Redesigning US STEM Doctoral Education to Create a National Workforce of Technical Leaders

Workshop Outcome

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I. Need for a new STEM doctoral educational paradigm

During 2020-2021, Lehigh University hosted a National Workshop Series: Role of Industry-University Partnership in Doctoral Training as part of an NSF sponsored Innovation in Graduate Education (IGE) project. It brought over 100 leaders of industry, academia, national labs, government funding agencies, national academies and professional societies to discuss critical needs of STEM doctoral training. The motivation was to discuss the current shortfalls in doctoral education in the US and how best to redesign it by incorporating active partnerships between universities and industry in the educational process. The overall goal has been the development of a national workforce of technical leaders to ensure that the U.S. maintains its technological leadership through use-inspired research and consequent cutting-edge innovations.

The workshops spotlighted the growing sense among industry leaders that the US doctoral education system needs to be redesigned to align with the needs of the employers (industry, national labs, academia, etc.). They also emphasized that doctoral programs should provide more effective pathways for diversifying the STEM workforce in industry. Ironically, although a great majority of STEM PhDs (e.g. 74% engineering and 69% physical sciences doctorates) work in the private/non-academic sector, industry employers are not involved in the development of academic programs or in the training of doctoral students, and few students gain practical training outside of the academy. Currently the US doctoral system prepares students well in subject matter expertise, but falls short in providing them meaningful exposure to industrial R&D challenges, knowledge about how industry conducts research to achieve its mission of innovation, and the non-technical professional competencies required for success. The decline of major corporate labs in the 1990s exacerbated this gap, especially in the physical sciences and engineering.

II. Outcomes of the National Workshop Series

II.1 Identification of essential competencies: In addition to technical excellence, the following five competencies were deemed essential for each STEM doctorate to acquire to have successful careers in industry, irrespective of the industry sector: (i) Effective communication; (ii) People skills, teamwork; (iii) Critical, independent thinking; (iv) Learning agility, openness to collaboration, cross-disciplinary interest, broad perspective; and (v) Ethics, research integrity. Stronger industry-university partnership in doctoral education was deemed critical for a comprehensive professional training via experiential learning during the formative years as the graduate students transition to becoming independent scientists.

II.2 A model program to initiate consortium discussion: The group recognized Lehigh University’s Pasteur Partners PhD (P3) program as one evidence-based model to address the lack of industrial perspective during doctoral training in the U.S. P3 is a student-centered program characterized by use-inspired research, co-advising by an industry scientist, required courses in essential skills and competencies, and a 1-2 semester residency at a company. At Lehigh University, the pilot P3 program is now being implemented and assessed – so far it is seen to be progressing well after initial exploration. The initial enrollment in P3 indicates that the program is particularly attractive to underrepresented communities, suggesting that it may also provide an effective mechanism for growing diversity in the STEM doctorate workforce.

In the long term, the benefits of a P3-like doctoral educational model for industry partners are expected to be: (i) universities conducting research on topics of direct interest to the company; (ii) the student trained under P3 program could be a future employee best-trained to address company’s needs,
III. Formulating a consortium to launch the new educational model

The formation of a consortium was seen as crucial to scale up and validate P3-like programs at partner institutions to achieve the needed transformation in STEM doctoral education in the country. The consortium can help improve STEM doctoral education at scale by providing: (i) a core curriculum to deliver identified skills that students need; (ii) best practices to facilitate university/corporate partnerships through centralized IP agreements; and (iii) establishing a database of faculty expertise and internships/residencies in industry for setting up a student’s P3 program. The consortium can also help member institutions access broader funding sources like federal agencies, corporate consortia, individual corporations, and private foundations.

Following the National Workshop series, 22 representatives from several potential partner universities met in November 2021 to formulate a consortium, which could implement a P3-like educational paradigm at a National level. Given the many differences in graduate education programs at the partner institutions, both in their curricular and funding structures, it was proposed that the consortium be designed around a hub-and-spoke model. The hub reflects and builds on the shared interests and benefits among university consortium members, whereas the spokes work out the details for the doctoral program to fit their specific contexts of institutional size, public/private affiliation, institutional/regional culture, etc.

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