

REF: PERSISTENCE PATHWAYS: CHANGING RESEARCH LABS TO PERSIST IN ENGINEERING GRADUATE EDUCATION

Dr. Matthew Bahnson, University of Cincinnati

Matthew Bahnson completed his Ph.D. in the Applied Social and Community Psychology program in at North Carolina State University. His previous training includes a B.A. in Psychology from the University of Northern Iowa and an M.A. in Social Sciences from the University of Chicago. Matthew's research focuses on sociocultural inequality in engineering graduate education with the intention of increasing diversity, equity, inclusion, and justice in STEM graduate education. He is completed a postdoctoral appointment in engineering education with the Engineering Cognitive Research Laboratory with Dr. Catherin Berdanier at Pennsylvania State University. He recently worked as a Research Scientist at Purdue University with the STRIDE research group directed by Dr. Allison Godwin at Cornell University. Matthew is currently an Assistant Professor of Psychology at the University of Cincinnati.

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This full empirical research study investigates the factors contributing to doctoral students changing research labs during their academic programs in engineering graduate education. Recent research has demonstrated over 70% of engineering doctoral students contemplate leaving their programs without a doctoral degree [1]. Depending on discipline, 40-60% of engineering doctoral students actually depart due to conflicts with advisors and peers, financial or academic difficulties, and personal or family concerns [2]. Some students remain in their doctoral programs by changing research labs, advisors, programs, or even universities [3], [4]. While changing research labs can help retain partially trained and qualified students, the associated individual costs, programmatic barriers, and advisor conflicts complicate the process. Consequently, the early departure of graduate students from their programs poses a significant issue in higher education. When these highly skilled, knowledgeable, and talented individuals leave, it results in losses for the workforce, universities, funding agencies, faculty members, and the students themselves [5]. Although this is a widespread issue across all doctoral programs, research indicates that engineering graduate students encounter distinct challenges and experience significantly higher levels of stress compared to graduate students in other fields [6], [7]. Graduate students with these experiences often report a decline in the quality of their advising relationships over time, which can lead to decisions to switch labs [8], [9].

Research Questions

This mixed-methods project examines the persistence pathways of doctoral engineering students as they change research labs to continue their graduate education. The goal of the project is to investigate how common changing labs is amongst engineering doctoral students and to identify the factors that influence those who are seriously considering changing labs (serious considerers), those who have taken steps towards changing labs, such as talking to potential advisors or school administrators (planners) and those who have already changed labs (changers). The following are the research questions for the project:

- 1) *How common is changing research labs during engineering doctoral study?*
- 2) *What predictors and career outcomes are related to changing research labs?*
- 3) *How do students experience changing research labs during doctoral study?*

Data collection and analysis is ongoing for the project. Current findings focus on research question 1 and findings that will contribute to understanding research questions 2 and 3. The longitudinal data is not yet available to begin answering research questions 2 and 3.

Methods

This study is part of a larger mixed-method longitudinal research project aimed at better understanding engineering doctoral students' experiences and behaviors related to changing labs. A self-report survey administered to these students examines the frequency, predictors, and outcomes of lab changes, as well as their persistence in their academic programs. From this survey, considerers, planners, and changers were selected for individual interviews. The survey and interview data will be collected three times over the course of two years. The project currently has two cohorts. Cohort 1 has completed two surveys and two interviews, and Cohort 2 has completed one survey and one interview.

Recruitment

The American Society for Engineering Education (ASEE) 2022 edition of "Engineering and Engineering Technology by the Numbers [10] was used to select the top 50 institutions awarding engineering doctoral degrees. Emails were sent to 448 engineering graduate program directors, coordinators, or heads of departments, inviting them to send information about the study to their doctoral students. Doctoral student participants volunteered to take part in this study through a survey on the Qualtrics online survey platform. In Year 1, participants could register for a compensation drawing of \$10. Ten participants were selected and emailed an Amazon gift card. This was expected to be about 1% of the participants. Year 1 sample (n = 233) includes participants from 26 highly ranked universities in the U.S. and 17 engineering doctoral disciplines (e.g., materials, electrical, mechanical). A subset of participants was selected to be interviewed via Zoom (n = 23) and received a \$25 e-gift card. Year 1 survey and interview participants were requested to participate in a second data collection of the same survey (n = 130) and a similar interview (n = 18). In year 2, all participants who completed the survey could register for \$10 gift card, and new survey participants in year 2 (n = 168) were also asked to participate in a first interview (n = 12). Year 2 data collection is continuing into Spring semester 2026.

Measures

The survey used items previously developed and evaluated items and scales to measure constructs of interest. Survey participants answered a series of questions on changing lab experiences [4], [11], changing lab behaviors [12], and advisor relationships [13] as well as graduate engineering identity scales [14], demographics, and degree progress items. Items were reviewed with minor adaptations to improve consistency with the research questions and motivations of this research. Qualitative interviews followed a semi-structured open-ended interview protocol that focused on experiences in doctoral studies before turning specifically to interest in and decision-making around changing research labs. Qualitative interviews began with an open question "Tell me about your trajectory into engineering?" with probes on advisor and peer relationships, funding, degree progress, and lab change considerations.

Results and Discussion

Frequency of Changing Labs and Considerations

Overall, the majority of students in this sample have never seriously considered leaving their PhD programs, a smaller percentage often seriously consider leaving by taking a master's degree (10%). A few have seriously considered leaving with no degree (1.6%). While substantially different from previous findings [15], the rate of departure considerations remains alarming. The difference in departure considerations may be due to the time of data collection (immediately post-covid vs. before current federal administrative decisions regarding higher education). The difference may point to the importance of socio-political factors that can influence students to persist or depart from graduate study. Gender and race/ethnicity differences were noted in changing lab and lab departure considerations [12]. Women were more likely to consider leaving with or without a degree (20%) than men (11.5%). The majority of students across race/ethnicity groups have never considered leaving, except for Asian (42.9%), Latina/o/x (22.2%) and White

(36.9%). However, with a rarely considered option included all race/ethnicity groups exceed 50% for not seriously considering leaving.

Changing Lab Behaviors

Lab change behaviors also differed based on gender and race/ethnicity [12]. Among women, there is a noticeable pattern where no individuals discussed changing with their advisor. However, some discussed changing with the program administrator, or searched for graduate college information. A smaller number discussed changing with a potential new advisor. In contrast, among men, some discussed changing with their advisor, while a lower number discussed changing with the program administrator. Only Asian and White students had discussed changing research labs with an advisor.

Advisor Relationship and Lab Change Consideration

A binary logistic regression demonstrated advisor relationship score significantly predicted students considering leaving the doctoral program ($\beta = -0.83(1)$, $p < .001$). Students who had not or rarely considered leaving the doctoral program had higher advisor relationship scores ($m = 4.31$, $S.D. = 0.82$) than those who had considered leaving ($m = 3.56$, $S.D. = 1.03$). Similarly, linear regression indicated that advisor relationship score explained 12% of variation in student consideration of leaving without a degree [16]. Further, mediation analysis demonstrated student's self-assess progress mediated the advisor-leaving relationship with small, but significant indirect effects ($\beta = -0.05$, $p < .05$).

To further explore the advisor-persistence relationship, qualitative interview transcripts were analyzed with Qualitative Comparative Analysis (QCA) [17]. Initial analyses across 23 interviews reported in this conference [17], participants described a diverse set of influences on persistence. We found that student persistence arises from multiple forces in combination that affect advisor relationships such as mentoring, belonging, financial stability, research alignment, and perceived support from advisors. Further, some students persist without these advisor related factors, relying instead on strong social, personal, and spiritual support networks. These varied combinations underscore the idea that persistence in doctoral engineering programs is contingent on both structural and individual level support.

Conclusion

This research project examines the persistence pathways of engineering doctoral students who change research labs during their graduate education. We first analyzed the prevalence of lab changes and found that students' decisions were shaped by their prior experiences. Common behaviors among students who changed labs included searching for programs online, communicating with prospective advisors, and consulting departmental resources. We also investigated the role of advisor relationships in shaping these transitions. The findings reveal that sexism, racism, financial support, and lab culture were significant factors influencing students' decisions to change labs. These results underscore the complexity of advisor-student relationships and the multifaceted challenges faced by doctoral engineering students. Changing labs can disrupt research progress and increase the burden of recruiting and training new students to sustain research efforts. In contrast, strong faculty-student relationships can foster new research directions, promote technological and engineering advancements, and support the

development of enduring professional relationships that benefit students, faculty, departments, institutions, and society. Such environments can also attract highly talented students to research labs, departments, and engineering programs. Consequently, understanding how faculty can best support graduate students remains a critical concern.

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