Perspectives of STEM Faculty on Their Role in the Training of Doctoral Students

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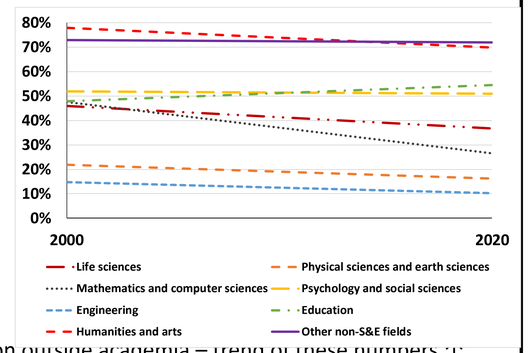
Background: There is a major problem with the current STEM doctoral education

- National Academies (1995): University departments should inform graduate students of various career options and offer a variety of curricular options so that they make more fulfilling career choices while more effectively fulfilling national goals.
- National Academies (2018): Need a cultural change and the system "must become more student-centric… The mind-set that seems to most heavily value preparing students at the Ph.D. level for academic research careers must readjust to recognize that some of the best students will not pursue academic research but will enter careers in other sectors, such as industry or government"
- 90% engineering and 84% physical + earth sciences PhDs had first position outside academia – trend of these numbers "[



nature EDITORIAL | 18 January 2023 PhD training is no longer fit for purpose – it needs reform now

If researchers are to meet society's expectations, their training and mentoring must escape the nineteenth century.

Pasteur Partners PhD (P3) model to address the problem

Curricular

- Pre-program summer internship (optional)
- Co-advisors—Lehigh professor and industry researcher
- Modular professional development courses
- Industry Residency (as in medical school)

Financial

- 4 years fully funded via various mechanisms

Visit P3 website: https://wordpress.lehigh.edu/inphd/

Challenges in the Implementation of P3 Model

(Jain, et al. Proc. ASEE Ann Meet (2023); Jain, Urban, Calabrese, Nature (2023))

- More than 70% of students admitted to STEM doctoral programs expressed interest in P3 track, but only 3% could be enrolled because of the challenges in establishing partnerships with industry.
- Preliminary evaluation: the enrolled students benefit significantly from gaining confidence and practical skills through industry involvement such as co-advising, a clearer understanding of how the industry operates, etc.
- The University administration also provided significant support for the program.
- Notwithstanding, **a broader implementation of P3 encountered hesitancy from faculty members because partnerships with industry are hard to organize.**
- Financial model of most private corporations prevents commitments for the long duration of PhD. Intellectual property agreements are often difficult to reach. Also, hesitation in a new program for which ROI will be known years later.
- Anecdotal observations: Senior faculty members see no need to change the system. Younger researchers are willing to adapt but constrained by the tenure, promotion and funding expectations that reward conventional research output.

Goals of This Study

Develop a comprehensive understanding of the STEM faculty's perspective of doctoral training, thereby help develop an action plan to address the problem of disconnect between STEM doctoral training and career needs. Specifically, we investigated:
(i) faculty members' perspective of their roles and responsibilities.
(ii) perceived challenges and resources needed to satisfy (i).
(iii) the skills and training needed for student centered doctoral training.

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Lehigh STEM Faculty Survey

Participants

- Every faculty in Lehigh's 13 STEM departments (Biological Sciences, Chemistry, Earth and Environmental Sciences, Mathematics, and Physics in **College of Arts and Sciences**; Bioengineering, Chemical and Biomolecular Engineering, Civil and Environmental Engineering, Computer Science and Engineering, Electrical and Computer Engineering, Industrial and Systems Engineering, Materials Science and Engineering, and Mechanical Engineering and Mechanics in **College of Engineering and Applied Sciences**)
- 125 or 47% faculty participated (37% from curiosity driven (CD) and 67% from use-inspired (UI) fields). Survey was anonymous and conducted by an evaluator from College of Education.

Results: Primary Roles and Responsibilities

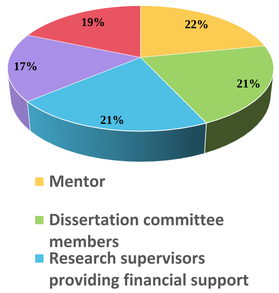

Fig 1. Distribution of primary roles as identified by the faculty members for themselves.

Fig 2. Distribution of main objectives as identified by the faculty for their role in doctoral training.

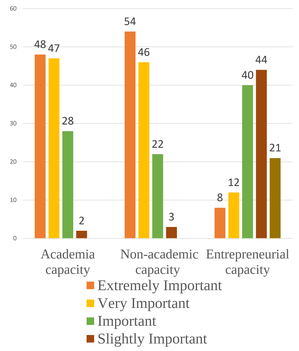

Fig 3. Faculty's assessment of the three capabilities that should be developed in doctoral students.

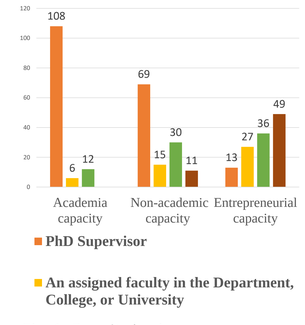

Fig 4. Faculty's views on person responsible for training with skills for academic, non-academic and entrepreneurship careers.

Results: Challenges and Resources

Challenges in decreasing order of difficulty: 1. Limited exposure to real-world industry experiences ≈ 2. limited access to industry-specific knowledge or expertise > 3. Balancing academic research and students' career readiness. ≈ 4. Career development resources at the university. > 5. Challenges in teaching practical career skills. > 6. Difficulty in aligning the existing academic training expectations with students' career goals. > 7. Lack of mentorship opportunities for students.

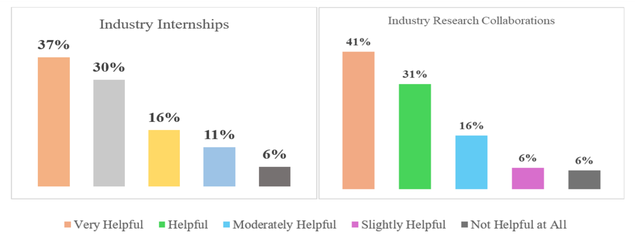

Fig 5. Faculty's perceptions of helpfulness of Industry Internship and Industry Research Collaborations for the training of their doctoral students.

Results: Skills and Trainings

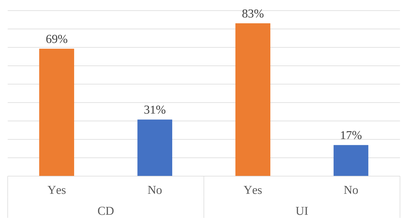

Fig 6. Proportion of agreement on encouraging collaborative research between PhD students and non-academic partners by CD or UI group.

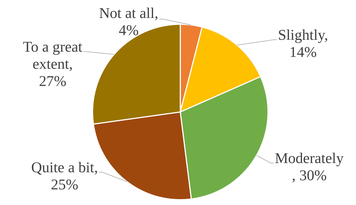

Fig 7. Proportion of belief on whether faculty should foster both academic and industrial experiences as part of doctoral training.

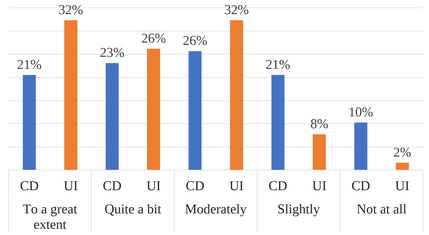

Fig 8. Proportions of belief on whether faculty should foster both academic and industrial experiences categorized by CD and UI group.

Key Conclusions

1. **Faculty place a strong and comparable emphasis on both academic and non-academic training. Entrepreneurial training is considered less important - it is best promoted by external professionals.**
2. **Majority of faculty support providing non-technical skills and encouraging collaborative research with non-academic partners, but their fraction is significantly smaller than the percent of students likely to be employed in industry. This discrepancy exists in spite of the strong tradition of use-inspired research focus of Lehigh faculty. Those in favor remain concerned about funding, potential disruptions, and lack of institutional support for establishing collaborative efforts.**
3. **Limited access to industry-specific knowledge is the largest impediment for preparing the students for jobs in industry. There is strong desire for stronger ties with industry to provide Industry Internships and Industry Research Collaborations.**

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