Feature Meeting Report

NEST 2014: Views from the Trainees—Talking About What Matters in Efforts to Diversify the STEM Workforce

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BACKGROUND AND INTRODUCTION

Efforts to diversify the U.S. science, technology, engineering, and mathematics (STEM) workforce have been led by various stakeholders across all disciplines but most notably by the funding agencies and by the trainers (National Research Council [NRC], 2007, 2011; Tabak and Collins, 2011; Wilder *et al.*, 2013). However, missing from this work and these conversations are the voices of the trainees at all levels. While this work has now begun to include the views and opinions of the postdoctoral community (www .nationalpostdoc.org), rarely does it involve trainees at midand entry levels of the pipeline. Interest in faculty careers decreases as training progresses (Gibbs and Griffin, 2013). Additionally, given that the greatest diversity in the scientific community is found at the undergraduate level, followed

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by the postbaccalaureate and graduate levels (Ramdial and Campbell, 2014), there is an urgent need to capture these unfiltered viewpoints that form the foundations for career decisions and actions.

STEM training program analyses aimed at defining what matters in trainee choices, persistence, and motivation have always been guided from the top. Part of this work relies on administering surveys constructed using assumptions and inferences that we as trainers make regarding what motivates trainees and the factors that affect their choices. While useful, these approaches are often derived in prescriptive ways, which can lead to unintended biases by undervaluing or failing to measure the traits and the attributes trainees themselves possess and value, attributes that could be beneficial in contemporary interdisciplinary science. The issue of career choice, persistence, and motivation is a complex matter; discussion should not be limited by top-down decision making or by overly structured theoretical frameworks. Trainee choices are shaped by internal decisions as well as by external factors (Skaalvik and Skaalvik, 2002) that are not always apparent or understood. These may go unrecognized, because adequate time is not given to trainees for reflection. With regard to knowing what matters, trainees must have adequate opportunities to think deeply and reflect on what is important to them and what motivates them most in pursuing STEM careers.

In spite of programmatic investments made over the past 40 yr, only modest gains have been seen in the number of underrepresented minority members (URMs) who join the STEM workforce (Mervis, 2006). Given that program features and training practices designed to increase URM entry into the STEM pipeline and workforce mirror those provided to their non-URM peers, the modest outcome

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achieved to date is disappointing. This outcome indicates that other elements essential for URM trainee recruitment and success may be missing from current training programs, which in turn suggests the need to empower trainees with the agency to contribute to the redesign of the STEM training pipeline by providing them with the opportunity for greater input into discussions aimed at improving practice to achieve better outcomes.

The Northeast Scientific Training (NEST) Programs Retreat was established with three purposes in mind: 1) to provide URM trainees with "a community of scholars retreat setting" as an alternative to the formal and highly structured experience of scientific conferences; 2) to create a venue and environment free from daily distractions, one in which trainees could meet peers and near peers along the entire training spectrum to informally discuss, inform, and question one another about careers, career paths, and choices; and 3) to give trainees the opportunity to formally report their concerns, desires, and recommendations on how to increase URM student involvement in STEM fields and careers. These purposes are linked to the goals of 1) broadening the trainees' views and understanding of the lives of scientists and scholars, and 2) providing trainees with a sense of purpose and empowerment as stakeholders in the future of science and of education in the United States. Figure 1 presents an outline of the 2-d NEST Retreat.

ORGANIZATION OF DISCUSSION GROUPS

Participants were assigned to working groups that were fixed for the duration of the retreat; each group included a mix of undergraduates, graduates, postbaccalaureate students, and postdoctoral fellows, as well as one to two faculty/staff. Initial group meetings took place in the absence of faculty/staff, allowing trainees to get to know one another and engage in peer and near-peer mentoring. These trainee-only sessions, moderated by peer leaders selected by peers from within each group, helped to maximize interactions and discussions about shared experiences and knowledge. Furthermore, the trainee-only group sessions helped 1) trainees speak freely with one another on topics and concerns they would not raise in the presence of faculty, 2) develop trainee consensus around ideas and opinions regarding training by drawing on contemporary and relevant examples from their own experiences, 3) minimize organizer control of the pace and direction of discussions, and 4) establish the parameters of the subsequent full group's work over the course of the retreat. The trainee-only group sessions also allowed trainees to preview the open-ended topics and questions, which were the centerpieces for full-group (groups involving faculty/staff) discussions that would take place over the day and a half that followed.



Northeast Scientific Training & Program Development Retreat Retreat Program

Day 1	Day 2 (continued)
Arrival and Registration (Late Afternoon)	Morning Session Report-Out & Feedback All Participants Lead: Small Groups Representatives (Trainees)
 Orientation: Ground Rules, Roles & Expectations (Early Evening) I. Trainee Orientation Lead: Retreat Organizer 1 II. Faculty/Program Directors Orientation Lead: Retreat Organizer 2 	
	Faculty–Trainee Group Discussion (Facilitator-moderated) (Afternoon) All Participants What are the traits of a good trainee and a good trainer? How do you measure trainee success?
Welcome & Introductions (Early Evening) All Participants Lead: Organizing Committee	
Pre-Dinner Social/Poster Session All Participants	Pre-Dinner Mixer/Poster Session All Participants
Concurrent Group Discussions (After Dinner) Discussion Topic Preview I. Trainee-Only Session II. 'Non-Trainee' Session	Afternoon Session Facilitator & Faculty Report-Out & Feedback (After Dinner) All Participants
Day 2	Day 3
 Concurrent Facilitated Group Discussions (Morning) Facilitator-led Trainee Group Discussions Lead: Individual Facilitators Understanding, Deciphering & Re-Imagining The Pathways to Training and Scientific Careers IF aculty/PD Group Discussion Lead: Retreat Organizer 1 Addressing Challenges & Developing Best Training Practices 	All-Attendee Gathering & Discussion (Morning) All Participants Overall summary of sessions – Presentation of areas of consensus and areas of difference and reconciling differences
	Evaluation All Participants
	END OF PROGRAM

Figure 1. NEST Retreat Program of Activities Daily activities of the day and a half long retreat are presented. Attendees arrived late Friday afternoon of day 1 and departed at noon on day 3. Participants were faculty members, most of whom were training program directors, and trainees, including undergraduate students, graduate students, and postdoctoral fellows. "Attendees" refers to retreat participants and members of the organizing committee.

The morning of the first full day of the retreat was devoted to full-group discussions facilitated by faculty and staff. Faculty and staff were excluded from groups in which trainees from their own institutions were present. During group sessions, participants discussed the open-ended topic "Understanding, Deciphering and Re-imagining the Pathways to Training and Scientific Careers." For the afternoon sessions, the same groups were reconvened, so participants could respond to the following two questions: 1) What are the traits of a good trainee and a good trainer? 2) How do you measure trainee success? For each session, trainees and facilitators summarized in writing the outcomes of their discussions. At the end of the day, one peer-elected trainee leader representing each group was selected to report to all retreat attendees the outcomes and actionable points expressed by their group.

MEETING ATTENDEES

Admission to the 2014 NEST Retreat was competitive and open to all; preference was granted to trainees involved in structured, federally funded, research training programs. Faculty and staff were similarly selected, with preference given to those demonstratively engaged in STEM student training. Attendees came from diverse backgrounds and academic institutions spanning the Carnegie classification system. These included majority-serving institutions, historically black colleges and universities, and Hispanic-serving institutions, large and small, as well as private and public. To ensure that pertinent student viewpoints and experiences were captured, the organizers sought attendees who represented programs at their home institutions that function specifically to increase the participation of individuals from underrepresented groups in the STEM disciplines. Faculty and staff in attendance were also drawn from these programs. Sixteen trainers and 50 trainees from colleges and universities representing undergraduate, graduate, postbaccalaureate, and postdoctoral training programs were invited to participate in a 1¹/₂-d retreat at the Marine Biological Laboratory in Woods Hole, MA. More than half of the trainees were students at various stages of undergraduate training. Most attendees were from the Northeast, representing Brown University, Harvard University, Morgan State University, Northeastern University, Tufts University, the University of Massachusetts Boston, Cornell University, the University of Buffalo, LaGuardia Community College, Pine Manor College, and the College of Mount St. Vincent. Additional attendees represented the University of Michigan, Arizona State University, the Universidad Metropolitana, and Elizabeth City State University. Trainees and trainers present represented the life, biomedical, public health, and engineering sciences. Nontrainees in attendance included faculty and nonfaculty program directors and high-level university administrators.

OBSERVATIONS AND OUTCOMES

The first observation noted at the start of the retreat was that trainees expressed satisfaction in being able to dress casually, which contrasted with their perceived need for a formal dress code at scientific meetings. Some expressed that the ability to dress casually was less constraining and meant they could bring their authentic selves to the retreat.

The retreat began with participants engaging in a competitive exercise in which they were asked to meet as many of the other participants as possible, learning their names and one unique STEM-related feature of the individual, and recording that information. Those who most successfully completed the exercise, which took place informally over the day-and-a-half retreat, received a prize.

Trainees attending the retreat were invited to bring a poster of their most recent research work to display for the duration of the retreat. Trainees presented the details of their work in these posters during two early-evening poster sessions. The poster sessions, which followed late afternoon socials, were held on the first and second evenings of the retreat. These sessions were useful, as they created informal galvanizing conversational settings primarily for trainees and displayed the broad range of scientific work in which trainees are involved. The majority of the retreat's work was accomplished in small groups, which met initially the first evening of the retreat for 2 h. These groups met during the following day for two 3-h group sessions followed by a 1-h evening plenary session in which representatives shared the outcomes of discussions. The open-ended nature of the retreat's discussion topic and questions fostered responses that were directly or indirectly related to the topics and questions posed. Reporting out provided trainees with opportunities to share with their peers and faculty/staff the outcomes of their discussions and to highlight the issues that resonated with them the most. This activity also allowed the process and considerations of career interest formation, desires, and concerns of each group to be shared with all groups.

The final morning of the retreat was dedicated to an overall summary of the retreat discussions that had taken place over the past day and a half, including the previous all-attendee session. This final morning session allowed for clarifications to be volunteered, corrections made, final questions asked, and consensus to be reached about what matters most to trainees, impacting their entry, persistence, and motivation to pursue STEM careers. Here we summarize the outcomes of this reporting out, framed as actionable items:

- 1. Adapt STEM training to include or make room for a social justice component. Trainees expressed the desire for opportunities to do science with a purposeful social justice component, a desire that does not preclude performing traditional bona fide research at the highest level. This desire appears to reflect the sense of disconnect and marginalization that trainees feel within the academy and the scientific community. It also appears to align with their concerns for issues such as health disparities, which are evident for underrepresented/disadvantaged groups. Coincidentally, this issue was recently a featured outreach topic in ASBMB Today, which is published by the American Society for Biochemistry and Molecular Biology (Thompson et al., 2014), indicating that, like so many other issues raised at the retreat, interest in this issue is not unique to URM students.
- Assist us in our desire to better communicate science to nonscientists. Trainees expressed a desire to have their STEM training experience prepare them to communicate science more broadly to nonscientists. This desire appears

to stem from the fact that the families of most trainees have a good understanding of (for example) what a physician does, but very little understanding of what a scientist does. This lack of awareness likely reflects inadequate communication from the science community to the larger world. By increasing public communication and education outreach, STEM trainees, especially those from underrepresented groups, may be able to build greater social and intellectual capital with their communities and thus garner the greater family support many need to persist and succeed in science.

As is the case with inclusion of a social justice perspective, the desire for better communication skills does not preclude performing bona fide research at the highest level. It again suggests the sense of isolation that trainees feel from the broader "lay" community. The failure of scientists to reach these and other underserved communities may create an unintended perception of elitism.

- 3. STEM to STEAM and beyond. Support trainee desires for interdisciplinary cross-talk and training. Trainees recognize the growing need for communication between the physical, life, and biomedical sciences and feel that this is important for the advancement of science. However, they feel that their interest in broader and truly interdisciplinary cross-talk and communication is neither supported or recognized and that little room exists for this type of interest. For them, there is a strong desire for STEM and non-STEM communication and cross-talk. The concept of STEM trainees and practitioners embracing non-STEM fields is a concept promoted by many, including John Maeda, president of the Rhode Island School of Design (http://stemtosteam.org). The premise of this concept is to have STEM trainees value the potential contributions of art and design to the sciences. STEM plus the arts transforms STEM to STEAM, which embodies the vision of interdisciplinary cross talk, training, and practice.
- 4. Educate us earlier rather than at the late graduate and postdoctoral levels about science careers. Trainees felt that their current training experiences should provide more information earlier about the world of research and research career options and paths that can help them understand better, and sooner, all of the things that they can do with a PhD. This desire is not a novel one. What is different, however, is that the current efforts for career planning appear to occur late in the training process, while trainees felt that they needed career information earlier in their training to make the most informed career choices.
- 5. Give better guidance and assistance in achieving work life–family life balance. Trainees expressed that they needed to be informed earlier about how to balance family life with the demanding life of a research scientist. This response affirms that mid- and entry-level trainees in the pipeline grapple with the same issues more senior trainees face. Current efforts in this area, through programs like ADVANCE (National Science Foundation) and other similar programs, are focused on postdoctoral fellows transitioning to faculty positions. More junior trainees, including those at the undergraduate level, face similar and immediate challenges around balancing family life and training life issues. Their challenges may not all be related to childbearing and child rearing, but may include

responsibilities for raising siblings and supporting their families in a nonparental but equally essential family role that oftentimes includes managing financial challenges.

- 6. Re-evaluate the current metrics that fail to value diverse traits trainees can bring to science that may benefit science. Trainees felt that some of their strong attributes are not being utilized or valued in evaluating them as prospective trainees and scientists. These included their capacity to think in truly interdisciplinary ways-connecting STEM field disciplines to other disciplines, including their creativity (all elements of STEAM); and their responsibility, organizational skills, ability to be good listeners, and capacity to develop independence. They felt that these traits, which added to the wholeness of being a scientist, continue to be undervalued. At the same time, trainees expressed concern that gender and other biases persist and that these continue as the by-products of insufficient interaction between trainers and trainees from diverse backgrounds. Cultural differences are still misunderstood in ways that may lead trainees to be perceived as lazy or as not enjoying science. The short summer training experiences these trainees have in labs at research-intensive institutions are not sufficient to address this problem.
- 7. Provide access to invested mentors and graduate school guidance. Trainees continue to feel that they do not have access to invested mentors who show a genuine interest in their careers. They felt that more work is needed to align trainee and trainer expectations. Trainees also expressed that they did not know what their goals should be for a given career path nor did they understand their mentors' goals.
- Create opportunities for ancillary training. Some trainees 8. indicated that greater definition of their areas of STEM career interests came about only after a series of meaningful experiences, at which point they might be 2 yr into an undergraduate or PhD program. The training process, however, committed them to paths that might not completely align with the preferred career interests they developed. These trainees felt that the only way to access those areas that truly interested them was by exiting their current training pathways. Others, who did not recognize some of the options available to them, would simply choose to exit the STEM fields altogether. Trainees asked for solutions to help better align their interests with the training process. Programs are clearly needed to meet this important need. One solution may be the pilot program launched by Brown University (2014), the Open Graduate Curriculum (www.brown.edu/academics /gradschool/opengraduateeducation). This program allows current PhD trainees in one discipline to enroll in a second graduate program to earn a master's degree, thereby receiving training in two complementary areas. A PhD student in pathobiology, for example, whose research focus in cancer biology research may be very basic in nature, may come to realize that his/her interest in cancer research overlaps epidemiology and public health. As part of the Open Graduate Curriculum, such a student would remain in his or her PhD program but could now enroll in the Master's of Public Health Program, resulting in training synergy. Supporting access to similar dual-degree programs accommodates these interests in early ancillary training. Accommodating these interests also has

the potential to lead to the birth and development of new interdisciplinary and emerging fields of study.

RELATIONSHIP OF RECOMMENDATIONS TO THE CURRENT TRAINING FRAMEWORK

Efforts to improve STEM diversity over the past 40 yr have been centered on identifying the key correlates for trainee success at the undergraduate, graduate, postdoctoral, and faculty levels and on providing support accordingly (NRC, 2005, 2011). Numerous published studies seek to define the contexts that promote diversity and engagement leading to pursuit of a science career by underrepresented individuals (Hurtado et al., 2009; McGee et al., 2012). These and other works have contributed to themes that have become universally recognized as critical for trainee success. Critical themes include helping trainees to understand the culture of science; to manage racial and social stigmas; and to develop scientific identity, self-efficacy, and motivation. The persistent deficit of URMs in STEM careers also validates the continued need for structured programs that create opportunities for student engagement in research activities. However, given the poor progress in diversifying the pipeline population and workforce thus far, it is clear that the current architecture and format of these programs is not sufficient for addressing the problem. More nuanced but equally important early-career trainee needs appear to have gone unaddressed, including some of those framed by the recommendations made in this report. It should, of course, be noted that the current report is based on a dialogue with a small sample of URM students (~50) and these ideas need to be vetted with a larger pool of students. When combined with the current knowledge of and efforts to implement intervention practices, the menu of actionable items presented here may provide the critical elements necessary to bridge programmatic and individual STEM aspirations. These are presented in Figure 2 as part of the revised training timeline for STEM trainees. Adopting these recommendations will likely be beneficial, as they would likely strengthen the current frameworks of the various intervention models and program practices designed to improve STEM field diversity, trainee persistence, and success.

LESSONS LEARNED

The NEST Retreat was designed to support a "discovery-driven" approach to training and program development. Many of the issues raised at NEST 2014 are familiar issues, such as those related to family life–work life balance,



Figure 2. The STEM training timeline and accompanying supporting activities. The training timeline moves from left to right; an arrowhead represents the end of one level of training. Standard curricular training at the undergraduate and graduate levels entails completion of "for-credit course work," indicated by the solid black arrows. Research training at the undergraduate, graduate, and postdoctoral levels is shown by the open/transparent arrows. The dashed-line, shaded arrow represents additional and often optional curricular training. Postbaccalaureate training, which occurs between the undergraduate and graduate training periods, is not shown but resembles training received in the terminal undergraduate year. An approximation of the start and duration of the current typical set of supporting activities that accompany formal degree and postdoctoral training is shown above the training line. The proposed revised and reimagined timelines for these supporting activities are shown below the training levels.

mentoring, and career pathways. What is different, however, is the early training levels at which they have been reported to be important, indicating the impact of these issues on entry-level trainees in making decisions about entering the pipeline and persisting to advanced levels. Many of the recommendations made can be addressed by integrating supporting practices into the standard plans at the undergraduate, graduate, and postdoctoral levels, without altering curricular or research expectations of trainees. For example, some of these supporting activities can be accomplished by providing trainees with non-credit bearing short-term educational training modules that deliver the necessary content to respond to trainee needs, while supporting their STEM persistence and success. Modules could be offered sequentially at times that do not conflict with the current training or educational programs. Each module could provide intensive training sessions with 10-12 contact hours offered over a 1to 2-wk period and could be cotaught by faculty and near peers who have had recent experiences in the area (Thompson and Campbell, 2013).

The concepts of including social justice considerations and communication training have never been central to the purview of STEM field scientists. These interests among current trainees may be a by-product of how the application of science in society differs today from its application in past decades and who this application impacts. In addition to sharing their views at the retreat, one group of trainees submitted written comments and summaries of their retreat experiences (Supplemental Material).

The outcomes of this first retreat yielded insights we believe would have gone undetected at traditional scientific gatherings. We expect that much of what has been learned will be incorporated into the training programs that many of us lead as program directors, faculty, and staff. In summary, the overall assessment of NEST 2014 is that much of what was learned points to the dynamic nature of the STEM training pipeline, which we have historically treated as a relatively static structure. Trainee feedback and input can and should stimulate pipeline change. Responding to many of the issues raised above can help us to reimagine the training pipeline as a structure that bends to better address and adapt to trainee interests and that broadens to help trainees to broaden their skill base and to create new training modalities that better serve the STEM disciplines.

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