

Doctoral Engineering Student Narratives of Factors Influencing Persistence in Doctoral Programs

Tabé Abane, Purdue University – West Lafayette (College of Engineering)

Tabé Abane is a PhD student in Engineering Education at Purdue University. He earned an MA in Leadership in Education (2023) from Liverpool John Moore's University (UK), a Bachelor of Technology in Renewable Energy (2018), and a Five-Year Diploma in Mechanical Engineering and Teaching (2015) from the University of Bamenda (Cameroon). His research interests include Systems Thinking, Sustainability, and Graduate Student Success.

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.

Doctoral Engineering Student Narratives of Factors Influencing Persistence in Doctoral Programs

This empirical study examines the relationships between doctoral engineering students and their advisors, as well as students' ability to assess their progress within doctoral programs. Recent research indicates that more than 70% of engineering doctoral students consider leaving their programs without completing the doctoral degree [1]. Across engineering disciplines, approximately 40–60% of doctoral students ultimately withdraw due to factors such as conflicts with advisors or peers, financial or academic challenges, and personal or family obligations [2]. Early attrition among graduate students represents a significant concern in higher education, as the departure of highly skilled and knowledgeable individuals results in substantial losses for the workforce, universities, funding agencies, faculty, and the students themselves [3]. Although doctoral attrition is a widespread issue across disciplines, prior studies suggest that engineering graduate students face distinct challenges and experience significantly higher levels of stress than their peers in other fields [4], [5]. One underexplored area in the literature is doctoral students' capacity to accurately assess their progress toward degree completion. Students who encounter these challenges frequently report a deterioration in the quality of their advising relationships over time [6], [7].

Background and Literature Review

The advisor-advisee relationship is crucial in shaping doctoral students' experiences and their ability to assess their degree progress [7], [8], [9]. This dynamic significantly affects students' academic satisfaction and emotional well-being [10], [11]. This study explores the quality of advisor relationships and students' ability to assess their progress in their doctoral engineering program.

The quality of the advisor-advisee relationship is closely connected to student satisfaction and retention [12]. Studies show that attributes like supportiveness, availability, and effective communication in an advisor contribute significantly to a fulfilling doctoral experience [13]. On the other hand, unsatisfactory relationships frequently result in frustration and disillusionment, causing students to contemplate changing labs. Craft et al. [14] point out that poor advisor-advisee relationships are a significant factor in doctoral student attrition, indicating that when students feel unsupported or undervalued, they may look for alternative environments where they feel a stronger alignment with their advisors [14]. Furthermore, the dynamics of the advisor-advisee relationship can shift over time, influencing students' decisions to change labs. Bryson and Kowalske [15] highlight that these relationships can particularly evolve for students from underrepresented groups in STEM fields, potentially prompting them to reassess their fit within their current lab [15].

Advisors serve as the central architects of doctoral success, with their multifaceted roles spanning three primary domains of influence. First, advisors support *academic success* by laying the foundation for degree progress and completion [2] and guide students' development throughout the program [16]. Second, advisors contribute to *personal growth* by providing mentorship [17], [18], [19] and support socialization, helping students shape their scholarly identities [20]. Third, advisors shape the *professional trajectory* through the overall graduate

experience [21], [22], facilitate professional development [23] and influence students' future careers [24], [25]. However, advisor roles are not just faculty obligations; they are relational cues that doctoral students use to assess the quality of their relationships with their advisors. For instance, when advisors provide (or fail to provide) research guidance or psychosocial support [20], students use these enacted roles as the basis for evaluating the quality of the relationship. One study indicated that the difficulty of research tasks intersects with the quality of the advisor relationship [26].

When students face significant emotional exhaustion because of insufficient support or mismatched expectations with their advisors, they might be more likely to leave their program [27], [28]. Additionally, the alignment between a student's research interests and their advisor's expertise is crucial [29]. Wofford et al. [30] highlight that students take into account various factors, such as the mentorship style and professional stability of their principal investigator (PI), advisor, or supervisor when choosing a lab [30]. If students discover that their advisor's research focus significantly diverges from their own interests, they might feel the need to leave to better pursue their academic goals [30].

Progress Assessment

Progress in doctoral education is grounded in two core components: the completion of coursework and the production of original research culminating in the dissertation [31], [32], [33]. Foundational coursework equips students with essential theoretical knowledge, methodological frameworks, and technical competencies required for laboratory-based and scholarly inquiry [33]. However, coursework alone is an insufficient indicator of meaningful progress, as doctoral education ultimately centers on sustained research productivity. Conventional metrics, such as grade point average, have been shown to be poor predictors of doctoral completion [33]. Instead, successful degree attainment is more closely associated with students' development into independent researchers [32], [33], [34]. Advisors therefore occupy a critical role in facilitating this transition [31], [35], as they guide research trajectories, provide access to financial resources, and connect students to professional networks that support scholarly growth and timely degree completion [36], [37].

In engineering doctoral programs, research activities are frequently embedded within advisors' externally funded projects, offering students structured opportunities for hands-on research training and scholarly advancement [36], [37]. Nevertheless, tensions may arise when advisors and students hold misaligned goals or operate under ambiguous expectations [46]. Such misalignment can delay progress toward key milestones and generate uncertainty regarding the criteria by which progress is evaluated [38], [39]. As a result, students may form personal assessments of their progress that differ from those of their advisors. A productive advisor–advisee relationship characterized by clear, consistent, and collaborative communication is therefore essential for evaluating research progress, which is inherently contextual and discipline-specific [38], [40]. Regular and transparent discussions of expectations enable both parties to interpret milestones, evaluate competencies, and develop a shared understanding of academic progress [32], [33], [34], [35], [40]. Positive advising relationships can mitigate misunderstandings and reduce risks associated with divergent research objectives or ambiguous evaluation standards [40]. Within such environments, students are more likely to view themselves as active contributors to the research enterprise, fostering trust, open communication,

and confidence in navigating doctoral challenges [40], [41], [42]. Nonetheless, for a variety of reasons, students may still determine that leaving a research lab represents the most viable, or least disruptive, path to persisting in the doctoral program.

Theoretical Framework

To examine how advisor relationships influence considerations of early departure and research lab changes among doctoral engineering students, this study adopts the Graduate Attrition Decisions (GrAD) model developed by Berdanier, Whitehair, Kirn, and Satterfield [43]. The GrAD model offers a structured framework for understanding the interconnected factors that shape graduate students' attrition-related decisions, thereby contributing to ongoing discussions of retention within engineering education. The model was developed through an extensive qualitative analysis of graduate student narratives collected from social media platforms. It identifies six interrelated themes (Figure 1), four of which have been widely examined in engineering and higher education research on graduate attrition, including advisor relationships, support networks, and cost [56]. Among these themes, advisor relationships function as a central organizing influence around which many of the others are situated.

Advisors exert a multifaceted influence on doctoral students' experiences [43], [44], [45]. Through academic and professional socialization processes, advisors can either strengthen or undermine students' academic and social support networks [46], [47]. Advisor dynamics also shape students' experiences of cost, extending beyond financial considerations to encompass emotional labor, research productivity, professional development, and opportunity costs [48]. The GrAD model elucidates how the advisor–advisee relationship intersects with and amplifies these factors, collectively shaping graduate students' experiences of stress, persistence, and decision-making within the broader doctoral education ecosystem.

Research Questions

This research is part of a larger mixed-methods project that examines the persistence pathways of doctoral engineering students as they consider early departure or changing research labs to continue their graduate education. The goal of this analysis is to investigate the lived experience of students' advisor relationships and how those relationships influence students' ability to assess their degree progress. The following are the research questions for this study: How do doctoral engineering students describe their advisor relationships? How do doctoral engineering students describe their degree progress? How are advisor relationships and degree progress related? In addition, we examine these relationships based on early, mid, and late-stage doctoral students.

Methods

This study is part of a larger mixed-method longitudinal research project aimed at better understanding doctoral students' experiences and behaviors. A self-report survey administered to these students examined a wide array of doctoral experiences. A subset of survey participants was selected for individual qualitative interviews. These interviews provide the data in this analysis. All procedures were approved by the authors' institutions (UC 2025-0295; Purdue 2024-1097).

Recruitment

The American Society for Engineering Education (ASEE) 2022 edition of "Engineering and Engineering Technology by the Numbers [49] 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. 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. Participants were asked if they would be willing to participate in additional research. Students who were interested in additional research and who had considered departing from their doctoral engineering program without the doctoral degree were contacted for individual interviews.

The data analyzed in this study consist of interviews with 23 doctoral engineering students from 13 engineering programs across 15 universities in the United States. Seven participants identified as international students, and 16 identified as U.S. citizens. Twelve participants identified as men, seven as women, and four as a third gender. Participants were grouped by stage in their program: early-stage (years 1-2), mid-stage (years 3-4), and late-stage (years 5+), to capture how persistence factors may evolve over time. Each participant took part in a semi-structured interview lasting approximately 50-60 minutes. Participants had the opportunity to choose a pseudonym. If they did not choose one, the authors assigned a pseudonym.

Analysis

Interviews were transcribed by a professional transcription company for analysis. To analyze the narrative data, we employed a hybrid approach combining deductive and inductive thematic analysis [50], [50], [51]. First, we used deductive analysis to identify the interconnected factors shaping graduate students' attrition-related decisions, drawing upon the Graduate Attrition Decisions (GrAD) model developed by Berdanier, Whitehair, Kirn, and Satterfield [43].

Second, we conducted an inductive analysis to capture emergent themes. The authors performed open coding on all interview transcripts using NVivo, subsequently collaborating to identify meaningful themes that addressed the research questions. Through iterative discussion of codes and student responses, the authors refined these themes to specifically understand the factors influencing student persistence.

Results and Discussion

Advisor Relationships

Participants reported a range of advisor relationships with positive and negative emotional context well reflected in existing literature [22], [25], [40], [41], [44], [45], [48]. For example, students noted advisors who showed caring and individual attention were positive advisor relationships. Artemis, an early stage, international student said, "I can definitely tell that he cares about me." Similarly, in reference to some personal problems, Richard, a mid-stage student from the US said, "So, she was very understanding and very supportive, and I think that the relationship overall was solid." After changing research advisors, Josh, a late-stage student from

the US said, "My advisor is now much more engaged [than a previous advisor]." These positive relationships often exhibit evolving or egalitarian relationships [52].

Other students noted anxiety in their relationships accentuated by negative emotional interactions. Marta, an early-stage US student said, "And again, he was kind of just dismissive." Rep, an international mid-stage student focused on his advisor's negative emotions. "He would get, like, upset and angry with me." Sofia, an international late-stage student felt intense pressure rather than lack of contact. She said, "They [her advisor] put me a lot of under pressure. And for me, it was like I was not happy. These negative relationships often strained relationships [52].

Still other participants discussed advisor relationships not based on emotional context, but on a lack of meaningful interaction or guidance. Lee, an international early-stage student said, "he's not very rigorous about his comments for advising." Similarly, Samantha a mid-stage US student said, "I feel like, for my project, it doesn't have a clear direction. It's just kind of like in the moment, oh, try this. Oh, try this. But there's not like a clear plan to get to the end goal." These absent or neglectful relationships often exhibit some portions of strained relationships [52] while placing more emphasis on the absence of a meaningful relationship. Students who discussed each time referenced their advisor when discussing their progress. Many participants connected their advisor to their ability to assess progress within the degree program.

Early-Stage Doctoral Students

As expected, students in their first years of the doctoral program emphasized classwork when describing their progress. MT a first-year student from the US described his progress as unexpected and difficult: "I never thought that the first year of my grad school would be like this. Actually... it's been tough, though. So, I've been, it's been seven years since I took my last thermo, a statistical class." Matteo, an international first-year student expressed similar sentiments: "So there are a lot of classes. I did not expect there to be so many classes."

When students reflected beyond their coursework, the focus was on advisor feedback which was dependent on the strength of the advisor relationship. Students with evolving or egalitarian relationships discussed progress, even when below expectations, in positive terms in working with their advisor. Typically, the progress assessment and advisor relationship support focused on academic success [2]. Ruthie, a second-year US student, described the change in her relationship with her advisor.

She said that she really wanted me to join the lab, because, during our initial like interviews, she said that I had like, a lot of confidence, and she really liked that. And so she said that I needed to, like, bring that confidence back in, like, the work that I do. And so right now, I think she would assess me at like average or slightly below. I think that's because she's been what uh, she's been looking to find um that researcher in me that feels um pretty well, um that that is like, confident in their work, and is able to, like, argue or support and defend their own research

Ivan, a first-year international student, described actions his advisor took to support his progress assessment including plans for future assessment.

I would assess it as quite good. He [my advisor] seems happy. So, in terms of, like, we have talked about, like, kind of this idea of, like, getting feedback and being evaluated on

my progress so far. But he prefers more of this, like, I think, like, once a semester, we sit down and talk about, you know, how I've been doing, you know, how I can improve and stuff. So, we haven't had one of those meetings yet.

However, students with poor or negative advisor relationships expressed negative reflections on their research progress. Marta a second-year student from the US said, "it's been pretty frustrating because the research direction has been kind of unclear." With some more advancement, students began reflecting more on research progress.

Mid-Stage Doctoral Students

In the mid-stage (years 3-4), participants reflected on completing coursework and official milestones such as preliminary exams or dissertation proposal. Advisor relationships continued to support academic success with some shift to professional trajectory [2], [16], [21], [22]. Leah, a third-year US student said, "I did pass my comprehensive exam or qualifying exam, which was a very good milestone." A few students included advisor comments as related to their progress. For example, Richard, a fourth-year US student said, "The most appreciation I got was one meeting where she said, 'this is really good work.' [Otherwise], it was constant criticism, which was constructive, and it was very detailed. It saves time."

Late-Stage Doctoral Students

At the late-stage (years 5+), participants focus on finishing the research project with more interaction with advisor the relationship becomes more existential with more focus on personal growth [17], [18], [19] and professional trajectory [23], [24], [25]. In these interviews participants reflected on the advisor's view of progress as distinct from the student's progress assessment. Abraham, a fifth-year US student, discussed the differences in progress assessment from his advisor saying, "I think my perception is that I'm way too far behind, and that's inaccurate. His perception is that I'm perfectly on time. But I also think he forgets." Sofia, a seventh-year international student, discussed the lack of contact with her advisor as interrupting her research and ability to assess her progress. She said, "Things have barely happened. Usually, it's like a meeting at the beginning of the semester, maybe a meeting in the middle, and a meeting in the end. So, I didn't make much progress."

General Discussion

Advisor relationship quality directly influenced students' ability to interpret and articulate their degree progress. Students' relationship with their advisor influenced the development of academic success and professional trajectory for students in the doctoral program [2], [16], [21], [22], [24], [25]. As students progressed into later stages, their development of an independent voice as a doctoral student able to separate their progress assessment from the advisor's progress assessment [33]. Through, the common use of hedging words to describe reflects a concerning uncertainty in what advisors think about students' progress. Uncertainty in degree progress assessment can lead to increased consideration of leaving the doctoral program [31], [53].

Limitations

The issues surrounding advisor relationships, degree progress, and students persisting in doctoral education are multifaceted and require additional investigation. The analysis presented here represents only those students who were considering departing from the doctoral program.

Similarly, students who completed the survey and interviews may not represent the breadth of student experiences in engineering doctoral education. In addition, the interviews represent one point in time with doctoral education taking years with necessary personal and professional development over time.

Future Work

Future studies should seek to further explore ways in which to support students' self-assessment of progress to develop throughout the doctoral process. Investigations that quantitatively measure advisor relationship and degree progress assessment could better demonstrate a significant relationship between these concepts while assessing the generalizability of the relationship. These findings could lead to proposing or adapting best practices for advisors and doctoral programs, including training programs, mentorship guidelines, and institutional policies that promote effective mentoring.

Conclusion

This study examines the advisor–advisee relationship in engineering doctoral education and its association with students' perceptions of their degree progress. Qualitative findings indicate a significant and evolving link between the quality of this relationship and students' self-assessment, with potential implications for doctoral completion. Investing in strong faculty–student relationships may foster new research directions, contribute to technological and engineering advancements, and support the development of lasting professional connections that benefit faculty, students, departments, institutions, and society. Such impacts may also help attract highly qualified students to research labs, departments, and engineering programs. Understanding how faculty can most effectively support graduate students therefore remains an important challenge.

Acknowledgments

This material is based upon work supported by the National Science Foundation under Grant Number EEC2603026. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

References

- [1] M. Bahnson and C. G. P. Berdanier, "Current Trends in Attrition Considerations of Graduate Engineering Students in the United States," *Int. J. Eng. Educ.*, vol. 39, no. 1, pp. 14–29, 2023.
- [2] C. R. Bair and J. G. Haworth, "Doctoral Student Attrition and Persistence: A Meta-Synthesis of Research," in *Higher Education: Handbook of Theory and Research*, vol. XIX, 2004, pp. 481–534.
- [3] M. Bahnson, G. Sallai, K. Jwa, and C. G. P. Berdanier, "Mitigating Ceiling Effects in a Longitudinal Study of Doctoral Engineering Student Stress and Persistence," *Int. J. Dr. Stud.*, 2023.
- [4] M. C. Parker, K. L. Stienhorst, D. Feil-Seifer, and A. Kirn, "Engineering Doctoral Students' Interpretations of Stress and Mental Health Experiences in Graduate Education," in *2023 IEEE Frontiers in Education Conference (FIE)*, College Station, TX, USA: IEEE, Oct. 2023, pp. 1–8. doi: 10.1109/FIE58773.2023.10342891.
- [5] G. Sallai, J. Vicente, K. Shanachilubwa, and C. Berdanier, "Coping Landscapes: How graduate engineering students' coping mechanisms correspond with dominant stressors in graduate school," in *2022 ASEE Annual Conference & Exposition Proceedings*, Minneapolis, MN: ASEE Conferences, Aug. 2022, p. 40782. doi: 10.18260/1-2--40782.
- [6] T. C. Bryson and M. Grunert Kowalske, "Black women in STEM graduate programs: The advisor selection process and the perception of the advisor/advisee relationship," *J. Divers. High. Educ.*, vol. 15, no. 1, pp. 111–123, Feb. 2022, doi: 10.1037/dhe0000330.
- [7] R. E. Gildersleeve, N. N. Croom, and P. L. Vasquez, "'Am I going crazy?!': A Critical Race Analysis of Doctoral Education," *Equity Excell. Educ.*, vol. 44, no. 1, pp. 93–114, Feb. 2011, doi: 10.1080/10665684.2011.539472.
- [8] A. M. Wofford and J. M. Blaney, "(Re)Shaping the Socialization of Scientific Labs: Understanding Women's Doctoral Experiences in STEM Lab Rotations," *Rev. High. Educ.*, vol. 44, no. 3, pp. 357–386, 2021, doi: 10.1353/rhe.2021.0001.
- [9] S. Joy, X. Fen Liang, D. Bilimoria, and S. Perry, "Doctoral Advisor-Advisee Pairing in STEM Fields: Selection Criteria and Impact of Faculty, Student and Departmental Factors," *Int. J. Dr. Stud.*, vol. 10, pp. 343–363, 2015, doi: 10.28945/2302.
- [10] K. G. Wilkins-Yel, A. Arnold, J. Bekki, M. Natarajan, B. Bernstein, and A. K. Randall, "'I can't push off my own Mental Health': Chilly STEM Climates, Mental Health, and STEM Persistence among Black, Latina, and White Graduate Women," *Sex Roles*, vol. 86, no. 3–4, pp. 208–232, Feb. 2022, doi: 10.1007/s11199-021-01262-1.
- [11] L. McAlpine and C. Amundsen, Eds., *Doctoral Education: Research-Based Strategies for Doctoral Students, Supervisors and Administrators*. Dordrecht: Springer Netherlands, 2011. doi: 10.1007/978-94-007-0507-4.
- [12] D. H. Mansson and S. A. Myers, "Mentoring Support and Relational Uncertainty in the Advisor–Advisee Relationship," *NACADA J.*, vol. 33, no. 1, pp. 54–60, Jun. 2013, doi: 10.12930/NACADA-13-208.
- [13] B. J. Barnes, E. A. Williams, and S. A. Archer, "Characteristics That Matter Most: Doctoral Students' Perceptions of Positive and Negative Advisor Attributes," *NACADA J.*, vol. 30, no. 1, pp. 34–46, Mar. 2010, doi: 10.12930/0271-9517-30.1.34.
- [14] C. M. Craft, D. Augustine-Shaw, A. Fairbanks, and G. Adams-Wright, "Advising Doctoral Students in Education Programs," *NACADA J.*, vol. 36, no. 1, pp. 54–65, Jun. 2016, doi: 10.12930/NACADA-15-013.

- [15] T. C. Bryson and M. Grunert Kowalske, "Black women in STEM graduate programs: The advisor selection process and the perception of the advisor/advisee relationship.," *J. Divers. High. Educ.*, vol. 15, no. 1, pp. 111–123, Feb. 2022, doi: 10.1037/dhe0000330.
- [16] B. A. Burt, A. McKen, J. Burkhart, J. Hormell, and A. Knight, "Black Men in Engineering Graduate Education: Experiencing Racial Microaggressions within the Advisor–Advisee Relationship," *J. Negro Educ.*, vol. 88, no. 4, pp. 493–508, 2019, doi: 10.7709/jnegroeducation.88.4.0493.
- [17] T. N. Saddler, "Exploring what engineering doctoral students, aspiring to faculty careers learn about research from faculty mentors," in *2009 39th IEEE Frontiers in Education Conference*, San Antonio, TX, USA: IEEE, Oct. 2009, pp. 1–5. doi: 10.1109/FIE.2009.5350497.
- [18] M. S. Artiles, A. M. Rivera, and J. M. Cruz, "Unprepared Spaces: A Longitudinal Examination of Black and Latine Students' First Year in doctoral Engineering Programs," *J. Women Minor. Sci. Eng.*, vol. 31, no. 5, 2025.
- [19] M. S. Artiles, D. B. Knight, and H. M. Matusovich, "Doctoral advisor selection processes in science, math, and engineering programs in the United States," *Int. J. STEM Educ.*, vol. 10, no. 1, p. 6, Jan. 2023, doi: 10.1186/s40594-022-00392-6.
- [20] Vicki (Baker) Sweitzer, "Towards a Theory of Doctoral Student Professional Identity Development: A Developmental Networks Approach," *J. High. Educ.*, vol. 80, no. 1, pp. 1–33, 2008, doi: 10.1353/jhe.0.0034.
- [21] A. Lee, "How are doctoral students supervised? Concepts of doctoral research supervision," *Stud. High. Educ.*, vol. 33, no. 3, pp. 267–281, Jun. 2008, doi: 10.1080/03075070802049202.
- [22] K. Shanachilubwa, G. Sallai, and C. G. P. Berdanier, "Investigating the tension between persistence and well-being in engineering doctoral programs," *J. Eng. Educ.*, vol. 112, no. 3, pp. 587–612, Jul. 2023, doi: 10.1002/jee.20526.
- [23] D. R. Simmons, "Creating a Sustainable Research Group Supporting the Professional Development of Engineering Education Graduate Students and Postdoctoral Researchers," in *2022 IEEE Frontiers in Education Conference (FIE)*, Uppsala, Sweden: IEEE, Oct. 2022, pp. 1–6. doi: 10.1109/FIE56618.2022.9962583.
- [24] M. Denton, A. Chasen, G. C. Fleming, M. Borrego, and D. Knight, "Agentic Actions and Agentic Perspectives Among Fellowship-Funded Engineering Doctoral Students," *Educ. Sci.*, vol. 15, no. 10, p. 1378, Oct. 2025, doi: 10.3390/educsci15101378.
- [25] N. Choudhary and B. K. Jesiek, "Engineering Ph.D. students' career preferences: Levels, changes, and the role of advisors," in *2015 IEEE Frontiers in Education Conference (FIE)*, Camino Real El Paso, El Paso, TX, USA: IEEE, Oct. 2015, pp. 1–4. doi: 10.1109/FIE.2015.7344217.
- [26] M. C. Parker *et al.*, "Engineering Doctoral Student Perceptions of Research Task Difficulty and the Student-Advisor Relationship," in *2019 IEEE Frontiers in Education Conference (FIE)*, Covington, KY, USA: IEEE, Oct. 2019, pp. 1–5. doi: 10.1109/FIE43999.2019.9028623.
- [27] K. Devine and K. Hunter, "Doctoral Students' Emotional Exhaustion and Intentions to Leave Academia," *Int. J. Dr. Stud.*, vol. 11, pp. 035–061, 2016, doi: 10.28945/3396.
- [28] D. Bedewy and A. Gabriel, "Examining perceptions of academic stress and its sources among university students: The Perception of Academic Stress Scale," *Health Psychol. Open*, vol. 2, no. 2, p. 2055102915596714, Jul. 2015, doi: 10.1177/2055102915596714.

- [29] M. Bahnson, D. Satterfield, M. Wyer, and A. Kirn, "Interacting with Ruling Relations: Engineering Graduate Student Experiences of Discrimination," *Stud. Eng. Educ.*, vol. 3, no. 1, p. 53, Jul. 2022, doi: 10.21061/see.76.
- [30] M. A. Maher, A. M. Wofford, J. Roksa, and D. F. Feldon, "Finding a Fit: Biological Science Doctoral Students' Selection of a Principal Investigator and Research Laboratory," *CBE—Life Sci. Educ.*, vol. 19, no. 3, p. ar31, Sep. 2020, doi: 10.1187/cbe.19-05-0105.
- [31] J. E. Girves and E. V. Wemmerus, "Developing Models of Graduate Student Degree Progress," *J. High. Educ.*, vol. 59, no. 2, pp. 163–189, 1988.
- [32] E. Holloway, D. Radcliffe, K. Douglas, and W. Oakes, "Assessing Engineering Ph.D. Students' Research Experiences: What is Important to Assess?," in *2020 ASEE Virtual Annual Conference Content Access Proceedings*, Virtual On line: ASEE Conferences, Jun. 2020, p. 34175. doi: 10.18260/1-2--34175.
- [33] B. E. Lovitts, "Being a good course-taker is not enough: a theoretical perspective on the transition to independent research," *Stud. High. Educ.*, vol. 30, no. 2, pp. 137–154, Apr. 2005, doi: 10.1080/03075070500043093.
- [34] S. W. Rogers and R. K. Goktas, "Exploring Engineering Graduate Student Research Proficiency with Student Surveys," *J. Eng. Educ.*, vol. 99, no. 3, pp. 263–278, 2010.
- [35] M. A. Maher, J. A. Gilmore, and D. F. Feldon, "Cognitive Apprenticeship and the Supervision of Science and Engineering Research Assistants," *J. Res. Pract.*, vol. 9, no. 2, pp. 1–22, 2013.
- [36] M. Borrego, D. B. Knight, and N. H. Choe, "Research group experiences and intent to complete," *Stud. Grad. Postdr. Educ.*, vol. 8, no. 2, pp. 109–127, 2017, doi: 10.1108/sgpe-d-17-00009.
- [37] E. Crede and M. Borrego, "Learning in graduate engineering research groups of various sizes," *J. Eng. Educ.*, vol. 101, no. 3, pp. 565–589, 2012, doi: 10.1002/j.2168-9830.2012.tb00062.x.
- [38] A. Sverdlik, N. C. Hall, L. McAlpine, and K. Hubbard, "the Phd Experience: a Review of the Factors Influencing Doctoral Students' Completion, Achievement, and Well-Being," *Int. J. Dr. Stud.*, vol. 13, pp. 361–388, 2018, doi: 10.28945/4113.
- [39] R. M. Felder, J. Spurlin, S. A. Rajala, and J. P. Lavelle, *Designing Better Engineering Education Through Assessment: A Practical Resource for Faculty and Department Chairs on Using Assessment and ABET Criteria to Improve Student Learning*, 1st ed. New York: Routledge, 2023. doi: 10.4324/9781003444107.
- [40] K. Roy, C. M. McGill, and J. L. Bloom, "Doctoral Student Perceptions of Faculty Advisors: Four Supportive Behaviors to Promote Doctoral Completion," *NACADA Rev.*, vol. 4, no. 1, pp. 27–38, 2023, doi: 10.12930/NACR-21-21.
- [41] C. G. P. Berdanier, K. Jwa, and M. Ellery, "How Satisfaction with Advisor Relationship Interacts and Evolves in Engineering Doctoral Students Questioning Whether to Leave the PhD," in *2024 IEEE Frontiers in Education Conference (FIE)*, Washington, DC, USA: IEEE, Oct. 2024, pp. 1–7. doi: 10.1109/FIE61694.2024.10893408.
- [42] C. M. Ruud, E. S. Saclarides, C. E. George-Jackson, and S. T. Lubieniski, "Tipping Points: Doctoral Students and Consideration of Departure," *J. Coll. Stud. Retent. Res. Theory Pract.*, vol. 20, no. 3, pp. 286–307, Nov. 2018, doi: 10.1177/1521025116666082.
- [43] C. G. P. Berdanier, C. Whitehair, A. Kirn, and D. Satterfield, "Analysis of social media forums to elicit narratives of graduate engineering student attrition," *J. Eng. Educ.*, vol. 109, no. 1, pp. 125–147, 2020, doi: 10.1002/jee.20299.

- [44] C. M. Zhao, C. M. Golde, and A. C. McCormick, "More than a signature: How advisor choice and advisor behaviour affect doctoral student satisfaction," *J. Furth. High. Educ.*, vol. 31, no. 3, pp. 263–281, 2007, doi: 10.1080/03098770701424983.
- [45] L. Z. Schlosser, H. Z. Lyons, R. M. Talleyrand, B. S. K. Kim, and W. B. Johnson, "Advisor-advisee relationships in graduate training programs," *J. Career Dev.*, vol. 38, no. 1, pp. 3–18, 2011, doi: 10.1177/0894845309358887.
- [46] E. Hocker, E. Zerbe, and C. G. P. Berdanier, "Characterizing Doctoral Engineering Student Socialization: Narratives of Mental Health, Decisions to Persist, and Consideration of Career Trajectories," *Proc. - Front. Educ. Conf. FIE*, vol. 2019-Octob, 2019, doi: 10.1109/FIE43999.2019.9028438.
- [47] J. C. Weidman, D. J. Twale, and E. L. Stein, *Socialization of Graduate and Professional Students in Higher Education: A Perilous Passage?* Washington, D.C.: ERIC Publications, 2001.
- [48] C. E. Brawner, A. Stancescu, M. Grasso, Y. M. Huet, R. Brent, and L. Merriweather, "The Advisor-Advisee Relationship in Engineering and Computer Science Ph.D. Programs: Understanding Who Benefits and How," in *2023 Collaborative Network for Computing and Engineering Diversity*, New Orleans, LA: ASEE Conferences, 2023.
- [49] Profiles of Engineering and Engineering Technology, "American Society for Engineering Education (2023)," Washington, DC, 2022. [Online]. Available: <https://ira.asee.org/wp-content/uploads/2024/03/Engineering-and-Engineering-Technology-by-the-Numbers-cover-combined.pdf>
- [50] V. Braun and V. Clarke, "Thematic analysis: A practical guide," 2021, Accessed: Dec. 18, 2025. [Online]. Available: <https://www.torrossa.com/it/resources/an/5282292>
- [51] V. Braun and V. Clarke, "Using thematic analysis in psychology," *Qual. Res. Psychol.*, vol. 3, no. 2, pp. 77–101, Jan. 2006, doi: 10.1191/1478088706qp063oa.
- [52] J. McCain, J. Roksa, and S. Breen, "Support without Status: Inequities in Student–Advisor Relational Dynamics between First-Generation and Continuing-Generation Doctoral Students," *Educ. Sci.*, vol. 14, no. 5, p. 441, Apr. 2024, doi: 10.3390/educsci14050441.
- [53] C. Devos, G. Boudrenghien, N. V. D. Linden, and A. Azzi, "Doctoral students' experiences leading to completion or attrition: A matter of sense, progress and distress," *Eur. J. Psychol. Educ.*, pp. 61–77, 2017, doi: 10.1007/s10212-016-0290-0.