



Professional
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hub



Enhancing Dissemination of Evidence-Based Models for STEM PhD Career Development

A Stakeholder Workshop Report



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Janelia Research Campus of the Howard Hughes Medical Institute, Ashburn, VA

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Preface

As we prepared this report and began to move actions forward, global events—including the COVID-19 pandemic and renewed acknowledgment of systemic racism—changed the world in which we were operating. The COVID-19 pandemic necessitated immediate change in graduate and postdoctoral training, shutting down labs and field work and moving educational programs online, while navigating additional impacts such as travel and visa restrictions for international scholars. National and global events rapidly heightened accountability for institutions, organizations, and individuals across stakeholder groups in graduate and postdoctoral education to reflect on racial inequity and injustice, the value of diversity in STEM, physical health and safety, and mental health and well-being for early-career scientists. PhD and postdoctoral education, which tend to evolve over years or even decades, have experienced rapid change and reflection in a matter of only a few months.



We can only begin to see ways that the global events of 2020 will impact graduate and postdoctoral education long-term. However, if anything, these events have demonstrated the importance of preparing PhD-level scientists adept in a host of professional skills. For example, creating a diverse, inclusive, equitable, and just scientific enterprise requires scientists at all levels to be able to listen, respect, self-assess, and communicate with others to dismantle racism and effect change. The rapid development of scientific advances to address emergent national crises requires interdisciplinary collaboration and teamwork, networking, project management, and communication skills. Building public trust in science, which is essential for implementing and enacting effective short- and long-term health and science policies, requires that scientists are able to interpret and communicate science for both the public and for policy makers.

These events have also demonstrated gaps and challenges in current educational structures for career and professional development. Economic impacts of the pandemic, including hiring freezes at universities, have revealed the risk in allowing graduate and postdoctoral education to be focused on academic careers, and how critical it is that PhDs be able to nimbly adapt for movement into different sectors and roles. Unfortunately, budget cuts are now threatening career and professional development programs, which continue to be seen as extracurricular to, rather than as core and essential for, graduate and postdoctoral education. At the same time, disruptions to academic

and research environments have exacerbated pre-existing challenges in mentorship. Strengthening professional development and mentorship, and integrating core themes such as mental health and well-being, cultural awareness, and combating systemic racism, will be essential as we move forward in supporting our most vulnerable populations, including students from underrepresented and marginalized groups, who can be disproportionately impacted by crises.

Though recent events have created challenges for professional development and mentoring, they have also created opportunities. Normalizing virtual work and moving national conferences online have the potential for making mentoring, networking, and professional development opportunities more accessible and inclusive. Heightened awareness of biases, xenophobia, and racial injustices open the door for reflection on educational practices and opportunities to innovate in ways that will lead to lasting change.

As policy makers and educators respond to these global events, our hope is that the professional development of graduate students and postdocs will be recognized as a key mechanism to support change, and that findings in this report will inform steps toward a broader vision of long-lasting, impactful change for graduate and postdoctoral education.

Cynthia Fuhrmann, December 2020

Executive Summary

Sustainability of the scientific enterprise requires being able to recruit, retain, and prepare ongoing generations of PhD-trained scientists ready to adapt with the evolving needs of the scientific workforce and society. The need for scientists in a variety of roles both within and beyond academe necessitates a broadened, trainee-centered view on training—including a focus on career planning, science across sectors, and development of professional skills. The evolution of doctoral and postdoctoral education to more directly address the career and professional development needs of future scientists has been raised in numerous national reports, tying this issue to trainees' mental health; diversity, equity, and inclusion in science; as well as scientific workforce development. Although there is energy and movement to enhance graduate and postdoctoral training, actions remain disparate, leading to inefficiencies in implementation and lack of systemic change. The 2019 Stakeholder Workshop, *Enhancing Dissemination of Evidence-Based Models for PhD Career Development*, was designed and implemented by the Professional Development Hub to advance stakeholder recommendations to action.

At this stakeholder workshop, held at Howard Hughes Medical Institute's Janelia Research Campus, organizations and individuals came together across stakeholder groups to hear new perspectives, see challenges through new lenses, and work together to define actionable next steps. Discussion focused on enhancing the development, dissemination, and wide-spread implementation of evidence-based practices for STEM graduate and postdoctoral education, with specific emphasis on career and professional development for PhD scientists. The fifty workshop participants represented nine key stakeholder groups: career development practitioners, scientific societies, disseminators, education researchers and evaluators, employers of PhD scientists, funders, professional associations, trainees, and university leaders and faculty. In addition, participants spanned different races, ethnicities, genders, disciplines, sectors, geographic locations, career stages, and levels of institutional resources.

Building on a decade of reports calling for a shift in graduate and postdoctoral education, this workshop represented a key step and catalyst for change. This report presents cross-cutting themes identified through intra- and inter-stakeholder discussion, along with examples of stakeholder-specific perspectives and actionable next steps. The goal is to stimulate discussion and broaden impact across the STEM community as we move actions forward together.



Taking the discourse and turning it into an application—something we can build action around—is really important. We owe it to future generations of trainees.

Stephani Page

Four key challenges to systemic change advancing PhD career and professional development

- The need for a trainee-centered perspective in PhD training
- The challenge of undervaluation of PhD career and professional development
- The challenge of misaligned incentive and reward structures for enacting change in graduate and postdoctoral education
- The need for cross-stakeholder communication and collaboration

Five critical actions for advancing evidence-based practices in PhD career and professional development

- Incentivizing change at institutions and programs, and establishing accountability
- Curating and disseminating resources for evidence-based career and professional development models in a way that supports widespread implementation
- Broadening and deepening evidence for effective career and professional development training and mentoring
- Improving communication within and across stakeholders in STEM PhD education
- Creating definitions and expectations for STEM PhD career and professional development

Enhancing Dissemination of Evidence-Based Models for PhD Career Development; **A Stakeholder Workshop Report**

Background

To address the complex challenges facing the world today, the scientific enterprise needs to continue attracting talented individuals into STEM and preparing them for the diversity of careers in which they are needed. Though fewer than 20% of PhDs move on to tenure-track faculty positions, PhD and postdoctoral education continues to focus on academic career outcomes, relying heavily on the traditional apprenticeship model of training.¹⁻⁴ A national movement is underway, bringing the career and professional development (CPD) of PhD scientists to the forefront of discussions about diversity, equity, and inclusion in science; mental health; workforce development; and sustainability of the scientific enterprise.^{1,4-12} However, actions for change to enhance CPD remain disconnected, leading to inefficiencies in implementation and innovation.

Key reports have brought attention to this topic, pointing to the need for enhanced CPD training within graduate and postdoctoral education, and for greater coordination among stakeholders to make this change. A report by the Council of Graduate Schools in 2017 defined the landscape of university CPD efforts across STEM graduate education, advocating for accessibility to evidence for program effectiveness and calling for greater coordination across stakeholders to enhance CPD.¹¹ The report from the 2017 Future of Bioscience Graduate and Postdoctoral Training meeting recommended that PhD training curricula be modernized to incorporate CPD, noting that stakeholder collaboration would facilitate these efforts.¹² The American Chemical Society's report *Advancing Graduate Education in the Chemical Sciences* recommended that scientific societies, universities, and funders provide resources and incentives to enhance PhD CPD.⁸ In 2018, two reports from the National Academies of Sciences, Engineering, and Medicine^{1,4} reinforced these recommendations, noting that ensuring that STEM PhD students achieve core professional competencies will require "focused actions by every stakeholder" to make "changes in both policies and practices throughout the system."¹⁴ Taken together, these national reports have called for greater coordination, resources, and expertise to support the development and dissemination of evidence-based approaches to enhance the preparation of PhD trainees for scientific careers. The Stakeholder Workshop described herein builds upon this prior work to move from recommendations toward collective action.

Bringing Stakeholders Together to Catalyze Change

For the past four years, a group of engaged stakeholders has been laying the foundation for an initiative to address these goals. The concept arose from the Summit on Sustaining the Biomedical Research Enterprise, hosted in 2016 by the American Society for Biochemistry and Molecular Biology (ASBMB). At the summit, leaders in the biomedical sciences representing funders, societies, universities, and employers proposed establishing a central mechanism for disseminating evidence-based practices for PhD CPD.^{10,13} Building with support from the ASBMB, the Burroughs Wellcome Fund, and University of Massachusetts Medical School, what emerged is a cross-stakeholder, cross-disciplinary STEM national initiative—called **Professional Development Hub**, or **pd|hub**—to address these challenges.

To define and catalyze first actions, pd|hub hosted a Stakeholder Workshop, *Enhancing Dissemination of Evidence-Based Models for STEM PhD Career Development*, with support from National Science Foundation and Howard Hughes Medical Institute, at the Janelia Research Campus in July 2019. The Stakeholder Workshop united 50 individuals—including leaders in



We have to change the way that we train PhDs and postdocs. It has to be more holistic, thinking about how they will translate the skills they are learning into different kinds of careers.

Erika Shugart



PhD education and professional development; experts in dissemination, CPD practice, evaluation, and workforce needs; and influencers of education and science policy (see Appendix B)—to define actionable next steps for enhancing the dissemination and implementation of evidence-based educational approaches for PhD career development.

The Stakeholder Workshop built on prior reports and efforts by convening this diverse set of stakeholders as equal voices in the room, allowing the discussion to move beyond prior workshops to address the specific identified challenge of promoting the dissemination of evidence-based practices. Stakeholder groups included career development practitioners, disseminators, education researchers and evaluators, employers of PhDs, funders, professional associations, scientific societies, trainees, and university leaders and faculty. The participant group also reflected diversity in racial and ethnic makeup, gender, discipline, sector, geographic location, career stage, and levels of institutional/organizational resources. To our knowledge, this was the first time that a balanced representation of this breadth of stakeholders was brought together to participate in discussions, creating an interactive, cross-cutting opportunity to address critical issues in graduate and postdoctoral CPD.

pd|hub's emphasis on stakeholder engagement is predicated on the recognition that meaningful interactions across stakeholder groups is critical for successfully addressing systemic challenges in graduate and postdoctoral education. Each stakeholder group has distinct roles, perspectives, resources, and biases. Enhancement of PhD education has often been hindered by individual stakeholders working in silos;

this stakeholder workshop—and the broader, ongoing pd|hub initiative—leverage working together as a key strategy for creating change.

We structured the workshop to use individual reflections, stakeholder-specific group discussions, mixed-expertise small group discussions, and full-group discussions to (1) define critical needs, challenges, and barriers hindering the spread of evidence-based practices for PhD CPD, and (2) define actionable steps that stakeholders will take responsibility to pursue. These discussions were informed by theories of organizational change and undergraduate STEM education reform¹⁴⁻¹⁶ via dissemination of pre-workshop materials and a diverse array of speakers, which also included stakeholders representing expertise in career development, diversity, equity, and inclusion, and funding and dissemination of educational practices (see Appendix A for full agenda and group activities).

In this report, we synthesize findings from the workshop to create a systemic view of needs and actions discussed across stakeholder groups—including a list of actionable next steps to be moved forward by individuals, stakeholder groups, and national efforts. The ideas in this report are suggestions by individuals representing different stakeholder groups. The synthesis of ideas is across stakeholder groups, rather than from a single stakeholder perspective; instead of attempting to be inclusive of all challenges, the goal was to identify challenging issues that impact multiple stakeholders. This workshop and report represent a critical step forward by intentionally moving from a discussion of needs and challenges to proposing and taking responsibility for practical actions to promote CPD efforts in STEM PhD education.

The diversity of the people in the room—it has been really exciting. This is the way we can change the system: working together toward a commonly understood goal.

Bob Mathieu



Needs, Challenges, and Barriers from Stakeholder Perspectives

Small group stakeholder discussions provided an open forum to explore the challenges and barriers that face dissemination of evidence-based models for STEM PhD CPD. Challenges were first collected from individuals via a pre-workshop questionnaire and an in-workshop exercise, then discussed in stakeholder-specific small groups. Subsequent full-group discussions were engaging and impassioned, identifying commonalities and distinctions among participants. Opinions were self-reported by the stakeholders, recorded by facilitators, and synthesized by the authors (Table 1). Four cross-cutting themes emerged.

The Need for a Trainee-Centered Perspective in PhD Training

A central theme repeatedly raised across discussions was that trainees' CPD is impacted by challenges they face in other facets of their training experience. Holistically considering the challenges in trainees' CPD means considering aspects beyond centralized curricula and training programs, such as mentorship,¹⁷ trainee agency, and institutional culture.⁶ When a systems-level approach is not taken to assess and address gaps in trainee CPD, trainees suffer from lack of empowerment, sense of belonging, and cohesive communities of support. Among other outcomes, this can have substantial negative effects on trainees' health and well-being.^{7,18}

The Challenge of Undervaluation of PhD Career and Professional Development

Workshop attendees observed that CPD, at a systems level, is frequently considered to be extracurricular to research training rather than valued as a core activity. There were multiple examples raised in discussions that linked to this underlying challenge: misaligned expectations of support between trainees and faculty advisors, under-valuation of the work of CPD practitioners, low priority placed on empirical support for educational models, and a mismatch between academic PhD preparedness and industry/employer expectations.

This overarching challenge hampers the spread of evidence-based practices for enhancing trainee CPD. A question underlying this challenge was how to encourage prioritization of CPD as an integral part of graduate education. Potential advocates for CPD, such as funders, institutional leaders, and/or policymakers, who have the resources and influence to motivate change, are often unaware of the value of and needs in the area of CPD. The challenge is to build a culture that values PhDs moving into diverse careers across sectors, supports customized approaches to facilitating those transitions, embraces CPD as a core element of graduate and postdoctoral training, and engages stakeholders who can bring unique expertise to enhancing CPD approaches.

The Challenge of Misaligned Incentive and Reward Structures

Workshop discussions pointed to the lack of incentive structures—such as those that can be developed by funders, institutional leaders, or policymaker—as a

major barrier to the propagation of evidence-based CPD approaches. One misaligned incentive is a lack of resources (such as time and money) dedicated to CPD activities, which manifests differently for different stakeholders. For example, many scientific societies and professional associations have limited time and resources to dedicate to addressing CPD as one of many education and workforce issues. Career development practitioners, though funded to enact CPD programs, may not have sufficient funds or time to rigorously evaluate or disseminate the programs they create, and doing so can be viewed as a distraction from their core job responsibilities.⁶ Other misaligned incentives include a dearth of training and reward structures for staff, faculty, and institutions to prepare and/or recognize strong mentorship and excellence in CPD training; for education researchers to communicate with practitioners; and for universities to emphasize CPD as a core part of training for doctoral students and postdoctoral fellows.

The Need for Cross-Stakeholder Communication and Collaboration

Several groups alluded to the urgent need to connect across stakeholders to address issues in PhD CPD. One of these critical connections is bridging research and practice. With minimal interdisciplinary collaboration between social scientists and education researchers, and the STEM researchers who train PhD students and postdocs, there is limited awareness and adoption of evidence-based educational practices—particularly in graduate and postdoctoral education.

Attendees reported other gaps in communication and interaction between stakeholders. For example, there is a lack of collaboration between employers and educational institutions to achieve shared goals of enhanced PhD trainee development, and there are distinctive discrepancies in the skills and knowledge expected of PhD graduates by academic institutions versus other PhD employers. As another example, journals are often not connected with the experts most appropriate to assess manuscripts submitted on CPD educational practices, risking propagation of ineffective practices. Siloed efforts limit the expertise available to focus on important actions, and this lack of communication was noted for generating significant inefficiency, such as overlap and duplication of efforts.

Challenges and Actions Self-Reported by Stakeholder Groups

| Stakeholder Group | Description & Examples of Group | Challenges & Barriers | Actions & Areas of Agency |
|---|--|---|--|
| Career development practitioners | An educator with a primary role specializing in pedagogy for CPD; e.g. career counselor, assistant dean of CPD, postdoctoral affairs specialist | Lack of time, funds, or support to access evidence-based models or to evaluate or publish their own work | Define CPD; Curate evidence-based training modules; Build community of practitioners interested in research; Develop a database of experiential learning opportunities |
| Disseminators | Specialists in dissemination through mechanisms such as journals or train-the-trainer activities | Limited access to knowledge about effective practices in CPD | Disseminate resources along with their evidence basis; Connect with experts in the field to better assess effectiveness of practices prior to dissemination; Help develop a narrative |
| Education researchers and evaluators | Individuals whose research expertise is in education, and/or who are skilled in evaluating educational programs | Empirical evidence to inform practice and support educational models is not valued | Synthesize the existing research; Compile valid metrics/benchmarks/instruments; Lead training opportunities; Contribute to platform that shares this info and facilitates conversation |
| Employers of PhD scientists | Representatives of organizations that hire a large number of STEM PhDs; e.g. those who work in companies, hiring managers, human resources professionals | Companies are more invested in role-specific career development, and in training professionals post-hire | Identify champions working in businesses as ambassadors to support academic-industry efforts; Develop business case for CPD; Help develop guidelines for curricula that businesses value |
| Funders | Representatives of agencies, foundations, and other organizations that fund scientific research or innovation in doctoral and postdoctoral training | Lack of data for evidence-based decision-making for funding; Lack of a definition of CPD | Adopt a definition of and guidelines for CPD; Connect practitioners and funders to discuss the movement; Incentivize change |
| Professional associations | Representatives of organizations whose members are higher education institutions | Limited resources and the need to prioritize those resources | Influence policy at a national level that trickles down to members; Promote behaviors among their members that support effective CPD |
| Scientific societies | Representatives of membership organizations of scientists and for scientific disciplines | Funding available to do CPD is becoming more limited; Lack of coordination across societies | Unite society voices behind a single message valuing CPD; Connect to leverage resources across multiple societies and with other stakeholders to support CPD of members |
| Trainees | PhD students and postdoctoral scholars in STEM fields | Lack of faculty and institutional support for trainee CPD | Tell their own stories to inform the conversation; Co-develop expectations and training goals; Participate in and help build communities to address CPD issues |
| University leaders & Faculty | Training program directors, thesis advisors or committee members, and academic leaders (e.g. deans, provosts) | Misalignment of trainee needs and mentor goals, lack of faculty mentor training, lack of data on how to improve CPD | Implement faculty training that must be completed in order to accept trainees, along with assessment and accountability; Create incentives at multiple institutional levels |

Critical Actions for Stakeholders

A major aim of this workshop was to move from the discussion of needs and challenges, to proposing and taking responsibility for practical actions. Systemic, lasting change will require actions pursued collaboratively across stakeholders, as well as individually by stakeholder groups. We used iterative rounds of break-out discussions—both within and among stakeholders—to define actions that participants felt their communities had control over and would pursue. These discussions converged on five common threads of critical actions that stakeholders are willing and able to move forward to transform the landscape of STEM PhD CPD.

1 Incentivizing change at institutions and programs, and establishing accountability

Individuals at the workshop strongly encouraged the creation of incentives—for STEM PhD and postdoctoral programs, and for faculty—to elevate CPD practices as a core element of training, emphasizing that central programs, curricula, and individual mentorship each play critical roles in STEM PhD CPD. Workshop participants recommended specific levers for change—including alignment of expectations for grants, awards, promotion, and tenure—from various influencers in STEM, in particular funders and universities. Within universities, participants suggested that department-level incentives would be most effective. New retention, promotion, and tenure (RPT) guidelines should include evaluation of a faculty member's mentoring, advising, and teaching efforts toward career and professional development, and faculty committees could attain training for incorporating these values into the RPT evaluation process. To be effective, this action area would comprise setting and tracking metrics to determine progress toward goals, making those results transparent, and holding people accountable for upholding new expectations. Furthermore, awards and recognition for departmental achievements in mentoring, rather than individual advisors, was suggested as a way to incentivize the adoption of new guidelines and expectations.

To address this action area, *funders* at the workshop suggested that they could incentivize adoption of new models and expectations; *professional associations'* representatives and members at the workshop shared that associations could act to influence policy at the national level and promote adoption among their institutional members; *university leaders and faculty* at the workshop indicated that they could create incentives to encourage adoption of effective models, assess programs, and promote faculty mentor training and accountability; and *education researchers* at the workshop suggested a role in leading trainings, for example on evidence-based practices in mentoring.²⁰

2 Curating and disseminating evidence-based CPD models in a way that supports their widespread implementation

To leverage what is already known in the field, workshop participants defined actions to help the community share, access, and implement effective, targeted CPD for STEM trainees. For example, curated training modules, with guidance for educators in how to tailor and implement evidence-based CPD training approaches, could support practitioners in building out program curricula. Linking these modules to reports on effectiveness could help practitioners make the case for implementation at their institutions, companies, or organizations. Citing studies of systemic change in undergraduate STEM education,^{15-16,19} workshop participants also suggested going beyond dissemination to train adopters in how to effectively implement these curated models.

To take action, *career development practitioners* indicated that they could help curate existing resources and trainings to promote effective practices in STEM PhD CPD. *Education researchers and evaluators* suggested that they could synthesize existing research to facilitate the influence of evidence on CPD training practices. *Disseminators* suggested that they could advise on curation methods and help disseminate CPD training resources via publications, webinars, and meetings. *Employers* indicated that they could help develop guidelines for curricula that address workforce needs.

3 Broadening and deepening evidence for effective CPD training and mentoring

Workshop participants suggested that the community's understanding and valuation of CPD educational practices would be bolstered by evidence of effectiveness. Evidence-based practice is critical for improving educational outcomes, avoiding unintended consequences, and supporting trainees with diverse backgrounds. Participants discussed strategies for facilitating rigor in evaluation (including development of training, resources, and infrastructure), communication of evidence, and the translation of evaluation and research into CPD educational interventions. For example, development of evidence-based practices could be facilitated via a collection of resources summarizing key social sciences theories or research findings, along with examples for how to apply those in practice. In addition, the community could develop clear standards for publishing articles on graduate education practices, helping readers distinguish exploratory approaches from those with rigorously-demonstrated effectiveness. Together, these and other actions would better connect research and practice, increase the likelihood of adopted practices being evidence-based, and facilitate practitioners' and STEM researchers' participation in the development of the evidence basis for CPD programming.

To take action, *education researchers and evaluators* suggested that they would work with practitioners to support the development of skills in education research and evaluation, develop resources to connect research to practice, and enhance assessment and evaluation of practices. *Disseminators, practitioners, and education researchers and evaluators* suggested that they would work together to develop standards and infrastructure for dissemination of resources that more clearly delineate the underlying evidence basis.

4 Improving communication within and across stakeholders in STEM PhD education

Workshop participants emphasized two methods through which improved communication would catalyze systemic change. First, workshop participants suggested developing coordinated networks of stakeholders interested in STEM PhD CPD. The workshop demonstrated the power of communication across multiple stakeholders as a united community, as well as the importance of communication of individuals and organizations within stakeholder groups. Specific suggestions included employers and universities working together to connect trainees to professionals and PhD internship opportunities, and stakeholders working together toward common goals such as enhancing CPD for underserved populations.

Second, workshop participants recommended leveraging data and narratives to develop clear, compelling, and targeted messaging to communicate the importance of CPD for STEM PhD and postdoctoral training. One specific suggestion was to shift the narrative from “training for a career” to “gaining skills and agency,” which could bolster efforts to facilitate a culture shift within the academic sector toward embracing CPD. Strategic and focused communications would recruit and empower early adopters, who could work at the forefront to advocate for local and national policies to advance CPD. By working together to improve communication within the scientific community, stakeholders could bring compelling stories forward and have a more powerful collective impact.

To take action, *trainees* suggested that they could engage with communities and tell their stories to inform the conversation, *scientific societies* indicated that they could form a unified voice to advocate for CPD at local and national levels, *employers* suggested that they could support academic-industry communication, *funders* indicated that they could facilitate practitioner-funder communication, and *disseminators* suggested that they could help develop narratives to communicate the importance of CPD in STEM PhD education.



Who benefits if the system doesn't change? If we don't change the system, what is going to happen to the diversity of students we are trying to recruit?

John Vasquez

5 Creating definitions and expectations for STEM PhD career and professional development

Workshop participants recognized a need to coalesce around a clear definition of CPD in the context of STEM PhD and postdoctoral training, including setting expectations for training, mentoring, and reporting outcomes. This would make it easier for changemakers to incentivize and promote CPD. For example, defining CPD would be a critical step to enable funders to support work in this space, and creating definitions and metrics for faculty mentoring in CPD would allow for incentivization of faculty to this end.

To address this action area, *career development practitioners* and *employers* suggested that they could define CPD expectations needed for diverse career outcomes, *education researchers and evaluators* suggested that they could compile existing research to establish metrics and benchmarks for definitions and expectations, and *university leaders* felt that they could disseminate and implement definitions and expectations. *Funders* indicated that they could leverage these newly articulated definitions and guidelines to clarify expectations for training- and research-grant awardees, and to more easily identify areas in CPD-related education or research that need further funding support.

Initial Actions Moving Forward

To leverage the strength of cross-stakeholder collaboration, multiple actions are already coming together as part of Professional Development Hub (pd|hub). Initial actions include:

- **Creating a pd|hub Coalition of Higher Education Organizations** committed to advancing CPD as a core component of doctoral and postdoctoral training (from “Improving communication”). Coalition members are national organizations focused on enhancing graduate and postdoctoral education, with a commitment to supporting the diverse career pathways available to PhD graduates. The idea for this Coalition was fleshed out by organization leaders during the Stakeholder Workshop as a way to connect, exchange ideas and resources, and leverage collective efforts toward shared goals. The Coalition launched in Fall 2019 and continues to meet bi-monthly.
- **Seeding a group of scientific societies** interested in working together to advance PhD and postdoctoral CPD (from “Improving communication”). A group of staff from six scientific societies who connected at the Stakeholder Workshop have continued meeting, forming a group in partnership with pd|hub to share ideas and resources that apply across disciplines and collaborate on projects. This group’s first joint project launched in June 2020.
- **Organizing a cross-stakeholder group of individuals to move forward actions to build capacity for evaluation and research in PhD career development** (from “Broadening and deepening evidence”). The group is laying out specific plans and proposals for next-step actions in this area.
- **Coalescing expertise and support to disseminate—and support implementation of—evidence-based approaches for graduate and postdoctoral CPD** (from “Curating and disseminating resources”). We are building toward a nationally-sourced, competency-themed set of collections of evidence-based professional skills models, with training and mentoring to support faculty and staff in implementing these models at their institutions, and infrastructure to support authors of educational models in disseminating their work. This project was recently awarded a 5-year grant by the National Institutes of Health to develop the first two collections, with the first collection launching in 2022.
- **Expanding engagement with broader communities of stakeholder groups** to continue defining next-step actions (from “Improving communication”). pd|hub has hosted workshops, listening sessions, and gatherings at conferences and will continue to do so moving forward, leveraging partnerships with organizations to broaden reach and build on priority action areas defined at the Stakeholder Workshop.

Conclusion

This Stakeholder Workshop was designed to catalyze action in a key area of need identified by previous workshops and reports: the dissemination of evidence-based practices in graduate and postdoctoral education, with career and professional development as a unifying focus for discussion. To stimulate new ideas and initiate an interdisciplinary community working together for change, we brought together a unique mix of stakeholders, including leaders and more junior colleagues, representing a wide variety of organizations, institutions, and areas of practice in STEM, to interact with one another in a retreat-like atmosphere. By design, workshop discussions identified actions that individuals and organizations could immediately start putting into motion.

The workshop demonstrated the value of working together across stakeholders, bringing a palpable energy to discussions and individual commitments for moving forward. Participants expressed strong interest in furthering networks within and between their stakeholder groups to address challenges facing STEM PhD CPD. As described in “Initial actions”, multiple actions are coalescing as cross-stakeholder efforts connected via pd|hub, seeking to enact practical, cross-cutting solutions for lasting, systemic change. Moving forward, pd|hub will be a hub of resources and a facilitator of collaboration, building capacity to empower and support the community to make change.

The stakeholder statements synthesized in this report are a call to action. These actions will move us toward a future where graduate and postdoctoral education fully integrate effective, trainee-centered CPD as a core component, thereby acknowledging CPD’s critical role in the development of a diverse scientific workforce. We envision robust cross-stakeholder and cross-discipline communication and collaboration that will value, incentivize, and support the creation, dissemination, and implementation of evidence-based CPD practices in training and mentorship. These goals are essential for cultivating a diverse, equitable, and inclusive scientific workforce ready to address the future needs and challenges facing science and society.

Connect with pd|hub to join us in this collaborative effort.

Visit pdhub.org
or follow us on Twitter @pdhubSTEM.

Acknowledgments

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Participants met July 11–12, 2019 and stayed onsite for this retreat-style workshop at the HHMI Janelia Research Campus in Ashburn, VA. Attendees participated in a pre-workshop survey, design thinking activities, stakeholder breakout discussions, mixed-stakeholder breakout discussions, and writing activities.

Key themes were captured via note-takers, post-it notes, and, in the case of full-group discussions, video recordings. Individual thoughts were also recorded in a pre-workshop survey, a handwritten reflection immediately post-workshop, and reflection via survey following the workshop. The opinions were compiled by the workshop organizers and analyzed for common themes among stakeholder groups, resulting in this report.

Day 1

Thursday, July 11 | Framing Needs, Challenges, and Opportunities

- 1:30 pm **Welcome and introductions.**
- 2:30 pm **Design thinking exercise:**
Needs, challenges, and solutions
- Explanatory Note:** Participants were asked to reflect and record on post-its: *What are the greatest challenges holding back the innovation and spread of effective evidence-based practices to prepare early-career scientists for their future careers?* Post-its were then clustered into themes:
- Disconnected stakeholders
 - Disseminating, accessing, and implementing evidence-based approaches
 - Incentive and reward structures
 - Institutional culture
 - Mentor preparation/mindset
 - Misaligned goals of trainees and faculty
 - Money and time
 - Undervaluation of career and professional development
- These needs and challenges also reflected those brought up in a pre-workshop survey.
- Participants were also asked to reflect and record on post-its: *What are solutions? What change would you like to see to address these challenges? What infrastructure or resources or efforts can we collectively move forward?* These “action” post-it notes were placed in “action parking lots” around the room, to be reserved for discussion on Day 2.
- 2:45 pm Break
- 3:00 pm **Small group stakeholder discussions & report outs:**
Defining stakeholder-specific needs, challenges, value propositions, future vision
- Explanatory Note:** Workshop participants shared their perspectives on the needs and challenges in PhD career and professional development within small stakeholder groups. Conversation summaries were reported out to the full group. Participants were encouraged to continue writing down action-oriented ideas on post-its for the “action parking lots”.



- 4:30 pm Break
- 4:45 pm **Panel and Discussion: Dissemination of evidence-based educational approaches**
- Discussant:
Ann Austin, Associate Dean for Research, Professor of Educational Administration, Michigan State University
- Panelists:
Laura Regassa, Program Director, Division of Graduate Education, National Science Foundation; Professor of Biology, Georgia Southern University
Charles Henderson, Co-Director, Center for Research on Instructional Change in Postsecondary Education, Western Michigan University; Senior Editor, *Physical Review - Physics Education Research*
Christine Pfund, Director, Center for the Improvement of Mentored Experiences in Research, University of Wisconsin—Madison
Bill Lindstaedt, Assistant Vice Chancellor, Career Advancement, International & Postdoctoral Services, University of California, San Francisco
Kimberly Griffin, Associate Professor of Student Affairs, University of Maryland; Editor, *Journal of Diversity in Higher Education*
- 6:15 pm Break
- 6:30 pm Dinner on-site, supporting continued mixed-stakeholder discussions

Day 2

Friday, July 12 | Coming to Solutions

8:00 am Working breakfast

9:00 am Opening

9:30 am **Prioritize action themes for discussion**

Explanatory Note: Nine action areas were identified by workshop organizers based on the individual perspectives and action parking lot exercises from Day One. Workshop participants were asked to vote for the action areas they thought were the most important and urgent.

Five action areas were discussed

(in order of the greatest number of votes):

1. Changing incentive structures (20 votes)
2. Providing research mentor training and incentives (20 votes)
3. Integrating career and professional development in curriculum and daily practice (19 votes)
4. Building community (16 votes)
5. Disseminating resources and best practices (13 votes)

9:45 am **Mixed small groups, Part A: Ideation for next steps/actions based on themes**

Participants chose one action-area discussion group, each composed of individuals across stakeholder groups. Discussion groups defined their action area, identified potential strategies to achieve the action area, and challenges to the action area. Those summaries are presented in "Critical Actions for Stakeholders."

10:45 am Break

11:00 am **Mixed small groups, Part B: Distilling and prioritizing next steps**

Participants continued discussions, remaining in the same groups as in Part A. Here, they moved toward specifying concrete next steps.

12:00 pm **Working lunch: Report-outs on prioritized next steps from each action area**1:00 pm **Stakeholder groups: Identify areas of agency and actionable next steps for your group**

Explanatory Note: Participants returned to their original stakeholder-specific group from Day One, and discussed examples of how they could address the five action areas and/or work across stakeholder groups to move forward actions.

2:15 pm **Reflections on community, next steps/how to make change**

Explanatory Note: At the end of the workshop, participants were given a worksheet for reflecting on ways the workshop had shifted their perspective, and for documenting actions they were personally committing to take.

3:00 pm Meeting summary and adjourn



What do the measures, benchmarks, and indicators look like for identifying effective career development interventions for our trainees?

Angela Byars-Winston



Titles and affiliations at time of workshop.

Stephanie Albin, PhD

Science Program Officer,
Kavli Foundation

David Asai, PhD

Senior Director for Science
Education, Howard Hughes
Medical Institute

Pranoti Asher, PhD,

Higher Education Manager,
American Geophysical Union

Sez Atamturktur, PhD

Professor & Head of the Department
of Architectural Engineering,
Pennsylvania State University

Ann Austin, PhD

Associate Dean for Research,
Department of Educational
Administration, Michigan State
University

Natasha Aziz, PhD

Associate Director, Project and
Portfolio Management, Novartis
Institutes for Biomedical Research

Suzanne Barbour, PhD

Dean, Graduate School, University
of Georgia; Education & Professional
Development Committee, American
Society for Biochemistry and
Molecular Biology

Ryan Bixenmann, PhD*

Director, PhD Career Services,
Michigan State University

Tony Boccanfuso, PhD

President, University Industry
Demonstration Partnership

Angela Byars-Winston, PhD

Professor, General Internal Medicine,
University of Wisconsin

Martha Escobar, PhD

Associate Professor, Department
of Psychology, Oakland University

Peter Espenshade, PhD

Professor & Associate Dean for
Graduate Biomedical Education,
Johns Hopkins University

David Feldon, PhD

Professor, Instructional Technology
& Learning Sciences, Utah State
University

Maryrose Franko, PhD

Executive Director, Health Research
Alliance

Cynthia Fuhrmann, PhD

Assistant Dean, Career &
Professional Development,
University of Massachusetts Medical
School; Principal Investigator,
Professional Development Hub

Alison Gammie, PhD

Director of the Division of Training,
Workforce Development, & Diversity,
National Institutes of Health

Kaylynne Glover, MA

Director of Legislative Affairs,
National Association of Graduate-
Professional Students; PhD
Candidate, University of Kentucky

Erica Gobrogge, PhD*

Postdoctoral Affairs Specialist,
Van Andel Institute

Kimberly Griffin, PhD

Associate Professor, Student Affairs,
University of Maryland; Editor,
*Journal of Diversity in Higher
Education*

Sonia Hall, PhD

Director, Engagement and
Development, Genetics Society
of America

Stephen Heinig, MA

Director, Science Policy, Association
of American Medical Colleges

Charles Henderson, PhD

Professor, Physics & Co-Director,
Center for Research on Instructional
Change in Postsecondary
Education, Western Michigan
University; Senior Editor, *Physical
Review - Physics Education
Research*

Yasmeen Hussain, PhD

Policy Analyst & Program Manager,
Professional Development Hub,
University of Massachusetts Medical
School

Lou Justement, PhD*

Professor, University of Alabama,
Birmingham; President-Elect,
Federation of American Societies for
Experimental Biology

Joanne Kamens, PhD

Executive Director, Addgene

Allyn Kaufmann, PhD

Section Head, Personal Healthcare
R&D, The Procter & Gamble
Company

Julia Kent, PhD

Vice President, Best Practices and
Strategic Initiatives, Council of
Graduate Schools

**denotes Small Group Facilitator*

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Beka Layton, PhD

Director, Professional Development Programs, University of North Carolina, Chapel Hill

Bill Lindstaedt, MS

Assistant Vice Chancellor, Career Advancement, International & Postdoctoral Services University of California, San Francisco

Natalie Lundsteen, PhD

Assistant Professor & Assistant Dean for Career & Professional Development University of Texas Southwestern Medical Center; President, Graduate Career Consortium

Bernard Mair, PhD

Senior Vice President, Academic Affairs & Chief Academic Officer, Association of Public and Land-Grant Universities

Stan Maloy, PhD

Associate Vice President for Research & Innovation, San Diego State University; Editor-in-Chief, *Journal of Microbiology & Biology Education*

Robert Mathieu, PhD

Professor, Astronomy, Director, Center for the Integration of Research, Teaching, and Learning, Director, Wisconsin Center for Education Research, University of Wisconsin—Madison

Ken Maynard, PhD*

Head, Global Patient Safety Evaluation Compliance, Standards & Training, and Business Partner Relations, Takeda Pharmaceuticals

Barbara Natalizio, PhD*

Science Program Administrator, Rita Allen Foundation; Chair, Board of Directors, National Postdoctoral Association

Mary O’Riordan, PhD

Professor & Associate Dean for Graduate and Postdoctoral Studies, University of Michigan

Stephani Page, PhD

Postdoctoral Research Associate, Duke University Medical Center

Christine Pfund, PhD

Director, Center for the Improvement of Mentored Experiences in Research, University of Wisconsin—Madison

John Pham, PhD

Editor, *Cell*

Amy Pszczlikowski, PhD

Assistant Dean for Professional Development, Princeton University

Laura Regassa, PhD

Program Director, Division of Graduate Education, National Science Foundation; Professor of Biology, Georgia Southern University

Joerg Schlatterer, PhD*

Manager, Graduate & Postdoctoral Scholars Office, American Chemical Society

Erika Shugart, PhD

Chief Executive Officer, American Society for Cell Biology

Toby Smith, MS

Vice President for Policy, Association of American Universities

Erik Snapp, PhD

Director, Student Programs and Postdoctoral Affairs, Janelia Research Campus, Howard Hughes Medical Institute

Rick Tankersley, PhD*

Vice Chancellor for Research and Economic Development, University of North Carolina at Charlotte

Matthew Thompson, PhD

Technology Development Manager, BAE Systems, Inc.; / Chair, American Physical Society Committee on Careers and Professional Development

John Vasquez, MHA, PhD

Candidate, Higher, Adult, and Lifelong Education, Michigan State University

Letha Woods, PhD

Assistant Professor and Director, RISE Office for Professional Development, Meharry Medical College

Sonia Zarate, PhD

President, Society for Advancement of Chicanos/Hispanics and Native Americans in Science; Program Officer, Howard Hughes Medical Institute

**denotes Small Group Facilitator*

Titles and affiliations at time of workshop.





Workshop Planning Committee

Ryan Bixenmann, PhD, Co-Chair
Director, PhD Career Services,
Michigan State University

Cynthia Fuhrmann, PhD
Principal Investigator, Professional
Development Hub; Assistant Dean,
Career & Professional Development,
University of Massachusetts Medical
School

Erica Gobrogge, PhD
Postdoctoral Affairs Specialist,
Van Andel Institute

Yasmeen Hussain, PhD
Policy Analyst & Program Manager,
Professional Development Hub,
University of Massachusetts Medical
School

Lou Justement, PhD
Professor, University of Alabama,
Birmingham; President-Elect,
Federation of American Societies
for Experimental Biology

Barbara Natalizio, PhD, Co-Chair
Science Program Administrator,
Rita Allen Foundation; Chair, Board
of Directors, National Postdoctoral
Association

Mary O'Riordan, PhD
Professor & Associate Dean for
Graduate and Postdoctoral Studies,
University of Michigan

pd | hub Steering Committee

Ryan Bixenmann, PhD
Director, PhD Career Services,
Michigan State University

Cynthia Fuhrmann, PhD
Principal Investigator, Professional
Development Hub; Assistant
Dean, Career & Professional
Development, University of
Massachusetts Medical School

Yasmeen Hussain, PhD
Policy Analyst & Program Manager,
Professional Development Hub,
University of Massachusetts
Medical School

Lou Justement, PhD
Professor, University of Alabama,
Birmingham; President-Elect,
Federation of American Societies
for Experimental Biology

Joanne Kamens, PhD
Executive Director, Addgene

Bill Lindstaedt, MS
Assistant Vice Chancellor, Career
Advancement, International &
Postdoctoral Services University
of California, San Francisco


Ken Maynard, PhD
Head, Global Patient Safety
Evaluation Compliance, Standards
& Training, and Business Partner
Relations, Takeda Pharmaceuticals

Mary O'Riordan, PhD
Professor & Associate Dean for
Graduate and Postdoctoral Studies,
University of Michigan

Rick Tankersley, PhD
Vice Chancellor for Research and
Economic Development, University
of North Carolina at Charlotte

Titles and affiliations at time of workshop.





You have a very important role to play in spreading science and scientific values across our nation. Our early career scientists are an invaluable resource, and we need to do much more to prepare them for contributing to the many different parts of society that can benefit from their talents and their values.

Bruce Alberts, in a message to workshop participants, July 11, 2019

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Professional Development Hub
University of Massachusetts Medical School
55 Lake Avenue North, Rm. S1-824
Worcester, MA 01655-0002
pdhub.org