The Future of Science Training: Institutional and Departmental Recommendations from Trainees

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Abstract

For over twenty years, reports from the National Academies of Science, Engineering, and Medicine and other groups have recommended changes to improve the training environments of graduate and postdoctoral trainees and promote a sustainable STEM workforce. In a hypercompetitive climate with a shortage of funds, academic institutions and departments have largely failed to prioritize and implement these recommendations, leading to a lack of change and exacerbation of problems. Here, we describe seven concrete and implementable changes, developed as part of a set of larger guidelines at a national meeting of stakeholders from across career stages, that departments and programs can make to improve their training environments.

Introduction

Ensuring that graduate students and postdoctoral researchers (here collectively referred to as trainees) are well-prepared for successful careers depends on the development of a training environment whose leadership fosters inclusive and effective training practices. Currently, there is a systemic lack of institutional and departmental evaluation of training climates and few incentives to implement best practices. These shortcomings have not gone unnoticed by stakeholders within and outside of academia. The National Academies of Science, Engineering, and Medicine (NASEM), as well as other groups, have released multiple recent reports with recommendations on how to best rescue the academic training system from its myriad flaws and crises (1-5). Unfortunately, a lack of buy-in by departmental and institutional leadership has led to no large-scale, concrete actions (3). Meanwhile, worsening issues such as trainee burnout (6,7) and systemic inequities (8,9) threaten its long-term sustainability. Securing a future scientific workforce and leadership requires widespread investing in training best practices.

On June 14th, 2019, The Future of Research (FoR), a non-profit organization that champions, engages, and empowers early career researchers (including graduate students, postdocs, and junior faculty), convened a meeting of trainees, academic faculty, industry professionals, and departmental administrators from six different R1 university campuses with the goal of developing feasible and actionable recommendations for improving graduate and postdoctoral training. While previous reports (1-4) have taken some stakeholder input into account, our meeting is the first, to our knowledge, to be organized for and by trainees and include attendees from academic leadership across academic research institutions to ensure recommendation feasibility and buy-in. Inspired by the Declaration on Research Assessment (DORA) (<https://sfdora.org/>), the Center for Open Science's TOP Guidelines (<https://cos.io/top/>) and the Athena Swan Initiative (<https://www.ecu.ac.uk/equality-charters/athena-swan/>), we developed a set of nine mentorship climate guidelines, each with bronze, silver, and gold tiers as an easy-to-use tool for those wishing to implement change. Here, we provide a further refined list of seven concrete actions that align with best-practices literature (1-4), as well as concrete examples of programs implementing such changes (*Table 1*).

Table 1. Recommendations. Seven concrete actions for department leadership with examples.

GUIDELINE	EXAMPLES
1. Supplemental Mentorship Departments should require at least one other mentor figure beyond the main supervisor, or the creation of a mentorship committee for graduate students and postdocs.	University of Michigan has recently piloted a mentorship committee program for postdocs (<i>M. Swanson, personal communication, May 2020</i>).
2. Peer Support Departments should facilitate peer cohorts for social support and peer mentorship, particularly where training start times are not synchronized, such as for postdocs.	University of Alabama at Birmingham Dept. of Sociology provides all incoming graduate students with peer mentors. While UW-Madison and Bringham and Women's Hospital have postdoc peer mentorship opportunities, these are not incorporated into training/departmental programming.
3. Required Mentor Training Departments should require mentor training not merely as a compliance exercise, but as an investment into the professional development of their faculty, staff, and senior trainees.	All basic science graduate science programs at UCSF require faculty to participate “in at least one mentorship development activity of their choosing each year they have a student in their lab.”
4. Exit Surveys Departments should require anonymous exit surveys from all trainees and staff, publishing aggregate data to ensure the transparent reporting of a department's climate, diversity and inclusion efforts, bullying and harassment, and trainee mental health.	To date, 53 schools have signed onto the NGLS coalition to “collect and publish data using common standards on their life science training programs.” We highlight University of Northern Colorado for publishing thorough information on student satisfaction with the program, research advisor, and factors associated with choosing their field of study.
5. Clear Guidelines and Timelines Departments should provide graduate students and postdocs with clear guidelines and timelines, beyond grad student qualifying exams; the timing of career stage advancement should not solely depend on the main supervisor or thesis committee.	Schools in the United Kingdom, such as Oxford and UCL , have PhD thesis submission deadlines of 3 - 4 years. Albert Einstein College of Medicine has a committee that “reviews the progress of all students who have been in the program for five years or longer and requests an Exit Strategy from [them]”
6. Standard and Transparent Salary and Benefits Departments should provide trainees with benefits and salaries adjusted for the local cost of living, along with transparent and standardized benchmarks for raises based on years of training.	To our knowledge, the NIH Office of Intramural Training and Education is the only place in the U.S. that enforces standardized benefits and salary floors, adjusted for years of experience, for both PhDs and postdocs.
7. Career and Professional Development Resources Departments should require trainees to participate in career and professional development training and workshops of their choice, allowing for exploration of careers beyond academia.	While many schools provide career development opportunities, we highlight the Graduate School of Biomedical Science at UMass Medical School for their career development curriculum built into the PhD training program.

Recommendations

Supplemental Mentorship

Trainees are normally expected to be reliant on a single person, likely providing mentorship to other trainees, to be the sole mentor. While graduate students may sometimes receive mentorship from members of their dissertation committee, neither they nor postdocs have official programmatic requirements to seek mentorship beyond the main supervisor. Requiring trainees to have a formal mentorship committee that encourages intentional consideration of their training needs serves multiple purposes. First, receiving input and guidance from multiple mentors broadens the training experience by allowing trainees to experience multiple points of view and feedback on specific aspects of their training from different people (4). The mentorship committee should contain mentors from other departments and outside of academia, fostering external collaborations. Adding and removing mentors through deliberate conversation empowers trainees to articulate their specific mentorship needs as they evolve (10). Officially designating multiple mentors can also mitigate power imbalances in the primary supervisory relationship by providing trainees with advocates who do not necessarily have a professional relationship with the supervisor, should conflicts arise. For example, additional mentors may provide letters of recommendation if the supervisor threatens to withhold them. Finally, having multiple mentors reduces the mentorship load on the trainee's primary supervisor, who is normally expected to meet the trainee's psychosocial, educational, technical, and professional development needs (4).

Peer Support

While faculty mentorship is a critical component of training, mentorship from peers may also cater to a trainee's career and psychosocial needs (4). Unlike grad students, postdocs do not usually begin positions synchronously. They therefore often lack the support of peer cohorts within their department, particularly where there are no postdoctoral associations on campus to provide a sense of community. Departments that group trainees into peer cohorts with trained and compensated staff to facilitate peer mentorship discussions on a recurring basis provide trainees the opportunity to personally reflect on their research progress and career development in a non-judgemental and supportive environment. Working in intentional groups creates a sense of community, expands trainees' networks, and helps them cope with academic stress (11). Departments can likewise provide funds for cohorts to organize social events for opportunities to regularly socialize in more informal settings, provided events are safe, inclusive, and accessible to everyone, including neurodiverse trainees and those with social anxiety.

Required Mentor Training

Despite data outlining mentorship best practices (12), most departments continue to take a laissez-faire approach to the mentorship of future scientists, leaving their faculty to experiment with trainees as they implement the traditional ad-hoc apprenticeship model with little to no training (4). While mentor training has become more available in the past years, it is not usually compulsory unless training grants, such as the Howard Hughes Medical Institute (HHMI) Gilliam Fellowship, require it as a funding condition (see *Table 1* for one exception). Anecdotes from trainees, faculty, and staff at our meeting suggest that many of the supervisors most in need of

mentor training, overly confident in their own practices, do not think they will receive any benefit from said training and therefore do not attend, despite studies showing training to be effective (12). To incentivize buy-in, departments should either provide funds for their faculty to attend training sessions or host on-site mentor training for all. Departments should recognize that requiring recurrent mentor training from their faculty is not merely an investment in the next generation of researchers, but also in the career development of their mentors, particularly those early in their careers. Trained mentors can list recurring mentor training in their biosketches and CVs for grant applications, and on their group websites to recruit potential trainees.

Exit Surveys

Anonymous exit surveys can be used to effectively assess the climate of a training environment. Survey data can provide insights into the mental health and well-being of trainees, faculty, and staff; their perceptions of departmental commitment to diversity and inclusion; overall trainee satisfaction with a training program and supervisors; and prevalence of bullying and harassment. Public reports of survey data provide opportunities for leadership to send a clear message to the department about which problems most require addressing and which behaviors are not tolerated. Two caveats for surveys must be taken into account: First, studies have shown that on average, historically underrepresented faculty receive lower satisfaction ratings from students due to unconscious bias (13,14); and second, where instances of harmful behavior are concerned, care must be taken to avoid inadvertently ‘outing’ the person reporting, as the threat of retaliation against whistleblowers in academia is very real (1) and low trainee turnover from a specific lab can lead to easily-identifiable survey data during a given reporting cycle. Best practices for measuring incidences of harassment and abuse should be followed (1). De-identified survey data should be public and transparent to empower prospective trainees and hold administrative leadership accountable.

Clear Guidelines and Timelines

Outside academic work settings, many organizations utilize tiered structured assessments and ratings to define expectations, provide performance feedback, and determine promotion potential. Within academia, there are similar skill development milestones required for degree conferral or completion of a fellowship. However, when a sole supervisor or committee is the arbiter in deciding when milestones are met, there is no accountability for assuring trainees advance in their careers and are not retained due to internal bias, departmental politics, or exploitation for more publications. Ultimately, trainees deserve a transparent understanding of expectations; specifically, trainees should be aware of what training they will be receiving beyond competency in their chosen field, as well as the duration of their training. Transparent communication of expectations can increase trainee self-efficacy, productivity, and commitment to a chosen career path. A clear set of guidelines would not only assist to assure consistency of skills across trainees but also to ensure they have realistic expectations of and limits to the time required to achieve these goals (see *Table 1* for examples). Clear timelines for graduate students and postdocs, while field-specific, can provide a framework with which to hold supervisors and departments accountable for delivering appropriate training within a timeframe

beneficial to the trainee's career advancement.

Standard and Transparent Salary and Benefits

To prevent financial considerations from excluding trainees from pursuing academic careers, it is critical to provide them with clear information on salary and benefits available to them at prospective institutions. Given large gender pay inequities and disparities among graduate stipends and postdoctoral salaries across U.S. institutions (15), this information is particularly important for trainees who are from low-income backgrounds, in high cost of living areas, supporting families, and/or international scholars (16). Disproportionate salaries and benefits have led to a significant number of recent trainee-led protests to improve working conditions and compensation (17). To this end, salaries and benefits should be adjusted for the local cost of living and include publicly available, standardized benchmarks from institutions related to minimum raises based on years of training. Departments should also have clear protections on trainee parental leave, sick leave, and vacation time, and provide affordable childcare for parents regardless of funding source or employee status. Finally, prospective trainees should also be informed of the potential loss of institutional benefits when obtaining certain fellowships or training awards (18). Available data on trainee compensation are scarce. This information should be publicly available, standardized by institutions, and clearly explained in both employment contracts and mentor/mentee compacts prior to having the trainee join a particular institution in which to pursue their research (3).

Career and Professional Development Resources

Over the years, there has been an increasing gap between the number of PhDs in STEM fields and available faculty positions, with only 10-12 percent of STEM trainees transitioning to independent, tenure-track research careers in academia (2). This has resulted in a declining interest in academic careers among trainees and an increasing demand for better, more comprehensive career and professional development resources from their training programs (19). Additionally, while academic institutions benefit from the skills and talents of their trainees, these programs largely focus on preparing them for research-intensive faculty careers. Meanwhile, structured and intentional resources that prepare trainees for non-academic careers are often scarce. For trainees to smoothly transition into non-academic jobs, departments should support their trainees in exploring all available career choices early in their training through individual development plans (IDPs). Career exploration exercises should be followed by options for integrated internship opportunities and specific skill training such as that provided by the UMass School of Biomedical Sciences (*Table 1*). Because supervisors may not be supportive of trainees spending time 'away from the bench' (19), departments must incorporate these activities into their core training requirements. Departments should also track the career trajectories of their alumni and regularly and transparently report aggregate data on graduate career trajectories, as has been previously proposed by various groups and reports (3, 15).

Discussion

The past few years have seen no shortage of reports pointing to the lack of transparency, sustainability, and equity of the STEM training landscape (1-5). One of these reports found a

high overlap of recommendations from the last twenty-five years, the major obstacle to their implementation being lack of buy-in and cooperation among departmental, institutional, state, and federal leadership (3). This reform gridlock and aversion to change has led to the continued widespread discontent among trainees. The myriad of trainee-led strikes and protests this past year (such as those at Harvard, UW-Madison, and the UC system) and reports of dismal trainee mental health are just two indicators of the current crisis which we have slowly boiled to. As recent and current trainees, we welcome readers to think of the opportunity cost of graduate students and postdocs leaving the academic workforce *en masse*, particularly when most leaving are from underrepresented backgrounds. We also ask our readers to ponder the opportunity cost of having those who remain in academic research spend cognitive and emotional energy fighting and reforming an inefficient system that prioritizes publications and grants over trainees.

The large-scale efficacy of many of these reforms has largely been untested precisely because of a reluctance to commit to them fully, despite their aligning with literature on best practices for academic training at smaller scales (1-4). The feasibility of these recommendations is demonstrated by the programs and institutions that have already made a commitment to their trainees by implementing them (*Table 1*). In this unprecedented historical time when the inequities of our society have become more apparent to those who do not experience them, programs and institutions have already been forced to make changes previously thought unfeasible. Forward-thinking departments and institutions that revitalize their programs to more intentionally train the next generation of our scientific workforce will not only see near-immediate gains in their scientific output, they will also be better equipped to recruit and train from the diverse pool of talented graduate students and postdocs.

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