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Doctoral Pathways in Government: Field Choices, Gender Gaps, and Motivations

murali krishna kaye, Kettering University
Dr. Diane L Peters P.E., Kettering University

Dr. Peters is a Professor of Mechanical Engineering at Kettering University.

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Abstract

This project looks at how government employees with engineering degrees move into Ph.D. programs and what drives those choices. The analysis uses weighted national survey data from the Survey of Doctorate Recipients to focus on workers in government jobs who reported being enrolled in a doctorate.Contrary to the idea that public sector engineers eventually drift into policy or management, the Survey of Doctorate Recipients reveals a different trend. Most are actually staying technical: 78.4% of the cohort earned their PhDs in Engineering. However, this technical retention is significantly uneven. Men make up 71.9% of the group, and they generally approach the degree as ”Climbers,” using it to scale the career ladder. Women, however, consistently act as ”Skill Seekers,” pursuing the doctorate to deepen their technical mastery rather than just for a promotion. This tells us that generic workforce policies won't bridge the gender gap. If we want a more diverse technical leadership in government, we need specialised tracks—like technical fellowships—that actually speak to these differing professional drivers..

1 Introduction

While many graduate students in the science, technology, engineering, and mathematics (STEM) fields begin their graduate program immediately after completing a bachelor's degree, there are also many who wait until later in life to pursue a graduate degree. In the larger population of graduate students, statistics show that many are older. In 2022, the average age of students studying for a graduate degree was 33, with 22% of students being over 40 years old [1]. Naturally, this will vary by discipline and over time, but it is evident that there is a significant group of students who are older and more experienced when they begin a graduate program. Their learning, therefore, can be expected to be influenced by their past experiences, putting them in a different place intellectually than their younger peers. Due to these differences, understanding this group is critical.

This population of students with significant experience prior to their graduate study is termed “returners”, with their counterparts who do not have much if any experience called “direct pathway” students. While there is room for debate over what constitutes “significant experience”, for the purposes of this study we use the definition established by Peters and Daly [2], in which returners have a gap of at least five years in their schooling, while direct pathway students have less than five years' gap.

While returners have existed for quite some time, the first clear appearance in the engineering education literature about this population dates back to 2008, with the work of Schilling [3]. Significant work began to appear several years later, with studies by Peters and Daly [2] and Strutz et al. [4]. Additional work followed, with some studies focusing on a broader group that included both master's and doctoral students [5, 6] and other studies focusing exclusively on doctoral students (e.g., [7, 8, 9, 10, 11, 12, 13]) or on master's students (e.g., [14, 15, 16, 17]). Some of these works focused on a relatively small cohort of participants (all returners) who were interviewed (e.g., [2, 4, 6, 11]), while others cast a broader net and included surveys of a larger number of both returners and direct pathway students (e.g., [10, 14, 17]). However, even in those cases where a survey was used and the pool of participants was larger, there remained an important limitation. Given the fact that returner status is not a tracked demographic, and survey participants were typically recruited through snowball sampling and convenience sampling, there is no reason to believe that they are representative of the population of returners as a whole. This limits the impact of the body of work and the conclusions that can be drawn from it.

This gap can be addressed, in part, through the use of existing large-scale datasets. There are multiple years' worth of data collected through surveys such as the Survey of Doctorate Recipients, which have been used by many researchers for different purposes, including examining patent activity [18], mapping scientists' career trajectories [19], and examining post-graduation plans of engineering PhD recipients [20]. Here, we use the data from a specific dataset to provide new perspectives on returners in a specific sector, that of government employees, in order to begin filling this gap.

2 Methodology

2.1 Data Source and Sample Selection

This study utilizes data from the 2021 Survey of Doctorate Recipients (SDR), a biennial longitudinal survey conducted by the National Center for Science and Engineering Statistics (NCSES).The SDR provides a representative sample of individuals with U.S.-earned doctoral degrees in science, engineering, and health fields.

To isolate the specific population of interest—engineering graduates who returned to education—we applied a stratified filtering process to the public-use dataset (epsd21.sas7bdat):

- **Primary Cohort (The "Returners")**: We filtered for respondents whose first bachelor's degree was in Engineering (Variable NBAMEMG = 5). This established a baseline of individuals with foundational engineering training who subsequently pursued doctoral education.
- **Sector-Specific Sub-cohort** : To analyze public sector pathways, we created a subset of the primary cohort comprising individuals currently employed in the Government sector (Variable EMSECSM = 2), distinct from those in Industry or Academia. This resulted in a specialized sample of n=1,251 respondents.
- **Returner Calculation** : To align with the definition of "returners" [2], we calculated the

gap between the bachelor's degree year and PhD conferral year. The analysis focuses on the cohort where this gap allows for significant work experience (average gap calculated at 9.1 years)

2.2 Operationalization of Variables

Key constructs were defined using specific survey items:

- **Career Pathways**: Post-doctoral career trajectories were categorized using the Primary Work Activity (WAPRSM) and Principal Job Field (N2OCPRMG) variables. We operationalized "Managerial Drift" as respondents who identified "Management or Sales/Administration" as their primary activity, distinct from "Research and Development" or "Teaching."
- **Time to Conferral**: We estimated the "Time to Degree" by calculating the difference between the year of PhD conferral (SDR5YRP) and the year of the first bachelor's degree (BAAYR5P). Since the public-use dataset provides these dates in 5-year intervals, we mapped each interval to its numeric midpoint to calculate the mean duration.
- **Motivation Constructs**: Motivation for pursuing a doctorate was analyzed using seven binary indicators (e.g., MRADV for Career Advancement, MRSKL for Skill Acquisition, MRLIC for Licensure). To ensure statistical validity, responses marked as "Logical Skips" were treated as null values.

2.3 Analytical Approach

Data processing was performed using Python (Pandas library). We utilized descriptive statistics to determine the distribution of gender and PhD domains. To assess the relationship between gender and motivation within the government sector, we calculated participation rates across all seven motivation factors.

3 Results

This study analyzed a weighted cohort of 1,251 individuals currently employed in the government sector who hold a bachelor's degree in engineering. The analysis reveals distinct trends in post-doctoral educational behavior, field retention, and demographic composition.

3.1 Post-Doctoral Educational Pathways:

The Shift from Degrees to Competency To address the research question regarding the pathways through further education followed by returners, the analysis examined participation behavior after re-entering the workforce. Figure 1 contrasts the rates of fdownload (1).pngormal degree enrollment against work-related training.

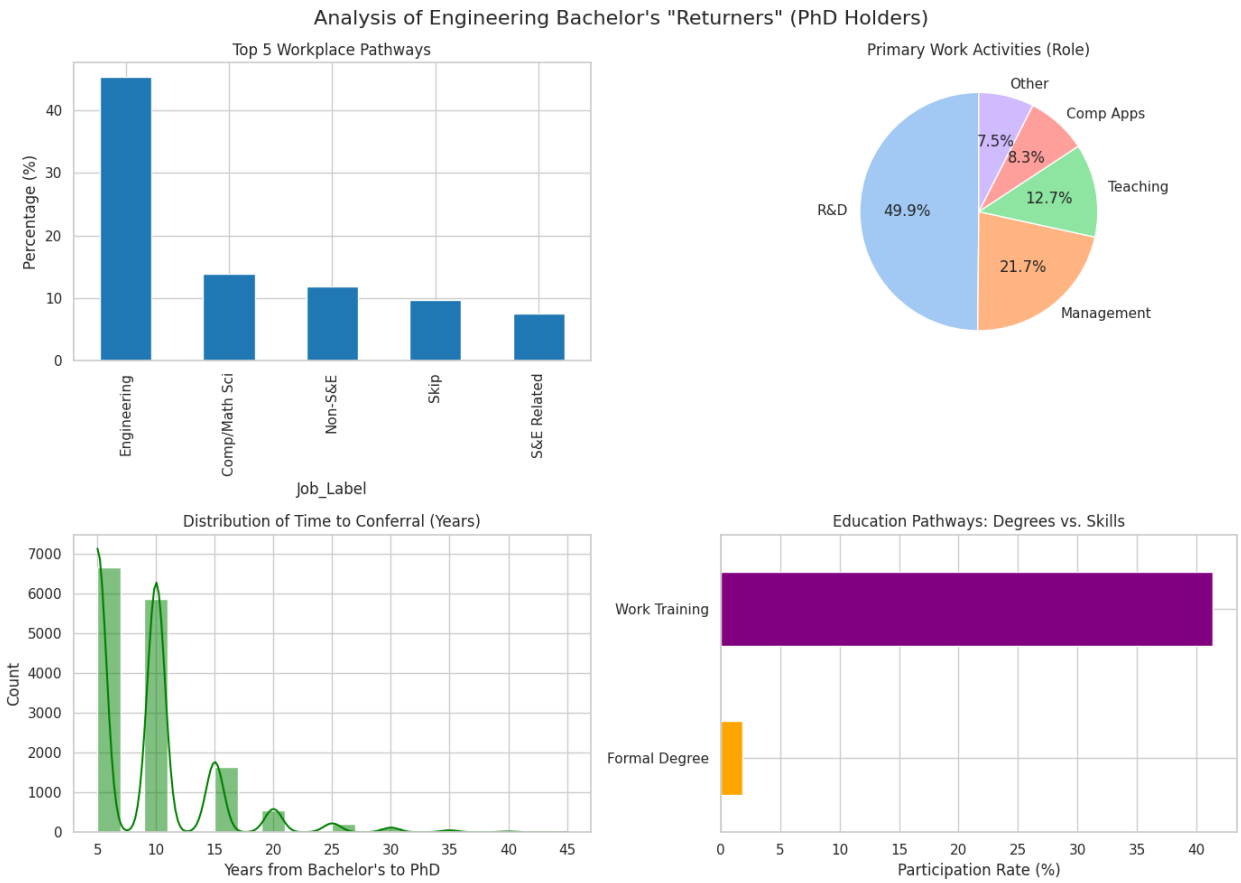

Figure 1: Post-doctoral educational participation rates

Pathways and Rates The data identifies a dominant **"Competency Maintenance Pathway"** for engineering returners. Unlike their earlier career trajectory, where the pathway involved returning to university for a multi-year credential (the PhD), the post-doctoral pathway is characterized by targeted upskilling.

- Rates of Adherence: Returners follow the "Training Pathway" at a rate of 41.3%, more than twenty times the rate of the "Formal Degree Pathway" (1.8%). This confirms that for 98% of the cohort, the PhD functions as the terminal academic credential.

Implications for Time to Conferral This disparity provides a critical answer regarding the average time to conferral for future skills. While the initial Bachelor's-to-PhD journey required an average of **9.1 years** (including workforce gaps), the dominance of the training pathway suggests that subsequent educational investments are measured in **days or weeks** (via workshops and seminars) rather than years. This marks a fundamental shift in the returner's relationship with time: moving from "time-intensive" degree seeking to "time-efficient" professional development to maintain relevance in a rapidly evolving technical landscape.

The data indicates a decisive shift away from formal credentialing after the PhD. While **41.3%** of the cohort participated in work-related training (workshops, seminars) during the reference period, only **1.8%** were enrolled in formal degree programs. This confirms that for this cohort,

the ”pathway” through further education is characterized by continuous, targeted upskilling rather than the pursuit of additional academic titles

3.2 Retention of Technical Specialization in Government

A key finding challenges the narrative of ”managerial drift” in the public sector. As shown in Figure 2, the overwhelming majority (78.4%) of engineering bachelor's degree holders in the government sector earned their PhDs in Engineering.

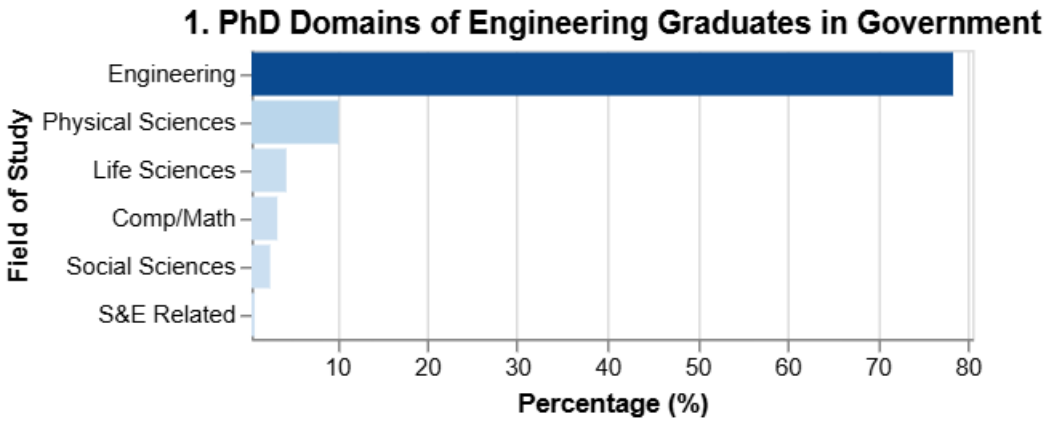

Figure 2: Distribution of doctoral fields of study for employees with a bachelor's degree in engineering currently working in the government sector (n=1,251)

This high retention rate suggests that the government sector mirrors the technical retention seen in industry, rather than serving as a primary exit route into administrative or non-technical policy roles. The transition into Physical Sciences (10.2%) and Life Sciences (4.4%) remains a minority pathway.

3.3 Gender Disparity in the Advanced Workforce

Despite the high retention of technical talent, the cohort displays a significant gender imbalance. Figure 3 illustrates that the population of engineering doctoral holders in the government is **71.9% Male and 28.1% Female**. This 43-point gap is wider than that observed in the general government doctoral workforce, suggesting that structural barriers remain particularly acute for women in public sector engineering roles.

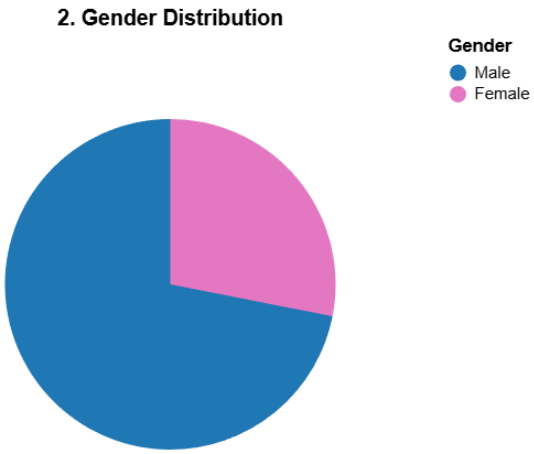

Figure 3: Gender composition of the engineering-government cohort. The distinct minority status of women (28.1%) highlights a persistent gap in the advanced technical workforce

3.4 The ”Credentialing Gap” in Motivation The most divergent findings emerge from the analysis of motivation. Figure 4 presents the self-reported reasons for pursuing a doctorate, revealing fundamentally different drivers for men and women

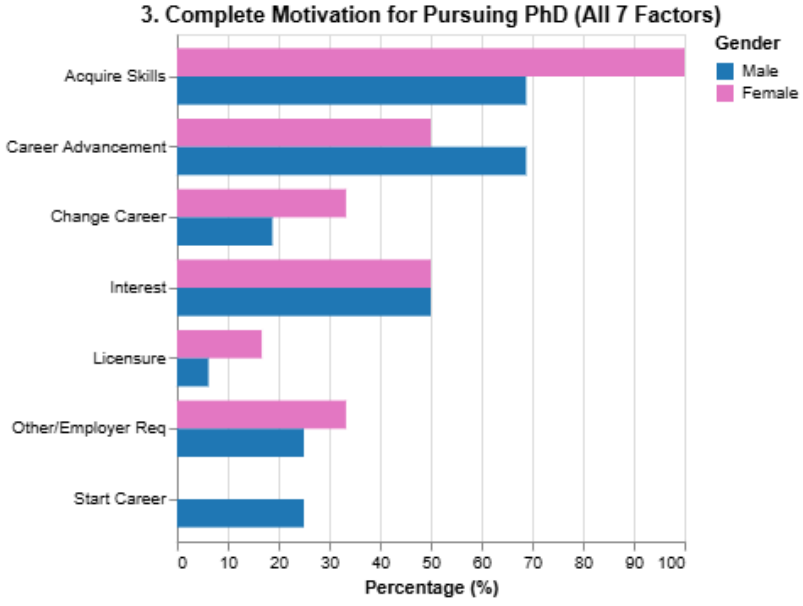

Figure 4: Comparative analysis of motivations for pursuing a doctoral degree by gender. Female engineers universally prioritize skill acquisition, whereas male engineers prioritize advancement

The data uncovers three critical behavioral distinctions:

- **Skill Acquisition**: 100% of female respondents cited acquiring further skills as a reason,

compared to 68.8% of men.

- **Licensure**: Women were nearly three times as likely as men (16.7% vs. 6.3%) to cite licensure.
- **Advancement**: Conversely, men were significantly more likely to cite ”Career Advancement” (68.8%) than women (50.0%).

4 Conclusion

4.1 Summary of Findings

This study reveals that the ”returner” pathway for engineering graduates in government is characterized by high technical retention. The 78.4% retention rate in engineering PhDs debunks the myth that government employees predominantly drift into management; rather, the sector retains technical specialists at rates comparable to private industry.

4.2 The Gendered Nature of Credentialing

A critical finding is the disparity in motivation. Female engineers in the government sector operate as ”Skill Seekers,” utilizing the PhD to establish competence and gain licensure. In contrast, male counterparts operate as ”Climbers,” driven more frequently by organizational mobility and advancement.

4.3 Implications for Workforce Policy

These findings suggest that a ”one-size-fits-all” approach to workforce development is inefficient.

- **Technical Tracks vs. Management Tracks**: Since men are often motivated by advancement and women by skill acquisition, agencies should decouple ”advancement” from ”management.” Creating high-level Technical Fellow or Senior Scientific tracks allows ”Skill Seekers” (predominantly women) to achieve career progression without being forced into administrative roles that may not align with their primary motivations.
- **Education Support**: Since ”Returners” prefer short-term training (41%) over formal enrollment (1.8%), agencies should prioritize funding for specialized technical certifications (MRSKL) over generic tuition reimbursement.

4.4 Limitations

This study is limited by the cross-sectional nature of the SDR 2021 data. Additionally, the specific breakdown of ”returner” status relies on calculated time gaps which may include variances based on interval reporting in the public-use dataset. Future work should validate these findings with longitudinal data from the National Survey of College Graduates.

4.5 Future Work

Future work should include repeating the analysis set forth here on additional years' datasets from the Survey of Doctoral Recipients. Furthermore, additional questions can be asked and answered about returners, particularly on how their prevalence and characteristics change over time. In addition, other datasets exist, such as the National Survey of College Graduates. This data could include information on returners in masters programs.

References

[1] D. A. Stapleton. (2022, nov) Typical graduate student age [data for average age]. Academia Insider. Accessed: 2026-01-02. [Online]. Available: https://academiainsider.com/typical-graduate-student-age-data-for-average-age/

[2] D. L. Peters and S. R. Daly, "The challenge of returning: Transitioning from an engineering career to graduate school," in *2011 ASEE Annual Conference & Exposition*, no. 10.18260/1-2–18729. Vancouver, BC: ASEE Conferences, June 2011, https://peer.asee.org/18729.

[3] W. Schilling, "Issues effecting doctoral students returning to engineering education following extensive industrial experience," in *2008 Annual Conference & Exposition*, no. 10.18260/1-2–3847. Pittsburgh, Pennsylvania: ASEE Conferences, June 2008, https://peer.asee.org/3847.

[4] M. L. Strutz, J. E. C. Jr., D. M. Ferguson, M. T. Carnes, and M. W. Ohland, "Returning students in engineering education: Making a case for "experience capital"," in *2011 ASEE Annual Conference & Exposition*, no. 10.18260/1-2–18735. Vancouver, BC: ASEE Conferences, June 2011, https://peer.asee.org/18735.

[5] D. L. Peters and S. R. Daly, "Why do professionals return to school for graduate degrees?" in *2012 ASEE Annual Conference & Exposition*, no. 10.18260/1-2–22234. San Antonio, Texas: ASEE Conferences, June 2012, https://peer.asee.org/22234.

[6] ——, "Returning to graduate school: Expectations of success, values of the degree, and managing the costs," *Journal of Engineering Education*, vol. 102, no. 2, pp. 244–268, 2013.

[7] E. Mosyjowski, S. R. Daly, , and D. L. Peters, "Challenges and benefits of applied experience as an engineering returner in a Ph.D. program," in *2017 ASEE Annual Conference & Exposition*, no. 10.18260/1-2–28021. Columbus, Ohio: ASEE Conferences, June 2017, https://peer.asee.org/28021.

[8] E. Mosyjowski, S. R. Daly, and D. L. Peters, "Engineering industry perspectives and policies related to employees' pursuit of engineering doctoral training," in *2018 ASEE Annual Conference & Exposition*, no. 10.18260/1-2–30412. Salt Lake City, Utah: ASEE Conferences, June 2018, https://peer.asee.org/30412.

[9] J. K. Murray, S. R. Daly, E. Mosyjowski, and D. L. Peters, "Practitioner experience meets graduate academic research: How intersections guide the work of returning engineering Ph.D. students," in *2017 ASEE Annual Conference & Exposition*, no. 10.18260/1-2–28749. Columbus, Ohio: ASEE Conferences, June 2017, https://peer.asee.org/28749.

[10] E. A. Mosyjowski, S. R. Daly, D. L. Peters, S. J. Skerlos, and A. B. Baker, "Engineering PhD returners and direct-pathway students: Comparing expectancy, value, and cost," *Journal of engineering education*, vol. 106, no. 4, pp. 639–676, 2017.

[11] D. L. Peters, M. H. Goldstein, and J. Lax, "From industry to graduate school: How returners (re)learn how to write," in *2017 ASEE Annual Conference & Exposition*, no. 10.18260/1-2–28391. Columbus, Ohio: ASEE Conferences, June 2017, https://peer.asee.org/28391.

[12] S. O'Brien and C. G. Berdanier, "How 'returner'and 'direct-pathway'graduate students' experiences may lead to attrition from doctoral programs," in *2022 IEEE Frontiers in Education Conference (FIE)*. IEEE, 2022, pp. 1–8.

[13] S. Zhuchkova and E. Terentev, "Non-linear path to a doctorate: A comparison of direct-and indirect-pathway doctoral students at Russian universities," *Higher Education*, vol. 87, no. 6, pp. 1729–1747, 2024.

[14] E. Gross and D. L. Peters, "Comparison of returning and direct pathway graduate engineering students," *The Journal of Continuing Higher Education*, vol. 69, no. 3, pp. 145–168, 2021.

[15] D. L. Peters and E. Gross, "Confidence of graduate students in engineering masters' programs: A comparison of returners and direct-pathway students," in *2021 ASEE Virtual Annual Conference Content Access*, no. 10.18260/1-2–36835. Virtual Conference: ASEE Conferences, July 2021, https://peer.asee.org/36835.

[16] A. G. Wanless, D. L. Peters, and E. Gross, "Returning and direct pathway students: How the decision-making process of engineering master's degree pursuit is influenced by industry experience," in *2023 ASEE Annual Conference & Exposition*, no. 10.18260/1-2–44134. Baltimore , Maryland: ASEE Conferences, June 2023, https://peer.asee.org/44134.

[17] O. Gettel, D. L. Peters, and E. Gross, "Impact of work experience on engineering graduate students' teamwork skills, knowledge, and terminology usage," *International Journal of Engineering Education*, vol. 39, no. 1, pp. 263–276, 2023.

[18] P. E. Stephan, S. Gurmu, A. J. Sumell, and G. Black, "Who's patenting in the university? Evidence from the survey of doctorate recipients," *Econ. Innov. New Techn.*, vol. 16, no. 2, pp. 71–99, 2007.

[19] K. A. Edwards, H. Acheson-Field, S. Rennane, and M. A. Zaber, "Mapping scientists' career trajectories in the survey of doctorate recipients using three statistical methods," *Scientific Reports*, vol. 13, no. 1, p. 8119, 2023.

[20] S. Mendez, "Exploring the effects of institutional research level on engineering PhD recipients' post-graduation plans," in *2021 Annual Meeting of the American Educational Research Association*, 2021.