PROFESSIONAL DEVELOPMENT

Shaping Effective Programs for STEM Graduate Students

CGS COUNCIL OF GRADUATE SCHOOLS

Professional Development

Shaping Effective Programs for STEM Graduate Students

By Daniel Denecke, Keonna Feaster, and Katherine Stone

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Foreword

Today's PhD candidates and research master's students comprise tomorrow's knowledge workforce. They will launch careers and make important contributions: in industry, government, and non-profits; in entrepreneurial ventures; and as faculty through academic teaching and research. And yet many agree that the way we prepare these graduate students, currently, is too narrowly focused on academic research skills at the expense of developing professional and personal skills valued by employers both outside and inside the academy. Universities have some programs in place to help graduate students develop skills in areas such as communication, teamwork, project management, and leadership. Such programs have been launched largely on an ad hoc basis on each campus, however, with little or no coordination with other universities or an infrastructure that would support an exchange of ideas. These programs also reach only a fraction of those graduate students who will enter careers outside of the academy and who in fact now comprise the majority of STEM PhDs and master's.

With a grant from the National Science Foundation, the Council of Graduate Schools launched a two-year project to improve professional development for US graduate students in science, technology, engineering, and mathematics (STEM). Through this project, we learned that many things are needed to provide quality professional development to these graduate students. Universities need: a mechanism for listening to students and employers; partnerships across campus and with employers and alumni; and human and financial resources. But above all, what is needed is leadership across the university to advocate for broadening our preparation of graduate students to include skills, beyond core research skills, that will position them for success in a variety of career paths. Graduate deans, directors of graduate study, and faculty must work together to convey the message that graduate students should seek out, and faculty support, such professional development. At the same time, national organizations such as the Council of Graduate Schools (CGS) will continue to seek ways to support needed university efforts to exchange promising practices, strengthen their relationships with alumni and employers, evaluate student needs and existing efforts, and prepare for the future.

I hope this report will inform your efforts to shape quality professional development programs for STEM graduate students and invite you to share this CGS report with colleagues, including faculty, professional development personnel, and graduate student leaders.

Suzanne Ortega
President
Council of Graduate Schools

Acknowledgments

This project brought together university leaders, employers, federal science agencies, and recent graduate students to inform our thinking about the professional development of graduate students for multiple careers in the advanced STEM workforce.

CGS would like to thank the many graduate deans, staff, and STEM faculty who contributed to this project through presentations at CGS meetings, by responding and distributing the Student Life Cycle Survey, and by participating in the rich discussions that took place at a Fall 2015 CGS Workshop on Shaping Graduate Student Professional Development for the STEM Workforce. Special thanks to those who provided feedback on this publication in draft form: Bob Augustine, Chuck Caramello, Jeff Engler, Brian Mitchell, Shana Passonno, and Amy Pszczolkowski. We would also like to thank Debra Stewart for her contributions at the early stages of this project and to CGS President Suzanne Ortega and CGS staff who worked on this project, including: Jeff Allum, Beth Buehlmann, Daniel Denecke, Keonna Feaster, Julia Kent, Maureen McCarthy, Hiro Okahana, Kenneth Polishchuk, and Katherine Stone.

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Executive Summary

While the majority of PhDs gain employment outside the academy, too often PhD candidates receive little or no preparation in skills and competencies needed to thrive in non-academic careers. US doctoral programs are widely reputed to do an excellent job of preparing candidates to conduct academic research. But the misalignment between the narrow preparation PhD candidates receive and the broad array of careers they pursue has resulted in widespread criticism and calls for reform. Criticism directed at the doctoral enterprise is equally applicable to the research master's degree. The research master's also remains too narrowly focused to meet the career goals of many master's students, despite the success of important innovations at the master's level, such as the Professional Science Master's (PSM).

The focus of this report is on current university efforts and recommended future improvements to prepare PhD and master's students for a fuller range of careers comprising the advanced STEM workforce. The report includes findings from a two-year CGS project (2014-2016), funded by a grant from the National Science Foundation (NSF #1413827), to map the landscape of professional development programming at US universities for graduate students in science, technology, engineering, and mathematics (STEM) and to identify opportunities to enhance professional development of STEM graduate students, nationally.

This project identified promising practices, common challenges, recommendations, and possible next steps toward coordinated improvements to the professional development of STEM graduate students, including PhDs, master's, and postdoctorates. To advance this goal, we probed answers to a number of questions, such as: How prevalent are formal graduate student professional development programs? Who needs to be involved in developing and delivering these programs? What skills do these programs address, and what skills are missing or underemphasized? Are graduate students participating in these programs? Do faculty support student participation in these programs? What are the biggest challenges facing student engagement in and faculty support for these programs? How do we know this programming is effective? And, what steps do recent graduates, employers, and university leaders think should be taken to improve professional development for graduate students?

We sought answers to these questions through three means: 1) a survey of graduate deans, STEM faculty, and staff responsible for professional development programming; 2) in-depth interviews with 10 chief research officers or other senior leaders at organizations from different sectors of the advanced STEM workforce responsible for supervising and hiring STEM PhDs and master's recipients; and 3) a workshop convened in fall 2015 of national experts, employers from multiple sectors of the advanced STEM workforce, federal funders, graduate deans, and recent PhDs to advance the conversation about challenges and promising solutions and models.

While the focus of this project was on formal university professional development programs for graduate students, examples of other types of professional development programs and experiences were frequently cited, ranging from large-scale federal fellowship and internship programs to particular university-industry partnerships. These, as well as the recommendations for stakeholders beyond universities, will be noted throughout the report. While postdoctoral training was not an explicit focus of this project, many of the programs described here serve postdoctoral fellows as well as PhD candidates and master's students.

The report includes discussion of useful tools and resources, as well as of issues that commonly arise in university discussion around professional development. Examples of such issues include: whether this training should be integral or supplemental to the education received in one's discipline or degree program; how to prepare a diverse group of students for the wide range of STEM- and STEM-related careers and whether this should even be a part of the mission of graduate degree programs in research fields; and whether the emphasis of professional development efforts should be on generic skills, STEM-specific skills, or professional formation, more broadly. As part of this project, CGS identified a large number and wide variety of US university professional development programs for graduate students. An online compendium of these programs is included both as an appendix to the electronic version of this report and in an interactive online format to inform program improvements. The compendium is intended for senior university leaders seeking a reference point for their efforts to develop or enhance existing programs.

Key findings

1. Professional development programs that prepare graduate students for a broad range of careers beyond academic research vary in their availability and content.

CGS surveyed member institutions and received 857 valid survey responses from graduate deans, college deans, faculty directors of graduate study, and professional development program directors at 226 institutions. Among those respondents, 62% indicated that their institutions and/or graduate programs offer some type of formal professional development program for graduate students in research degree programs to obtain skills beyond core academic research skills. A third of these respondents described programs that focused exclusively on preparing graduate students with additional skills for academic careers, such as teaching and academic job search preparation. Fewer than half (375, or 44%) of respondents representing 134 institutions (59% of the total) reported having existing formal programs for graduate students to develop skills for non-academic careers.

2. Graduate school leadership is key to integrating professional development into graduate education for students who will pursue a broad array of advanced STEM and non-STEM careers.

Graduate deans and graduate schools currently provide essential leadership and support for professional development activities and programs for PhDs, master's students, and postdocs. Graduate deans, college deans, and professional development directors all identified a "strategic priority of university/graduate school" as the most influential factor *motivating* the creation of professional development programs, followed by "graduate student interest/demand" and "the job market." The graduate school was also the most commonly cited source of *funding* for professional development programming, with nearly twice as many respondents, overall, identifying "graduate schools" (65%) than "graduate programs" (34%) or "colleges" (31%). Graduate deans and college deans were also the groups most likely to identify *collaborations* among internal campus units such as writing centers and external stakeholders, such as alumni and companies/private industry. Because of their leadership role, graduate schools are key partners in any future coordinated effort to expand and improve graduate student professional development.

3. Most existing university professional development programs combine both centralized and program- or department-based activities and experiences.

University professional development programs and experiences are structured differently at different institutions depending upon available resources, faculty support and/or expertise, and skills focus. Centralized structures typically serve all or multiple disciplines and are housed in the graduate school, a career center, or other campus unit while activities housed in departments or degree programs are typically more narrowly focused in terms of discipline and skills. The majority of respondents (56%) described programs that serve graduate students through a combination of both centralized and

program-based activities, with 27% describing solely program-based, and 17% describing solely centralized programs. Centralized and combined centralized-/program-based programs served the most graduate students in the 2014-15 academic year, with 39% and 32%, respectively, of respondents serving 100 or more doctoral students per year. Respondents reporting on program-specific professional development programs, by comparison, were most likely to report serving five or fewer doctoral students in the 2014-15 academic year.

4. Transferable skills and academic career skills are the primary focus of most existing professional development programs, but non-academic employers also seek more specific STEM-related skills among graduates with advanced STEM degrees.

The vast majority of respondents described professional development programs that focus on skills that are transferable across multiple careers and disciplines. The most frequently identified skills include *communication and presentation, writing, mentoring, and leadership*. Common STEM-specific skills, where included, are *research ethics, research development, technology commercialization,* and *entrepreneurship.* There is a growing trend in developing cultural competency and intercultural teamwork skills for a diverse workforce and in preparing graduate students to see career skills development as life-long process as opposed to one-time preparation for job placement.

Some STEM-specific skills noted as generally deficient in today's PhDs and master's by employers, however, currently receive little attention. These skills include: data science and big data skills; science policy; governance, risk and compliance; and time management and project management, with only approximately one out of 10 programs, on average, addressing these needs.

Challenges and barriers

Universities face the following challenges and barriers to enhancing graduate student professional development:

1. Faculty attitudes about professional development and multiple career paths for PhDs and master's in their field can prevent students from obtaining valuable skills needed for career success after graduation. As one respondent noted: *"Many students tell us they are afraid to tell their faculty advisor that they are considering a non-academic career because they fear their advisor will not be supportive. Many students do not even want anyone to know they are coming to a workshop/ program related to non-academic careers for fear of retribution."* Faculty leaders and graduate school leaders need to work together to communicate the importance of professional development to graduate students for success in a variety of careers including but not limited to academic research careers.

2. The proportion of funding in the forms of STEM support and programs most conducive to broad skills training, such as traineeships, is currently overshadowed by research assistantships that do not encourage or require skills training beyond academic research. The competitiveness of research funding and the need to generate results can have a negative impact on such training. Federal funding structures for STEM graduate student support play a strong role in inhibiting or encouraging today's STEM master's and PhDs to develop skills valued outside their core academic research field.

3. Employers seek PhDs and master's with more STEM-specific and transferable skills beyond those skills developed in academic research programs, but:

    a. Universities lack guidance, resources, and expertise that would enable them to identify these skills and deliver this training, and

b. The variety of career paths available to STEM graduates and the speed of change in some sectors make it difficult to provide programming that goes beyond general, transferable skills and addresses the full spectrum of employer needs.

4. A lack of evidence about what forms of professional development are most effective and most worthy of investment hampers engagement of key potential advocates including faculty, student participants, alumni, employers, funders, and senior administrators.

Recommendations

Recommendations for improving the professional development of STEM graduate students in research degree programs include:

1. **Greater coordination and research among graduate schools, graduate programs, employers, alumni, and federal funding agencies is needed to meet the professional development needs of graduate students seeking careers in STEM.** Among the structured professional development programs currently in place, the majority were created on an ad hoc basis, formed with scarce resources and little or no coordination with other university programs, and informed by limited research about what works and what doesn't.

2. **More evidence and more accessible information about the effectiveness of different models for delivering engaging and relevant professional development programs to graduate students.** Such evidence about best practices could strengthen the advocacy role for improved professional development that graduate deans and faculty can provide. Through this project, the following statement provided in response to a survey question on recommendations for improvement was echoed repeatedly: "Culture change should be promoted broadly and from a variety of sources. The graduate school, graduate fields, student organizations, and others should engage employer representatives, content experts and alumni, and should employ established and/or research best practices."

3. **Greater alignment among employers and universities to ensure that the professional development experiences provided to advanced STEM graduate students are relevant, and where possible tailored, to employer needs.** This message came from graduate deans and directors of graduate study, business leaders, CEO's and chief research and talent officers from established industries and small enterprises, as well as from successful entrepreneurs from the rapidly evolving start-up sector, directors of university and federal professional development programs, and graduate deans from leading universities.

4. **Professional development should be designed to strengthen and complement academic rigor.** Employers unequivocally stated that the US PhD is the "gold standard" in research excellence. Several employers emphasized this point by noting that the integration of professional skills into graduate programs should not occur by sacrificing the excellent preparation in academic research skills received by today's master's and PhDs. Generic skills, STEM-specific skills, and personal attitudes and habits developed in formal professional development programs can strengthen graduates' success in both academic as well as non-academic careers.

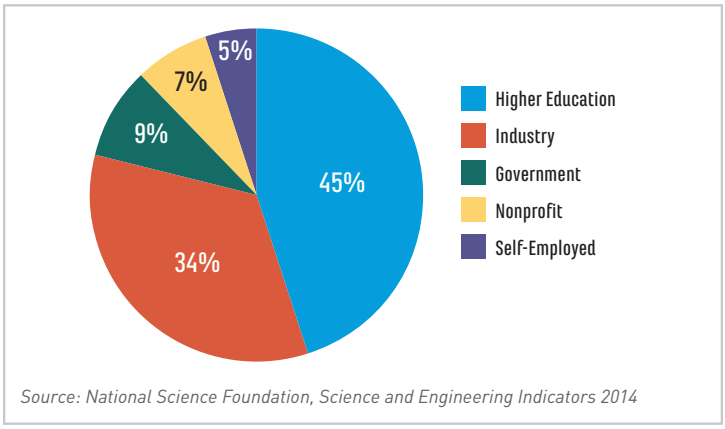
5. **Assessment of professional development must evolve beyond student participant satisfaction to include evaluation of the effectiveness of training in participants' subsequent non-academic and academic careers.** Universities currently lack the best practice models, infrastructure, and resources needed to conduct sustainable, long-term tracking of career outcomes. Best practices are also needed in the use of these data to inform graduate degree programs and professional development programs.

Introduction

For more than a decade, graduate students have reported that in addition to preparation in research and scholarship in their disciplines, they seek professional development opportunities in graduate school for careers both inside and outside of academe (Golde & Dore, 2001; Nerad, Rudd, Morrison, and Picciano, 2007; Fuhrmann, Halme, Sullivan, & Lindstaedt, 2011; Thiry, Laursen, & Loshbaugh, 2015; National Academies of Sciences, Engineering, and Medicine, 2016). This demand has been partly answered through coordinated efforts to enhance the preparation of graduate students for academic careers, for example through programs such as Preparing Future Faculty (PFF), NSF's Alliance for Graduate Education and the Professoriate (AGEP), and the Center for Integration of Research, Teaching, and Learning (CIRTL) network. However, no comparable nationally coordinated activity has yet taken shape around preparation for careers outside the academy. The career trajectories for advanced STEM degree-holders, combined with strong student demand for professional development and calls for reform among both governmental and disciplinary associations, all point to the value of greater national coordination among universities and other key stakeholders. Such coordination will be required to deliver these programs on a scale and on the accelerated timeline required to meet the needs of graduate students and employers.

The broader employment context for master's and PhDs alone would seem to make the argument for preparing students for multiple career pathways irrefutable. More than half of those who earn doctorates in the United States in science and engineering (S&E) fields work in careers outside the academy (Figure 1).

Figure 1. Employment of S&E Doctorates by Employment Sector, 2010



Source: National Science Foundation, Science and Engineering Indicators 2014

A recent study notes pronounced differences in career paths by gender and race/ethnicity: "Approximately half of Black, Hispanic, and White female STEM PhD holders and Black and Hispanic male STEM PhD holders were in nonacademic careers, whereas two thirds of Asian female STEM PhD holders and almost three fourths of Asian male STEM PhD holders were in nonacademic careers. About three fifths of White male STEM PhD holders were in nonacademic careers" (Turk-Bicacki, Berger, & Haxton, 2014). In such an environment, those US graduate programs that continue to remain narrowly focused on preparing candidates only for careers in academic research remain vulnerable to negative criticism from employers, funding agencies, legislators, the public, prospective students and alumni.

The current misalignment between the skills PhD candidates receive and the careers they subsequently pursue has garnered criticism from many sectors and numerous calls for reform (e.g., CGS, 2010; CGS, 2012; NIH, 2012; Grafton and Grossman, 2011; Re-envisioning the PhD Initiative, 2000; Cassuto, 2015; Golde and Dore, 2001). As this report documents, US universities and graduate programs have begun to respond by offering a variety of professional skills experiences for PhD and master's students considering multiple career options. These offerings range from required and elective courses integral

to the curriculum, co-curricular workshops, and immersion experiences such as internships to formal certificate programs and even fully evolved degree programs (best exemplified at the master's level, by the Professional Science Master's [PSM] degree) (Francis, Goodwin, & Lynch, 2011).

Recent federal programs such as the National Institutes of Health (NIH) BEST program and the National Science Foundation Research Traineeship (NRT) program present promising models and incentives to advance this work. Currently, however, these traineeship programs benefit only a small portion of graduate students. Traineeships constitute just a fraction of graduate student support in STEM fields, where the overwhelming majority of students are funded on research assistantships that students may feel discourages them from taking advantage of such professional development opportunities. Arguably, the predominance of research assistantships as the primary vehicle for US federal funding of STEM graduate students has impeded that professional development of PhDs and postdocs for the advanced STEM workforce. Ensuring that more graduate students who pursue careers in STEM are afforded access to high quality professional development opportunities will require identifying and addressing these and other factors in the culture of graduate training that currently serve as barriers.

The programs that have been established to redress the misalignment between academic preparation of STEM graduate students and the careers of STEM graduates have largely been created on an ad hoc basis. The growth of professional development opportunities for graduate students has also been slowed by a scarcity of information about what programs are currently in place, what works, and what is needed. Indeed, many of the key questions raised in a 1995 National Academies Committee on Science, Engineering, and Public Policy (COSEPEP) report, *Reshaping the Graduate Education of Scientists and Engineers,* remain unanswered, including: "What are typical career paths for scientists and engineers, and how have they changed in recent years? Given present career paths, what are the most appropriate structures and functions for graduate education? [and] How can science and engineering graduate students be prepared for a variety of careers in teaching, industry, government, and other employment sectors, in addition to research?" (Institute of Medicine, et al., 1995).

Graduate deans, faculty, and university staff supportive of professional development for master's and PhD students seek answers to these questions through greater coordination, resources, and expertise. They also seek stronger evidence about what works and more guidance on what skills are most appropriate, for whom, and at what stage of study. Throughout this project, a range of stakeholders expressed a strong need for improved research to help us determine whether more coordinated activity is called for than the ad hoc programs that now exist and if so, where our efforts are best directed.

A core part of this research would focus on improving our understanding of career pathways of US graduate students. *Understanding Career Pathways for Program Improvement* represents a multi-year effort of CGS to advance this goal. With input from a range of stakeholders in the higher education community, CGS has developed survey instruments and guidelines for data collection across a broad range of fields. These guidelines will help universities gather long-term career information from their PhD students and alumni with the goal of improving PhD programs (Allum, et al., 2014). Ultimately, more comprehensive information on career pathways and guidelines on the use of pathways data could be indispensable for multiple stakeholders and for multiple purposes, including the improvement of professional development programming.

A separate but related research inquiry concerns the structure, support, and delivery of current professional development programming as well as the factors that inhibit and facilitate student participation. The project described in this report represents CGS's initial inquiry into this subject and probes the question: How can US universities work most effectively internally and with others beyond their institutions to position students for success in these diverse career paths? The focus is on university efforts to prepare PhD and master's students for the full range of careers comprising the advanced STEM workforce. The report describes the results of a two-year (2014-16), NSF-funded project (#1413827) to map the landscape of professional development programming at US universities

for graduate students in STEM. In addition to identifying challenges, promising solutions, and recommended next steps for universities, the project also yielded perspectives on how employers of STEM master's and PhDs as well as federal funders of STEM graduate students might work together to better prepare the advanced STEM workforce, and these perspectives are included as a part of this report.

Calls For Change

Calls for better alignment between the skills students develop in graduate school and the careers they subsequently pursue in the advanced STEM workforce have come from many corners. Graduate schools have provided a strong voice on this issue. The Council of Graduate Schools (CGS) and the Educational Testing Service (ETS), for example, in April of 2012 released a report titled *Pathways Through Graduate School and into Careers* (Council of Graduate Schools and Educational Testing Service, 2012). The blue ribbon advisory committee that oversaw this research project called on government, industry, and universities to work together to collectively foster the development of appropriate professional skills that would better prepare students for the careers they ultimately pursue. A lead role for CGS in this area was appropriate, for as the results of the current project reveal, graduate deans and graduate schools provide key leadership, structure, and support for many of the professional development programs and activities in place to serve graduate students.

Disciplinary associations also have provided leadership in this area. They have done so, for example, through task force recommendations for graduate programs, career portals and other resources for students, and profile pages that highlight examples of successful PhDs and their achievements in a variety of careers. The American Chemical Society issued a report in December 2012 calling on universities and programs to do a better job of preparing chemistry graduate students for careers after graduate school. In the direct words of that report's authors: "Current educational opportunities for graduate students, viewed on balance as a system, do not provide sufficient preparation for their careers after graduate school" (American Chemical Society, 2012, p. 2). Other disciplinary associations that have been strong advocates for graduate student preparation for multiple career pathways include, in STEM fields, the American Statistical Association (ASA), the Federation of American Societies for Experimental Biology (FASEB), the Society for Industrial and Applied Mathematics (SIAM), and the American Geosciences Institute (AGI) as well as the American Historical Association (AHA) in the humanities (e.g., see Society for Industrial and Applied Mathematics, 2012; Grafton & Grossman, 2011).

Calls for change have also come from government as evident in congressionally commissioned reports as well as recent federal science agency programs and directives. The National Science Board (2015), National Research Council (2012), National Institutes of Health (2012), and National Science and Technology Council (2013) have all issued reports calling for greater alignment between STEM graduate training and STEM workforce needs. In June 2012, the National Academy of Sciences released a congressionally requested report, *Research Universities and the Future of America,* which called for universities to strengthen the preparation of graduates for careers both within and beyond the academy (National Research Council, 2012). The same month, the Biomedical Research Workforce Working Group, appointed by the Director of NIH, issued a report calling for the creation of a program to supplement its training grants to provide additional training and career development in areas such as project management and entrepreneurial skills (National Institutes of Health, 2012). Through the fall of 2012 and spring of 2013, the Graduate Education Modernization Working Group, convened by the Office of Science and Technology Policy in the executive branch, worked to promote multi-agency efforts in the federal government to support professional development of STEM doctoral students and their preparation for diverse careers, including those outside of academe (Stewart, 2013). These priorities are beginning to show up in funding opportunities. The NSF, for example, acting under an Agency Priority Goal to improve STEM graduate preparedness for the workforce, in 2016-17 will fund several summer institutes and provide "75 supplements to existing awards to provide STEM doctoral

students with opportunities to expand their knowledge and skills to prepare for a range of careers" (https://www.performance.gov/node/40262?view=public).

Perhaps the most important calls for reform in doctoral education have come from graduate students themselves. As this project's survey results show, graduate student demand was the biggest factor" with "As this project's survey results show, overall, graduate student demand was the biggest factormotivating the creation of professional development programs overall and a crucial factor in building support among program faculty in graduate studies. As further evidence of this demand, students responded enthusiastically to a "challenge" supported by the Division of Graduate Education at NSF in 2013, which invited STEM graduate students to offer innovative ideas to improve graduate education. Students were asked to identify an issue in graduate education, propose an idea or solution, and explain how the idea would change graduate education for the better. Among the ideas submitted by 534 teams, nearly 40% of the submissions identified improvement needed in the key aspects of professional development, including *collaboration* skills and *communication* skills (National Science Foundation, 2013).

Calls from graduate students for more direct preparation in those skills, beyond research, that would contribute toward a successful professional career are not new. The more recent development has been, rather, the proliferation of public forums that have enabled these voices to be heard and allowed solutions to be considered. The *Chronicle of Higher Education* and *Inside Higher Ed*, as well science magazines such as *Nature* and *Science*, for example, regularly provide forums for graduate student and alumni voices on the gap between PhD preparation and the expectations and opportunities of non-academic employers.

Finally, calls for enhanced skills training of STEM PhDs and master's students have come from employers. The Bureau of Labor Statistics forecasts that occupations typically requiring a graduate degree for entry will grow the fastest and have higher median annual wages through 2024 (Bureau of Labor Statistics, 2015). At the 2016 CGS Summer Workshop, Sean Gallagher, chief strategy officer for Northeastern University's Global Network, cited a recent employer survey study which showed that nearly a third (32%) of employers increased their educational requirements of new hires over the past year. And among the 27% who reported now hiring employees with master's degrees for positions previously at bachelor's level, 60% said they had done so because the skills needed to succeed in their fields had evolved (Gallagher, 2016). Employers who raised their degree requirements reported the following benefits: quality of work (57%), productivity (43%), communication (38%), innovation (37%), and employee retention (32%) (Gallagher, 2016).

The correlation between the rise in degree levels required for employment and the improved skills employers are perceiving suggests that employers already value skills master's and PhDs bring to the workplace. But employers also say they are seeking a wider range of skills among new hires than are currently emphasized in STEM graduate programs. Employers from industry, government, and non-profits hiring STEM graduate degree holders seek skills in addition to research such as leadership, teamwork/collaboration, project management, critical thinking, intercultural competency, and problem solving. Many also seek evidence that graduate students have developed these skills in a real world context (Gallagher, 2016; Casner-Lotto and Barrington, 2006; Jerald, 2009.) Furthermore, employers are looking for candidates with personal skills and attributes such as empathy and emotional intelligence, resilience, and a passion for life-long learning and for the organization's mission (O'Meara, Knudson, and Jones, 2013; Dening, 2015; Wilson, 2015.). Finally, many large, established companies have undergone organizational transformations from a highly vertical structure (with highly specialized roles and functions for workers) to a more horizontal one (in which employees must work in "cross-functional" contexts). To succeed, these organizations seek what has been called "t-shaped" people who have a breadth of skills and competencies beyond research that complement the deep content knowledge they acquired in the research master's or PhD program (Business-Higher Education Forum, 2013; Wladowski-Berger, 2015; Donofrio, Sanchez, & Spohrer, 2008).

Mapping the Landscape of Graduate Student Professional Development Programs

While professional development programs for graduate students share a number of features in common, the best of these programs have unique characteristics shaped by the partnerships involved and the students served. To understand the prevalence of such programs for STEM students as well as common features, challenges faced, and potential solutions, CGS conducted a survey of North American institutions. After discussing survey results, case studies are provided to shed light on the unique characteristics and approaches of promising programs.

Results from a CGS survey of US and Canadian institutions

In April 2015, CGS launched the Student Life Cycle Survey, which included 16 questions about existing professional development programs for graduate students. The survey was designed to gather baseline data about what US universities are now doing to create and support professional development opportunities for their students. In the survey, we asked about program goals and motivation, graduate student participation, funding and administrative structures, program content (including skills taught), challenges faced, and future needs. We inquired about central, university-wide programs as well as departmental, academic degree-program- or unit-level professional development programs and hybrids of the two, and so sought perspectives of different university leaders.

To collect this information on such a range of programs, we queried graduate deans, academic college deans, professional development directors, and graduate studies faculty leaders (including department chairs and directors of graduate study). The survey was originally open from April 21 through June 19, 2015. Deans were asked to answer questions with reference to the offerings available at their institution. Other university administrators were directed to provide information about the specific programs for which they are responsible. All were asked to consider only research degree programs in their answers, excluding professional degrees such as the JD, MBA, or DPT.

CGS received 857 responses to the survey from individuals at 226 institutions. The majority of respondents reported having an area of responsibility within graduate degree programs (45%) followed by those in the graduate school (29%), professional development staff (7%), college deans (4%), and other campus staff (14%). Of these respondents, 531 (62%) indicated that their institutions/graduate programs offer formal professional development programs for graduate students, outside of formal curriculum toward their degree objectives. Among this group, 156 reported programs that exclusively prepared students for academic teaching and university research careers. The following analysis focuses on the 531 respondents among these who described professional development programs at 158 institutions. Among this group, 184 were graduate deans and college deans, 237 were directors of graduate study or program faculty, and 110 were professional development directors or other staff. Percentages listed in tables and referred to in text may not sum to 100% where questions allowed respondents to select multiple answers.

Among the remaining group of 326 respondents, 172 indicated that they did not have professional development programs, and 52 were uncertain about whether or not such programs existed at their institutions. Among these 326, approximately 4 in 10 reported that they are in the early or advanced planning stages of such a program.

Limitations

There are several limitations which should be taken into consideration. First, multiple respondents within the same institution completed the survey, so the total number of responses does not represent a number of unique institutions; a third of all surveys received were from 10 of the 226 institutions. Second, multiple respondents may have provided information about the same program. Third, respondents' areas of responsibility may influence their perceptions about the program details of the program; respondents include both individuals who are and those who are not directly responsible for professional development programming. Finally, non-response bias is possible among those surveyed whose institutions do not currently have structured professional development programs.

- *How common are professional development programs for graduate students pursuing research degrees?*

More than half of all 857 respondents (62%, 531) indicated that their institutions/graduate programs offer formal professional development programs for graduate students, outside of the formal curriculum toward their degree objectives. One fifth of the programs identified (19%) focused exclusively on preparing graduate students for academic teaching and research careers. Less than half of the total (44%, 375) described programs that include activities designed to prepare graduate students for a range of careers including non-academic careers. These respondents described programs at 133 institutions, representing approximately 88% of the total number of institutions represented in the survey.

- *What motivates universities to launch professional development programs?*

Overall, *graduate student interest/demand* (69%) and the *job market* (67%) were the main factors that influenced creation of professional development programs (see Table 1). However, among graduate school and academic college deans and professional development directors who together comprise the majority of respondents, *strategic priority of university/graduate school leadership* was the leading factor.

Table 1. Factors Motivating Program Development by Area of Responsibility

Factors Identified as "Very Important"	Graduate Degree Programs (170)	Professional Development Programs (43)	Graduate School/ Academic College (162)	Total (375)
Strategic priority of university/graduate school leadership	22%	70%	80%	53%
Strategic priority of degree program leadership	34%	23%	30%	31%
Other	3%	5%	1%	2%
National reports	13%	44%	35%	26%
Job market for students completing with graduate degrees	60%	67%	74%	67%
Graduate student interest/demand	61%	63%	79%	69%
Federal grant/traineeship requirements	21%	30%	24%	23%
Employer interest/demand	31%	35%	31%	31%
Alumni input	17%	26%	12%	16%

- *How is graduate student professional development currently structured?*

University professional development programs are structured differently at different institutions depending upon available resources, faculty support and/or expertise, and skills focus. Centralized structures typically serve all or multiple disciplines and are housed in the graduate school, a career center, or another campus unit; activities housed in departments and/or hosted by research degree programs are typically more narrowly focused in terms of discipline and may address a more limited range of skills and/or focus on skills relevant to the field of study. The majority of respondents (56%) described programs that serve graduate students through a combined structure (consisting of both centralized and program-based components), with 27% describing solely program-based, and 17% describing solely centralized programs.

- *How many graduate students are served by current professional development programs?*

Programs described by graduate schools and professional development staff, the majority of which are centralized or combined programs, served the most graduate students in the 2014-15 academic year. Half of the graduate schools (49%) and two thirds of professional development staff (66%) reported programs serving 100 or more doctoral students per year. Among these same groups, 38% and 49%, respectively, reported serving 100 or more master's students per year. By contrast, two thirds of graduate studies respondents reported serving 25 or fewer students in the 2014-15 academic year, and half of these respondents reported serving five or fewer students, in programs that were predominantly program-based.

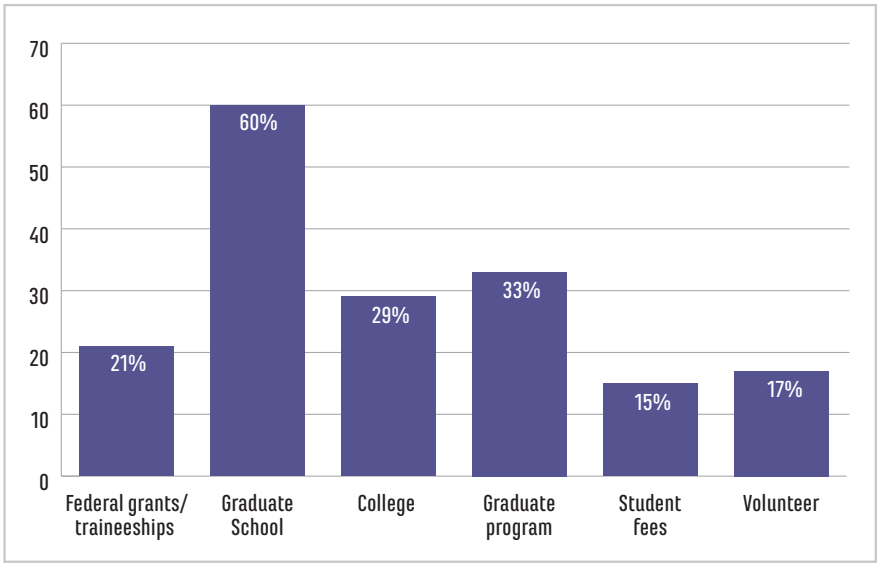
- *How are university professional development programs funded?*

Graduate schools provide key financial support for professional development programming. Respondents were asked to identify which among seven funding sources currently supported their program. These sources included: *federal grants/traineeships, graduate school, college, graduate program, student fees, volunteer,* and *other.* Overall, the graduate school was the source of funding most often reported; 60% of respondents identified the graduate school as a source of funding for their graduate student professional development programs (see Figure 2). The graduate school was also the source most often identified by graduate deans (86%) and professional development staff (65%); college deans were equally likely to describe the graduate school and their college as a funding source, with more than half identifying each source.

Half of all respondents (51%) identified two or more funding sources; 37% identified one funding source. Additionally, 43% selected the graduate school and at least one other funding source as compared to 28% who selected at least one funding source that did not include the graduate school. Respondents from graduate degree programs (44%) were much less likely to identify the graduate school as a source of funding for their professional development programs.

- *What skills do university professional development programs emphasize?*

Figure 2. Funding Sources for Graduate Student Professional Development Programs



Survey respondents were asked to identify the skills emphasized in their professional development programs by selecting among a list of general skills (such as *communication* and *presentation*, and *leadership*), STEM-specific skills (such as *data science, research development,* and *lab management*), and skills related to career placement (*job search, professional networking*) and academic careers (*teaching*).

Academic career skills such as *teaching* (66%), while not the focus of this study, and career placement skills relating to the *job search* (72%) and *professional networking* (61%) were among the most prevalent. Among general skills, *communication/presentation* (68%), *writing* (62%), *mentoring* (48%), and *leadership* (45%) received highest mention. Over one-third of respondents (34%) identified between four and six skills followed by 30% who identified between seven and nine skills.

The STEM-specific skills most commonly included in professional development programs are: *research ethics* (53%) and *research development* (46%).

Several skills specifically noted by STEM employers as lacking in today's graduates (as discussed in the next section) are not commonly addressed, currently, in university professional development programs. These skills include: *data science* (11%); *governance, risk and compliance* (11%); *technology commercialization* (15%); *entrepreneurship* (23%); and *science policy* (8%).

Other STEM-specific skills that receive little coverage, with less than 15% of respondents noting them, include: *science policy* (8%) and *lab managemen*t (11%). Notably, programs described by graduate school, college dean, and professional development personnel were more likely than those described by graduate studies respondents to include topics such as *technology commercialization, project and budget management, science policy,* and *leadership*. The only skills area in which graduate studies respondents reported greater rates of coverage than graduate deans, academic college deans, and professional development staff was *research development.*

- *How common are Individual Development Plans (IDPs) and/or career advising requirements?*

An Individual Development Plan (IDP) is a tool to help individual students assess their career goals and track their professional development as scholars and professionals during graduate school. With encouragement from NIH and others, these plans are being widely used to support structured conversations among graduate students and their advisors and/or mentors.

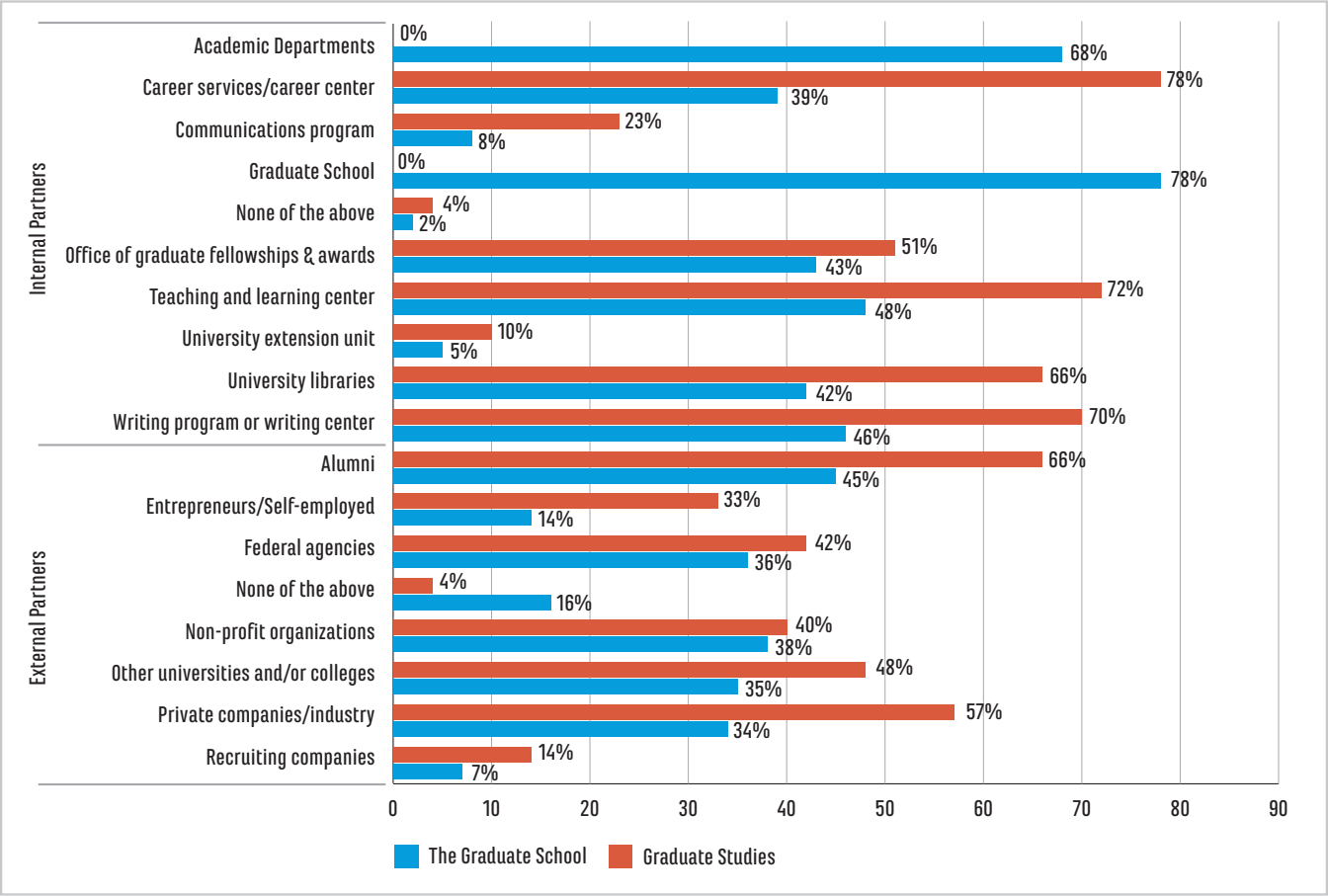
Survey respondents were asked if graduate students were encouraged to complete an IDP and/or meet at least once annually with a mentor/advisor about their IDP during their course of study. Among respondents from graduate schools, nearly half (45%) reported that graduate students are encouraged, but are not required, to complete an IDP (Individual Development Plan) and/or meet at least once annually with a mentor/advisor about their IDP during their course of study; among graduate studies respondents, the majority reported that this was either required (48%) or encouraged (32%).

- *Who are the key partners involved in graduate student professional development?*

Respondents provided information about both internal university partners and external partners with whom they have collaborated to develop and deliver professional development programs. Overall, the three most commonly cited internal partners, aside from the Graduate School and academic departments, were the *teaching and learning center* (58%), *writing program/writing center* (57%), *career services/ career center* (54%), *university libraries* (53%) and *office of graduate fellowships and awards* (48%). The most commonly cited external partners included *alumni* (51%), followed by *other universities and/or colleges* (44%), and *private companies/industry* (41%).

Graduate schools identified significant collaborations with *career services/career centers* (80%), *teaching and learning centers* (75%), and *writing programs or writing centers* (70%). Notably, graduate

Figure 3. Professional Development Partnerships by Graduate School/Academic College and Graduate Studies



school respondents were much more likely than those from graduate studies to collaborate with external partners in their professional development programs (see Figure 3). For example, nearly two thirds of respondents from the graduate school (64%) identified partnerships with alumni compared to 39% selected by respondents from graduate studies. Graduate schools were also much more likely (56%) than those holding responsibility in graduate studies (28%) to identify partnerships with *private companies/industry.*

- *What methods are universities using to assess professional development programs?*

Respondents were asked to identify the assessment tools/approaches used in evaluating their professional development program. Options included: (1) *participation satisfaction and participation metrics,* (2) *employer feedback/satisfaction,* (3) *career placement and career pathways tracking information*, and (4) *other.* Overall, the approach used most by respondents was *participant satisfaction and participation metrics* (67%), followed by *career placement and career pathways tracking information* (34%), and *employer feedback/satisfaction* (15%). Nearly all graduate school respondents (91%) reported using *participant satisfaction and participation metrics* to assess their programs by comparison to 54% of graduate studies respondents for whom this was also the most common means of assessment.

- *What are the biggest challenges?*

Deans, faculty, and staff described several challenges encountered in providing professional development opportunities to graduate students considering multiple career paths.

1. Limited resources

The number one challenge was limited resources. The majority of respondents stated that a lack of funding, staffing, time and/or other resources limited their ability to provide professional development to graduate students. Some mentioned the challenge of meeting the demand of a large student population with limited resources. Others noted that of identifying content experts who can also supervise and mentor graduate students on their internships and/or practicum. Related challenges also noted included program sustainability given the program costs and funding constraints as well as providing students with "access to alumni and others who have experience in different types of career paths."

2. Selecting content

The second most frequently cited challenge was that of identifying or selecting content. As one respondent stated the problem: "The possible range of non-academic career settings makes it hard to do justice to the entire territory." Others noted that graduate faculty typically have limited information about the variety of available careers for PhDs. While faculty are not necessarily resistant to professional development for these careers, graduate programs need assistance in identifying the appropriate content and content experts. Others noted the fast pace of changing demands, for example: "Our field is rapidly changing and keeping up with employer needs is a constant challenge."

3. Lack of student interest/participation

While many noted a challenge in meeting student demand and reported that such demand was a primary driver in shaping professional development programs, others reported low student participation and emphasized the need for "making students realize the importance of these programs." As one respondent stated: "One of the biggest challenges is relaying to students the value in attending these programs." Another said, "The time demands on students and their interest in participation in programming outside of their program is limited." Scheduling courses was also mentioned, as some noted that graduate students who commute may have particular difficulty attending in-person activities, as "they don't want to make a special trip to campus for professional development." Graduate school respondents were slightly more likely than those from graduate studies to identify a lack of student interest and/or low student participation as a challenge (whereas graduate studies respondents were more likely to identify the challenge of selecting appropriate content).

4. Faculty buy-in

While some respondents noted that faculty were not necessarily opposed to graduate students pursuing professional development opportunities for multiple career paths, lack of faculty support for student participation was frequently cited as a major challenge. Several respondents noted "overcoming faculty resistance" and "getting faculty to agree that it is important for their students." As one respondent noted: *"Many students tell us they are afraid to tell their faculty advisor that they are considering a non-academic career because they fear their advisor will not be supportive. Many students do not even want anyone to know they are coming to a workshop/program related to non-academic careers for fear of retribution."* Some respondents speculated that the perceived lack of student demand in fact resulted from a perceived lack of support by their advisors or other program faculty, as expressed in this statement: *"Student reluctance to participate because of time demands and/or perception (real or imagined) that advisor or other program faculty will disapprove."* Pressures on faculty for scholarly productivity and expectations for graduate students that are implied by grant funding clearly play a role in faculty attitudes toward graduate student preparation. Just as a lack of faculty support can be a source of discouragement, their support and encouragement can be key to advancing graduate student professional development.

Recommendations for shaping and promoting professional development programs
Survey respondents provided a range of opinions on how to promote and shape professional development activities to meet the needs of graduate students and employers of STEM doctoral and master's students.

Recommendations for **promoting** professional development included:

- Improve communication from faculty, academic units, alumni, and institutional leaders about the value of professional development and opportunities for graduate students to develop skills for post-graduate success across a range of careers.
- Integrate and embed information within existing events, activities, and/or curriculum.
- Include information in formal programming and add-on requirements such as 1-credit courses, transcript notations, etc.

Recommendations for **shaping** professional development included:

- Collaborate with multiple stakeholders to shape programs and content:
  - *Engage employers* to share their expertise on professional practices with current students (for example, on meeting facilitation, business etiquette, etc.).
  - *Identify faculty champions* and allies with strong voices and bring them together with skeptics. Those who join a faculty after industry careers can be role models and help broaden the conversation about careers for graduates.
  - *Bring back graduate alumni* at both the departmental-level and at the graduate school level advisory boards to offer input.
- Use real data/feedback, including employee trend data, career tracks of alumni, and identified employer needs to shape professional development content.
- Use multiple types and locations of delivery, for example both online and in person panels of alumni/employers, and at both universities and national and international discipline-specific conferences.
- Integrate discipline-specific degree requirements with professional development skill sets and experiences.
- Design programs that offer credentials for participation and incorporate experts from various units across campus.

Summary of survey results
While many universities already provide structured professional development programs to graduate students that go beyond the core research skills provided in typical research programs, these programs are still the exception rather than the rule. The majority of professional development programs that do exist currently combine centralized and program-based activities and serve large numbers of doctoral candidates and master's students from diverse fields of study.

Ideally, professional development programs should: (1) be appropriately staffed and funded, (2) emphasize skills relevant to employers, and (3) involve both internal (university) and external partners in ways that best deliver the content and meet the needs of the graduate student population. Graduate schools play an important leadership role in the motivation, coordination, and financial support of graduate student professional development programs. Given this leadership role, graduate schools are key to helping universities meet these criteria; however, more guidance is needed. University leaders seek: greater clarity about the skills and competencies sought by employers on which to focus their investments, more internship and immersion opportunities for graduate students considering careers outside the academy, greater alumni engagement, and stronger partnerships with the external

community, as well as additional financial and staff resources to enhance existing offerings. Where universities struggle with challenges such as faculty resistance to the idea of co-curricular professional development, or low student participation, they are interested in identifying promotional strategies and promising practices to foster these important programs.

Sample university programs

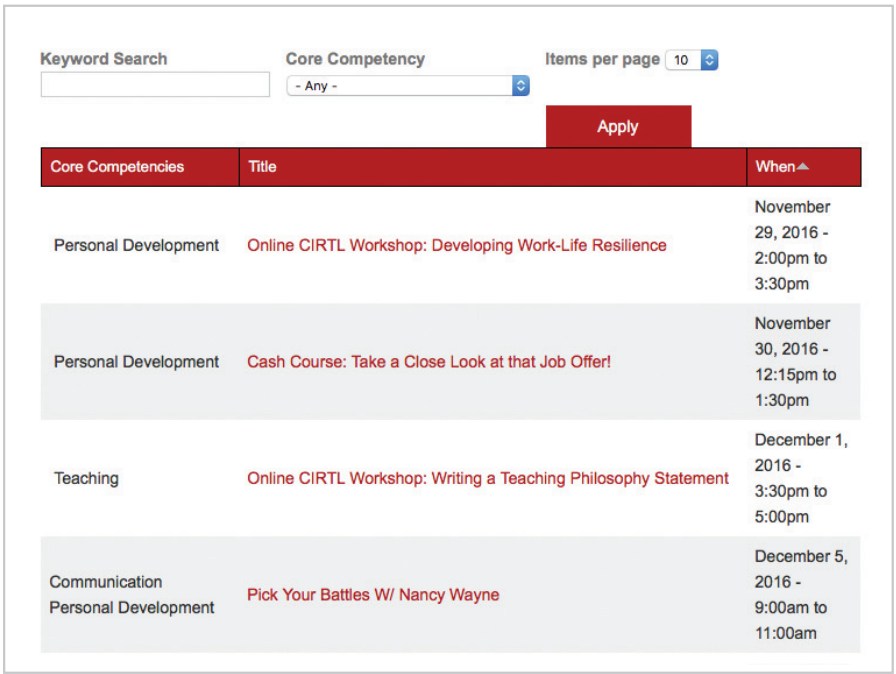
Survey responses and web research informed the CGS-developed compendium of university professional development programs (http://cgsnet.org/professional-development-programs-online-compendium). The compendium provides program profiles that include the skills, information about student populations served, and links to the programs so users can explore the programs in greater detail. The following is just a sample of programs that exhibit both features commonly found in other university professional development programs for graduate students as well as strengths, strategies, and partnerships that make these programs unique.

Cornell University's Pathways to Success Program

Cornell University's Pathways to Success program is housed in the Graduate School, but is the result of collaborations among the Office of Inclusion and Professional Development, the Office of Graduate Student Life, CU-CIRTL, the Center for Teaching Excellence, the Office of Post-Doctoral Studies, and Career Services. Structured activities offered through these partnerships focus on building core competencies and transferable skills. For example, the "CV to Resume Seminar," which teaches graduate students and postdocs to create a professional resume from an academic CV and addresses the career development core competency, is co-sponsored by Cornell Career Services, the Office of Postdoctoral Studies, and the Graduate School Office of Inclusion and Professional Development.

Cornell University's use of a competency development model for its Professional Development Program allows participants to track their skills development and progress. For example, on the Current Programs section of their Professional Development website, core competencies are identified as: communication, career development, leadership & management, teaching, responsible conduct of research, and personal development (see Figure 4). They are listed next to the program that covers them specifically and there is also a filter function which allows the user to sort the list specific to the competency covered in the program. Some examples of the types of programs that meet these competencies include seminars, networking opportunities, panel presentations, and workshops.

Figure 4. Cornell University's Core Competencies in Professional Development



Michigan State University's PREP Program

Michigan State University's Graduate School Career Success Program is offered to graduate students, post-doc scholars, and faculty mentors. Through the career success website the user is able to identify their status (graduate student, post-doc, or faculty mentor) and take advantage of relevant resources and programs offered by the graduate school. For graduate students and post-doc scholars, these include resources and tools for graduate students to evaluate their skills and plan and create a strategy to document their progress in the program. Users are able to track their completed self-assessments, resources, and events in an online professional portfolio. Users can also create an individual development plan (IDP) featuring their own activities and accomplishments which can then be shared with their advisors and mentors. The faculty mentor portion of the website includes resources and tools about mentoring and also includes university policies and guidelines as well as best practices relating to graduate students, mentoring, research, and teaching.

Within the Career Success Program, PREP, a career and professional development model is offered for graduate students and postdocs. This program was launched in 2006 and is designed to provide graduate students and postdocs a competitive edge when transitioning into future job opportunities. PREP consists of a suite of workshops, programs, and resources for career planning and is based upon four professional skills that are key to one's professional career: **P**lanning, **R**esilience, **E**ngagement, and **P**rofessionalism.

A key aspect of the program is a matrix that participants can use to identify appropriate activities and resources at different stages (early, mid, and late) in their professional development process.

Figure 5. PREP Matrix: Professional Development Skills by Stages of the PhD

	Planning	Resilience	Engagement	Professionalism
Early	• Financial planning • Setting expectations • Identifying career goals	• Creating a wellness plan • Developing support systems	• Choosing an advisor • Building professional networks • Identifying transferable skills	• Developing teaching skills • Research ethics training • ESL resources
Mid	• Preparing for the job search or postdoc • Preparing for comprehensive exams • Funding your research • Approaching dissertation research	• Sustaining support systems • Conflict resolution • Managing stress	• Working with your committee • Maintaining professional networks • Applying transferable skills	• Planning your portfolio • Using your teaching skills • Conducting ethical research
Late	• Writing the dissertation • Financial planning for the early career • Securing academic positions and postdocs • Securing non-academic positions	• Surviving the dissertation • Managing professional transitions	• Working professional networks • Negotiating the job offer • Employing transferable skills in your new career	• Publishing your work • Creating your portfolio • Defending and submitting the dissertation

Using the online version of this interactive matrix, participants are able to click on a topic area and view a list of corresponding resources, assessments, and events. If the participant has an account and is logged into the system, they are able to save their list and personalize their matrix (see Figure 5).

The Self-Assessment section of the model has six skill areas that participants are able to evaluate. These skills have been cited as crucial for success in all settings, both within and beyond the academy. They include: Communication; Leadership; Ethics and Integrity; Research, Scholarship, and Creative Activities; Collaboration; and Balance and Resilience. Participants are also able to save their assessment

skills test results to their personal profile. Once an assessment test is taken, resources are suggested in areas where more work is required and they are linked back to the PREP Matrix.

University of California, Davis's Grad Pathways Program
UC Davis's GradPathways program helps graduate students and postdoctoral scholars succeed in graduate school and future careers through a program of over 150 workshops, seminars, and panel discussions throughout the year. The program involves partnerships between Graduate Studies and other campus units, including the Internship and Career Center, the Center for Educational Effectiveness, the University Writing Program, Counseling Services, the Graduate School of Management, and the Child Family Institute for Innovation and Entrepreneurship.

The GradPathways professional development framework is based on eight core competencies with four tiers of programming within each competency. The eight core competencies are: Success and Socialization in Your Graduate Program; Writing and Publishing; Presentation Skills; Teaching and Mentoring; Leadership and Management; Scholarly Integrity and Professionalism; Career Exploration, Job Searching, and Networking; Wellness and Life Balance. In order to meet the needs of the graduate students and postdoc scholars at the appropriate time in their graduate school or postdoctoral career, four tiers of programming have been developed for each competency. The GradPathways website defines the tiers as the following:

- **Tier 1, Introductory,** consists of workshops.
- **Tier 2, In-Depth,** features classes and seminars.
- **Tier 3, Individualized Advising,** provides one-on-one mentoring or specialized programming to meet individual needs.
- **Tier 4, Community Building and Activities,** is designed to break the isolation experienced by many graduate students, particularly underrepresented groups, and further enhance the retention of UC Davis graduate students.

In addition to offering the GradPathways, the UC Davis Professional Development Program also offers Professors For The Future (PFTF), Internship and Career Exploration Programs, an annual Interdisciplinary Graduate & Professional Symposium (IGPS), Grad Slam Competition (a competition to find the best three-minute research presentation given by a UC Davis graduate student), Individual Development Plan (IDP) Resources, and access to The Versatile PhD.

University of Toronto – Biochemistry Program
An example of a successful department-specific program that focused on the professional development needs for those considering careers outside the academy is offered through the Biochemistry Department at the University of Toronto. A survey of Biochemistry PhDs graduating from the University of Toronto revealed that over the past decade only 15% remained in academia, and that most graduates were pursuing successful careers in areas such as government, hospitals, biotechnology, patent law, publishing, and sales sectors (http://www.sciencemag.org/careers/2013/10/graduate-course-professional-development). To address the need to develop the skill set for lifelong career development, in 2012, the Biochemistry Department developed University of Toronto's first graduate course in professional development. This course is a requirement for all Biochemistry graduate students and provides them with the information, network, and skill assessment tools needed to succeed in a competitive market for academic and nonacademic biomedical careers. Through this course, students are able to develop skills needed for career success both inside and outside the classroom and laboratory.

The course is six classes in length, each class consisting of a one-hour lecture followed by a 90-minute guest panel and a networking session with three or four professionals. The topics of the six classes are: success in academia, success outside academia and career transitions throughout life, the importance of mentorship, research ethics, how to succeed as a postdoctoral fellow, how to cultivate essential soft skills during graduate school. Students are given opportunities to strengthen their communication skills, network, and discuss their individual career plans face-to-face with professionals including program alumni who discuss their career pathways and the skills that are now especially valued in their careers.

As described in the *Science* article which featured the program (http://www.sciencemag.org/careers/2013/10/graduate-course-professional-development):

> The course also featured: a presentation by each participant for a panel that included a patent attorney, a newspaper editor, and an innovations specialist; a one-on-one consultation with Nana Lee, the course co-coordinator, a former senior scientist and director in the biotech industry who is experienced in career transitions and in dealing with life balance issues; and a presentation by [the University of Toronto's] Graduate Enterprise Internship program, which provides internships for students to explore opportunities in the business world.
>
> Assignments included a report about participants' research written in laymen's terms, another written for other scientists, and a cover letter and resumé customized for a job opening. Participants also wrote an essay about creating a career that combines their educational background and passions outside of science. In another valuable assignment participants made real "cold-call" contact with alumni to start building the network that will be essential to developing their careers.
>
> Highlighted throughout the course was the importance of assessing one's passions, of surrounding oneself with different types of mentors beyond the research supervisor, of effective communication, and the need to use and develop one's imagination.

Summary

The CGS project survey results revealed that university professional development programs for graduate students share a number of common skills emphases and characteristics. The sample programs described above, however, point to the unique character of many of these programs and the range of distinct skills and approaches that can result from strong leadership from graduate schools, professional development directors, and collaborators across and beyond the institutions.

Stakeholder Perspectives on Graduate Student Professional Development

Employers, graduate students and alumni, graduate deans, and program directors all have valuable perspectives to share about how to improve the preparation of today's master's and PhDs for tomorrow's careers in the advanced STEM workforce. Through this project, CGS project staff carried out two activities to better understand these perspectives on graduate student professional development and opportunities to improve on current efforts. First, we conducted in-depth interviews with chief research, talent, and executive officers from some of the nation's leading employers of recent STEM PhDs and master's. These employers represented a wide range of fields including biotechnology, agribusiness, aerospace and engineering, government, technology, computer and information science, and assessment. They also represented enterprises varying in scale from a federal mission science agency and national labs to multinational corporations and small business and start-up sectors.

Next, in November 2015, CGS convened approximately 50 individuals at a workshop, *Shaping Graduate Student Professional Development for the STEM Workforce: Opportunities, Gaps, and Strategic Directions*. Workshop participants included graduate deans and recent PhDs and postdoctorates who currently play an active role in graduate student professional development, as well as key leaders from business, non-profits, and federal science agencies. (The agenda for this meeting is included as Appendix C in the electronic version of this publication.) The workshop sought to identify:

- Employer perspectives on skills valued and needed across the STEM workforce;
- Model programs and promising practices in professional development for STEM master's, PhDs, and postdocs;
- Opportunities and gaps in existing skills preparation and professional development programs (e.g., content, replicability, scale-up, impact data);
- Enablers and impediments (including support and funding mechanisms) to professional skills development for PhDs considering careers in industry, government, or non-profit sectors; and
- Recommendations for coordinated national efforts to advance professional development of STEM graduate students and postdocs at U.S. universities.

Several common themes emerged from the interviews and workshop presentations that are summarized below. For example, differing and sometimes opposing viewpoints emerged about such questions as:

- Whether professional development is best structured to be integral to graduate curricula or as a co-curricular experience;
- The optimal timing of student exposure to professional development;
- Whether skills such as teamwork and communication are generic and best acquired in courses or workshops or are context-specific and best developed experientially, for example, in internships;
- Whether skills-based programs are sufficient to employer needs, or whether an emphasis on a broader formation of professionals would be more effective; and

- The role that federal funding mechanisms such as traineeships and research assistantships play in encouraging or discouraging students from participating in graduate student professional development activities.

What do employers see and seek in today's STEM workforce?

Master's and PhDs play a vital role in U.S. industries, in applied and translational science, as well as in science entrepreneurship and start-up companies. More dialogue is needed, however, among employers and universities to answer such questions as: Do different sectors require unique skills and talents? How do employers look for demonstrated competencies beyond core research skills? Is the pace of change accelerating in the skills required for success? And if so, how can universities work, alone and in tandem with industry, to help graduate students meet such rapidly evolving needs?

To better understand these issues, CGS staff interviewed chief research officers and other senior leaders with experience and/or direct responsibility for supervision of recent STEM PhDs and master's. In these in-depth interviews and at the Fall 2015 workshop, leaders from a range of STEM employment sectors addressed key questions that included: What skills strengths and what opportunities for enhanced skills training do they see among newly minted master's and PhDs? What skills trends do they foresee as they look to the future? And how might universities learn from employers as they seek to position graduate students for success in the STEM workforce?

One challenge faced, whether designing new programs or evaluating current activities, is that of determining whether the core, transferable skills typically covered in university professional development programs are in fact the skills sought by students and valued by employers and/or alumni. At the Fall 2015 workshop and in focused interviews, many representatives of the STEM employment sector discussed the need for greater alignment between graduate education and employers of individuals with advanced STEM degrees to answer such questions.

At the workshop, for example, Dr. Brian Fitzgerald, CEO of the Business Higher Education Forum (BHEF), emphasized the need for higher education to "move at the speed of business" to respond to job market demand. To do this, greater alignment and collaboration is required. Dr. Fitzgerald discussed a number of actions BHEF is taking to improve alignment between higher education and the workforce. In discussing STEM skills in the 21st Century workplace, he noted that BHEF members and staff have documented that the demand for STEM skills—especially in the areas of data science and analytics—extends well beyond STEM sectors. Organizations in every sector have become "data-intensive enterprises" requiring new skills from all employees. BHEF has begun efforts to document the skills needs of employers who hire holders of advanced STEM degrees and work with universities to map these against existing courses and embed them as learning outcomes. This integrated approach is much more valuable than a "bolt on" approach exemplified by skills "bootcamps" and short skills training workshops. More work is needed, however, to identify these skills and approaches at the master's and PhD degree levels.

Strengths and attributes of successful hires

When discussing the need to better prepare graduate students for multiple careers, it is possible to overlook the high regard with which employers already perceive US graduate students and the skills they bring to the workplace. Dr. Ron Townsend, executive vice president of global laboratory operation at Battelle Memorial Institute, oversees Battelle's role in the management of eight laboratories: six national laboratories for the U.S. Department of Energy, one laboratory for the Department of Homeland Security, and a nuclear energy laboratory in the United Kingdom. Prior to joining Battelle, he served as the President of Oak Ridge Associated Universities (ORAU). Dr. Townsend stated emphatically that the US PhD is widely seen as the "gold standard" for high quality research skills. Whatever professional development programs are developed for PhD candidates, he emphasized, these should not distract doctoral programs from continuing in their successful mission of research excellence.

At the same time, Dr. Townsend noted that Battelle has to be very strategic about the skills it is looking for as it is now in a major hiring phase, employing between 200 to 500 new PhDs per year at each national lab. He described seven attributes that, from his perspective, the national labs are looking for in new PhD students. These are:

1. **Quality technical degrees** that indicate the student "has done a deep dive" into a specific discipline as opposed to being "a dilettante" who has dabbled in different areas. "While a little breadth is good," he stated, "the labs are looking for the deep technical expertise a PhD confers."

2. **Research experience** that indicates the individual has worked across disciplines and recognizes a more global research experience.

3. **Experience in a team and experience with addressing a difficult challenge,** either a research challenge or a social challenge, such that the end result is more than the product of an individual working in isolation.

4. **Communication skills:** new hires should be able to be succinct and communicate with a variety of audiences and should have an agility to go deep in a technical context but also present a technical topic in laymen's terms than anyone can understand; they should be able to do this in both written and oral formats.

5. **Project management and business acumen,** including the ability to deliver on schedule and on budget and an understanding of schedule and budget pressures.

6. **Attention to safety:** an inability to operate safely will prevent hires from earning the recognition they would need to get research awards.

7. **Passion for the mission:** "Batelle and the national labs may not pay more than other employers," Dr. Townsend said, "but a lot of people come because they are passionate about issues such as climate, energy challenges, renewable energy, national security, cybersecurity."

Dr. Wayne Camara, senior vice president of research, ACT, Inc. reflected on the skills trends and needs among new PhD and master's degree recipients from various STEM fields. He emphasized the need for new hires to be self-starters who are able to communicate across an organization and troubleshoot and solve problems. Dr. Jeffrey Rosichan, new technology leader, Dow AgroSciences and Dr. David Isenhour, professor in the Department of Entomology and a research stations lead for Dow AgroSciences noted that by and large Dow as a company has very strong relationships with universities, and they look to PhDs for the next generation of leaders. Dow AgroSciences especially values PhDs for their ability to look to the future and see where the science is going, which can help steer the future direction of the company. PhDs are recruited not only for their ability to perform the job, but also for their career potential as the future company leaders.

General skills deficiencies and unmet needs

When asked about what, if any, skills deficiencies they see in new STEM PhDs and master's, employers mentioned a wide range of skills gaps in graduate student training and experience and unmet needs in terms of disciplinary and interdisciplinary expertise. The general skills gaps most commonly noted were:

- Writing, speaking, and presentation including effective PowerPoint
- Cross-disciplinary and cross-cultural communication and teamwork
- Time management and project management in an experiential context

Employers noted the highly valued, but in new PhDs rare, *communication skills* of effective writing, speaking, and presentation including effective PowerPoint. Dr. Harold Garner, executive director, Primary Care Research Network and The Center for Bioinformatics and Genetics, at VCOM (The Edward Via College of Osteopathic Medicine), is founder of leading-edge biotechnology companies, including Heliotext, Xanapath, BioAutomation, and Light Biology. Dr. Garner noted that in the entrepreneurial context, when scientists have to convince angel investors and venture capitalists of the value of a proposed project, it is "very clear that people who are confident, who know their science AND who can communicate are far more likely to succeed because they stand out." PhDs and master's students often lack experience "selling" their research ideas to prospective funders. Understanding how to speak about one's research to a general audience, specifically to one of potential funders who may not have expertise in one's discipline but may have specific interests in application and return on investment, may require different skills and different messages. "When we go to bankers we have one set of messages," one employer said, whereas "their technology experts want to know details." Being able to quickly pivot and adapt your message with information at varying levels of technical detail to multiple audiences is crucial: "In 45 minutes, their future is determined."

Employers also noted, in both interviews and at the workshop, the importance of *cross-disciplinary and cross-cultural communication and teamwork;* that is, not just being able to communicate to a general audience but to work with specialists from a different discipline and/or different country from their own. Steven Miller, data maestro, global leader academic programs & outreach for IBM Analytics Group, described how IBM noted the example of computer program designers who may be assigned with implementing an idea from another science discipline into a program that might, in turn, be designed to serve the needs of users without expertise from either discipline. He and others from multiple sectors noted, as well, that as their organizations expanded globally, identifying team scientists with experience in international contexts was a plus in the hiring process. And Dr. Garner noted that, particularly in the context of small business and science entrepreneurship, "red teaming" or being able to help a team identify where breakdowns are occurring and "bind the holes" is especially valuable among new PhDs. Dr. C. Allen Butler Wagoner noted that while they are primarily looking for deep research expertise and provide training in skills needed for success at the organization, interdisciplinary study and teamwork in particular is a sign of "problem solving potential" among PhD and master's students.

Other skills mentioned as deficient in newly hired PhDs include *time and project management and personnel management.* One employer said, "We can teach project management, but it would be better if they had some coming in; they are more effective if they have had team experience in an experiential context." Another said, "We don't often find these skills fully developed in fresh academic hires of graduate students but project management and business acumen [are important]. Delivery on schedule and on budget. An understanding of schedule and budget pressures." Another noted that, in the context of the university, PhDs often don't have an opportunity to develop personnel management issues that are often needed even among new PhDs such as hiring and firing. Dr. André Rupp, research director, Educational Testing Service (ETS) commented on the fact that graduate education often does not provide students with the opportunity to gain experience in these areas so important to PhDs' career success in the advanced STEM workforce. He noted, in particular, the competitive advantage of those with cross- or poly-disciplinary work, legal experience, and/or a track record in real entrepreneurship (successful or not).

STEM-specific skills deficiencies and unmet needs

The STEM-specific skills gaps and unmet needs most commonly noted were:

- Analytics, data science
- Statistics and computational ability, especially in working with Big Data

- Genetics and genomics
- Cognitive computing
- Information Systems that can keep up with the pace of change
- Lab safety

Several employers noted that many of the STEM graduate students they were hiring came with just a cursory, weak knowledge of statistics and lack versatility in computer science. In working with big data, in particular, many issues arise that require statistical approaches that are unfamiliar or new to these students. Dr. Garner (VCOM) noted that in the area of bioinformatics and genome sequencing for example, students need to have strong skills in platforms such as Python, and Perl, Linux; "even hardcore wet-bench biologists now need a sophisticated understanding of big data and a familiarity with the relevant tools and approaches." Dr. Klaus Schäfer, chief medical officer, client executive, health market sector, CACI International Inc., emphasized the huge opportunities in government contract work with Big Data as well as the need for people who are flexible. While many programmers may come in familiar with the latest and greatest software packages, many government systems still rely on coding languages from the 1970's and 1980's. Modernization across government IT systems will be a multibillion dollar effort, and people who are most competitively positioned will be "integrators" who are flexible and can work across coding languages and help update these older systems.

Steven Miller (IBM Analytics Group) noted that IBM's "Watson" technology platform project requires people with highly specialized skills, for example in cognitive computing and machine learning, that are currently difficult to find among today's STEM graduates. In the area of information systems, in particular, he noted, "right now most universities in this field prepare graduate students for yesterday's needs." Aside from a few excellent programs around the US, demand for students from "information systems" programs is dropping because it has been too hard for universities to keep up with the pace of change where faculty have never worked in industry. This is an area where universities "are living in the past."

Personal attributes

Personal attributes, or so-called "non-cognitive" skills, are less frequently identified among the core competencies in university professional development programs than other skills such as communication and teamwork. However, employers made frequent mention of attributes such as an ongoing thirst for learning, a hunger for innovation, a passion for the mission of the organization including public impact, resiliency, creativity, and risk tolerance.

Jeffrey M. Gallagher, CEO of Virginia Bio, a statewide non-profit trade and advocacy association representing the life sciences industry, called on graduate degree educators to instill in graduates a desire to create value. A PhD signals the degree-holder's potential to constantly grow intellectually: to "unlearn, "relearn," and learn things that are not yet known, and these qualities are highly valued in industry. Cultivating in students a thirst for lifelong learning is something that should be cultivated in our graduates.

Existing relationships and the ability to build relationships are also highly valued in the workplace. Dr. Schafer (CACI International Inc.) noted that his company is looking to hire people who already "have relationships with our customers;" this trait, though rare among new graduate students, is "golden."

Dr. Garner (VCOM) echoed this call by stating that in order to succeed in the biotech startup sector, students must be "hungry" and have a "real mastery of the subject area" while being able to also perform many functions beyond their area of research expertise. He encouraged institutions to provide students opportunities beyond academic research that prepare them for this variety of functions.

Several noted the importance of purpose and mission. Organizations that are mission-driven can attract students who resonate with the organization's purpose. These organizations are looking for individuals with deep research expertise who also "know what they're doing, where they're going, and why."

While these personal-professional skills are rarely the central focus of university programs, as the examples discussed below show, these programs can address such skills through activities that focus on skills ranging from networking to resilience, self-awareness, and emotional intelligence.

Integrative experiences, internships, and immersion

One way to help graduate students acquire the broad range of professional and interpersonal skills sought by employers is by providing integrative experiences that allow graduate education to develop these skills in context. Leaders from consulting, biotech, and pharmaceutical industries also all stressed the need for collaborations that result in integrative experiences and internships for professional development.

Dr. Rupp (ETS) emphasized the importance of such experiential training. Experiences in real-world contexts, he noted, help students develop the combination of attributes needed to be successful in today's workplace: knowledge, experience, and creativity. It is vital, Dr. Rupp said, that students are able to gain project experience including exposure through courses and independent self-study, hands-on experience through funded research projects, and professional experience through internships at companies. Solutions to foster such opportunities include: supporting cross-team collaboration within campus schools/colleges and with regional partners, developing more flexible intellectual property rules and guidelines that facilitate partnerships, and taking some financial risks to develop partnerships with for-profit and not-for-profit companies. Finally, he encouraged "lots of collaboration with interesting characters." Dr. Camara (ACT) noted that internships, in particular, help prepare graduate students to transition out of graduate school and into the workforce and familiarize them with the organizational cultures and expectations of prospective employers.

The future of work

In general, employers noted that a breadth of skills in addition to research depth made PhDs more competitive and new hires more successful in their organizations. Several employers noted that the organizational characteristics of their companies are changing and that, as a result, they were looking for new attributes among new hires.

For example, Steven Miller (IBM Analytics Group) described how IBM has evolved as a company from a highly differentiated structure organized around key corporate functions (hardware, software, consulting, and research) to one that is more about targeting efforts to meet customer needs. These customer-based needs now shape the company's organizational structure, with teams that collaborate in areas such as analytics, cloud and hybrid cloud workspaces, security, and the internet of things. As the company grew, Mr. Miller said, it became harder to collaborate to meet these needs given the old structure, so the organization evolved. Now there are multiple subunits that provide analytics platforms, system integration, and data management. "Systems" units have replaced organizational units formerly distinguished between hardware and software, and staffing needs have changed accordingly, as now the focus is more about integrated hardware and software solutions, and software-defined networks and strategies. Keys to employee success in this environment are: effective teamwork skills and sufficient breadth to understand how your field and that of a collaborator might complement one another to achieve goals. Such calls for a combination of deep research expertise and experience working in cross-functional team. Support the argument for university programs and professional development activities that allow PhD and master's students to develop their skills in an experiential context, such as an internship or immersion experience.

Attributes such as breadth in addition to depth as well as flexibility and initiative are needed for today's graduates to be prepared for success in the "gig economy," i.e., the world of work in short-term

project-based and contract-based jobs that characterize many of the growth opportunities in the advanced STEM workforce. Dr. Schäfer (CACI International Inc.), for example, highlighted the need for greater flexibility among PhDs and master's in this new economy as they consider careers outside the university. Traditionally, workers established long-term relationships with companies and develop their careers in this same context over decades. Now, for people willing and able to work on large-scale but short-term science contracts will join organizations that "search for opportunities, bid on contracts, and then scramble for individuals to hire." Such short-term, contract work might have a negative connotation among faculty, who may equate such work with "adjunct" positions. But today's students should be flexible, Dr. Schäfer urged, and be able to demonstrate a breadth of expertise in their fields so they can be prepared and ready for the advanced STEM workforce of the future.

Promising practices in university professional development

At the workshop, graduate deans and directors of professional development programs shared different perspectives on principles of program structure and content.

Is there a core curriculum for graduate professional development programs?

As the survey data described in the preceding chapter show, a core set of skills has emerged in university programs that prepare graduate students for multiple career pathways. These include: communication, leadership, teamwork, mentoring, writing, teaching, job search, and networking skills. At the Fall 2015 workshop, speakers described model programs that develop a broad range of such skills and competencies for graduate students and post-doctorates. Participants emphasized that many of these skills are those valued across multiple sectors.

Graduate deans with successful professional development programs discussed guiding principles by which their institutions have identified content and structured professional development curricula. Two specific strategies emerged by which universities have identified skills content include core competency frameworks and needs assessment.

Core competency frameworks

A core competency approach typically provides a conceptual framework of between four to eight high-level competencies in which graduate students may develop a larger set of skills. The program at the University of North Carolina at Chapel Hill, for example, uses a matrix that includes the following competencies: communication, academic development (scholarship, teaching & mentorship); leadership and professionalism; and career development (http://gradprofdev.web.unc.edu/core-competency-framework/). For each core competency, there is an associated group of "elements" or skills; a description of the abilities associated with each of these elements; and a link to actions and programs relevant to early-, mid-, and late-stage graduate students. At the Fall 2015 workshop, Dr. Steve Matson, dean of the UNC-Chapel Hill Graduate School described the successful Professional Development Program which averages 50 events with a total of approximately 1,800 students attending per year. Consisting of faculty, staff, and students from across the university, the Graduate School Professional Development Advisory Council meets twice a year to review offerings, provide feedback, and set the agenda for the professional development programs. Florida International University similarly organizes its program around core competencies including: communication, professoriate and research training, leadership, and well-being (https://gradschool.fiu.edu/current-students-professional-development.shtml). Some other universities that use a core competency framework to structure their professional development programs for graduate students include: Michigan State University; Florida State University; Cornell University; and the University of California, Davis.

Needs assessment

Another strategy deans have used to identify core-skills content and structure programs is needs assessment. At the Fall 2015 workshop, Dr. Barbara Knuth, senior vice provost and dean of the Graduate School, Cornell University discussed the institution's strategy of conducting needs assessments which includes an Alumni Career Outcomes Survey, a Graduating Student Exit Survey, a Doctoral Student Experience Survey, and the New Student Survey. Using information from these surveys, Cornell has been able to develop comprehensive programs offering both training in high demand skills (e.g., writing) and just-in time programs for students with specific needs (e.g., in financial literacy and personal financial management). She also discussed the importance of identifying resources, including what the Graduate School can provide with internal and external funding, as well as the other existing resources that might be leveraged to meet these needs. It is important, Dr. Knuth emphasized, that graduate schools partner with multiple units across campuses in order to deliver a successful program.

Approaches to core skills development

While programs typically address transferable skills such as communication, teamwork, and leadership, universities take very different approaches to developing these skills in their students. Examples in just two areas, communication and leadership/management, illustrate this diversity of approach.

Communication

Among the skill areas most commonly addressed and most often cited by employers is communication. Programs use communication to refer to a wide variety of skills. For example, some universities use the term to refer to training in research writing, such as grant writing and preparing articles for submission to scholarly journals, while others use the term to refer to cross-disciplinary and cross-cultural communication and teamwork or effective science advocacy and science policy.

Depending on how universities identify competencies and organize their programs, other topics encompassed by communication can include: interpersonal understanding, mentoring, collaboration, networking, courses on professional written communication, effective presentation and public speaking, classroom communication and engagement strategies including classroom communication for non-native English speakers, and science communication and advocacy. For example, in addition to offering courses on public speaking, the University of Wisconsin includes training in: digital and visual communication, the digital humanities, and science communication and advocacy through which the Graduate School offers funding for graduate student participation in an annual Catalyzing Advocacy in Science and Engineering (CASE) Workshop in Washington, D.C. (https://grad.wisc.edu/pd/communication/).

Some innovative approaches that have been effectively used to enhance graduate student skills in science communication include the Three Minute Thesis, community engagement activities, and improvisatory theater.

Three Minute Thesis

One activity that is being increasingly used to help graduate students sharpen their communication skills is the "Three Minute Thesis" or "3MT®." Developed by the University of Queensland, the 3MT competition involves training PhD students to effectively communicate the results of their dissertation research to a non-specialist audience in three minutes (http://threeminutethesis.org/). The 3MT activity cultivates presentation and research communication skills in an engaging and entertaining way that prepares students for career success in any setting. As described on the University of Utah Graduate School website, "the goal of 3MT is for students to articulate the significance of their research without using jargon, field-specific terminology, and other language unfamiliar to those outside their fields of study" (http://gradschool.utah.edu/3MT/).

Students compete with each other at their own universities as well as with students from other universities in broader forums, such as Universitas 21 and annual meetings of organizations such as the Conference of Southern Graduate Schools (CSGS) and Midwestern Association of Graduate Schools (MAGS) (http://www.csgs.org/annual_meeting/, http://mags-net.org/three-minute-thesis-award/). University competitions are typically judged by an interdisciplinary panel that may also include employers and/or local policymakers, providing the host universities with an important opportunity to provide graduate student professional development while at the same time deepening networking connections with industry and advocating for graduate education.

Communications training and community engagement

Other programs develop communication skills by engaging graduate students with communication to different audiences from the community. The RELATE program at the University of Michigan Rackham Graduate School, for example, is a "communications training and community engagement program" designed to improve dialogue between researchers and different public audiences (http://www.learntorelate.org/about-us/). Co-founded by graduate students in Neuroscience, the program helps graduate students develop skills in science communication as a conversation with lay audiences in the community and not merely as a one-way lecture to audiences about their work. Through intensive workshop participation and feedback and subsequent work with diverse audiences and community engagement events, student scientists make their work "accessible and meaningful to a broad audience." The program's developers received the "Community Choice Award" from the National Science Foundation's "Innovation in Graduate Education Challenge" to further implementation.

Improvisatory theater

Another approach to enhancing graduate students' public communication skills is improvisatory theater. The Alan Alda Center for Communicating Science at Stony Brook University, a pioneer in this area, was established in 2009 by the actor Alan Alda, known for his successful film career and role on the long-standing TV show M*A*S*H. The center mission "is to train the next generation of scientists and health professionals to effectively communicate with the public and others outside of their discipline in a more clearly and conversationally manner" (http://www.centerforcommunicatingscience.org/). The center offers a range of programs including workshops, conferences, lectures, courses and coaching opportunities for science graduate students and scientists. In 2010, Alan Alda led a CGS Annual Meeting plenary session joined by theater director Steve Marsh and five graduate students from the sciences to demonstrate a range of methods to improve students' abilities to communicate science (http://www.proquest.com/blog/gradshare/2014/Communicating-Science-with-Help-from-Hawkeye. html).

Leadership and management

Leadership skills comprise another area commonly addressed in university programs and highly valued by employers. Leadership skills cover a wide spectrum of competencies including project and personnel management, budget management, entrepreneurship, teamwork and inclusive collaboration, self-awareness, and understanding group dynamics.

The Grad Pathways program at UC Davis includes a leadership component conducted in collaboration with the Office of Research and the Child Family Institute for Innovation and Entrepreneurship. This part of the program consists of four tiers. The first tier includes of workshops for graduate students and postdocs, also made available via podcast, in project management and understanding learning styles; entrepreneurship events and workshops; and a program in the Responsible Conduct of Research (RCR). The second tier combines multiple options for experiential development of leadership skills by which students can earn a competitive fellowship to develop leadership skills for faculty careers or serve in various leadership capacities in campus leadership organizations, committees, or the graduate school. In tier three, science and engineering graduate and postdoctoral students gain hands-on experience and receive individualized advising in developing business skills for a career in industry. Here, they have an opportunity to develop new business ventures as well as work in the non-profit start-up

sector, with tailored programs for students in agricultural sciences and biomedical engineering. For example, participants in biomedical engineering work with venture capitalists, angel investors, entrepreneurs, and industry executives to develop entrepreneurship skills in a three-day intensive program that integrates lecture, exercises, and individual projects where they work to identify, design, and validate new business opportunities for their research. In tier four, graduate students and postdoctoral scholars work with campus communities such as student associations and coalitions, advocacy programs, and the graduate school. More information about the UC Davis program is available at *UC Davis* https://gradstudies.ucdavis.edu/professional-development/gradpathways/leadership-and-management.

The Graduate Leadership Development Series (GLDS) at North Carolina State University works with graduate students to help them develop a range of leadership skills including communication, self-awareness, professional adaptability, interdisciplinary teamwork, and critical thinking. Participation in team projects and presentations, reflection, and peer feedback enable students to demonstrate a "readiness for increasing responsibility and promotion" as soon as they enter the workplace (https://www.ncsu.edu/grad/preparing-future-leaders/career-skills/glds.html). More information about the NC State program is available at https://www.ncsu.edu/grad/preparing-future-leaders/career-skills/glds.html.

UNC-Chapel Hill has a Leadership Development Scholars Program to support student-designed specific projects that will contribute to the professional development of their peers. Supported projects range from student-facilitated or organized workshops on a specific transferable skill, development of online resources, student-organized panel discussions on an area of leadership, peer-support mechanisms focused on teaching development, etc. For more information on the UNC Leadership Development Scholars program, see http://gradprofdev.web.unc.edu/leadership-development-scholars-program/.

Cornell University hosts two leadership certificate programs within their professional development program. The Colman Leadership Program for PhD Students in engineering and other related STEM fields was established in 2012 and includes up to 30 PhD students from all graduate fields annually. The intensive four-day program provides students with practical skills and knowledge that will support their development as leaders in graduate school and beyond.

The program includes readings and discussion, interactive group activities, case studies, student presentations and professionally conducted workshops. Skills covered include negotiation and conflict resolution, teamwork and inclusive collaboration, self-awareness, interpersonal and group dynamics, and appreciating diversity in all contexts. Cornell also offers a 10-module Postdoc Leadership Program. For more information about Cornell's Colman leadership programs see: http://gradschool.cornell.edu/inclusion/inclusion-initiatives/colman-leadership-program.

Self-Assessments and Individual Development Plans (IDPs)

As noted earlier, the use of individual development plans in structured conversations between students and their advisors is being used by a growing number of graduate schools and programs. Beginning in 2014, based on recommendations from the Working Group that issued the NIH biomedical workforce report, NIH now strongly encourages the use of IDPs to structure the identification and achievement of career goals for graduate students and postdoctoral researchers (https://grants.nih.gov/grants/guide/notice-files/NOT-OD-14-113.html). IDPs and other self-assessments help students be intentional about setting goals and planning for a career while in graduate school. They also help students document progress in acquiring both the depth of research and breadth of other skills sought for by employers.

One resource for students, myIDP, is an interactive website designed as a career-planning tool for PhD students and postdocs in the sciences. Based on the Federation of American Societies for Experimental Biology's (FASEB's) Individual Development Plan for Postdoctoral Fellows and developed by Cynthia Fuhrmann, Jennifer Hobin, Bill Lindstaedt, and Philip Clifford, the myIDP website creates an Individual Development Plan (IDP) for scientists in a four-step process involving: assessment, career exploration, goals, and implementation. The first step, assessment, helps the student evaluate scientific skill and knowledge areas, while the second step uses information from the first step to determine possible career options based on one's skills, interests, and values. Goals are set and a plan is formulated in step three while step four puts the plan into place. The myIDP website is free to use, and many Professional Development Programs link to this website through their list of resources and/or offer their own IDP templates and tools. Other examples of IDPs and other similar self-assessment resources include: the University of Wisconsin-Madison's IDP Form, Iowa State University's Humanities and Social Sciences Self-Assessment and IDP forms, and Stanford Biosciences IDP forms. The Graduate Career Consortium is developing a similar career planning tool, ImaginePhD, for PhDs in the humanities and social sciences (http://www.gradcareerconsortium.org/consortium_projects.php).

Some programs, including the NIH Broadening Experience in Scientific Training (BEST) Program, require that an IDP plan be created for the graduate or postdoc student (http://myidp.sciencecareers.org/Home/About, http://www.sciencemag.org/careers/2012/09/you-need-game-plan). A number of universities, including Florida State University and the University of Alabama at Birmingham, for example, have recently required that all graduate students develop an individual development plan. Though some expressed resistance to federal mandates, some experts who work with student IDPs and academic departments believe that these would be even more beneficial if federal funders such as NIH and NSF required their use and provided guidance and support for their use to support broader professional development goals.

Delivery format and timing

Engaging graduate students with relevant content also requires deliberate thinking about the format and timing of delivery. There was consensus that, ideally, universities should:

- Provide information and opportunities about professional development to graduate students early and often;
- Offer multiple types and locations of delivery, both online and in person, including panels of alumni and employers both at universities and at national and international and discipline-specific conferences; and
- Provide resources in multiple formats to help those students who have trouble attending the workshops because they have competing work, lab, or other obligations. Some universities have begun taping their forums and making these available on their websites and/or as podcasts for access by their students.

Dr. Cynthia Fuhrmann, assistant dean of career & professional development in the Graduate School of Biomedical Sciences at the University of Massachusetts Medical School, addressed good practice in structuring professional development. She especially emphasized the timeline of professional development training; to ensure this training is viewed as a priority, it should not be deferred until the end of the student's degree program where it might be considered an afterthought, but must instead be integral to the student's experience from the beginning. Dr. Matson (UNC-Chapel Hill) also stressed the timing of professional development and the importance of sequencing activities from the beginning of the graduate school career. From the time of admission, students should be made aware of the availability of online courses and activities, and thereafter periodically should receive communications through a variety of means including direct email and social media communications about program opportunities.

Partnerships

Universities can expand the range of skills content they offer by enlarging the network of campus and external partners. While survey results shed light on the most common partners, a closer look at well-developed individual programs reveals the range of partnerships involved in delivering professional development to graduate students.

For example, in addition to partnering with its Career Center, Office of Graduate Fellowship and Awards, and Library Services, Florida State University also partners with its Office of Distance Learning, Center for Global Engagement, Center for Intensive English Studies, and Center for Leadership and Social Change (http://gradschool.fsu.edu/professional-development/professional-development-workshops). Similarly, the University of Wisconsin partners with a wide range of campus programs and community resources. In addition to the writing center and library, partners include: the international fellowships office; the Greater University Tutoring Service (GUTS); McBurney Disability Resource Center; The Delta Program for the Integration of Research, Teaching, and Learning in the social and natural sciences; a teaching academy; an interdisciplinary Center for Patient Partnerships; the Science Alliance, digital humanities initiative; and Design Lab. Understanding where promising programs are already in place on campus and determining how to collaborate with these programs is key to diversifying the range of skills offered.

Dr. Lisa Tedesco highlighted the partnership between Emory University and Georgia Tech that is at the core of the Atlanta BEST program, which serves PhDs and postdocs in the biological and biomedical sciences. Dr. Tedesco noted that Emory's Laney Graduate School offers a range of professional development and career planning events and resources that they have been able to grow through the Atlanta BEST program, which she described as a "proving ground" for modeling activities in other areas. Funded by the NIH, the Broadening Experiences in Scientific Training (BEST) program is intended to help institutions centralize approaches to career-exploration through resources and professional development and encourage more conversations around preparing PhDs and postdocs for a broadened spectrum of careers. Dr. Tedesco discussed the importance of creating a culture of expectation for both faculty and students that prioritizes content, training, and "ownership" for professional development and career planning. The Atlanta BEST program coordinates and builds upon existing expertise and professional development programming at Emory and Georgia Tech to provide career guidance, mentoring, and deep immersion experiences to a cohort of 20 to 30 trainees per year to help them explore and prepare for a variety of STEM careers.

Immersion and internships

Several participants discussed activities that provide valuable immersion experiences in doctoral education. Dr. Maureen Grasso, dean, Graduate School, North Carolina State University outlined employment success skills for STEM workforce readiness which included communication, teamwork and collaboration, and entrepreneurship. In the immersion model she described, aspects taken from both an extracurricular program and the Professional Science Master's (PSM) program are combined to include technical/research skills, employment success skills, and an integrated internship in the program. Dr. Grasso encouraged participants to consider questions including: What techniques are useful in identifying discipline-specific skills that prepare graduate students for employment success? How could integrative models of skills development such as those developed effectively in PSM degrees be applied to doctoral education? What principles may be applied to creating effective learning experiences to help develop these skills? And what are productive strategies for building university-industry partnerships?

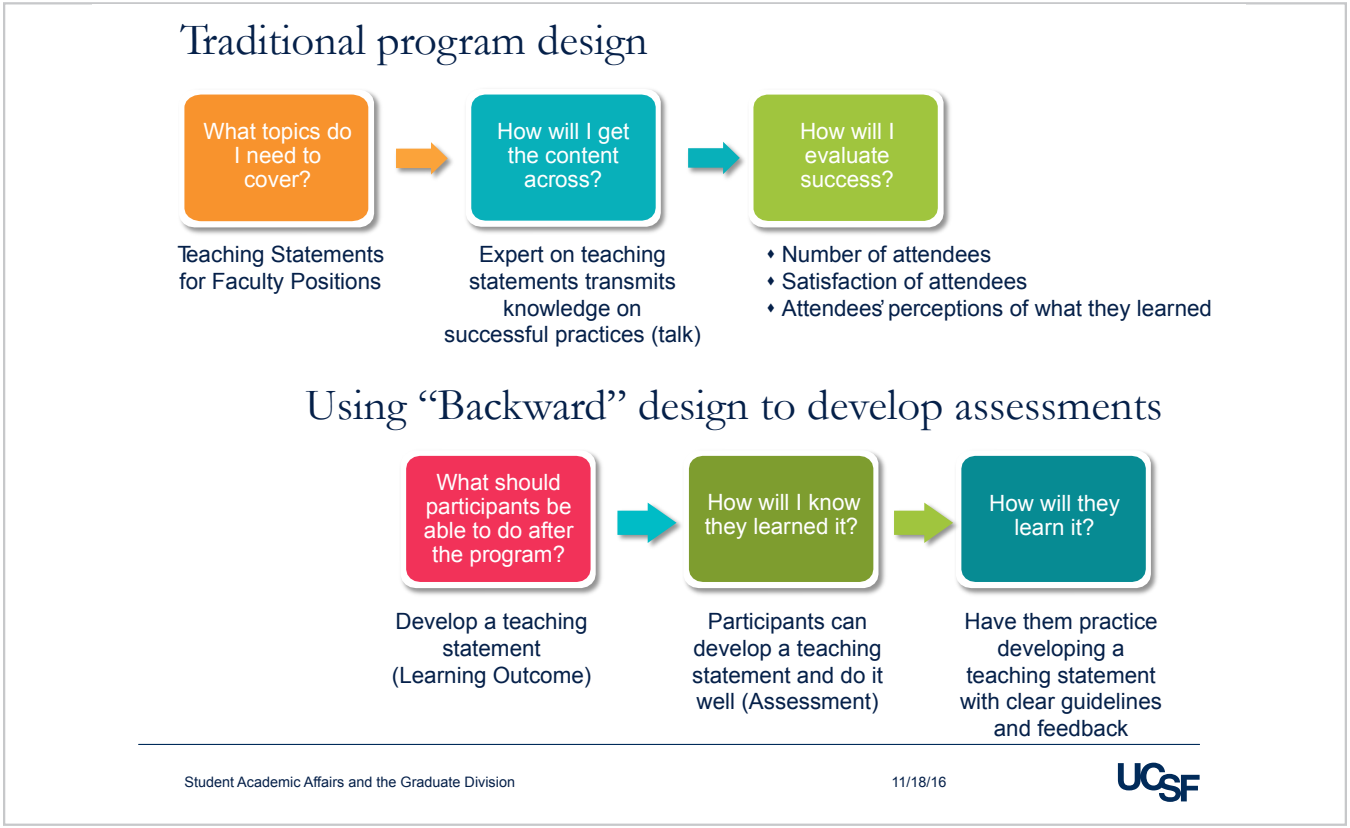
How do we know our programs are effective?

As the survey data described in the previous chapter show, most universities with professional development programs primarily use participation and participant satisfaction to assess those programs,

though a more robust assessment is called for. At the Fall 2015 workshop, Dr. Elizabeth Watkins, dean, Graduate Division, University of California, San Francisco (UCSF) described efforts to assess current professional development at UCSF supported by a collaborative unit: Career Advancement, International and Postdoctoral Scholars (CAIPS). The unit serves graduate and professional students and postdoctoral students and encompasses activities supported by an NIH BEST grant and offered by the Graduate Student Internships for Career Exploration, the Office of Career of Professional Development, an Office of Postdoctoral Scholars, and an International Students and Scholars Office. The program encompasses self-assessment, career exploration and decision-making (e.g., through alumni panels and networking opportunities), job search strategies for academic and non-academic careers, and professional skills.

Dr. Watkins emphasized the need to re-think the way we measure success. She discussed the range of questions we might ask and metrics we might use to answer them, including: student awareness of the program, participation, satisfaction, learning outcomes ("Did they learn what we wanted them to?"); behavioral outcomes ("Did they change behavior as a result of participation?"); correlated outcomes ("Were they more likely to achieve the desired outcome if they participated?"); and causation outcomes ("Did they achieve the desired outcome because they participated?"). While traditional program design might begin with questions about what content should be covered, and how we deliver that content, and end with the question of how to evaluate success, a "backwards design" approach begins with the question, what should participants be able to do after the program? (see Figure 6). Then one asks, how will we know they learn it? Then, how will they learn it? By shifting our approach to assessing professional development activities from participant approval and satisfaction to the more difficult-to-measure but more valuable actual learning gains and behavioral changes (using both subjective and objective evaluative methods), we will able to use assessment more intelligently and more effectively to shape program design and delivery.

Figure 6. From a Traditional to a Backwards Design Approach to Program Assessment



Next Steps: How can we improve graduate student professional development?

Project participants made multiple recommendations for improving graduate student professional development and, specifically, for tailoring this skills development to better meet STEM sector needs. Recommendations for US institutions clustered around four themes: improved relationships, strengthened leadership, curricular integration, and greater coordination.

Improved relationships

Participants recommended that universities strengthen relationships with employers. Examples cited of ways to do this include:

- Creating opportunities for internships and other immersion experiences,
- Engaging employers in skills and competency mapping dialogues,
- Bringing employers to campus for career fairs and local meetings with graduate students, and
- Exploring private-sector sponsorship of activities such as summer "boot camps" and webinars related to STEM career opportunities (examples cited were in aerospace and cybersecurity).

Participants also recommended that universities strengthen relationships with alumni. Examples of effective ways to do this include inviting alumni to serve: on panels; as mentors; as sources for informational interviews, internships, and shadowing experiences; and as highlighted examples of success in graduate school and/or department communications.

Relationships with both employers and alumni can be bolstered through their inclusion on community advisory boards, and faculty can help to establish contacts with their connections with both.

Strengthened leadership

Project participants emphasized that leadership across the university is required to address the current overly narrow emphasis in graduate education on preparation for academic research careers. Culture change in this area will require serious commitment from deans, directors of graduate study, and faculty.

Graduate school leadership, in particular, was called to: promote professional development among directors of grad study, other administrators, and student leaders; assess graduate student needs; and evaluate university efforts to meet these needs. Participant comments highlight a number of ways in which the leadership of the graduate school can be influential:

- "A variety of career paths for PhDs should be promoted broadly and from a variety of sources – graduate school, graduate fields, student organizations, etc." Universities "should incorporate engagement of employer representatives, content experts, and alumni. "These efforts "should be informed by established and/or research best practices."
- "Top-down leadership [is needed to shape] requirements [and] incentives; upper level administrators who value trainee needs and employee outcomes should encourage alternate careers outside academe."
- Support from the top can serve as a "form of emotional support" for those students who feel as though their advisors have "written them off" if they are considering non-academic career options.

- Graduate schools can prioritize "presentation to students and faculty on job markets and career trends."

While graduate school leadership is crucial, many pointed to the equally vital need for greater faculty leadership including their support for, and engagement in, professional development of their PhD students and trainees. As one respondent stated: "get the faculty on board! While many faculty have yet to be convinced…. many are supportive but overwhelmed."

Graduate schools can help build faculty support and understanding in different ways. They can provide information to faculty about programs, resources, and opportunities. Graduate schools can also work with faculty to gather and use career pathways data or identify external partners and create and promote discipline-specific events. One respondent stated, "there needs to be consistent messaging from the department as well as the graduate school. Sometimes these are at cross purposes."

Curricular integration

Many project participants stated that professional development programs should be more closely integrated into the academic experience. As one said, "We need to embed [professional development] into existing core courses so we can alleviate the need for add ons." Such integration can help to ensure that the "student sees a broad range of career options and [seeks to develop a range of] skills from the beginning of their graduate experience and is less likely to see academic jobs as 'plan a' and jobs in other sectors as 'plan b'."

Some observed that integration of professional development into the curricula can serve both to engage faculty and increase graduate student participation. Others noted, however, that a first step in securing buy in for such integration may be identifying faculty champions who can mentor their peer faculty.

Recommendations for curricular integration at both the academic program-level as well as the centralized level included:

- Certificate programs, which recognize participation in professional development activities, and/or non-credit courses that are listed on students' transcripts.
- Centrally organized professional development in partnership with industry.
- More structured research-professional degree programs like the Professional Science Master's.
- A required business course and required training in presentation skills.
- Training for faculty to support the connection between higher education and multiple career pathways.
- Activities that are sequenced and/or scaffolded to make a coherent program and are not merely a series of unrelated talks given by unrelated individuals. As one participant stated, "Students should have a procedure to follow and an outcome, such as a certificate, developed in coordination with a mentor who oversees the students work. If programs are run collaboratively between units, it takes considerable coordination and communication to maintain, but [this] is possible and important."
- Individualizing services and project-based experiences that enable students to list tangible experiences on their resume rather than more coursework or passive learning.

Some recommended that graduate student professional development programs consist of two-tracks, one for students aspiring to academic faculty positions and another for those aspiring to other positions, with overlap between the two. Others, however, held that programs should provide students early exposure to skills that may be equally valuable in all career contexts. Also noted was the fact that

students may not know in advance what direction their career paths will take. As one participant stated, "We emphasize that the skills learned in professional development training have broad application across careers."

There was divided opinion about whether universities should make broadened professional development and/or IDP's mandatory, and whether this should be required at the federal level by funding agencies such as NIH and NSF. One project participant stated, "programs like My IPD help. I'm not a fan of big, centralized, administrative dictates. Asking faculty and leadership to do more with less, and to do things other than their primary interest, just doesn't seem to work. I ask faculty members to do just two things: 1) encourage your students to explore their career options early and often, and 2) give them straight feedback on their strengths and weaknesses."

Obtaining support from key faculty champions may be needed to begin the process of fuller integration of professional development into the graduate curriculum. One recommendation for securing broader faculty buy-in is that faculty who support professional development programs and give students appropriate guidance on career options in the field be encouraged to serve as faculty mentors to their colleagues.

Greater coordination

Finally, participants recommended better coordination and collaboration at the national, regional, and local levels. National collaboration among universities was encouraged with continued leadership and best practice dissemination by groups like the Council of Graduate Schools (CGS) and regional graduate school groups. Participants also called for more accessible evidence-based best practices that are scalable and replicable across the diversity of institutions preparing PhDs, master's, and postdoctorates for the advanced STEM workforce. Another recommendation was for more visible and accessible sources for common resources that faculty could draw upon, for example, with breakout sessions that can address the range of student interests. Organizations of graduate deans such as CGS can provide key leadership for promoting and coordinating scalable and replicable university program development, evaluation, resource adoption, and enhancement while disciplinary associations and science associations can provide leadership for support and program-based activities among STEM faculty. CGS and associations of university program directors such as the Graduate Career Consortium also can play a key role in the identification, curation, advocacy, and exchange of best practices. Finally, organizations of graduate deans such as CGS and regional associations can also help to facilitate broader alignment and competency mapping efforts in graduate education between universities and employers.

Participants noted that while individual universities and consortia of universities have engaged in alignment exercises that bring employers and educators together in ways that have implications for undergraduate and technical curricula, more such activity and greater national coordination would be helpful. Such alignment is a resource-intensive activity, and replicable results of local efforts have not been broadly disseminated.

Within universities, greater collaboration was called for among campus units. Participants called for greater coordination and linkage between central graduate school programs and seminars and other activities offered in the departments. The office of career development, graduate school, and graduate leadership council were identified as key partners in this work. Participants also identified the importance of reaching out to student groups and department staff to help promote professional development programs and tailor them to specific audiences.

Conclusion

The conviction that the purpose of a PhD or research master's degree is to prepare future scholars for careers solely in academic research remains strong in many university quarters. This poses one such barrier to broadening the preparation graduate students receive for multiple career paths. Another barrier is the language used to refer to the broad spectrum of career pathways taken by our graduates. In her presentation at the Fall 2015 CGS project workshop, Dr. Cynthia Fuhrmann (University of Massachusetts Medical School) stressed the need to change attitudes and develop a culture around professional development, beginning with the language we use. Even speaking of "non-academic" careers can imply to students and faculty that academic careers are the norm and can inhibit the culture change necessary. Similarly, words like "alternative careers" and "alt-ac" (for alternative-academic) may lend further credence to the myth that careers outside academe are "fall-back" or "sub-prime" career choices for today's PhD and master's students. Dr. Sharon Milgrim, director, Office of Intramural Training and Education, NIH, reiterated this point, stating that one of the assumptions underlying the professional development NIH provides is that no satisfying careers are "alternative." Other terminology that can potentially alienate support from faculty and graduate students includes "soft skills" and "non-cognitive" skills.

Attitudes of faculty and trainees must adjust as careers beyond academic research are not only common and viable for the majority of STEM graduate students but in fact the intended destination for many of our PhDs, master's, and postdocs. To meet the needs of these students and employers, graduate schools and academic programs must work together to track student career paths and engage alumni and employers in closer dialogue. At the same time, federal funders should continue to consider ways in which funding mechanisms can support or inhibit improved preparation of graduate students for the advanced STEM workforce. Students and employers from many sectors value US master's and PhD degrees for depth of research and other qualities suggesting leadership in the field. Greater dialogue about the numbers of students who pursue career paths in various sectors, their successes and pathways, and feedback from them and their employers about how preparation of future students might further student success in the STEM workforce is a complex task but a vital one for the nation.

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APPENDIX A
Resources

COUNCIL OF GRADUATE SCHOOLS

CGS Online Compendium of Graduate Professional Development Programs
Council of Graduate Schools
http://cgsnet.org/professional-development-programs-online-compendium

Survey results and web research were used to develop profiles of existing university professional development programs for STEM graduate students. Each profile was then sent to the appropriate institutional contact for review, and completed profiles were compiled in a searchable electronic compendium. Program profiles include information about the mission of each program as well as skills focus, funding sources, and student populations served (e.g., PhDs, master's, postdocs); they also include a web link for those seeking further information.

The primary purpose of the compendium is to spotlight promising programs, enhance understanding of program skills and structures, and provide an opportunity for graduate school and other professional development leaders to connect to others as they seek to develop robust programs for STEM graduate students. While this database is public, the resource was designed to inform university leaders seeking to create or enhance professional development programs for STEM graduate students and postdocs at U.S. universities and not as a resource to promote university offerings to prospective or current students.

Understanding PhD Career Pathways for Program Improvement
Council of Graduate Schools
http://cgsnet.org/understanding-career-pathways

With funding from the Alfred P. Sloan Foundation, the Andrew W. Mellon Foundation, and the National Science Foundation (NSF #1534620), CGS has worked to advance national and local understandings of the career pathways of PhD holders. With input from a range of stakeholders in the higher education community, CGS has developed survey instruments and guidelines for data collection across a broad range of fields to help universities gather long-term career information from their PhD students and alumni with the goal of improving PhD programs. CGS has received a grant from the Andrew W. Mellon Foundation to work with institutions to implement these survey materials. In addition to gathering data on PhD careers, this project will identify effective strategies for collecting and using career pathways data to improve the experiences of PhD students.

Scholarly Integrity and Responsible Conduct of Research Initiatives
Council of Graduate Schools
http://cgsnet.org/scholarly-integrity-and-responsible-conduct-research-rcr

Since 2003, CGS has worked with members to develop promising practices in responsible conduct of research (RCR) and research ethics education for graduate students. Recently, with funding from the Office of Research Integrity (ORI), the Project for Scholarly Integrity supported the development of comprehensive institutional models for embedding enhanced research integrity and responsible conduct of research education into graduate education. Through "Modeling Effective Research Ethics Education in Graduate International Collaborations" and with a grant from the National Science Foundation (NSF), CGS worked with members to use a learning outcomes approach to develop effective

programs and graduate curricula that address the research ethics issues that arise in international collaborations. Publications from each of these projects provide guidance to institutions seeking to develop new, or enhance existing, research ethics and scholarly integrity programs for graduate students.

Preparing Future Faculty (PFF) Initiatives
Council of Graduate Schools
http://cgsnet.org/preparing-future-faculty

The Preparing Future Faculty (PFF) program is a national movement to transform the way aspiring faculty members are prepared for their careers. CGS first supported the development of graduate students aspiring to faculty careers through its involvement in promoting the diffusion of Preparing Future Faculty (PFF) programs (1993-2003). During this time, CGS collaborated with universities, disciplinary societies, and the Association of American Colleges and Universities to develop and foster programs to prepare graduate students for the full variety of faculty roles and responsibilities. PFF and other, similar programs now provide doctoral students, as well as some master's and postdoctoral students, with opportunities to observe and experience faculty responsibilities at a variety of academic institutions with varying missions, diverse student bodies, and different expectations for faculty. Most recently, with grant funding from the Teagle Foundation and the Alfred P. Sloan Foundation, CGS worked with institutions in the "Preparing Future Faculty to Assess Student Learning" initiative to develop model approaches to preparing graduate students to assess undergraduate learning. As faculty roles and responsibilities evolve, CGS continues to work with universities to expand and enhance programs to prepare graduate students for faculty careers.

NATIONAL SCIENCE FOUNDATION

NSF Research Traineeship (NRT) Program
National Science Foundation
http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=505015

The NRT Program, launched in 2014, is designed to create resources and opportunities for students in research-based master's and doctoral programs to develop skills, knowledge, and workforce exposure in order to purse a range of STEM careers. The NRT program includes two tracks: the Traineeship Track and the Innovations in Graduate Education (IGE) Track. Using a traineeship model aligned with changing workforce and research needs, the Traineeship track is dedicated to training graduate students in high-priority interdisciplinary research areas. The IGE track is solely focused on piloting and testing new and innovative approaches to both disciplinary and interdisciplinary graduate education. Collaborations with a variety of organizations including the private sector, non-governmental organizations (NGOs), government agencies, national laboratories, field stations, teaching and learning centers, informal science centers, and academic partners is encouraged for both tracks.

Graduate Research Internship Program (GRIP)
National Science Foundation
http://www.nsf.gov/pubs/2016/nsf16024/nsf16024.jsp

Launched in September 2014, NSF's GRIP program is designed to provide professional development experiences to NSF Graduate Research Fellows through research internships developed in partnership with Federal Agencies. NSF Graduate Research Fellows participate in mission-related, collaborative research under the guidance of host research mentors at U.S. federal facilities and national laboratories, developing expertise in STEM areas of national need and preparing for an array of career options. The program supports 10-week to 12-month internships at four federal agencies: the Office of Naval Research, the Department of Homeland Security, the Federal Bureau of Investigations, and the Smithsonian Institution. As of 2015, NSF estimates that up to 75 internship allowances of $5,000 will be made each year, with varied amounts of support from participating federal agencies. Eligible are

active NSF Graduate Research Fellows (MS and PhD, on tenure or reserve) who have completed at least one year of their graduate program at the time of application and will retain their active status for at least 12 months following the application submission deadline. For some internship opportunities, Fellows must also be able to pass background and/or security checks.

NSF Graduate Research Opportunities Worldwide (GROW)
National Science Foundation
https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=504876

Graduate Research Opportunities Worldwide (GROW) is a collaboration between NSF and international partners to provide NSF Graduate Research Fellows with expanded opportunities to enhance professional development through research collaborations at science and engineering research sites abroad. GROW has established research cooperation with counterpart funding organizations in Australia, Austria, Brazil, Chile, Columbia, Denmark, Finland, France, India, Ireland, Japan, South Korea, the Netherlands, Norway, Singapore, Sweden and Switzerland.

OTHER STEM-RELATED RESOURCES

NIH Broadening Experience in Scientific Training (BEST) Programs
National Institutes of Health

In 2013, the National Institutes of Health Common Fund issued a funding opportunity: NIH Director's Biomedical Research Workforce Innovation Award: Broadening Experiences in Scientific Training (BEST) (DP7) with the purpose to "seek, identify and support bold and innovative approaches to broaden graduate and postdoctoral training, such that training programs reflect the range of career options that trainees (regardless of funding source) ultimately may pursue and that are required for a robust biomedical, behavioral, social and clinical research enterprise." http://grants.nih.gov/grants/guide/rfa-files/RFA-RM-12-022.html

A total of 17 institutions were selected to participate in this long term study – ten were awarded grants in 2013 with seven more institutions receiving awards in 2014. Institutions are employing various models of participation and programming in order to explore and identify new and innovative approaches for career and professional development for graduate students and postdoctoral fellows. The target populations are PhD and postdoctoral students and the various participation models include a cohort model that fosters peer-to-peer mentoring and team building for scientists, a broad exposure model which allows all scientists to participate in the activities, and an alumni mentoring which includes alumni serving as mentors to scientists in the BEST program. The programming includes: Career Development; Professional Development; Experiential Learning; and Mentoring.

Georgia Tech Graduate Cooperative Education Program
Georgia Institute of Technology
http://www.gradcoop.gatech.edu/

Established in 1983, and currently the largest co-op program in the United States, the Georgia Tech Graduate Co-op Program provides graduate students with an opportunity to gain full-time work experience while currently enrolled in school. Through this innovative approach to learning, students acquire valuable, real-life exposure to their field of study by working with industry and government leaders. The program is open to all graduate students including international students provided they have successfully completed one academic semester and are in good academic standing. There are no fees or tuition associated with the program.

Alan Alda Center for Communicating Science
Stony Brook University
http://www.centerforcommunicatingscience.org/

Established in 2009, the Alan Alda Center for Communicating Science at Stony Brook University has a mission to train the next generation of scientists and health professionals to effectively communicate with the public and others outside of their discipline in a more clear and conversational manner. A range of programs including workshops, conferences, lectures, courses and coaching opportunities are offered for science graduate students and scientist to help further this mission.

Versatile PHD
https://versatilephd.com/

The Versatile PHD is a website that provides tools for graduate students and postdoctoral scholars interested in non-academic careers. These tools are designed for students in the humanities, social sciences and STEM disciplines and they provide both free and subscription based services to its users. Features include interactive tools, community discussions, job listings, networking opportunities and local meet-ups. If an institution participates in the subscription based service, they can host the portal with access to additional content for log-in by students, postdocs, faculty, staff, and alumni on their website.

GradShare
http://www.proquest.com/researchers/graduate-student/

GradShare, a website developed by ProQuest, is an online community that allows graduate students to connect with one another across universities to discuss the challenges they face in graduate education and to share strategies for success. GradShare also allows universities to customize links to recommend resources to their students logged into GradShare, including university programs and services, policies, and events.

The Professional and Organizational Development (POD) Network
http://podnetwork.org/

The Professional and Organizational Development (POD) Network in Higher Education is a professional society that focuses on advancing the research and practice of educational development in higher education by providing support and services for its members through publications, conferences, and networking. Through faculty and organizational development, POD provides a community for scholars and practitioners who advance teaching and learning.

Graduate Career Consortium (GCC)
http://gradcareerconsortium.org/

The Graduate Career Consortium (GCC) is a professional association focused on graduate-level career and professional development. The GCC provides its members with career and professional development help for doctoral students and postdoctoral scholars. Membership benefits include discussion forums, access to resources, mentoring, national conference and regional meetings, and involvement on committees and task forces. GCC members contribute to "Carpe Careers," a weekly column in *Inside Higher Ed* on career preparation and development. One of the main efforts of the GCC is the development of Individual Development Plan (IDP) for Humanities and Social Science. The GCC has formed an ad hoc committee of 23 members whose goal is to model the humanities IDP after the MyIDP for STEM fields.

OTHER RESOURCES

MITACS
https://www.mitacs.ca/en

Mitacs is a Canadian non-profit organization that works with universities, companies, and both federal and provincial governments to design and deliver research and training programs. Mitacs builds partnerships that support industrial and social innovation in Canada. A research internship program is designed to increase deployment of highly educated graduates into the private sector. Open to all disciplines since 2007, Mitacs has expanded in response to industrial and university needs, including programs in R&D management, professional skills development, and international research training.

TRaCE
Track, Report, Connect, Exchange
Future Humanities: Institute for the Public Life of Arts and Ideas (IPLAI) at McGill University
http://iplaitrace.com/
http://iplai.ca/what-we-do/research-public-exchange/future-humanities/trace/

TRaCE is a pilot-project comprised of 25 Canadian universities and headquartered at The Institute for the Public Life of Arts and Ideas (IPLAI) at McGill University. The goal of the project is to increase awareness of the value of a humanities degree and the contributions these graduates make to Canadian society. The project aims to meet this goal by tracking ten cohorts of PhD graduates from 2004-2014 and creating a community of peers in order to provide mentorship and networking opportunities. Narratives about individual PhD and work experience challenges and insights are currently features on their website here: http://iplaitrace.com/category/narrative/

Mellon Immersive Experiences
Mellon Public Humanities, Rackham Graduate School, University of Michigan
http://www.rackham.umich.edu/publichumanities/immersives/

Recognizing the rapidly changing employment environment and the variety of opportunities and needs for humanities scholars, the Humanities Doctorate in the Twenty-first Century offered through the University of Michigan's Rackham Graduate School is an effort to directly address these issues by providing immersive experiences, fellowships, and courses for doctoral students.

The Immersive experience offers students brief experiences lasting one to several days in order to increase understanding about career possibilities and allow for career exploration. Through this activity, students are exposed to workplaces, projects, research, and other opportunities presented in a work environment. Students are able to choose their experience location from already identified host sites that have an established relationship with Rackham Graduate School or students can identify an organization of their own choosing. The experience requires that the student must attend an orientation to make a plan, participate in the immersion experience, and then have the option to consult with a career development professional following the experience.

APPENDIX B
Survey

CGS 2015 Student Life Cycle Survey

Welcome

The Council of Graduate Schools (CGS) is conducting a survey of graduate deans and other university administrators on institutional practices and programs affecting different aspects of the graduate student "life cycle" from admission to completion of graduate degree programs.

Responses to this year's survey will inform two current CGS Best Practice projects, one examining **graduate admissions processes** and another exploring **professional development opportunities** for graduate students (funded by grants from Hobsons and NSF #1413827, respectively).

As a representative of a CGS member institution, your perspective on these topics will lend important insight to our understanding of current practices in master's and doctoral education. Please note the following about the survey:

• The survey has been designed to allow individuals to answer questions appropriate to their area of responsibility. For this reason, some survey-takers will only answer questions about one of the two areas of practice outlined above.

• Information collected on admissions practices at individual institutions *will be kept confidential*. Admissions data will be reported in aggregate in ways that do not attribute their origins to any contributing individual or institution.

• Information collected on professional development opportunities will be kept confidential with the exception of publicly available links you may choose to provide to existing programs. Website links may be included in a public online compendium of Professional Development programs. All other information collected through the professional development portion of this survey will be reported in aggregate.

Thank you in advance for your contribution to this important effort.

Please click **NEXT** to begin the survey.

CGS 2015 Student Life Cycle Survey

Basic Information

*** 1. Please enter the full name of your institution. (No abbreviations, please).**

*** 2. Which of the following best describes your area of responsibility?**

- ○ The graduate school (e.g., graduate dean; associate dean)
- ○ An academic college (e.g., dean of the College of Engineering)
- ○ Graduate studies in an academic program or department (e.g., director of graduate studies; department chair)
- ○ Diversity and inclusion initiatives (e.g., director of diversity and inclusion)
- ○ Graduate admissions (e.g., graduate admissions or enrollment management professional)
- ○ Professional development program(s) (e.g., professional development program coordinator; career services professional; student services professional)
- ○ Other

CGS 2015 Student Life Cycle Survey

Master's Admissions--Dean Survey

This section asks about **MASTER'S DEGREE ADMISSIONS** processes at your institution. Please only consider processes for evaluating applications for **master's degrees** in your answers.

*** 3. Which of the following best describes the entity MOST DIRECTLY responsible for making master's-level admissions decisions at your institution?**

- ○ Graduate school
- ○ Academic department(s)
- ○ An admissions committee not located in the graduate school
- ○ Other (please specify)

CGS 2015 Student Life Cycle Survey

4. Which of the following <ins>materials</ins> are the MOST IMPORTANT at each of the specified phases in the master's-level admissions process at your institution? Select all that apply.

	Initial screening	Final admissions decision	Funding decision
Letters of recommendation	☐	☐	☐
Personal and/or research statements	☐	☐	☐
Publications	☐	☐	☐
Academic transcripts (GPA)	☐	☐	☐
Resume or CV	☐	☐	☐
Writing sample	☐	☐	☐
Interviews	☐	☐	☐
GRE, GMAT, LSAT, etc.	☐	☐	☐
CAE, TOEFL, or other language test scores	☐	☐	☐
N/A	☐	☐	☐

CGS 2015 Student Life Cycle Survey

5. In your opinion, which applicant <ins>qualities</ins> below DESERVE GREATER ATTENTION in master's-level admissions at your institution? Please select up to FOUR.

- ☐ Past academic performance
- ☐ Standardized test performance
- ☐ Past research or work experience
- ☐ Fit with program
- ☐ Passion for field of study
- ☐ Proficiency in language in which subject matter is taught
- ☐ Writing ability
- ☐ Other (please specify)
- ☐ Critical thinking ability
- ☐ Creativity
- ☐ Leadership potential
- ☐ Contribution to campus/program diversity
- ☐ Contribution to campus/program prestige
- ☐ Resilience or grit
- ☐ None

CGS 2015 Student Life Cycle Survey

Doctoral Admissions--Dean Survey

This section turns to **DOCTORAL** admissions processes at your institution. Please only consider processes for evaluating applications for **RESEARCH DOCTORAL** degree programs in your answers.

6. Are your responses to the previous questions about master's admissions identical for doctoral admissions at your institution?

- ○ Yes
- ○ No
- ○ N/A, my institution does not award doctoral degrees

CGS 2015 Student Life Cycle Survey

*** 7. Which of the following best describes the entity most directly responsible for making DOCTORAL-level admissions decisions at your institution?**

- ◯ Graduate school
- ◯ Academic department(s)
- ◯ Admissions committee not located in the graduate school
- ◯ Other (please specify)

CGS 2015 Student Life Cycle Survey

8. Which of the following <ins>materials</ins> are the MOST IMPORTANT at each of the specified phases in the doctoral-level admissions process at your institution? Please select all that apply.

	Initial screening	Final admissions decision	Funding decision
Letters of recommendation	☐	☐	☐
Personal and/or research statements	☐	☐	☐
Publications	☐	☐	☐
Academic transcripts (GPA)	☐	☐	☐
Resume or CV	☐	☐	☐
Writing sample	☐	☐	☐
Interviews	☐	☐	☐
GRE, GMAT, LSAT, etc.	☐	☐	☐
CAE, TOEFL, or other language test scores	☐	☐	☐
N/A	☐	☐	☐

CGS 2015 Student Life Cycle Survey

9. In your opinion, which applicant <ins>qualities</ins> below DESERVE GREATER ATTENTION in doctoral-level admissions at your institution? Please select up to FOUR.

- ☐ Past academic performance
- ☐ Standardized test performance
- ☐ Past research or work experience
- ☐ Fit with program
- ☐ Passion for field of study
- ☐ Proficiency in language in which subject matter is taught
- ☐ Writing ability
- ☐ Other (please specify)
- ☐ Critical thinking ability
- ☐ Creativity
- ☐ Leadership potential
- ☐ Contribution to campus/program diversity
- ☐ Contribution to campus/program prestige
- ☐ Resilience or grit
- ☐ None

CGS 2015 Student Life Cycle Survey

General Graduate Admissions--Dean Survey

This section considers graduate admissions at your institution **in general**. Please consider **both** master's and doctoral admissions processes (when applicable) in your answers.

10. IN GENERAL, how would you describe your institution's use of standardized test scores (e.g., GRE scores) in graduate admissions?

- ○ Places the APPROPRIATE emphasis on standardized test scores
- ○ Places TOO MUCH emphasis on standardized test scores
- ○ Places TOO LITTLE emphasis on standardized test scores
- ○ I'm not sure

11. Does your institution use formal guidelines (e.g., rubrics) for evaluating applicant credentials other than standardized test scores and GPA in graduate admissions decisions?

- ○ Yes, the use of formal guidelines is required
- ○ Yes, the use of formal guidelines is encouraged
- ○ No
- ○ Not to my knowledge/I'm not sure

CGS 2015 Student Life Cycle Survey

12. Which, if any, BARRIERS does your institution encounter to evaluating applicant qualities other than past academic or standardized test performance in graduate admissions?

Please select up to THREE.

- ☐ Limited staff and faculty time
- ☐ Limited resources
- ☐ Limited technology
- ☐ Lack of rubrics for evaluation
- ☐ Concern about rankings
- ☐ Other (please specify)

- ☐ Accreditation standards
- ☐ Legal concerns
- ☐ Lack of data correlating admissions criteria and student success
- ☐ N/A; None

13. What information or resources would best support your institution's efforts to evaluate applicant qualities other than past academic or standardized test performance?

Select all that apply.

- ☐ Improved technologies for reviewing applications
- ☐ Rubrics and other tools for evaluating applications
- ☐ Guidelines and/or training materials for faculty and admissions staff
- ☐ Data demonstrating relationship between admissions criteria and student success
- ☐ N/A; None
- ☐ Other (please specify)

CGS 2015 Student Life Cycle Survey

14. Which of the following practices do you associate with the terms “holistic review” or "broad-based admissions"?

Select all that apply.

- [ ] Considering all the ways an applicant might contribute to a diverse educational environment.
- [ ] Equally weighing applicants' experiences, attributes, and academic metrics.
- [ ] After an initial screening based on academic metrics, considering additional criteria.
- [ ] Considering the demographic characteristics (race, gender, etc.) of an applicant.
- [ ] Measuring characteristics of applicants other than past academic performance and test scores.
- [ ] These terms are unfamiliar to me.

Other (please specify)

Thank you for taking the time to complete the sections above on graduate admissions processes.

Please click **NEXT** to submit your answers and to be directed to the portion of the CGS 2015 Student Life Cycle Survey that will ask about graduate student professional development.

CGS 2015 Student Life Cycle Survey

Graduate Student Professional Development--Dean Survey

Graduate students receive professional development, beyond research training, through a variety of means (workshops, mentoring, internships, online and face-to-face activities, etc.). This section of the CGS 2015 Student Life Cycle Survey seeks information about structured **professional development programs** and opportunities for graduate students considering careers in various sectors (e.g., in industry, higher education, government, non-profit and entrepreneurial self-employment).

Please consider only **RESEARCH DEGREE PROGRAMS** in your answers to these questions, <ins>excluding</ins> professional degrees such as the JD, MBA, or DPT.

15. Does your institution currently have a program or programs that offer formal professional development in skills (beyond core research skills acquired in their programs) to graduate students?

- ○ Yes
- ○ No
- ○ I'm not sure

CGS 2015 Student Life Cycle Survey

16. Select the statement that best applies. "Our professional development program(s) focus on preparation for..."

- ◯ Academic teaching and university research careers.
- ◯ Non-academic careers.
- ◯ Both academic and non-academic careers.

*** 17. Please select the statement that best describes the structure of your professional development program(s).**

- ◯ Centralized (not offered by a specific department), open to graduate students from across the campus, focusing on issues that pertain to multiple fields and programs
- ◯ Program-specific, housed in the departments or programs, including emphasis on issues specific to the field or program
- ◯ Hybrid, contains both centralized and program-specific components and participants
- ◯ Other (please specify)

CGS 2015 Student Life Cycle Survey

*** 18. Where does the centralized professional development program(s) reside?**

- ◯ Graduate School or Graduate College
- ◯ Career Services/Career Center or Career Counselling
- ◯ Other (please specify)

CGS 2015 Student Life Cycle Survey

19. Where does the centralized component of your hybrid program(s) reside?

- ○ Graduate School or Graduate College
- ○ Career Services/Career Center or Career Counselling
- ○ Other (please specify)

CGS 2015 Student Life Cycle Survey

20. How is/are your professional development program(s) funded?

Select all that apply.

- [ ] Federal grants/traineeships (e.g., NIH BEST, NSF NRT/IGERT):
- [ ] Graduate School
- [ ] College (e.g., College of Engineering, College of Arts and Sciences)
- [ ] Graduate program
- [ ] Student fees
- [ ] Volunteer
- [ ] Other (please specify)

21. Which of the following are emphasized in your professional development program(s)?

Select all that apply.

- [ ] Lab management
- [ ] Communication and presentation (e.g., communicating research to a non-specialist audience, "three minute thesis" competitions)
- [ ] Writing
- [ ] Professional networking
- [ ] Personal finance
- [ ] Research development
- [ ] Governance, risk and compliance
- [ ] Project management and budget management
- [ ] Job search (e.g., cv-to-resume, cover letter, self-branding, job interview preparation, negotiating a job offer, etc.)
- [ ] Mentoring
- [ ] Leadership (e.g., collaboration/teamwork, conflict management, negotiation, decision-making, emotional intelligence)
- [ ] Data science
- [ ] Science policy
- [ ] Technology commercialization (e.g., tech transfer, patent law)
- [ ] Entrepreneurship
- [ ] Teaching
- [ ] Research ethics
- [ ] Other (please specify)

CGS 2015 Student Life Cycle Survey

22. In your opinion, how influential were the following factors in motivating the creation of your professional development program(s) for graduate students?

	Very important	Somewhat important	Not at all important
Federal grant/traineeship requirements	○	○	○
Graduate student interest/demand	○	○	○
Employer interest/demand	○	○	○
Strategic priority of university/graduate school leadership	○	○	○
Strategic priority of degree program leadership	○	○	○
National reports (e.g.,)	○	○	○
Job market for students completing with graduate degrees	○	○	○
Alumni input	○	○	○
Other	○	○	○

Other (please specify)

CGS 2015 Student Life Cycle Survey

23. How many individuals participate in the activities for your professional development program(s)?

For each category selected, please estimate the approximate number of individuals who participated in the 2014-2015 academic year in each category.

	(0-5)	(6-25)	(26-50)	(50-99)	(100+)	Not sure
Master's students	○	○	○	○	○	○
Doctoral students	○	○	○	○	○	○
Professional degree students (e.g., MBA, JD)	○	○	○	○	○	○
Postdoctoral Scholars/Researchers	○	○	○	○	○	○
Other	○	○	○	○	○	○

If Other, please describe

24. With which of the following external partners does/do your program(s) collaborate?

Select all that apply.

- ☐ Private companies/industry
- ☐ Non-profit organizations
- ☐ Federal agencies (e.g., NSF, NIH, NSERC)
- ☐ Recruiting companies
- ☐ Other universities and/or colleges
- ☐ Alumni
- ☐ Entrepreneurs/Self-employed
- ☐ None of the above
- ☐ Other (please specify)

25. With which of the following internal (university) units does/do your program(s) collaborate?

Select all that apply.

- ☐ Career services/career center
- ☐ Communications program
- ☐ Writing program or writing center
- ☐ Office of graduate fellowships & awards
- ☐ Teaching and learning center
- ☐ University libraries
- ☐ University extension unit
- ☐ None of the above
- ☐ Other (please specify)

CGS 2015 Student Life Cycle Survey

26. Are graduate students encouraged to meet at least once annually with a mentor/adviser about their career plans (e.g., to review an Individual Development Plan (IDP))?

- ◯ Yes, this is required for all students
- ◯ Yes, this is required **only** for students funded by National Institutes of Health (NIH)
- ◯ Yes, this is encouraged but is not required
- ◯ No

27. Which of the following tools/approaches are used to assess your professional development program(s)?

Select all that apply.

- ☐ Participant satisfaction and participation metrics
- ☐ Employer feedback/satisfaction
- ☐ Career placement and career pathways tracking information
- ☐ Other (please specify)

CGS 2015 Student Life Cycle Survey

28. In your opinion, what is the biggest *challenge* in providing professional development programming to graduate students considering non-academic careers?

29. Please provide any LINKS to website URL's or other publicly available information on your institution's or programs professional development program(s).

30. In your opinion, how could professional development programs for graduate students aspiring to *non-academic careers* (e.g. in industry, government, non-profit) best be promoted and shaped to meet the needs of graduate students and employers of STEM doctoral and master's students?

CGS 2015 Student Life Cycle Survey

Introduction--DGS Survey

31. Please indicate the department(s), program(s), or area(s) for which you are responsible.

CGS 2015 Student Life Cycle Survey

Master's Admissions--DGS Survey

This section asks about **master's degree** admissions processes in the program(s) for which you are responsible.

Please only consider processes for evaluating applications for **MASTER'S** degrees in your answers.

32. Which of the following best describes the program(s) for which you are responsible?

- ○ Directly responsible for master's-level admissions
- ○ Shared responsibility for master's-level admissions
- ○ No responsibility for master's-level admissions/we do not have a master's program

CGS 2015 Student Life Cycle Survey

33. Which of the following <ins>materials</ins> are the MOST IMPORTANT at each of the specified phases in the master's-level admissions process in the program(s) for which you are responsible? Select all that apply.

	Initial screening	Final admissions decision	Funding decision
Letters of recommendation	☐	☐	☐
Personal and/or research statements	☐	☐	☐
Publications	☐	☐	☐
Academic transcripts (GPA)	☐	☐	☐
Resume or CV	☐	☐	☐
Writing sample	☐	☐	☐
Interviews	☐	☐	☐
GRE, GMAT, LSAT, etc.	☐	☐	☐
CAE, TOEFL, or other language test scores	☐	☐	☐
N/A	☐	☐	☐

CGS 2015 Student Life Cycle Survey

34. In your opinion, which applicant <ins>qualities</ins> below DESERVE GREATER ATTENTION in master's-level admissions in the program(s) for which you are responsible? Please select up to FOUR.

- ☐ Past academic performance
- ☐ Standardized test performance
- ☐ Past research or work experience
- ☐ Fit with program
- ☐ Passion for field of study
- ☐ Proficiency in language in which subject matter is taught
- ☐ Writing ability
- ☐ Other (please specify)
- ☐ Critical thinking ability
- ☐ Creativity
- ☐ Leadership potential
- ☐ Contribution to campus/program diversity
- ☐ Contribution to campus/program prestige
- ☐ Resilience or grit
- ☐ None

CGS 2015 Student Life Cycle Survey

Doctoral Admissions--DGS Survey

This section turns to **DOCTORAL** admissions processes in the programs for which you are responsible.

Please only consider processes for evaluating applications for **RESEARCH DOCTORAL** degrees in your answers.

35. Are your responses to the previous questions about master's admissions identical for doctoral admissions in the program(s) for which you are responsible?

- ○ Yes
- ○ No
- ○ N/A, my institution does not award doctoral degrees

CGS 2015 Student Life Cycle Survey

36. Which of the following best describes the program(s) for which you are responsible?

- ◯ Directly responsible for doctoral-level admissions
- ◯ Shared responsibility for doctoral-level admissions
- ◯ No responsibility for doctoral-level admissions/we do not have a doctoral program

CGS 2015 Student Life Cycle Survey

37. Which of the following <ins>materials</ins> are the MOST IMPORTANT at each of the specified phases in the DOCTORAL-level admissions process in the program(s) for which you are responsible? Please select all that apply.

	Initial screening	Final admissions decision	Funding decision
Letters of recommendation	☐	☐	☐
Personal and/or research statements	☐	☐	☐
Publications	☐	☐	☐
Academic transcripts (GPA)	☐	☐	☐
Resume or CV	☐	☐	☐
Writing sample	☐	☐	☐
Interviews	☐	☐	☐
GRE, GMAT, LSAT, etc.	☐	☐	☐
CAE, TOEFL, or other language test scores	☐	☐	☐
N/A	☐	☐	☐

38. In your opinion, which applicant <ins>qualities</ins> below DESERVE GREATER ATTENTION in doctoral-level admissions in the program(s) for which you are responsible? Please select up to FOUR.

- ☐ Past academic performance
- ☐ Standardized test performance
- ☐ Past research or work experience
- ☐ Fit with program
- ☐ Passion for field of study
- ☐ Proficiency in language in which subject matter is taught
- ☐ Writing ability
- ☐ Other (please specify)
- ☐ Critical thinking ability
- ☐ Creativity
- ☐ Leadership potential
- ☐ Contribution to campus/program diversity
- ☐ Contribution to campus/program prestige
- ☐ Resilience or grit
- ☐ None

CGS 2015 Student Life Cycle Survey

General Graduate Admissions--DGS Survey

This section considers graduate admissions **generally** in the program(s) for which you are responsible.

Please consider **both** master's and doctoral admissions processes (when applicable) in your answers.

39. IN GENERAL, how would you describe your program's (or programs') use of standardized test scores (e.g., GRE scores) in graduate admissions?

- ◯ Places the APPROPRIATE emphasis on standardized test scores
- ◯ Places TOO MUCH emphasis on standardized test scores
- ◯ Places TOO LITTLE emphasis on standardized test scores
- ◯ I'm not sure

40. Are formal guidelines (e.g., rubrics) used for evaluating applicant credentials other than standardized test scores and GPA in graduate admissions decisions in the program(s) for which you are responsible?

- ◯ Yes, the use of formal guidelines is required
- ◯ Yes, the use of formal guidelines is encouraged
- ◯ No
- ◯ Not to my knowledge/I'm not sure

41. Which, if any, BARRIERS to evaluating graduate applicant qualities other than past academic or standardized test performance does/do your program(s) encounter ?

Please select up to THREE.

- ☐ Limited staff and faculty time
- ☐ Limited resources
- ☐ Limited technology
- ☐ Lack of rubrics for evaluation
- ☐ Concern about rankings
- ☐ Other (please specify)
- ☐ Accreditation standards
- ☐ Legal concerns
- ☐ Lack of data correlating admissions criteria and student success
- ☐ N/A; None

42. What information or resources would best support efforts by your program(s) to evaluate applicant qualities other than past academic or standardized test performance?

Select all that apply.

- ☐ Improved technologies for reviewing applications
- ☐ Rubrics and other tools for evaluating applications
- ☐ Guidelines and/or training materials for faculty and admissions staff
- ☐ Data demonstrating relationship between admissions criteria and student success
- ☐ N/A; None
- ☐ Other (please specify)

CGS 2015 Student Life Cycle Survey

43. Which of the following practices do you associate with the terms “holistic review” or "broad-based admissions"?

Select all that apply.

- [ ] Considering all the ways an applicant might contribute to a diverse educational environment.
- [ ] Equally weighing applicants' experiences, attributes, and academic metrics.
- [ ] After an initial screening based on academic metrics, considering additional criteria.
- [ ] Considering the demographic characteristics (race, gender, etc.) of an applicant.
- [ ] Measuring characteristics of applicants other than past academic performance and test scores.
- [ ] These terms are unfamiliar to me.

Other (please specify)

Thank you for taking the time to complete the sections above on graduate admissions processes.

Please click **NEXT** to submit your answers and to be directed to the portion of the CGS 2015 Student Life Cycle Survey that will ask about graduate student professional development.

CGS 2015 Student Life Cycle Survey

Graduate Student Professional Development--DGS Survey

Graduate students receive professional development, beyond research training, through a variety of means (workshops, mentoring, internships, online and face-to-face activities, etc.). This section of the CGS 2015 Student Life Cycle Survey seeks information about structured **professional development programs** and opportunities for graduate students considering careers in various sectors (e.g., in industry, higher education, government, non-profit and entrepreneurial self-employment).

Please consider only **RESEARCH DEGREE PROGRAMS** in your answers to these questions, <ins>excluding</ins> professional degrees such as the JD, MBA, or DPT.

44. Does/Do the program(s) for which you are responsible currently offer formal professional development in skills (beyond core research skills acquired in their programs) to graduate students?

- ○ Yes
- ○ No
- ○ I'm not sure

CGS 2015 Student Life Cycle Survey

45. Select the statement that best applies. "Our professional development program(s) focus on preparation for..."

- ◯ Academic teaching and university research careers.
- ◯ Non-academic careers.
- ◯ Both academic and non-academic careers.

*** 46. Please select the statement that best describes the structure of your professional development program(s).**

- ◯ Centralized (not offered by a specific department), open to graduate students from across the campus, focusing on issues that pertain to multiple fields and programs
- ◯ Program-specific, housed in the departments or programs, including emphasis on issues specific to the field or program
- ◯ Hybrid, contains both centralized and program-specific components and participants
- ◯ Other (please specify)

CGS 2015 Student Life Cycle Survey

*** 47. Where does the centralized professional development program(s) reside?**

- ◯ Graduate School or Graduate College
- ◯ Career Services/Career Center or Career Counselling
- ◯ Other (please specify)

CGS 2015 Student Life Cycle Survey

48. Where does the centralized component of your hybrid program(s) reside?

- ◯ Graduate School or Graduate College
- ◯ Career Services/Career Center or Career Counselling
- ◯ Other (please specify)

49. How is/are your professional development program(s) funded?

Select all that apply.

- ☐ Federal grants/traineeships (e.g., NIH BEST, NSF NRT/IGERT):
- ☐ Graduate School
- ☐ College (e.g., College of Engineering, College of Arts and Sciences)
- ☐ Graduate program
- ☐ Student fees
- ☐ Volunteer
- ☐ Other (please specify)

50. Which of the following are emphasized in your professional development program(s)?

Select all that apply.

- ☐ Lab management
- ☐ Communication and presentation (e.g., communicating research to a non-specialist audience, "three minute thesis" competitions)
- ☐ Writing
- ☐ Professional networking
- ☐ Personal finance
- ☐ Research development
- ☐ Governance, risk and compliance
- ☐ Project management and budget management
- ☐ Job search (e.g., cv-to-resume, cover letter, self-branding, job interview preparation, negotiating a job offer, etc.)
- ☐ Other (please specify)
- ☐ Mentoring
- ☐ Leadership (e.g., collaboration/teamwork, conflict management, negotiation, decision-making, emotional intelligence)
- ☐ Data science
- ☐ Science policy
- ☐ Technology commercialization (e.g., tech transfer, patent law)
- ☐ Entrepreneurship
- ☐ Teaching
- ☐ Research ethics

CGS 2015 Student Life Cycle Survey

51. In your opinion, how influential were the following factors in motivating the creation of your professional development program(s) for graduate students?

	Very important	Somewhat important	Not at all important
Federal grant/traineeship requirements	○	○	○
Graduate student interest/demand	○	○	○
Employer interest/demand	○	○	○
Strategic priority of university/graduate school leadership	○	○	○
Strategic priority of degree program leadership	○	○	○
National reports (e.g.,)	○	○	○
Job market for students completing with graduate degrees	○	○	○
Alumni input	○	○	○
Other	○	○	○

Other (please specify)

52. How many individuals participate in the activities for your professional development program(s)?

For each category selected, please estimate the approximate number of individuals who participated in the 2014-2015 academic year in each category.

	(0-5)	(6-25)	(26-50)	(50-99)	(100+)	Not sure
Master's students	○	○	○	○	○	○
Doctoral students	○	○	○	○	○	○
Professional degree students (e.g., MBA, JD)	○	○	○	○	○	○
Postdoctoral Scholars/Researchers	○	○	○	○	○	○
Other	○	○	○	○	○	○

If Other, please describe

CGS 2015 Student Life Cycle Survey

53. With which of the following external partners does/do your program(s) collaborate?

Select all that apply.

- ☐ Private companies/industry
- ☐ Non-profit organizations
- ☐ Federal agencies (e.g., NSF, NIH, NSERC)
- ☐ Recruiting companies
- ☐ Other universities and/or colleges
- ☐ Alumni
- ☐ Entrepreneurs/Self-employed
- ☐ None of the above
- ☐ Other (please specify)

54. With which of the following internal (university) units does/do your program(s) collaborate?

Select all that apply.

- ☐ Graduate School
- ☐ Academic Departments
- ☐ Career services/career center
- ☐ Communications program
- ☐ Writing program or writing center
- ☐ Other (please specify)
- ☐ Office of graduate fellowships & awards
- ☐ Teaching and learning center
- ☐ University libraries
- ☐ University extension unit
- ☐ None of the above

CGS 2015 Student Life Cycle Survey

55. Are graduate students in your program(s) encouraged to meet at least once annually with a mentor/adviser about their career plans (e.g., to review an Individual Development Plan (IDP))?

- ◯ Yes, this is required for all students
- ◯ Yes, this is required **only** for students funded by National Institutes of Health (NIH)
- ◯ Yes, this is encouraged but is not required
- ◯ No

56. Which of the following assessment tools/approaches are used in your professional development program(s)?

Select all that apply.

- ☐ Participant satisfaction and participation metrics
- ☐ Employer feedback/satisfaction
- ☐ Career placement and career pathways tracking information
- ☐ Other (please specify)

CGS 2015 Student Life Cycle Survey

57. In your opinion, what is the biggest*challenge* in providing professional development programming to graduate students considering non-academic careers?

58. Please provide any LINKS to website URL's or other publicly available information on your professional development program(s).

CGS 2015 Student Life Cycle Survey

Thank you

Thank you for participating in this survey. The results will be evaluated later this year and findings will be reported to the graduate community.

To learn more about the Council of Graduate Schools (CGS), please visit**cgsnet.org**.

CGS 2015 Student Life Cycle Survey

Future Plans

59. Does the unit for which you are responsible plan to implement formal professional development in skills (beyond core research skills acquired in their programs) to graduate students?

- ◯ Yes, we are in advanced stages of planning
- ◯ Yes, we are in early stages of planning
- ◯ No, there are no plans to implement this type of program at this time

CGS 2015 Student Life Cycle Survey

Thank you

Thank you for participating in this survey. The results will be evaluated later this year and findings will be reported to the graduate community.

To learn more about the Council of Graduate Schools (CGS), please visit**cgsnet.org**.

APPENDIX C

Shaping Graduate Student Professional Development for the STEM Workforce: Opportunities, Gaps, and Strategic Directions

The Fairfax Embassy Row Hotel
2100 Massachusetts Avenue, NW
Washington, DC 20008

Sunday, November 8 – Monday, November 9

WORKSHOP GOALS

The goal of this workshop is to identify:

- Employer perspectives on skills valued and needed across the STEM workforce;
- Model programs and promising practices in professional development for STEM master's, PhDs, and postdocs;
- Opportunities and gaps in existing skills preparation and professional development programs (e.g., content, replicability, scale-up, impact data);
- Enablers and impediments (including support and funding mechanisms) to professional skills development for PhDs considering non-academic careers; and
- Recommendations for coordinated national efforts to advance professional development of STEM graduate students and postdocs at U.S. universities.

Sunday, November 8

6:30-7:00 p.m. Reception, The Capitol Room

7:00-8:30 p.m. Dinner and Panel Presentations, Ballroom

Welcome and Opening Remarks

7:00-7:10 p.m. Suzanne Ortega, President, Council of Graduate Schools

Reflections of Early-Career Researchers on Professional Development

7:10-8:30 p.m. Introduction and Overview of the Meeting
Daniel Denecke, Vice President, Best Practices and Strategic Priorities, CGS

Panel Discussion
In this panel, early career researchers will share their perspectives on the opportunities and challenges surrounding the preparation of today's STEM graduate students and postdocs for multiple career paths.

Daniel Choi, PhD candidate (Princeton University)

Mike Hepler, PhD candidate (Princeton University)

Donato Giovannelli, Postdoctoral Research Fellow (Rutgers University)

Robyn Marty-Roix, Postdoctoral Associate (University of Massachusetts Medical School)

Monday, November 9

Introduction

8:30-9:00 a.m. Continental Breakfast, Ballroom

9:00-9:10 a.m. Welcome and Introduction
Suzanne Ortega, President, CGS

Fostering Dialogue between Employers and Universities about Professional Skills Development

9:10-9:30 a.m. Speaker: Brian Fitzgerald, CEO, Business Higher Education Forum

What Do Employers See and Seek in Today's Stem Workforce?

9:30-10:50 a.m. In this session, leaders from a range of STEM employment sectors will address key questions including: What skills strengths and what opportunities for enhanced skills training do they see among newly minted master's and PhDs? What skills trends do they foresee as they look to the future? And how might universities learn from employers as they seek to position graduate students for success in the STEM workforce?

Facilitator: *Kinchel Doerner, Dean, Graduate School, South Dakota State University*

Speakers: *C. Allen Butler, President and CEO, Daniel H. Wagner Associates, Inc.*

Harold Garner, Executive Director of the Office of Medical Informatics Translation, Training and Ethics, Virginia Tech

André Rupp, Research Director, Educational Testing Service (ETS)

Klaus Schäfer, Chief Medical Officer, Client Executive, Health Market Sector at CACI International Inc.

Full Group Discussion

10:50-11:00 a.m. Coffee Break

Professional Development for Graduate Students: How is it Structured?

11:00-11:30 a.m. What has worked well and what has not worked in structuring professional development programs? What are the gaps in current approaches? And what are the challenges in institutionalizing efforts and bringing them to scale? In this session, experienced leaders in professional skills development from distinct institutional contexts will address these issues as well as the rationale for professional development and its implications for structuring programs and establishing key partnerships.

Chair: *Lakshmi Reddi, Dean, Graduate School, Florida International University*

Speakers: *Cynthia Fuhrmann, Assistant Dean, Career & Professional Development of the Graduate School of Biomedical Sciences, University of Massachusetts Medical School*

Sharon Milgrim, Director, Office of Intramural Training and Education, National Institutes of Health

Full Group Discussion

Is There a Core Curriculum for Graduate Professional Skills Development?

11:30 a.m. -12:30 p.m. In this session, graduate education leaders will discuss guiding principles by which they have identified content and structured professional development curricula in model programs that develop a broad range of skills and competencies for graduate students and post-doctorates.

Facilitator: Nancy Marcus, Dean, Graduate School, Florida State University

Speakers: Barbara Knuth, Senior Vice Provost and Dean of the Graduate School, Cornell University

Steve Matson, Dean, The Graduate School, University of North Carolina-Chapel Hill

Full Group Discussion

12:30-1:30 p.m. Working Lunch

Breakout Tables, The Capitol Room Preparing Graduate Students for the Stem Workforce of the Future

1:30-1:45 p.m. **Panel Discussion, Ballroom**

Master's and PhDs play a vital role in U.S. industries, applied and translational science, as well as in science entrepreneurship and start-up companies. Panelists from diverse industries and STEM fields will address questions such as: Do these sectors require unique skills and talents? How do employers look for demonstrated competencies beyond core research skills? Is the pace of change accelerating in the skills required for success? And how can universities work, alone and in tandem with industry, to help prepare graduate students meet such rapidly evolving needs?

Facilitator: Jeffrey M. Gallagher, CEO, Virginia Bio

Panelists: Cindy Georgette, Staffing Consultant, Portola Pharmaceuticals

Crystal Icenhour, CEO, Aperionomics

Denise McCusker, Senior Director of Human Resources, L-3 Communications

Linda Ness, QEDelta

How Do We Know Our Programs are Effective?

1:45-2:15 p.m. In this session, graduate education leaders will present examples and lead discussion about efforts to assess current professional development efforts, metrics used to measure success, and opportunities for improving on current practice.

Facilitator: John C. Keller, Associate Provost for Graduate and Professional Education, Dean of the Graduate College, The University of Iowa

Speakers: Judith Stoddart, Interim Dean and Associate Provost for Graduate Education,

Michigan State University

Elizabeth Watkins, Dean, Graduate Division, University of California San Francisco

How Can Professional Development Be Tailored to Meet Stem Sector Needs?

2:15-2:45 p.m. This session will include reflections of a senior research leader from a rapidly evolving employment sector—educational assessment—on skills trends and needs among new hires of graduate students from various STEM fields. Respondents will highlight case studies of exemplary models of graduate student professional development programs (such as the Professional Science Master's and an NIH-funded BEST program) that have been tailored to specific STEM-sector needs.

Chair: *Jeff Engler, Associate Dean for Academic Affairs, Graduate School, University of Alabama Birmingham*

Speaker: *Wayne Camara, Senior Vice President of Research, ACT, Inc.*

Respondents: *Maureen Grasso, Dean, Graduate School, North Carolina State University*

Lisa Tedesco, Dean, Laney Graduate School, Emory University

Final Reflections on Opportunities, GAPS, and Strategic Directions

2:45-3:20 p.m. **Open Discussion**
Facilitator: Robin Garrell, Vice Provost and Graduate Dean, UCLA

Wrap-Up

3:20-3:30p.m. Suzanne Ortega, Daniel Denecke

APPENDIX D

A Compendium of Professional Development Programs

Institution Name	Program Name	Program Description	Population Served		Structure*	Skills Emphasized**	
			Degree Level	0-5 ■ 6-50 ◆ 51-99 ▲ 100+ ❖ N/A ●		General Skills	STEM-specific Skills
Alabama A&M University	Career Development Services	Career Development Services (CDS) is committed to helping AAMU students prepare for and achieve professional success. Students that receive support from CDS staff and participate in CDS-sponsored events are able to confidently transition from the classroom to the workplace.	Master's	◆	Program-specific	✓	Entrepreneurship; Research development
			Doctoral	◆			
Baylor University	Grad Tracks	Grad Tracks offers resources to students for professional development and graduate life.	Master's	◆	Program-specific & Centralized	✓	Lab management; Research ethics
			Doctoral	❖			
			Professional	◆			
Bloomsburg University of Pennsylvania	Center for Professional Development and Career Experience	Students participate in free workshops and learn how to pinpoint career goals, write a resume, dress for success and more. Students gain workplace experience while earning their degree through job shadowing (SEL), academic internships, study abroad, or academic research.	Master's	◆	Program-pecific & Centralized	✓	Research development; Governance, risk and compliance; Technology commercialization; Research ethics
			Doctoral	◆			
			Professional	◆			
			Postdoc	◆			
Boise State University	Graduate Certificate in College Teaching	The Graduate Certificate in College Teaching is designed to enhance teaching effectiveness of graduate teaching assistants and provide marketable skills for graduate students wishing to seek employment in higher education as instructors.	Master's	❖	Program-specific & Centralized	✓	Research development; Governance, risk and compliance; Project management and budget management; Research ethics
			Doctoral	▲			
			Professional	❖			
Brown University	Professional Development	The Graduate School encourages students to develop an Individual Development Plan (IDP) to map out career goals and the relevant steps, or building blocks, of their professional development.	Master's	◆	Centralized	✓	—
			Doctoral	❖			

Institution Name	Program Name	Program Description	Population Served		Structure*	Skills Emphasized**	
			Degree Level	0-5 ■ 6-50 ◆ 51-99 ▲ 100+ ❖ N/A ●		General Skills	STEM-specific Skills
Bryn Mawr College	The Center for Professional Development	The GSSWSR Professional Development Center seeks to enhance the career-long learning objectives of professional social workers, counselors, and marriage and family therapists. Its trainings offer a broad range of opportunity for personal reflection and enrichment in areas ranging from ethical principles that guide professional practice to dimensions of diversity that characterize and shape the human experience.	Master's	◆	Program-specific & Centralized	✓	Lab management; Science policy; Research ethics
			Doctoral	◆			
			Postdoc	■			
California State University, Fullerton	Professional Development	University Extended Education collaborates with University departments to provide educational programs and extend the University's resources to the community and around the world.	Master's	❖	Program-specific	✓	Lab management; Research development; Entrepreneurship
California State University, Los Angeles	Graduate Resources Center	The Graduate Resource Center provides academic support, professional networking, and community building opportunities in a space dedicated to graduate students. It guides students through writing, editing, and formatting the thesis and dissertation and assist in preparing their work for publication; host workshops and presentations to support students' academic and professional development; and act as a general resource for graduate student needs.	Master's	❖	Program-specific & Centralized	✓	—
			Doctoral	◆			
			Professional	▲			
			Postdoc	■			
California State University, San Bernardino	Graduate Resources	Graduate students at CSUSB are involved in a wide range of academic, career, and personal enrichment activities, developing real-world skills while enhancing their personal and professional lives. Students are involved in research, teaching, study abroad, business development, and volunteer programs.	Master's	◆	Program-specific & Centralized	✓	Research Ethics
			Doctoral	◆			
			Professional	◆			

Institution Name	Program Name	Program Description	Population Served		Structure*	Skills Emphasized**	
			Degree Level	0-5 ■ 6-50 ◆ 51-99 ▲ 100+ ❖ N/A ●		General Skills	STEM-specific Skills
Case Western Reserve University	Professional Development Center	The Professional Development Center within the School of Graduate Studies provides programming and services that support the professional development needs of graduate students and postdocs.	Master's	❖	Program-specific & Centralized	✓	Research Ethics
			Doctoral	❖			
			Professional	◆			
			Postdoc	◆			
College of Charleston	University of Charleston, S.C. Professional Development	The Graduate School of the University of Charleston, South Carolina partners with other departments on campus to provide numerous professional development opportunities including one-time events, workshop series, peer-to-peer mentoring, and career skill training. This variety of offerings allows students to develop a broad array of transferable skills while focusing on particular skill sets of interest throughout their graduate careers. The goal is to prepare graduates for the world beyond the classroom by advancing communication and teaching skills, as well as developing leadership, self-awareness, and professional adaptability.	Master's	●	Centralized	✓	Lab management; Data science; Technology commercialization; Research ethics
			Certificate	●			
			Professional	◆			
Colorado State University	Professional Development for Graduate Students	The Graduate School provides students with the skills necessary to achieve their professional goals. Students are provided with resources and the opportunity to participate in professional development events in order to polish their skills and enhance career goals.	Master's	❖	Program-specific & Centralized	✓	Research development; Entrepreneurship; Research ethics
			Doctoral	❖			
			Professional	◆			
			Postdoc	◆			
Cornell University	Professional Development	The Graduate School and partners offer programs designed to support graduate students and postdoctoral scholars in their development, progression, and career outcomes.	Master's	●	—	✓	Lab management; Research development; Governance, risk, and compliance; Project management and budget management; Data science; Science policy; Technology commercialization; Entrepreneurship; Research ethics
			Doctoral	●			
			Professional	●			
			Postdoc	●			
			Undergraduate	●			
			Faculty	●			
			Program support staff	●			

Institution Name	Program Name	Program Description	Population Served		Structure*	Skills Emphasized**	
			Degree Level	0-5 ■ 6-50 ◆ 51-99 ▲ 100+ ❖ N/A ●		General Skills	STEM-specific Skills
Drexel University College of Computing & Informatics	Professional Development Programs	The College of Computing and Informatics offers a variety of professional development programs that provide the opportunity for students holding a bachelor's or master's degree in any field to update their education and develop new expertise.	Master's	●	—	✓	Lab management; Research development; Project management and budget management; Technology commercialization; Research ethics
			Certificate	●			
Duke University	Professional Development	The Graduate School provides programs, resources, and events to help students with every step along the way—from identifying potential career paths, to developing skills to compete for them, to managing careers. These opportunities help prepare students for success in academia, business, entrepreneurship, government, and nonprofits. Professional development is not one workshop or one course; it is something students do throughout their time at Duke.	Master's	❖	Program-specific & Centralized	✓	Lab management; Research development; Project management and budget management; Science policy; Technology commercialization; Entrepreneurship; Research ethics
			Doctoral	❖			
			Professional	◆			
			Postdoc	❖			
Emory University	Professional Development and Career Planning	The Laney Graduate School offers a range of programming that encourages students to develop their professional skills and engage with broader professional communities.	Master's	◆	Program-specific & Centralized	✓	Lab management; Research development; Governance, risk, and compliance; Project management and budget management; Data science; Science policy; Technology commercialization; Entrepreneurship; Research ethics
			Doctoral	❖			
			Professional	■			
			Postdoc	❖			
Florida Atlantic University	Professional Development Workshop Series	The Graduate College offers workshops and resources to assist graduate students in completing their degree. Some of the regularly scheduled workshops include: Producing and Presenting Scholarly Work and Developing and Formatting Theses and Dissertations. There are various other professional and personal development workshops offered to students throughout the year.	Master's	▲	Program-specific & Centralized	✓	Lab management; Research development; Governance, risk, and compliance; Data science; Science policy; Technology commercialization; Research ethics
			Doctoral	▲			
			Professional	◆			
			Postdoc	◆			

Institution Name	Program Name	Program Description	Population Served		Structure*	Skills Emphasized**	
			Degree Level	0-5 ■ 6-50 ◆ 51-99 ▲ 100+ ❖ N/A ●		General Skills	STEM-specific Skills
Florida State University	Professional Development	The Graduate School's Professional Development efforts (e.g., workshops, certificate programs, faculty shadowing program, scholarly integrity course) are designed to enhance the academic training of graduate students and postdoctoral scholars within the competencies of Communication, Teaching, Scholarly Development (advanced knowledge and skills in the field), Professionalism (leadership, scholarly integrity, transferable skills), and Career Development. The Graduate School promotes professional development so that when graduate students and postdoctoral scholars enter their careers--whether in academia, the private sector, government, or non-profit organizations—they are prepared and confident.	Master's	●	—		Research development; Project management and budget management; Data science; Entrepreneurship; Research ethics
			Doctoral	●			
			Postdoc	●			
George Mason University	Professional Development	George Mason offers resources to help graduate students develop skills and make connections beneficial to their professional careers.	Master's	❖	Program-specific & Centralized	✓	—
			Doctoral	❖			
			Professional	◆			
			Postdoc	◆			
			Undergraduate students	●			
			English-language pathway program students	●			
Grand Valley State University	PACES Professional Development for Graduate Students	The PACES program offers professional development opportunities for students, and helps students increase their professionalism, academic advancement, communication, engagement, and success. By participating in PACES, students are supported in developing communications, interview, stress management and debt management skills – among other critical and timely topics.	Master's	❖	Program-specific & Centralized	✓	Research development; Research ethics
			Professional	◆			

Institution Name	Program Name	Program Description	Population Served		Structure*	Skills Emphasized**	
			Degree Level	0-5 ■ 6-50 ◆ 51-99 ▲ 100+ ❖ N/A ●		General Skills	STEM-specific Skills
Hood College	Professional Development Institute	The Hood College Graduate School offers a Professional Development Institute (PDI) designed for graduate students who want to enhance their marketability, sharpen their soft skills, and experience great networking and learning opportunities. Students in the five-Saturday program learn from industry and community leaders who bring their expertise to the seminar series.	Master's	◆	Centralized	✓	—
			Doctoral	■			
			Professional	◆			
			Postdoc	■			
Illinois State University	ISU Graduate School Professional Development Program	The Graduate School offers a series of workshops and training opportunities throughout the year to help with such things as the job search and the research process.	Master's	●	—	✓	—
			Doctoral	●			
			Professional	●			
			Postdoc	●			
			Specialist Degree Students	●			
Iowa State University	Graduate Student and Postdoc Competencies	Developing professional skills is an essential component of a graduate student's career; whether it's speaking at a conference, learning how to network with other academics, or preparing a vitae. The Graduate College has identified 6-essential skills to help graduate students and postdocs become successful in their respective disciplines. The six core competencies are: Career, Communication, Management, Research, Teaching, and Wellness.	Master's	●	—	✓	Research development; Governance, risk, and compliance; Project management and budget management; Research ethics
			Doctoral	●			
			Postdoc	●			
Kansas State University	Professional Development	The Kansas State University Graduate School and Graduate Student Council (GSC) provide informational meetings, workshops, and forums that enhance the professional development of graduate students. This program promotes interdisciplinary activities to enrich graduate students' education beyond their own disciplines. Also, through collaboration with campus partners numerous seminars, workshops, and other professional development events are available to graduate students weekly.	Master's	▲	Program-specific & Centralized	✓	Research development; Research ethics
			Doctoral	◆			
			Professional	◆			
			Postdoc	■			

Institution Name	Program Name	Program Description	Population Served		Structure*	Skills Emphasized**	
			Degree Level	0-5 ■ 6-50 ◆ 51-99 ▲ 100+ ❖ N/A ●		General Skills	STEM-specific Skills
McGill University	Skillsets	SKILLSETS is a centrally-managed program that is jointly hosted by Graduate and Postdoctoral Studies and Teaching and Learning Services. Interdisciplinary professional development offerings are developed by SKILLSETS and promoted to all Graduate Students and Post-Doctoral Fellows.	Master's	❖	Program-specific & Centralized	✓	Research development; Governance, risk, and compliance; Project management and budget management; Data science; Science policy; Technology commercialization; Entrepreneurship; Research ethics
			Doctoral	❖			
			Postdoc	❖			
McMaster University	Graduate Professional Skills	Ontario universities with the help of funding from the Ontario government have developed www.mygradskills.ca, a set of free online professional skills training tools that will help grad students find their future.	Master's	❖	Program-specific & Centralized	✓	Research development; Technology commercialization; Entrepreneurship; Research ethics
			Doctoral	❖			
			Professional	❖			
			Postdoc	▲			
Medical College of Wisconsin Graduate School of Biomedical Sciences	MCW Virtual Career Center	To help students take charge of their career in science, self-help resources and links for developing personal career plan, including practical tools for specific stages of the process are available.	Master's	◆	Program-specific & Centralized	✓	Research development; Technology commercialization; Research ethics
			Doctoral	❖			
			Professional	■			
			Postdoc	▲			
Michigan State University	Graduate Student Career and Professional Development	PREP is the MSU Graduate School career and professional development model, designed to help students plan for a successful doctoral and postdoc experience and a smooth transition into a future role in academia, government, industry, corporations, or agencies.	Master's	●	—	✓	Research development; Governance, risk, and compliance; Project management and budget management; Science policy; Technology commercialization; Entrepreneurship; Research ethics
			Doctoral	●			
			Professional	●			
			Postdoc	●			

Institution Name	Program Name	Program Description	Population Served		Structure*	Skills Emphasized**	
			Degree Level	0-5 ■ 6-50 ◆ 51-99 ▲ 100+ ❖ N/A ●		General Skills	STEM-specific Skills
Middle Tennessee State University	Professional Development	Professional Development Training offers a wide variety of programs and topics specializing programs to those interested in developing their professional expertise. Programs are offered in a variety of modes, helping people of all ages achieve CEUs and certificates, accomplish professional development goals, and pursue recreational and intellectual interests. Hundreds of courses are available online or on-demand covering topics as diverse as test preparation, software mastery, professional development, and personal enrichment.	Master's	●	—	✓	Research development; Project management and budget management; Data science; Entrepreneurship; Research ethics
			Doctoral	●			
			Professional	●			
Montclair State University	Graduate Development Conference	The Graduate Student Development Conference sponsored by The Graduate School in collaboration with faculty from the five colleges and schools, provides students with workshop sessions that cover topics for academic and professional development.	Master's	❖	Program-specific	✓	—
			Doctoral	◆			
			Professional	▲			
			Postdoc	■			
New Jersey Institute of Technology	NJIT Office of Graduate Studies	Through Career Development Services, students gain a clear understanding of career options and workplace requirements through experiential learning opportunities in the private and public sectors and are provided with opportunities to develop their job search and interviewing skills.	Master's	●	Centralized	✓	Project management and budget management
			Doctoral	●			
			Graduate Certificates	●			
New York University	Academic and Professional Development	The Graduate School of Arts and Science offers a broad range of activities and support services to assist students in their graduate and post-graduate career. Students are encouraged to pursue their research, hone their teaching skills, develop their skills outside of the classroom, and build a community.	Master's	❖	Program-specific & Centralized	✓	Entrepreneurship
			Doctoral	❖			

Institution Name	Program Name	Program Description	Population Served		Structure*	Skills Emphasized**	
			Degree Level	0-5 ■ 6-50 ◆ 51-99 ▲ 100+ ❖ N/A ●		General Skills	STEM-specific Skills
North Carolina State University	Preparing Future Leaders	The Graduate School's Professional Development Initiative is an inclusive community that provides support and coaching to help students develop their communication, academic, leadership, and professional skills.	Master's	●	—	✓	Research development; Governance, risk, and compliance; Project management and budget management; Entrepreneurship; Research ethics
			Doctoral	●			
			Professional	●			
			Postdoc	●			
			Faculty and Staff	●			
North Dakota State University	Professional and Career Development	The Graduate School offers a number of opportunities through workshops and events. Additionally, staff members are very willing to provide more focused assistance regarding topics such as recruitment, thesis and dissertation preparation, or financial awards to groups of students or faculty in individual departments.	Master's	▲	Program-specific & Centralized	✓	Lab management; Science policy; Technology commercialization; Entrepreneurship; Research ethics
			Doctoral	❖			
			Professional	◆			
Northwestern University	Graduate Student and Postdoctoral Fellow Professional Development	The Graduate School at Northwestern University (TGS) offers a variety of resources and programming to contribute to the professional development of graduate students and postdoctoral fellows.	Master's	❖	Program-specific & Centralized	✓	Lab management; Project management and budget management; Technology commercialization; Entrepreneurship; Research ethics
			Doctoral	❖			
			Postdoc	●			
Oakland University School of Engineering and Computer Science	Professional and Workforce Development Courses	Oakland University offers several courses which focus on professional and workforce development for engineers working in industry. These courses emphasizes engineering tools and their applications, rather than teaching theory.	Master's	●	—	✓	Lab management; Research development; Project management and budget management; Technology commercialization
			Doctoral	●			
			Certificate	●			
Oregon State University	Graduate Student Success	Whether pursuing a career in the public or private sector, or in academia, it's clear that to be competitive in today's marketplace, graduates need to have advanced professional skills in addition to being experts in their disciplines. Through classes, workshops, and symposia, many resources and opportunities are offered to build skills for enhancing a professional repertoire.	Master's	●	Program-specific & Centralized	✓	Research development; Governance, risk and compliance; Data science; Technology commercialization; Entrepreneurship; Research ethics
			Doctoral	●			

Institution Name	Program Name	Program Description	Population Served		Structure*	Skills Emphasized**	
			Degree Level	0-5 ■ 6-50 ◆ 51-99 ▲ 100+ ❖ N/A ●		General Skills	STEM-specific Skills
Penn State Harrisburg	Professional Development	Wellness and professional development events are offered on campus.	Master's Faculty from other universities	◆ ■	Program-specific	✓	—
Pennsylvania State University	Professional Development	The Office of Graduate Educational Equity Programs within the Graduate School, in collaboration with the academic colleges, sponsors professional development opportunities for underrepresented STEM graduate students. These workshops, seminars, and conferences are intended to address issues that may not be addressed in the academic units that can serve as barriers to students' academic success.	Master's Doctoral Postdoc	● ● ●	—	✓	Lab management; Research development; Governance, risk and compliance; Project management and budget management; Data science; Technology commercialization; Entrepreneurship; Research ethics
Princeton University	Career Services for Graduate Students	Whether pursuing a career either inside or outside the lines of academia — or even in both environments, this program provides guidance to help navigate these options.	Master's Doctoral Professional Postdoc	■ ● ■ ●	—	✓	Research development; Governance, risk and compliance; Data science; Entrepreneurship; Research ethics
Purdue University	Graduate Student Professional Development	Purdue's Graduate Student Professional Development provides free services & programs to help students navigate and conquer the graduate school experience, as well as reach academic, professional, and career goals. The mission is to provide students with the resources they need to succeed in Graduate School such as workshops, online modules, personal resume reviews, and an active social media community.	Master's Doctoral	❖ ❖	Program-specific & Centralized	✓	Lab management; Research development; Governance, risk and compliance; Project management and budget management; Data science; Science policy; Technology commercialization; Entrepreneurship; Research ethics
Radford University	Professional Development Award	Graduate students in Masters or Doctoral programs as well seniors in five-year programs that will lead to a Masters at Radford University may apply for professional development grants.	Master's	◆	Program-specific & Centralized	✓	—
Rensselaer Polytechnic Institute	Office of Graduate Education's Professional Development Programs	Throughout the Academic year, current graduate students (including post docs) are given the opportunities to attend various professional development programs.	Master's Doctoral Postdoc	● ● ●	—	✓	Research development; Data science; Technology commercialization; Research ethics

Institution Name	Program Name	Program Description	Population Served		Structure*	Skills Emphasized**	
			Degree Level	0-5 ■ 6-50 ◆ 51-99 ▲ 100+ ❖ N/A ●		General Skills	STEM-specific Skills
Rutgers University	Professional Development	The Graduate School-New Brunswick, and other organizations at Rutgers, provide a wealth of professional development workshops, courses, and resources to supplement graduate student's and postdoc's academic, scholarly endeavors while at Rutgers.	Master's	●	Program-specific & Centralized	✓	Research ethics
			Doctoral	●			
			Professional	●			
			Postdoc	●			
Stanford University Engineering	Professional Development and Continuing Education	The Stanford Center for Professional Development offers master of science degrees on a part-time basis, graduate certificates, and professional certificates, individual graduate courses and professional courses, workshops, free online seminars, and more.	Master's	●	—	✓	Lab management; Research development; Project management and budget management; Technology commercialization
			Professional	●			
			Certificate	●			
State University of New York at Buffalo	Graduate Professional Development	Graduate Professional Development helps students prepare for career success through opportunities and resources to build professional skills, prepare for the job search, and enrich personal development. Students are encouraged to participate in professional development throughout their academic program to enhance their academic and professional success.	Master's	●	—	✓	Lab management; Research development; Governance, risk and compliance; Science policy; Technology commercialization; Entrepreneurship; Research ethics
			Doctoral	●			
			Professional	●			
			Postdoc	●			
Stony Brook University	Integration of Research, Education, and Professional Development (IREP)	The Office for the Integration of Research, Education, and Professional Development (IREP) serves as a central resource for students, postdocs, faculty and staff engaged in Stony Brook's research and educational missions in order to ensure that undergraduate and graduate students and postdoctoral scholars (postdocs) receive a well-rounded and multi-dimensional education.	Master's	●	—	✓	Research development; Project management and budget management; Data science; Science policy; Technology commercialization; Entrepreneurship; Research ethics
			Doctoral	●			
			Professional	●			
			Postdoc	●			

Institution Name	Program Name	Program Description	Population Served		Structure*	Skills Emphasized**	
			Degree Level	0-5 ■ 6-50 ◆ 51-99 ▲ 100+ ❖ N/A ●		General Skills	STEM-specific Skills
SUNY Upstate Medical University	Career Development	The College of Graduate Studies is continually striving to incorporate more formal career development events for its students.	Master's Doctoral Postdoc	◆ ❖ ◆	—	✓	Research development; Governance, risk and compliance; Project management and budget management; Data science; Science policy; Technology commercialization; Entrepreneurship; Research ethics
Temple University College of Science and Technology	Student Professional Development	The Student Professional Development office provides comprehensive lists of available internships and research opportunities. CST students can also use the many resources of Temple's Career Center.	Master's Doctoral Professional Postdoc	❖ ❖ ❖ ❖	Program-specific & Centralized	✓	Research development; Governance, risk and compliance; Entrepreneurship; Research ethics
Texas A&M University	Professional Development Opportunities	The Office of Graduate and Professional Studies strives to promote and expand opportunities for graduate students to engage in professional development activities that will prepare them for their future careers - whether in academia, industry, government, non-profit organizations, or elsewhere. These activities help graduate students develop professional skills to complement the discipline specific knowledge gained in their degree program.	Master's Doctoral, Postdoc	❖ ❖ ◆	Program-specific & Centralized	✓	Research development; Entrepreneurship
Texas State University	Grad College Shop Talks	Grad College Shop Talks provides presentations on everything from strategies for moving through the degree to research support to disseminating scholarship to planning for a career.	Master's Doctoral Professional	◆ ◆ ◆	Centralized	✓	Research development; Research ethics
Texas Tech University	Professional Development	Whether one's aspirations are an academic position or a career outside academia, the Office of the Vice Provost for Graduate Affairs and the Graduate School are dedicated to preparing graduate students and postdoctoral scholars to be ethical leaders for a diverse and globally competitive workforce.	Master's Doctoral Professional Postdoc	● ● ● ●	—	✓	Lab management; Research development; Governance, risk and compliance; Project management and budget management; Data science; Technology commercialization; Entrepreneurship; Research ethics

Institution Name	Program Name	Program Description	Population Served		Structure*	Skills Emphasized**	
			Degree Level	0-5 ■ 6-50 ◆ 51-99 ▲ 100+ ❖ N/A ●		General Skills	STEM-specific Skills
Texas Woman's University Education Department	Professional Development Center	The Professional Development Center (PDC) serves all teacher education preparation programs. The PDC arranges practicum and student teaching placements in Early Childhood through grade 12 settings as well as graduate internships for students seeking teacher certification.	Master's	●	—	✓	Lab management; Research development; Governance, risk and compliance; Project management and budget management; Data science; Research ethics
			Doctoral	●			
			Postdoc	●			
The College of William and Mary	Cohen Career Center	As partners in the educational process, the center supports students and alumni through access to comprehensive career development programs, services, connections, and resources, empowering them to pursue their post-graduate plans and navigate lifelong career changes.	Master's	●	—	✓	Research ethics
			Doctoral	◆			
			Alumni	●			
			Undergraduate Students	●			
The Ohio State University	Career Development for Graduate Students at Ohio State	Career development resources are decentralized at Ohio State. Several key programs reside in the Graduate School and others are found across campus. The Graduate School is a clearinghouse for information about university resources, advocates for graduate students and their career needs, develops collaborations with campus offices, and shares research and best practices in career development and pathways with the graduate community.	Master's	◆	Program-specific & Centralized	✓	Research ethics
			Doctoral	◆			
			Postdoc	◆			
The University of Alabama	Graduate School Professional Development	The Graduate School at The University of Alabama offers a comprehensive suite of professional development programs. The skills gained in these programs will give students the tools necessary to be successful in the job market and in life.	Master's	●	—	✓	Research development; Governance, risk and compliance; Project management and budget management; Data science; Technology commercialization; Entrepreneurship; Research ethics
			Doctoral	●			
			Professional	●			
			Postdoc	●			

Institution Name	Program Name	Program Description	Population Served		Structure*	Skills Emphasized**	
			Degree Level	0-5 ■ 6-50 ◆ 51-99 ▲ 100+ ❖ N/A ●		General Skills	STEM-specific Skills
The University of Arizona	Graduate Center	The programs and partnerships across campus are designed to help develop inclusive leadership skills and collaborative opportunities. They support academic units by providing professional development that increases success both within and beyond the Academy. Fostering interdisciplinary engagement with diverse communities, the Graduate Center supports students as they prepare to address society's grand challenges and shape a changing world.	Master's	●	Program-specific & Centralized	✓	Lab management; Research development; Governance, risk and compliance; Project management and budget management; Science policy; Technology commercialization; Entrepreneurship; Research ethics
			Doctoral	●			
			Professional	●			
			Postdoc	●			
The University of Georgia	Professional Development	UGA Grad Studies sponsors and/or offers a variety of professional development programs and resources for students.	Master's	▲	Program-specific & Centralized	✓	Research ethics
			Doctoral	●			
			Professional	◆			
The University of North Carolina at Chapel Hill	Graduate School Professional Development	The Graduate School Professional Development Program provides a full range of training opportunities and resources to graduate students to develop core competencies important for academic and professional success. Using a comprehensive framework of competencies appropriate to different stages of a graduate student career, guidance is provided on actions graduate students can take and programming to develop each competency in order to be prepared for career success as innovative future leaders.	Master's	●	—	✓	Lab management; Research development; Governance, risk and compliance; Project management and budget management; Data science; Science policy; Technology commercialization; Entrepreneurship; Research ethics
			Doctoral	●			
			Professional	●			
			Postdoc	●			
			Staff & Faculty	●			
			Students from non-UNC institutions	●			
The University of North Carolina at Greensboro	Preparing Future Leaders	The Graduate Schools of UNCG and N.C. A&T, in partnership, have established the Preparing Future Leaders (PFL) program as a strong foundation for graduate student professional development and career preparation. The program is designed to provide valuable, transferable skills and knowledge that will prepare currently enrolled, degree seeking graduate students to be successful and dynamic leaders in their chosen disciplines and careers as they complete their degree.	Master's	◆	Program-specific	✓	Lab management; Research development; Governance, risk and compliance; Project management and budget management; Entrepreneurship
			Doctoral	◆			

Institution Name	Program Name	Program Description	Population Served		Structure*	Skills Emphasized**	
			Degree Level	0-5 ■ 6-50 ◆ 51-99 ▲ 100+ ❖ N/A ●		General Skills	STEM-specific Skills
The University of Southern Mississippi	Professional in Preparation: A Professional Development Program for Graduate Students	At The University of Southern Mississippi graduate education is more than just advanced study in a specific discipline. Graduate education at Southern Miss also encourages the holistic development of students through opportunities for personal and professional growth that enrich their lives. Professionals in Preparation, a professional development program for graduate students, is designed to cultivate "transferable skills" that cross disciplinary boundaries, set graduates apart from others in the increasingly competitive job market, and prepare them to be a positive force in our global society.	Master's	●	Program-specific & Centralized	✓	Research ethics
			Doctoral	●			
			Specialist Students	●			
University of Alabama at Birmingham	Professional Development Program	UAB's Professional Development Program offers ongoing support for graduate students, post-doctoral fellows and visiting scholars who want to take advantage of the school's resources to enhance their skills.	Master's	▲	—	✓	Lab management; Entrepreneurship; Research ethics
			Doctoral	●			
			Professional	◆			
			Postdoc	●			
University of Alberta	Professional Development	A graduate education is not just about advancing research. Professional development is also a key part of building a future career. Making students competitive in the global market begins the day they arrive on campus. Graduate students can develop professional skills and qualities sought by employers through many UAlberta resources. From cultivating a teaching portfolio to preparing for careers outside academia, there are online resources, workshops, and internship opportunities year-round to help sharpen skills, gain experience, and achieve career goals.	Master's	❖	Program-specific & Centralized	✓	Research development; Project management and budget management; Technology commercialization; Entrepreneurship; Research ethics
			Doctoral	❖			
			Professional	❖			
			Postdoc	❖			

Institution Name	Program Name	Program Description	Population Served		Structure*	Skills Emphasized**	
			Degree Level	0-5 ■ 6-50 ◆ 51-99 ▲ 100+ ❖ N/A ●		General Skills	STEM-specific Skills
University of British Columbia	Graduate Pathways to Success	The Graduate Pathways to Success (Pathways) program is a palette of non-credit workshops, seminars, and other activities designed to complement a graduate program's academic curriculum and mentorship experience. Offerings cover a wide range of personal and professional development topics to support students throughout their time in graduate school and to allow them to develop some of the skills and competencies needed to thrive as professionals and to make meaningful contributions to society.	Master's	❖	Centralized	✓	Lab management; Project management and budget management; Data science; Technology commercialization; Entrepreneurship; Research ethics
			Doctoral	❖			
			Professional	◆			
			Postdoc	◆			
University of Calgary	My GradSkills - Professional Development for Graduate Students	My GradSkills workshops, resources, and events are designed to be both academically sound and incredibly useful which build the skills that students need now, and in their future career.	Master's	❖	Program-specific & Centralized	✓	Project management and budget management; Technology commercialization; Entrepreneurship; Research ethics
			Doctoral	❖			
University of California, Davis	Professional Development	Graduate Studies offers unparalleled opportunities and support for professional and career development. The nationally-recognized GradPathways program has served as a model for other graduate student and postdoctoral professional development programs across the nation. This comprehensive program is designed to help graduate students and postdoctoral scholars succeed both at UC Davis and in their chosen career paths.	Master's	❖	Centralized	✓	Entrepreneurship; Research ethics
			Doctoral	❖			
			Professional	▲			
			Postdoc	▲			
University of California Irvine	Professional Success	The UC Irvine Graduate Division is committed to supporting graduate students and postdoctoral students in developing a strong professional identity and career plan. The Graduate Professional Success Program (GPS) serves as an umbrella for individual or thematic workshops, certificate programs, and academic courses designed to educate students about and prepare them for new and exciting career opportunities within academia and beyond.	Master's	●	—	✓	Research development; Data science; Science policy; Technology commercialization; Entrepreneurship; Research ethics
			Doctoral	●			
			Professional	●			
			Postdoc	●			

Institution Name	Program Name	Program Description	Population Served		Structure*	Skills Emphasized**	
			Degree Level	0-5 ■ 6-50 ◆ 51-99 ▲ 100+ ❖ N/A ●		General Skills	STEM-specific Skills
University of California, Los Angeles (UCLA)	Professional Development	The Professional and Career Development site is a collaborative project of UCLA campus units representing the interests of graduate students and postdoctoral scholars at UCLA. This program hosts workshops, speakers, and presenters from both on and off campus who can provide insight and expertise on professional and career development topics.	Master's	❖	Program-specific & Centralized	✓	Technology commercialization; Entrepreneurship
			Doctoral	❖			
			Professional	❖			
			Postdoc	❖			
University of California, Merced	Graduate Enrichment and Advancement Resources and Services (GEARS)	Graduate Enrichment and Advancement Resources and Services (GEARS) is the Graduate Division's multi-track professional development series designed to prepare graduate students for success while at UC Merced and beyond.	Master's	■	Program-specific & Centralized	✓	Research development; Research ethics
			Doctoral	❖			
			Postdoc	■			
University of California, San Diego	GrAdvantage	At UC San Diego the aim is to prepare graduate students and post-doctoral scholars for a range of careers, from industry to academia. To complement the offerings of the Career Services Center, the Graduate Division collaborated with campus partners and local employers to develop a new professional development program, GrAdvantage. GrAdvantage is a hub of campus-wide professional development opportunities and provides a suite of resources to develop the leadership, teamwork, communication, and networking skills graduate students need to become successful leaders in their field.	Master's	●	—	✓	Lab management; Research development; Governance, risk and compliance; Project management and budget management; Data science; Science policy; Technology commercialization; Entrepreneurship; Research ethics
			Doctoral	●			
			Professional	●			
			Postdoc	●			
University of California, San Francisco	Career and Professional Development	Teach UCSF provides students and postdoctoral scholars with the professional skills they need to navigate their careers successfully.	Master's	●	Centralized	✓	Lab management; Research development; Governance, risk and compliance; Project management and budget management; Data science; Science policy; Technology commercialization; Entrepreneurship; Research ethics
			Doctoral	●			
			Postdoc	●			
			Researchers	●			

Institution Name	Program Name	Program Description	Population Served		Structure*	Skills Emphasized**	
			Degree Level	0-5 ■ 6-50 ◆ 51-99 ▲ 100+ ❖ N/A ●		General Skills	STEM-specific Skills
University of California, Santa Barbara	Graduate Student Resource Center	The GSRC seeks help graduate students with many aspects of graduate student life, including funding applications, writing and editing, and navigating the job search process. It also offers information and referrals to other campus entities that assist graduate students.	Doctoral Postdoc	❖ ◆	Program-specific & Centralized	✓	—
University of Central Florida	Pathways to Success	Pathways to Success offers free development opportunities for graduate students including workshops in Academic Integrity, Research, Graduate Grantsmanship, Graduate Teaching, Professional Development, and Personal Development.	Master's Doctoral Postdoc	❖ ❖ ▲	Program-specific & Centralized	✓	Governance, risk and compliance; Entrepreneurship; Research ethics
University of Cincinnati	Professional Development Institute	Graduate students at the University of Cincinnati become experts in their fields, but they also benefit from enrichment opportunities that hone their leadership and interpersonal abilities, speaking and writing skills, grant-writing talents, teaching proficiencies, and capacity to transform knowledge into the wisdom.	Master's Doctoral Postdoc Certificate Students	■ ◆ ■ ●	Program-specific & Centralized	✓	Technology commercialization; Research ethics
University of Colorado Boulder	Teaching and Professional Development	The Graduate School offers support for professional development through two main avenues: Career Services and the nationally-renowned Graduate Teacher Program.	Master's Doctoral Professional Postdoc	● ● ● ●	—	✓	Lab management; Research development; Project management and budget management; Data science; Technology commercialization; Entrepreneurship; Research ethics
University of Connecticut	Graduate Students and Postdoctoral Scholars	The Center for Career Development provides career services for UConn Masters and PhD students and postdoctoral scholars interested in pursuing a range of professional options.	Master's Doctoral Professional Postdoc	◆ ◆ ◆ ◆	Program-specific & Centralized	✓	Research ethics

Institution Name	Program Name	Program Description	Population Served		Structure*	Skills Emphasized**	
			Degree Level	0-5 ■ 6-50 ◆ 51-99 ▲ 100+ ❖ N/A ●		General Skills	STEM-specific Skills
University of Florida	Graduate Professional Development	This newly formed unit within the Graduate School promotes professional development activities to expose students to a range of career opportunities within and outside academia, and to provide sessions and workshops. This program provides graduate students with additional skills and tools in areas that transcend disciplinary knowledge and content, including both written and oral communication with non-scientific audiences, the ethical conduct of inquiry, critical thinking and the like.	Master's	❖	—	✓	Research development; Project management and budget management; Research ethics
			Doctoral	❖			
University of Illinois at Chicago	Graduate College Professional Success Program (PSP)	The UIC Graduate College is invested in the success of graduate students and committed to helping them enhance their career and professional development as a graduate student and beyond. Succeeding in graduate school and a future career requires a plan, taking advantage of resources and opportunities to develop a set of skills, and exploring career resources and options. By actively participating in professional development programs at UIC, students build the skills intended to help them in their research, teaching, job search and enhance their life skills and employability.	Master's	❖	Program-specific & Centralized	✓	Research development; Project management and budget management; Research ethics
			Doctoral	❖			
			Professional	▲			
			Postdoc	◆			
University of Illinois at Urbana-Champaign	Graduate College Career and Professional Development Programming	Graduate College Career Development fosters personal growth and professional development in graduate students and postdocs during their time at Illinois and in their future careers.	Master's	❖	Program-specific & Centralized	✓	Lab management; Research development; Governance, risk and compliance; Research ethics
			Doctoral	❖			
			Postdoc	●			
			Faculty mentors	●			
University of Iowa	Professional Development	Iowa takes a holistic approach to graduate student and postdoctoral scholar preparation. Whether the goal is a career in academe, industry, government, or elsewhere—professional development can expand students options and make them more marketable to employers.	Master's	●	—	✓	Lab management; Research development; Governance, risk and compliance; Project management and budget management; Data science; Science policy; Technology commercialization; Entrepreneurship; Research ethics
			Doctoral	●			
			Professional	●			
			Postdoc	●			

Institution Name	Program Name	Program Description	Population Served		Structure*	Skills Emphasized**	
			Degree Level	0-5 ■ 6-50 ◆ 51-99 ▲ 100+ ❖ N/A ●		General Skills	STEM-specific Skills
University of Maryland Baltimore County	PROMISE & Professional Development	UMBC provides professional development and career guidance through services and workshops designed to assist graduate students with their future plans and current success.	Master's	●	—	✓	Lab management; Research development; Governance, risk and compliance; Project management and budget management; Science policy; Technology commercialization; Entrepreneurship; Research ethics
			Doctoral	●			
			Professional	●			
			Postdoc	●			
University of Massachusetts Amherst	Graduate School of Professional Development	The Office of Professional Development (OPD) positions graduate students and postdoctoral researchers for success in their careers at UMass and beyond. Building upon the technical and academic expertise of the scholars served, OPD provides professional skills training to cultivate strengths in the areas of career preparation, communication, grants and fellowships, personal development, and teaching. The extensive programming—created in collaboration with a far-reaching network of partners—prepares program participants to thrive in academia, industry, government, and the non-profit sector.	Master's	●	—	✓	Research development; Governance, risk and compliance; Project management and budget management; Data science; Science policy; Technology commercialization; Entrepreneurship; Research ethics
			Doctoral	●			
			Postdoc	●			
University of Massachusetts, Boston College of Science and Mathematics	Professional Development - Biotechnology Certificate Program	The Graduate Certificate in Biotechnology is a non-thesis program designed to provide students with a sound theoretical background for working in the research and development divisions of biotechnology companies or biomedical research laboratories.	Graduate	●	—	✓	Lab management; Project management and budget management; Technology commercialization; Research ethics
University of Minnesota College of Science & Engineering	Professional development and continuing education	From on-site training and professional certifications to executive education and industry seminars, this program provides a wide range of opportunities for training, continuing education, and professional development.	Master's	●	—	✓	Lab management; Research development; Project management and budget management; Technology commercialization; Research ethics
			Professional	●			

Institution Name	Program Name	Program Description	Population Served		Structure*	Skills Emphasized**	
			Degree Level	0-5 ■ 6-50 ◆ 51-99 ▲ 100+ ❖ N/A ●		General Skills	STEM-specific Skills
University of Mississippi Department of Writing and Rhetoric	Graduate Writing Center	The goal of the Graduate Writing Center (GWC) is to provide free consultations to help graduate students produce successful academic writing by further developing effective writing skills. Writers from any discipline or department are encouraged to seek assistance with any stage of the writing process: from conception to composition to revision, from first to final draft.	Master's	▲	Program-specific & Centralized	✓	Research ethics
			Doctoral	◆			
University of Missouri Columbia	Professional Development	At the graduate level, research and advanced coursework helps achieve disciplinary expertise; faculty mentoring helps to acclimate to a profession. Professional development provides leadership abilities and transferable skills that are in high demand by employers across job sectors.	Master's	▲	Program-specific & Centralized	✓	Technology commercialization; Research ethics
			Doctoral	◆			
			Postdoc	◆			
University of Nevada, Las Vegas	Professional Development	The Graduate College Professional Development Program provides a formal, value-added experience for graduate students to enhance their academic, professional, and career preparation and readiness. In addition, the programming centralizes essential information, facilitates greater access to resources, organizes and promotes academic and professional development opportunities, and collaborates with other campus units to ensure that an array of opportunities are available to graduate students.	Master's	❖	—	✓	Research development; Governance, risk and compliance; Technology commercialization; Entrepreneurship; Research ethics
			Doctoral	❖			
			Professional	●			
University of New Hampshire	Professional Development	The Graduate School offers a variety of professional development opportunities throughout the year to better prepare students for their future careers and research endeavors, and foster a sense of community within which graduate students can learn from UNH faculty and staff, guest lecturers and researchers, and each other.	Master's	●	—	✓	Research development; Entrepreneurship; Research ethics
			Doctoral	●			
			Professional	●			
			Postdoc	◆			

Institution Name	Program Name	Program Description	Population Served		Structure*	Skills Emphasized**	
			Degree Level	0-5 ■ 6-50 ◆ 51-99 ▲ 100+ ❖ N/A ●		General Skills	STEM-specific Skills
University of North Florida	Graduate Lecture Series	The Graduate Lecture Series (GLS) is a series of workshops throughout the year sponsored by the Graduate School to provide professional and educational development opportunities for students. The workshops are free and open to all graduate students and prospective graduate students. The sessions, offered throughout the academic year, provide resources on a variety of topics related to graduate student life and work.	Master's	◆	Program-specific & Centralized	✓	Data science; Research ethics
			Doctoral	■			
			Postdoc	◆			
University of Northern Colorado	Graduate Student Professional Development	UNC's Graduate Student Professional Development is dedicated to assisting graduate students in their development as researchers and teachers. GSPD also assists in preparing students for employment upon graduation.	Master's	●	Centralized	✓	Research development; Data science; Research ethics
			Doctoral	●			
			Professional	▲			
			Postdoc	◆			
University of Northern Iowa	Professional Development	The Graduate College sponsors various Professional Development workshops throughout the year.	Master's	◆	Program-specific & Centralized	✓	Research ethics
			Doctoral	◆			
			Postdoc	■			
University of Notre Dame	Professional Development	The Professional Development Program complements graduate students and postdoctoral scholars academic training, fostering the skills and insights that help them stand out in their fields. The program offers more than 100 events across four spires--Ethics, Research, Teaching, Career--to help graduate students and postdocs develop core competencies and skills.	Master's	❖	Program-specific & Centralized	✓	Research development; Governance, risk and compliance; Science policy; Technology commercialization; Entrepreneurship; Research ethics
			Doctoral	❖			
			Professional	▲			
			Postdoc	❖			
University of Pittsburgh Chemistry	Professional Development	In an effort to make sure that graduates have a competitive edge when it comes to getting their first job and beyond, the Chemistry Department is developing a formal Professional Development Curriculum. A curriculum that systematically addresses the wide range of skills needed to be successful. The time commitment is modest and the program can be tailored to a student's individual needs.	Master's	●	Program-specific	✓	Lab management; Research development; Project management and budget management; Technology commercialization; Research ethics
			Doctoral	●			
			Postdoc	●			

Institution Name	Program Name	Program Description	Population Served		Structure*	Skills Emphasized**	
			Degree Level	0-5 ■ 6-50 ◆ 51-99 ▲ 100+ ❖ N/A ●		General Skills	STEM-specific Skills
University of South Alabama	Graduate Student Professional Development	USA offers a program in Graduate Student Professional Development.	Master's	●	—	✓	Research development; Governance, risk and compliance; Data science; Research ethics
			Doctoral	●			
			Postdoc	◆			
University of Southern California	Academic Professional Development	USC is committed to the holistic development of doctoral students from all disciplines through programs that enhance their professional competencies and better equip them for both academic and alternative career paths.	Master's	❖	Program-specific & Centralized	✓	Research development
			Doctoral	❖			
			Postdoc	▲			
University of Toronto	Graduate Professional Skills (GPS) Program	The Graduate Professional Skills (GPS) program, an initiative from the School of Graduate Studies, is designed to help all graduate students become fully prepared for their future. GPS focuses on skills beyond those conventionally learned within a disciplinary program—skills that may be critical to success in the wide range of careers that graduates enter, both within and outside academe. The program can help students to communicate better, plan and manage their time, learn entrepreneurial skills, understand and apply ethical practices, and work effectively in teams and as leaders.	Master's	❖	Program-specific & Centralized	✓	Research development; Project management and budget management; Data science; Entrepreneurship; Research ethics
			Doctoral	❖			
			Professional	❖			
University of Toronto Biochemistry	Professional Development	Developed and implemented in 2012 and highlighted in Science Careers 2013, the graduate course in Professional Development provides student with the information, network and skill assessment tools outside the laboratory needed to succeed in the competitive market for academic and nonacademic biomedical careers. Students are given opportunities to strengthen their communication skills, face-to-face networking with expert professionals outside the academic environments, and to discuss their individual career plans.	Doctoral	●	—	✓	Lab management; Research development; Project management and budget management; Technology commercialization; Research ethics
			Postdoc	●			

Institution Name	Program Name	Program Description	Population Served		Structure*	Skills Emphasized**	
			Degree Level	0-5 ■ 6-50 ◆ 51-99 ▲ 100+ ❖ N/A ●		General Skills	STEM-specific Skills
University of Utah	Graduation and Student Development	The Graduate School fosters excellence by providing administrative structure and leadership to maintain and enhance graduate education at the University of Utah. The programs offer financial assistance, support innovative academic opportunities, and provide professional development to students, postdoctoral fellows, staff and faculty.	Master's	●	—	✓	Lab management; Research development; Governance, risk and compliance; Project management and budget management; Data science; Technology commercialization; Entrepreneurship; Research ethics
			Doctoral	●			
University of Wisconsin Milwaukee	Professional Development	A graduate degree is a flexible basis for a professional career within and beyond one's chosen field of study. Graduate students are encouraged to participate broadly in the intellectual life on campus, attend public lectures and research talks in their own home department, as well as those sponsored by many research centers, institutes, schools and colleges.	Master's	●	—	✓	Research development; Data science; Science policy; Technology commercialization; Entrepreneurship; Research ethics
			Doctoral	●			
			Professional	●			
			Postdoc	●			
Virginia Commonwealth University	Professional Development Opportunities	The Graduate School at Virginia Commonwealth University provides courses and programs to help graduate students achieve their career and professional goals.	Master's	●	—	✓	Research development; Project management and budget management; Data science; Technology commercialization; Entrepreneurship; Research ethics
			Doctoral	●			
			Professional	●			
			Postdoc	●			
Virginia Polytechnic Institute and State University	Transformative Graduate Education	The transformative graduate education initiative provides graduate students with opportunities to acquire knowledge, leadership skills, and professional development that complement disciplinary training with the aim of preparing graduates to become scientists, educators, scholars, engineers, artists, and career professionals in an ever-evolving global context.	Master's	❖	Centralized	✓	Entrepreneurship; Research ethics
			Doctoral	❖			

Institution Name	Program Name	Program Description	Population Served		Structure*	Skills Emphasized**	
			Degree Level	0-5 ■ 6-50 ◆ 51-99 ▲ 100+ ❖ N/A ●		General Skills	STEM-specific Skills
Washington State University	Professional Development	Professional Development often refers to practical skills, including those in the area of personal development, needed to sustain and succeed in a specific career. Professional Development includes training to keep abreast with advancing technology, up-to-date practical skills in any profession, and the path to lifelong learning. Professional Development may also include training to become more effective in the classroom, enhance leadership and communication skills, develop management skills, successfully collaborate with colleagues, manage conflict, and negotiate in the workplace.	Doctoral	◆	Centralized	✓	Research development
Wayne State University	Broadening Experiences in Scientific Training (BEST)	The goal of this program is to help prepare doctoral trainees to meet the needs of the 21st century economy in a dynamic and evolving job market, in such areas as business and industry, undergraduate teaching, communication, law, and government. The skill sets associated with these fields will be developed in partnership with local and national employers through mentored field experiences to ensure alignment between the employers' expectations and the skills of the trainees.	Master's	●	—	✓	Lab management; Research development; Governance, risk and compliance; Project management and budget management; Data science; Science policy; Technology commercialization; Entrepreneurship; Research ethics
			Doctoral	●			
West Virginia University	Graduate Academy	The Graduate Academy, a collaborative project of the Office of Graduate Education & Life and Academic Innovation, is comprised of programs that help graduate and professional students complete their degrees, teach and research effectively, and plan for their careers. The goal is to enhance graduate students' experience at WVU by preparing them for academic and nonacademic positions to increase their competitiveness in the job market.	Master's	❖	—	✓	Research development; Entrepreneurship
			Doctoral	❖			
			Professional	●			
			Postdoc	●			

Institution Name	Program Name	Program Description	Population Served		Structure*	Skills Emphasized**	
			Degree Level	0-5 ■ 6-50 ◆ 51-99 ▲ 100+ ❖ N/A ●		General Skills	STEM-specific Skills
Western Michigan University	Professional Development	WMU Professional Development provides noncredit learning opportunities that foster critical thinking and stimulate creative solutions. The competency-based programs offer clients real-world projects and activities that are relevant, practical and challenging.	Master's	❖	Program-specific & Centralized	✓	Governance, risk and compliance; Research ethics
			Doctoral	▲			
Yale University	Yale Office of Career Strategy	Yale's Office of Career Strategy supports students in the Graduate School of Arts and Sciences and postdoctoral associates and fellows engaged in the exploration of careers outside the academy. It provides the resources to guide graduate students and postdocs through every step of the job search process, from industry research to salary negotiations.	Master's	❖	—	✓	Technology commercialization; Entrepreneurship; Research ethics
			Doctoral	❖			
			Postdoc	❖			

Source: CGS 2015 Student Life Cycle Survey. Please see links for the most current information.

*Program structure:
- **Centralized programs** are open to graduate students from multiple fields of study and focus on issues that pertain to multiple fields and programs.
- **Program-specific** programs are housed in the academic departments or programs.
- — Program structure not identified.

**Skills emphasized:
Survey respondents were asked to select, from a list, the skill(s)emphasized in their professional development program.
General skills refer to the following: (1) communication and presentation, (2) writing, (3) professional networking, (4) personal finance, (5) job search, (6) mentoring, (7) leadership, and (8) teaching.
STEM-specific skills include the following: (1) lab management, (2) research development, (3) governance, risk and compliance, (4) project management and budget management, (5) data science, (6) science policy, (7) technology commercialization, (8) entrepreneurship, and (9) research ethics.

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