduate curriculum where students identify the career paths that most appeal to them and develop the skills to effectively prepare them for those careers.

Career Mentoring

STEM graduate students typically choose a research mentor within their first year of study. This mentor can also help them to develop skills in presenting, writing, etc., but I propose that students should also choose one or two career mentors. Graduate programs should identify faculty members willing to serve as career mentors, and help students choose which mentors would provide the best guidance over the course of the student's time in graduate school. Faculty with experience in industry, teaching, public policy, and outreach should be recruited to meet with students at least twice per year.

The focus of this mentorship should be on identifying particular experiences and credentials during graduate school that will help the student move toward his/her career goals. Programs may have to establish relationships with different colleges to find mentors with similar interests. For instance, a mathematics department may reach out to neighboring schools of public health or education. Ideally, the career mentors will share various resources and opportunities with the graduate students, such as fellowships in science policy through AAAS, postdoctoral training in teaching, or how to find open positions at nearby corporations. In essence, the research mentor will ensure that graduate students deserve the masters or doctorate degree, and the career mentor will ensure that they can put it to good use.

Courses

Graduate programs should offer career-oriented courses. Specifically, I recommend a full semester course in grant writing and a modular course in scientific skills.

Grant Writing

The financial mechanism of most academic STEM disciplines is obtaining grants from various funding agencies. Hence, I propose that graduate programs should require students to take a course in grant writing. The beginning of the course would inform students about different funding agencies and mechanisms. Then students would draft specific aims pages for review by the instructors. After incorporating the initial comments, students would write the first draft of their grant proposal, modeled after a predoctoral fellowship proposal. At a mock study section, peer and faculty reviewers would share their assessment of the proposal's content and style. A final round of revisions would then be followed by the second mock study section to assess the revised proposals. Second year students are more likely to find this class useful as they will have a greater depth of knowledge of their research projects, making for stronger proposals. After the class is finished, each student would have a document that is ready to submit to a funding agency and/or as the basis for a preliminary thesis examination. Plus, students would be acquainted with the peer review process, which will be useful if they are asked to review grant proposals or manuscripts for publication. A formal grant writing course would also help students think about proper experimental design, innovation, and broader impacts.

Modular Scientific Skills Course

A number of skills are essential to working in STEM disciplines, but there is currently no formal way to develop these skills. Training graduate students in these various areas would alleviate stress and increase productivity and quality of life as they transition to new jobs.

Modular courses are an appropriate way to meet this need. Instead of a single course to cover all of the career information and skills, the content units can be divided into modules, each taught by a different faculty member. The example I've shown below is for a modular class during a shorter summer semester, though the course could be offered and extended to a traditional fall/spring semester. For each two week period of the semester, students choose one module to take from the two or more options that are offered. In this manner, the student has a personalized educational experience. Students should also have the ability to repeat this course in subsequent years so that each student could feasibly take most or all of the modules.

	Module 1 Weeks 1-2	**Module 2 Weeks 3-4**	**Module 3 Weeks 5-6**
Option 1	Mentoring/ lab management	Teaching	Service/ outreach
Option 2	Academia – liberal arts to Research 1	Lab budgeting	Public policy
Option 3	Entrepreneurship/ Industry	The job search	University & department governance

Descriptions of potential modules:

Mentoring/lab management – The mentoring relationship can be an essential part of the graduate school experience. Faculty mentor graduate students and postdocs, who in turn mentor undergraduates and high school students. This module would handle good and bad mentoring strategies. As an extension, the module could cover general principles of lab management, such as maintaining a friendly working environment, building rapport, establishing authorship, and resolving conflicts.

Teaching – Good teaching is more than telling students what you know. It involves designing courses and lectures with particular goals in mind. Graduate students in this module would learn about and experience the best practices in pedagogy and classroom management. At the end of the course, interested students could be provided with teaching assistant opportunities.

Academia – Research in an academic setting can take on many forms. This module would compare and contrast research-focused schools, liberal arts colleges, large state schools, private universities, and community colleges. What type of scholarship is produced at each school? How is this balanced by teaching and service?

Lab budgeting – To graduate students, the lab budget is a nebulous concept. Why not show students how a lab budget works? Where does money come from and where does it go? How many salaries does an NSF grant cover? And is there enough left over to run experiments? This module would give students the chance to see the financials of running a lab. Ideally, research mentors would then share their lab budgets with students, adding a new level of transparency to an otherwise vague system.

Entrepreneurship/Industry – How do academic findings translate into real-world solutions? This module would examine the patent system and startup companies, as well as how industry is different from academia. Invited speakers from nearby corporations would share their experiences in moving away from academic work.

University & department governance – The structure of departments within colleges and universities is not always clear, especially with multiple committees, centers, and divisions with overlapping responsibilities. Students in this module would learn about the internal functioning of their institution. An formative part of the module could be participation in a department faculty meeting.

Many of these modules can serve as an in-depth introduction to these topics, connecting students with relevant resources and opportunities. Through these modules, students could further seek out the institution's teaching certificate programs, outreach initiatives, student government committees, externships, Preparing Future Faculty programs, and career counseling services. It is also feasible that students could enroll in combined degree programs, such as MS-MBA or PhD-MPH.

Conclusion

The overarching purpose of this proposal is to allow graduate students to develop as unique individuals. Many STEM disciplines are evolving, and academia is not currently equipped to thoroughly prepare graduate students for the wide variety of jobs available to them. By providing the resources and facilitating the connections, graduate programs would acknowledge that there are many paths available after graduate school. Many institutions have efforts to improve graduate student training, and this proposal builds on those efforts by indentifying the students who would benefit from them most. Additionally, graduate programs would provide well-rounded training to students, not only in content knowledge but also in the activities and skills most essential to their future success.