

A call for transparency in tracking student and postdoc career outcomes

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ABSTRACT There is a common misconception that the United States is suffering from a “STEM shortage,” a dearth of graduates with scientific, technological, engineering, and mathematical backgrounds. In biomedical science, however, we are likely suffering from the opposite problem and could certainly better tailor training to actual career outcomes. At the Future of Research Symposium, various workshops identified this as a key issue in a pipeline traditionally geared toward academia. Proposals for reform all ultimately come up against the same problem: there is a shocking lack of data at institutional and national levels on the size, shape, and successful careers of participants in the research workforce. In this paper, we call for improved institutional reporting of the number of graduate students and postdocs and their training and career outcomes.

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We and our fellow postdocs across the Boston area (from institutions including Tufts, Harvard Medical School, MIT, Brandeis, and Boston University) organized the Future of Research Symposium (<http://futureofresearch.org>). In so doing, we sought to give young scientists in Boston a voice in discussions of fundamental challenges facing the research enterprise, such as hypercompetition, skewed incentives, and an unsustainable workforce model (Alberts *et al.*, 2014). During the symposium, attendees (largely postdocs and graduate students) participated in workshops designed to identify the most pressing concerns for trainees and to solicit their thoughts on possible solutions. While the complete outcomes of those sessions are listed in our meeting report (McDowell *et al.*, 2015) and the supporting data (McDowell *et al.*, 2015, Data set 1), the organizing committee identified three principles crucial to building a more sustainable scientific enterprise, among them transparency in collecting and sharing information on the research workforce.

Our culture is affected by a deeply ingrained notion that there is a “STEM shortage”—a dearth of graduates with scientific, technological, engineering, and mathematical backgrounds—an assertion that has been repeated too many times to count (Teitelbaum, 2014).

For example, the President’s Council of Advisors on Science and Technology called for an additional one million science, technology, engineering, and mathematics (STEM) trainees in 2012 (PCAST, 2012). Yet a recent report by the Center for Immigration Studies using U.S. census data is one of a chorus of recent publications asserting that STEM graduates are actually struggling to get relevant jobs (Camarota and Zeigler, 2014). For example, only 11% of those who hold a bachelor’s degree in science actually work in a science field (table 2 in Camarota and Zeigler, 2014). This rhetoric is also blatantly misleading for PhD holders in biomedical science and probably lulls students interested in this path into a false sense of job security. The number of graduate students has roughly doubled from 1990 to 2012 along with a comparable increase in the number of postdocs (figures 1 and 5 in National Institutes of Health [NIH], 2012). Yet there is little evidence to suggest that permanent research positions, whether in academia or industry, have increased concomitantly. The problem has been eloquently summed up by Henry Bourne, referring to the swelling postdoc pool (Bourne, 2013a) that becomes a “holding tank” (Bourne, 2013b) from which PhD holders find great difficulty transitioning into permanent positions. Tellingly, in the National Science Foundation’s (NSF) *Science and Engineering Indicators 2014* report, the most rapidly growing reason cited for starting a postdoc is “other employment not available” (table 5-19 in National Science Board, 2014, p. 5-34). Recent efforts to make PhD programs broadly applicable outside academia (through the NIH BEST grants and other efforts) have bolstered the argument that a PhD in biomedical sciences is broadly applicable for many careers, but a culture still exists in academia that graduate students should be training only for academic tracks. While there may be some argument for maintaining current levels of graduate student

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Abbreviations used: NIH, National Institutes of Health; NSF, National Science Foundation; STEM, science, technology, engineering, and mathematics.

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numbers, on the condition that they receive training relevant to their own career goals, the benefits of a large postdoctoral workforce are still being called sharply into question.

Despite this, many leading officials have yet to take a position on the issue of the size of the workforce. For example, Sally Rockey and Francis Collins have written that “there is no definitive evidence that PhD production exceeds current employment opportunities” (Rockey and Collins, 2013).

Technically, this is correct, but only because there are *no definitive data at all*. Take, for example, a very basic metric: How many postdocs are there in the U.S. research system? This is clearly a statistic that the NIH should have on hand to make the bold assertion that PhD numbers do not exceed employment opportunities: after all, many PhDs simply transition into becoming postdoctoral researchers. Except, the NIH does *not* know how many postdocs there are. The *Boston Globe* recently reported that, “The National Institutes of Health estimates there are somewhere between 37,000 and 68,000 postdocs in the country,” a tolerance of 15,500 (Johnson, 2014). The NIH’s *Biomedical Research Workforce Working Group Report* gives no concrete numbers, and it qualifies data it does show with “the number of postdoctoral researchers ... may be underestimated by as much as a factor of 2” (National Institutes of Health, 2012, p. 2) One estimate puts the number at a little more than 50,000 (National Research Council, 2011), while the NSF, using data from the Survey of Graduate Students and Postdoctorates in Science and Engineering, estimates 63,000 postdocs,

44,000 of whom are in science and engineering (National Science Board, 2014). From data from Boston-area postdoctoral offices, we are certain the number of postdocs in the Boston area alone approaches 9000, and so we agree with the National Postdoctoral Association that all these estimates are too low and that the number of postdoctoral researchers in the United States is close to 90,000 (www.nationalpostdoc.org/policy-22/what-is-a-postdoc). But the fact that this number is up for debate at all speaks to a need for better accounting practices, especially since alarms have sounded at the pyramidal nature of the workforce for more than a decade (National Research Council, 1998; Kennedy *et al.*, 2004).

While data on the biomedical research workforce are still incomplete, anecdotal evidence suggests graduate students are finally becoming savvier about their professional futures. We conducted an informal poll of a dozen students from across the United States, asking them what they thought of the job market for PhDs at the time they accepted the offer to go to graduate school (Figure 1). Those who entered graduate school earlier reported not considering the job market before starting their PhD; by contrast, those who matriculated more recently reported low expectations, especially for academic careers. While our extremely small survey would suggest that some students are entering graduate school with no expectation of staying in academia whatsoever, their choices are by necessity based on hearsay rather than concrete information.

Therefore we believe that graduate programs and postdoc offices have a moral imperative to inform students and fellows of what

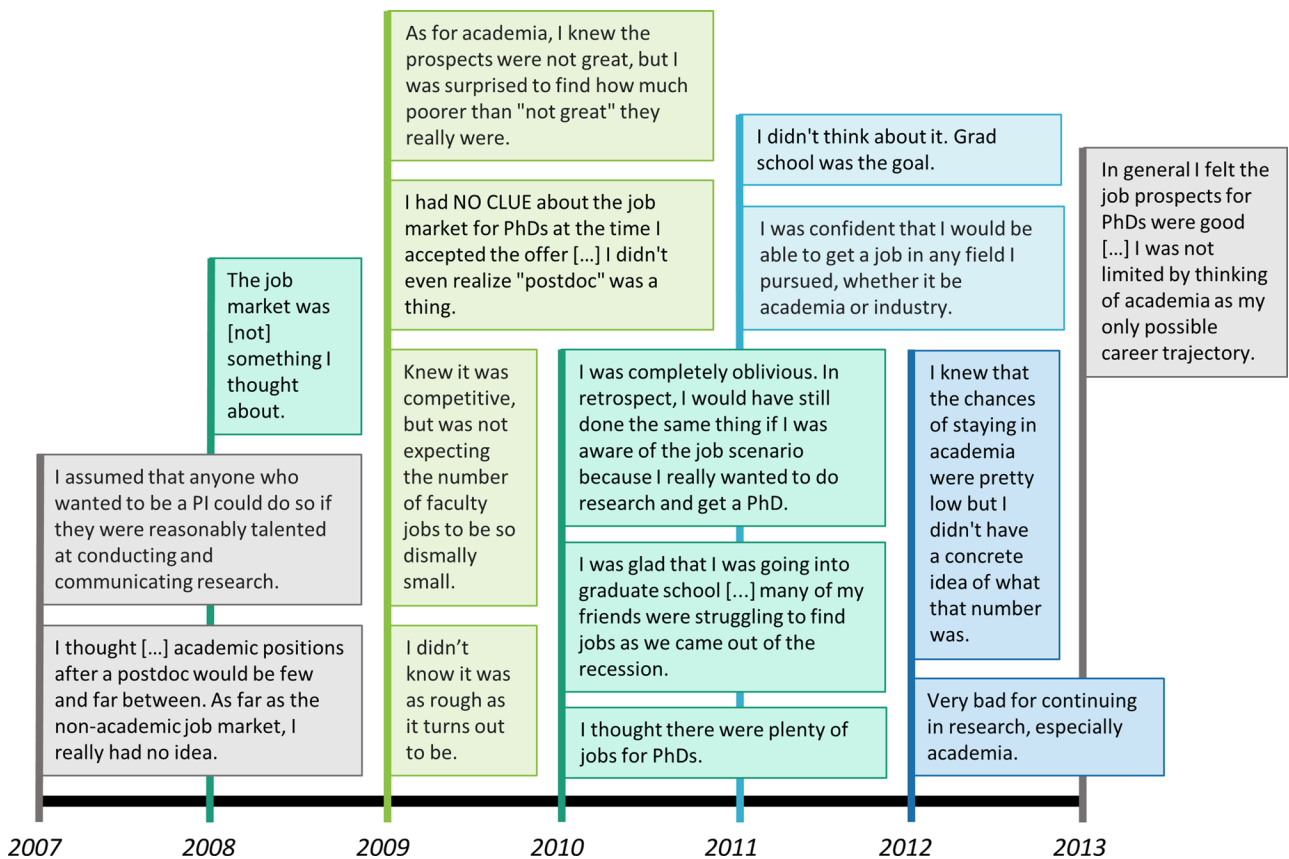


FIGURE 1: Excerpted quotes from survey respondents. The question posed was “What did you think of the job market for PhDs at the time you accepted the offer to go to graduate school?” The year of matriculation is listed below each quote. Full responses are listed in Supplemental Table 1.

they are getting into. We call for increased efforts in collecting and sharing data on student and fellow demographics and career outcomes, such as by conducting thorough exit and alumni surveys. We also encourage our recently graduated peers to cooperate fully with such requests from our alma maters. In biomedical science, some institutions are leading the way on this front, with the University of California–San Francisco and Duke University’s Program in Cell and Molecular Biology posting some statistics online (UCSF Graduate Division, 2013; Duke University, 2015). We believe that there is an obligation for other institutions to follow their lead. In addition, we believe that a culture supporting transparency will ultimately strengthen the scientific enterprise.

First, clear communication of career information may increase student and postdoc productivity down the road. While research shows that postdocs are able to accurately estimate their chances of attaining a faculty position (Sauermaun, 2013), our experience suggests that many current graduate students do not gain this awareness until later in their careers. When rosy illusions are shattered only after an investment of many years, the ensuing disgruntlement can negatively impact trainees themselves, others in the lab, and even entire communities at particular institutions. Instead, making student outcomes more readily available is likely to select for students with realistic expectations of their training. Much like Orion Weiner’s finding that students with prior research experience subjectively perform better in graduate school, trainees who “know what they are getting into” may be more likely to display sustained motivation (Weiner, 2014).

Second, disclosure of these data will act as a catalyst for change. Increased transparency of program outcomes will help hold institutions and programs accountable for the quality of training they provide. Also, increased awareness of the actual career paths chosen by trainees will encourage programs to offer training in skills apart from those required to conduct academic research. Increased instruction in writing, management, and leadership will benefit all trainees, including those who do stay in academic research.

Students’ motivations for entering graduate school are already changing; academic institutions must now discard old rhetoric about the purpose of graduate school and confront this new landscape. It can no longer be acceptable to drive graduate programs purely toward academic career paths. While critics may worry that honesty could discourage some trainees from applying, it will also encourage those whose goals are better in line with their likely outcome. While the research enterprise is changing shape, students and postdocs deserve to enter it with their eyes open.

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