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What supports graduate student success in engineering fields? A scoping review of influences and challenges

Mr. Nnamdi Chinomso Chikere, University of Notre Dame

Nnamdi Chikere is a Ph.D. candidate in Electrical Engineering at the University of Notre Dame, where he conducts research in bioinspired robotics, focusing on embodied control and adaptive locomotion. In addition to research, his interests include engineering education, mentoring, and broadening participation in STEM, particularly in support of underrepresented and international student communities. He actively contributes to outreach and student-led initiatives that integrate robotics with inclusive learning strategies.

John Lubker, University of Notre Dame
YASEMİN OZKAN AYDIN, University of Notre Dame

Dr. Yasemin Ozkan-Aydin is an Assistant Professor in the Department of Electrical Engineering at the University of Notre Dame with extensive experience in the field of robotics, specializing in the intersection of robotics, biology, and computer science. She completed her Ph.D. in Electrical and Electronics Engineering at Middle East Technical University, Turkey, in 2014, and subsequently served as a Postdoctoral Fellow at Georgia Tech from 2016 to 2021. At her research laboratory, the Minimalist Naturally Inspired Robotics (MiNiRo) Lab, she conducts research focused on uncovering the complex factors that influence how animals move and how they interact with their surroundings. Dr. Ozkan-Aydin is particularly dedicated to advancing the field of soft robotics, bio-inspired design, and swarm robotics. Her mission is to facilitate the development of predictable, precise, and resilient robotic systems capable of navigating unpredictable and complex terrains with the same finesse and adaptability exhibited by their biological counterparts. By merging insights from biology with state-of-the-art engineering, Dr. Ozkan-Aydin aims to push the boundaries of robotic innovation and contribute to the growing body of knowledge in this interdisciplinary field.

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ABSTRACT

This research examines graduate student success in engineering as a multidimensional construct encompassing academic achievement, professional development, and psychosocial well-being. Supporting graduate success is critical not only for individual career trajectories but also for sustaining innovation, diversifying the STEM workforce, and maintaining national research competitiveness. We conducted a scoping review of peer-reviewed literature published between 2015 and 2025, examining factors shaping graduate student success in U.S. engineering programs. Guided by Social Cognitive Career Theory (SCCT) and Ecological Systems Theory (EST), 65 studies meeting the inclusion criteria were analyzed through structured and iterative coding. Success was defined across academic (e.g., persistence, research productivity), professional (career readiness, skill development), and psychosocial (well-being, self-efficacy) domains. Findings indicate that individual resources such as self-efficacy, intrinsic motivation, and resilience support persistence, while advisor quality and peer community function as central interpersonal supports. Institutional structures, including financial stability, departmental climate, and structured professional development, shape both opportunity and stress exposure. For international and underrepresented students, these dynamics intersect with immigration uncertainty, discrimination, and acculturative pressures. By synthesizing multilevel influences and integrating SCCT with EST, this review advances a unified conceptual model of graduate student success in engineering. The proposed integrated ecosystem framework links cognitive processes with nested structural contexts, identifying leverage points for improving equity, persistence, and well-being in graduate engineering education.

INTRODUCTION

This research examines graduate student success in engineering as a multidimensional and system-level phenomenon shaped by cognitive, relational, institutional, and societal forces. Graduate engineering programs are pivotal to sustaining the research enterprise and cultivating advanced technical talent, since graduate students contribute directly to scientific knowledge production, mentor undergraduate researchers, and form an important segment of the future engineering workforce[1]. At the same time, graduate education is associated with substantial personal and institutional consequences: when students struggle to persist or to thrive, the effects extend beyond delayed degree progress to include disrupted research trajectories, lost training investments, and diminished well-being[2,3]. These concerns are especially prominent in engineering, where persistence decisions are often made under conditions of high workload, uncertainty, and uneven access to mentoring,

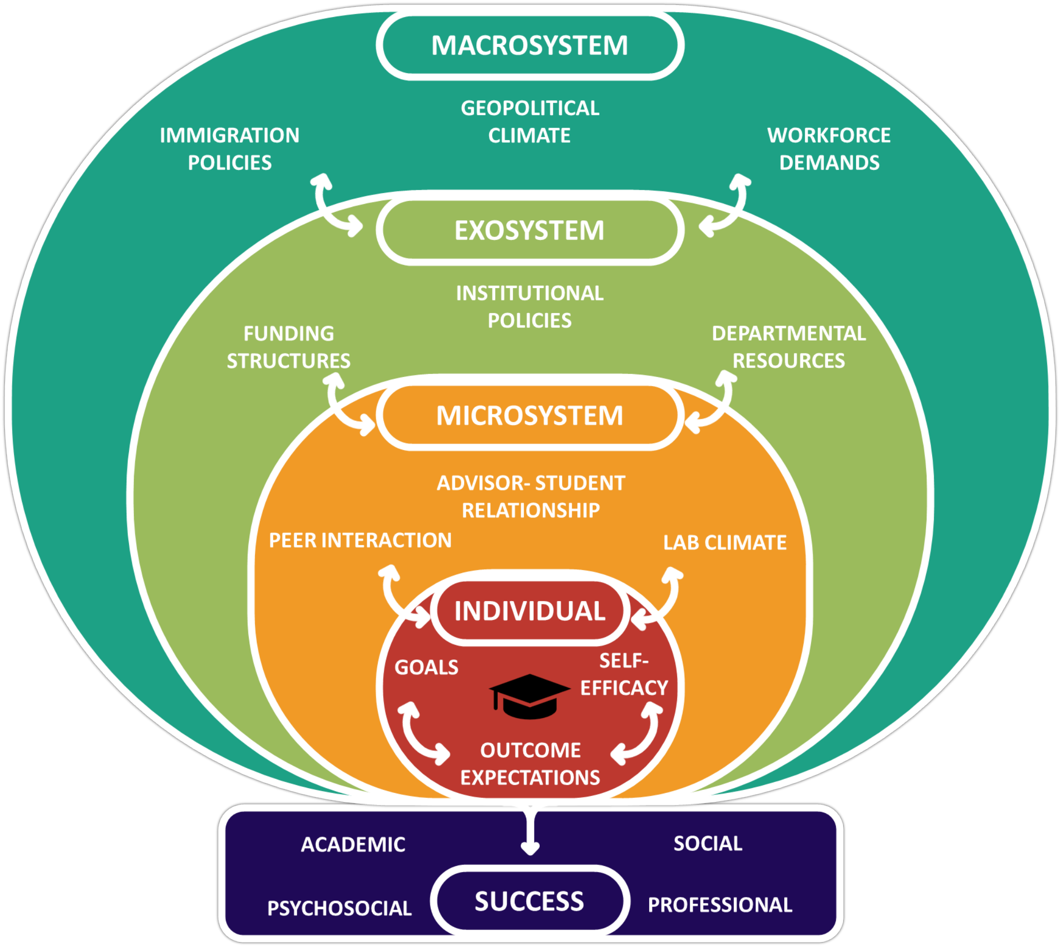

Figure 1: **Integrated Ecosystem of Engineering Graduate Success.** This model integrates SCCT and EST to conceptualize graduate success as an emergent outcome of interacting multi-level systems. Self-efficacy, outcome expectations, and goals form the core of the individual-level SCCT, shaped by reciprocal influences across microsystemic, exosystemic, and macrosystemic contexts.

financial stability, and institutional support[4].

As engineering disciplines face increasing demand for advanced-degree holders, understanding what supports graduate student success has become increasingly urgent[5]. Yet, despite the centrality of graduate education to innovation and workforce development, graduate-level engineering education remains less thoroughly studied than undergraduate education, and the nature of success at the graduate level remains inadequately theorized[2,5]. Challenges related to persistence remain a defining feature of graduate engineering education. Attrition pathways in engineering doctoral programs include formal withdrawal as well as "mastering out," wherein students exit doctoral study after completing a master's degree, representing a substantial loss of time, effort, and institutional investment[6,7]. Moreover, research consistently shows that many engineering doctoral students consider leaving their programs, underscoring the fragile and dynamic nature of persistence decisions[3,4].

The demographic composition of graduate engineering programs further complicates this landscape. International students constitute a substantial portion of United States (U.S.) engineering graduate enrollments and play a critical role in research productivity and innovation, while women and students from historically underrepresented backgrounds continue to encounter structural and cultural barriers despite incremental gains in representation [8,9]. First-generation college students pursuing graduate engineering degrees may face additional challenges related to limited access to navigational capital, mentoring networks, and implicit knowledge of academic norms [10,11]. These intersecting conditions suggest that graduate student success cannot be understood as a uniform or purely individual outcome, but rather as an emergent product of personal, interpersonal, and institutional contexts.

A growing body of work argues that "success" in graduate education cannot be reduced to a single endpoint such as degree completion. Instead, it is increasingly conceptualized as a multidimensional construct that includes academic progress, professional development, and psychosocial functioning [5,2]. This broader framing reflects two realities. First, many outcomes that graduate programs value (e.g., research productivity, professional skill development, career clarity) unfold alongside and sometimes in tension with student well-being [3,4]. Second, outcomes frequently overlap in practice: for example, publishing papers is simultaneously an academic milestone and a form of career preparation, while mentoring relationships can shape both scholarly productivity and a student's sense of belonging [3]. As a result, outcome categories are best treated as analytically distinct but empirically intertwined, requiring transparent classification decisions when synthesizing evidence across studies.

We define *graduate student success in engineering* as a multidimensional construct spanning three overlapping domains: academic, professional, and psychosocial outcomes [12,5]. This taxonomy is used to organize evidence across the literature. **Academic outcomes** include persistence and retention, timely completion of degree milestones, and research productivity (e.g., publications and conference dissemination). **Professional outcomes** encompass skill development and career preparation, including communication, collaboration, leadership, and alignment between training experiences and post-graduation pathways. **Psychosocial outcomes** capture well-being and mental health, sense of belonging, self-efficacy, identity development, and the capacity to sustain engagement without high personal cost.

Because many constructs span domains, overlap is treated as expected. Outcomes are classified by their *primary function* within each study (e.g., academic progress, career readiness, or well-being), while cross-domain linkages are addressed in synthesis to avoid artificial separations.

Theoretical Framing: Cognitive and Ecological Perspectives To organize evidence on graduate student success in engineering, this review adopts two complementary frameworks: Social Cognitive Career Theory (SCCT) [13] and Ecological Systems Theory (EST) [14]. Together, these perspectives link individual motivation and decision-making to the institutional and societal contexts that shape persistence, well-being, and professional development.

(a) Social Cognitive Career Theory (SCCT) SCCT, grounded in Bandura's social cognitive theory, is widely used to explain persistence and career development in engineering education [13,15]. It posits that academic and career behavior is shaped by the interaction of **self-efficacy** (beliefs about one's ability to perform required tasks), **outcome expectations** (anticipated consequences of engagement), and **goals** (intentions to persist or pursue specific pathways). In graduate engineering contexts, these mechanisms encompass research-related confidence, coping with uncertainty and failure, and beliefs about the returns of advanced training.

A key contribution of SCCT is its emphasis on how environmental supports and barriers operate through these cognitive processes. Mentorship, feedback, and access to resources can strengthen self-efficacy and reinforce persistence intentions, whereas unclear expectations, limited support, or marginalizing experiences may undermine motivation even among highly capable students[8,13]. In this review, SCCT informs the analysis of individual-level success factors related to motivation, confidence, and persistence decisions.

(b) Ecological Systems Theory (EST) EST provides a complementary lens by situating graduate student experiences within nested environmental contexts[14]. These include immediate **microsystems** (advisor–student relationships, labs, peer communities), interactions among settings (**mesosystem**), institutional structures that indirectly shape experiences (**exosystem**), broader cultural and policy environments such as disciplinary norms, immigration regimes, and labor markets (**macrosystem**), and temporal dynamics across training stages and historical events (**chronosystem**).

EST emphasizes that graduate student success emerges from interactions across these levels rather than from individual attributes alone. In this review, EST guides the classification and interpretation of interpersonal, institutional, and societal factors influencing success.

Integrating Cognitive and Ecological Perspectives Integrating SCCT and EST enables a multilevel interpretation of graduate student success as an emergent property of interactions between students' beliefs, goals, and the environments in which they are embedded. This combined framing as shown in Fig. 1 is particularly important for understanding differential experiences across programs and student groups, as organizational climate, equity conditions, and access to support vary widely across contexts[6,9]. Using both frameworks allows the synthesis to preserve heterogeneity in pathways to success rather than assuming uniform mechanisms across engineering graduate education.

Although prior research has identified important predictors of graduate student persistence and well-being, existing work is often fragmented across psychological, interpersonal, and institutional domains. Studies grounded in Social Cognitive Career Theory emphasize internal mechanisms such as self-efficacy and outcome expectations, whereas structurally oriented scholarship highlights funding structures, departmental climate, and policy constraints. However, few reviews have systematically integrated these perspectives to explain how cognitive processes and contextual forces interact across levels. This review addresses that gap by synthesizing findings through a combined SCCT–EST framework, advancing a multilevel model that conceptualizes graduate student success as an emergent property of interacting systems rather than an individual attribute alone.

Purpose, Research Questions, and Contribution This scoping review maps and synthesizes research published between 2015 and 2025 on factors influencing graduate student success in U.S. engineering programs, encompassing both domestic and international students. Guided by Social Cognitive Career Theory and Ecological Systems Theory, the review examines how success-related factors operate across individual, interpersonal, institutional, and broader contextual levels, and uses this synthesis to develop an integrative, multilevel conceptual model.

The review addresses three research questions: (1) What individual, interpersonal, and institutional factors have been identified as shaping graduate student success in engineering? (2) How can these factors be organized within complementary theoretical frameworks to explain persistence, achievement, and well-being in engineering graduate education? (3) What gaps remain in the literature, and what priorities emerge for future research and graduate program design? In addressing these research questions, this review advances the literature in three primary ways. First, it synthesizes academic, professional, and psychosocial outcomes within a unified outcome taxonomy, clarifying overlap while preserving analytic coherence. Second, it integrates Social Cognitive Career Theory (SCCT) and Ecological Systems Theory (EST) to link individual cognitive mechanisms with multilevel structural influences. SCCT alone cannot account for macrosystemic constraints, whereas EST does not fully specify the psychological processes that mediate environmental effects. Their integration provides a more complete account of graduate persistence and well-being. Third, the review advances an Integrated Ecosystem of Engineering Graduate Success, conceptualizing success as an emergent system-level property rather than solely an individual trait.

METHODOLOGY

Review Design We conducted a scoping review to map and synthesize research on graduate student success in engineering. Scoping reviews are well-suited for clarifying constructs, identifying dominant themes, and highlighting research gaps across fragmented bodies of work[16].

The review followed the framework proposed by Arksey and O'Malley[17], with refinements by Levac et al.[18], emphasizing iterative study identification, selection, data charting, and synthesis. Consistent with scoping review conventions, no formal quality appraisal was conducted, as the goal was descriptive and integrative rather than evaluative.

Search Strategy and Study Selection Peer-reviewed literature (2015–2025) was reviewed to capture recent developments in U.S. engineering graduate education. Searches were conducted using the Consensus platform[19], which aggregates major engineering education venues (e.g., ASEE proceedings, *JEE*, *IJER*) and multidisciplinary databases (e.g., Semantic Scholar, PubMed). Search strings combined population, context, and outcome terms (e.g., "graduate student," "engineering," "persistence," "mentorship," "self-efficacy," "belonging," "international students," "underrepresented minorities"), supplemented by citation chaining.

Inclusion criteria required studies to: (1) examine graduate-level engineering or engineering-relevant STEM populations; (2) address U.S. graduate education contexts; and (3) report academic, professional, or psychosocial success-related factors. Only peer-reviewed English-language publications were included. Undergraduate-only, non-engineering, and non-empirical opinion pieces were excluded.

The search identified 950 records; 522 underwent title/abstract screening and 315 full-text review. A final sample of 65 publications met the inclusion criteria.

Data Charting and Synthesis Data were charted using a structured extraction protocol that captured the study population, context, methodology, theoretical framing, and reported success factors. Analysis employed iterative thematic coding. Deductive codes were informed by Social Cognitive Career Theory and Ecological Systems Theory (e.g., self-efficacy, mentoring, institutional context), with inductive codes added to capture emergent themes. Themes were synthesized across individual, interpersonal, institutional, and macrosystemic levels, informing the multilevel conceptual model of graduate student success presented later in the paper.

RESULTS

Individual-Level Factors Across the literature, individual-level factors play a central role in engineering graduate student persistence and success. Within both SCCT and EST, the individual serves as the locus through which contextual supports and barriers shape outcomes.

Among individual factors, self-efficacy emerges as the most consistent predictor of persistence. Engineering- and research-specific self-efficacy predicts persistence intentions and degree commitment more strongly than general academic confidence or prior performance[20,21,22].

Self-efficacy develops through mastery experiences, feedback from advisors, and social modeling. Women and first-generation students show heightened sensitivity to these cues, reflecting unequal reinforcement rather than ability differences[23,24,21]. Longitudinal evidence further shows that self-efficacy partially mediates the relationship between departmental supports and persistence over time[20,25]. Within SCCT, it functions as a central mediator linking environmental conditions to persistence intentions.

Beyond self-efficacy, resilience, and goal orientation shape how students respond to sustained challenge. Students driven by intellectual interest or personal values show greater persistence than those motivated primarily by external rewards[26,27]. Resilience, the capacity to sustain functioning under adversity, emerges as a key mediator of degree progress, yet it is context-dependent, strengthened by mentoring quality, peer relationships, and financial stability[28,29]. Goal orientation further conditions outcomes: mastery goals support engagement, whereas performance-avoidant goals predict stress and withdrawal[30,31]. Together, these factors reinforce persistence and well-being.

Mental health represents a critical constraint on graduate success. Engineering graduate students report elevated stress, anxiety, and depression, which are associated with slower progress and higher attrition intentions[2]. Distress is linked to structural features of graduate training, including research uncertainty, heavy workloads, advising power asymmetries, competitive lab cultures, and financial strain[2]. Norms that normalize extreme stress discourage help-seeking, and isolation during dissertation phases further amplifies distress, particularly for students facing acculturative challenges[32,33].

Interpersonal Factors: Microsystemic Influences At the interpersonal level, graduate student success in engineering is shaped primarily by interactions within students' immediate academic environments, particularly the advisor–student relationship and peer networks.

The advisor–student relationship is consistently identified as a major determinant of persistence, satisfaction, and mental health, as advisors control access to funding, research opportunities, professional networks, and disciplinary norms[34,35,36]. Research distinguishes between instrumental mentoring (technical guidance) and psychosocial mentoring (emotional support and validation), with strongest outcomes observed when both are present[34,37]. In contrast, negative advising relationships—characterized by neglect, hostility, or exploitation—are associated with elevated stress, reduced self-efficacy, and increased attrition risk[34,38,39]. Structural power asymmetries, funding dependence, and limited exit options often trap students in harmful advising situations, while limited advisor availability due to workload pressures further exacerbates disengagement, particularly for students with lower self-efficacy[36].

Peer relationships operate both within and beyond individual research labs, whereas lab climate reflects advisor leadership, expectations, and collaborative norms. Peer networks provide daily academic collaboration, informal knowledge exchange, and emotional support, which are consistently linked to higher satisfaction, reduced isolation, and stronger persistence intentions[40,41,42]. Structured peer communities and cohort models further strengthen belonging and self-efficacy, particularly for underrepresented and international students[43,44].

Lab climate, in contrast, is shaped primarily by advisor leadership and shared norms within the research group. Collaborative lab environments are associated with higher morale and productivity, whereas competitive or isolating climates increase stress and disengagement[45]. Together, peer support and lab climate reinforce individual-level psychological resources and can partially buffer inconsistent faculty mentoring, especially for marginalized students[46,47,25].

Institutional-Level Factors: Exosystemic Influences At the institutional level, funding structures, departmental climate, and professional development opportunities indirectly shape graduate student success by structuring advising practices, peer interaction, and access to resources. Although students do not engage these systems directly, they define the material and normative conditions of graduate training and influence persistence, productivity, and well-being.

Financial support is a primary determinant of outcomes. Stable, multi-year funding is associated with higher retention and shorter time-to-degree, whereas funding gaps, inadequate stipends, and outside employment increase attrition risk[48,4,49]. Funding type also matters: research assistantships and fellowships tend to support stronger research integration, while heavy teaching loads—especially when misaligned with research—delay progress and elevate stress[49,50]. Rising living costs intensify strain, disproportionately affecting underrepresented, low-income, and international students[51,52]. Persistence decisions therefore reflect broader sustainability concerns, including mental health and work–life balance[3,7].

Beyond funding, departmental climate and career preparation further condition outcomes. "Chilly" climates marked by exclusion, microaggressions, and competition undermine belonging and self-efficacy[53,54,55], whereas inclusive environments with transparent expectations and representative faculty improve satisfaction and retention[56,57]. Structured professional development—transferable skills training, career guidance, and tools such as Individual Development Plans—strengthens career clarity and persistence, particularly for international and underrepresented students[58,59,60]. From an EST perspective, these exosystemic conditions shape microsystem interactions and individual outcomes.

Macrosystemic Factors: Societal and Global Contexts Macrosystemic conditions shape engineering graduate education through national policy, geopolitical forces, and global labor markets.

In the United States, immigration and visa regimes are particularly consequential given the central role of international students, who comprise roughly one-third to two-fifths of science and engineering graduate enrollments and earn most engineering doctorates[61,62,63]. Visa uncertainty, restrictive policies, and processing delays are consistently associated with reduced applications and lower post-graduation stay rates[61,64,65]. Following 2016, policy volatility and anti-immigrant rhetoric coincided with sharp declines in international applications, even without formal bans[66,67]. Intensifying global competition from countries offering clearer work-to-residency pathways has further weakened U.S. pull factors for STEM talent[64,68], posing long-term risks to research capacity and workforce sustainability[61].

International engineering graduate students also face acculturative stress linked to language barriers, cultural norms, temporary legal status, and constrained timelines, all of which shape well-being and persistence[62,63]. Longitudinal studies show that satisfaction with advising, social support, and quality of life often declines over time, indicating that adaptation is uneven and fragile[69]. Social and institutional support networks act as key buffers against acculturative and mental-health stressors[62,70]. These pressures intersect with immigration precarity: perceived policy instability, discrimination, or limited opportunity reduces the likelihood that graduates remain in the U.S. workforce[67,65]. Stay–return decisions reflect shifting economic opportunities and policy incentives across host and home countries[61,71,72].

Labor-market structures further shape engineering graduate students' professional identities and career decisions. Engineering PhD graduates are critical contributors to innovation and high-skill labor markets, and declines in enrollment or retention threaten national competitiveness[72,68]. Yet many doctoral programs continue to operate under an academic apprenticeship model despite most graduates pursuing non-academic careers. Prior work identifies a growing misalignment between doctoral training and workforce expectations, arguing that limited exposure to industry-relevant practices undermines employability, career clarity, and economic resilience[73,74]. Evidence suggests that structured industry exposure, such as internships providing mentoring, role models, and professional socialization, strengthens engineering identity, confidence, and workforce integration beyond research training alone[75].

DISCUSSION

This discussion synthesizes findings across individual, interpersonal, institutional, and macrosystemic levels to interpret how contextual factors jointly shape engineering graduate student success, persistence, and well-being. Rather than operating independently, supports and constraints interact across levels, amplifying or mitigating their effects on student experiences. Situating these findings within established theoretical frameworks highlights key leverage points for improving persistence and equity in graduate engineering education.

At the individual level, psychological factors, particularly self-efficacy, motivation, resilience, and sense of belonging form a foundational pathway through which external conditions influence outcomes. Supportive mentoring, constructive feedback, and early mastery experiences strengthen self-efficacy and persistence, whereas hostile climates, uncertainty, or repeated negative feedback erode confidence and belonging, even among academically strong students. These findings indicate that effective interventions must address both skill development and the psychological conditions that sustain engagement.

Interpersonal systems, especially advisor relationships and peer communities, consistently emerge as central facilitators of graduate success. Advisors who integrate intellectual guidance with psychosocial support help students navigate setbacks and maintain motivation, while peer networks buffer stress, reduce isolation, and reinforce belonging. Together, these findings emphasize that graduate education is a social process, underscoring the need for mentor training, structured peer support, and departmental norms that promote collaboration.

At the institutional level, funding stability, professional development, and departmental climate strongly shape graduate trajectories. Reliable funding, transparent expectations, and embedded professional development enable individual and interpersonal supports to function effectively. In contrast, financial precarity, unclear structures, or biased and high-pressure climates can override strong mentoring and motivation, increasing attrition risk. These institutional factors also interact with interpersonal dynamics: funding stability reduces advisor–student strain, while inclusive climates facilitate mentoring and peer engagement.

Across studies, marginalized and international students face compounded challenges spanning all levels of influence. External stressors such as financial insecurity, immigration uncertainty, and cultural adjustment intersect with internal challenges, including impostor phenomenon and reduced belonging. The literature consistently indicates that uniform mentoring and program designs are insufficient; targeted, context-aware strategies, such as culturally responsive mentoring, and explicit efforts to address bias are necessary for equitable outcomes.

Overall, the evidence demonstrates that improving engineering graduate student success requires coordinated action across levels. Mentors shape daily experiences and self-efficacy, departments structure resources and climate, and policymakers influence funding, immigration regimes, and workforce alignment. These multilevel interactions motivate the integrated conceptual model presented next, which synthesizes these dynamics into a unified framework for understanding and improving graduate engineering education.

Conceptual Model of Multi-Level Influences Drawing on Social Cognitive Career Theory (SCCT) and Ecological Systems Theory (EST), we propose the *Integrated Ecosystem of Engineering Graduate Success*. The model frames graduate success as an emergent property of interacting systems rather than an individual trait.

At the individual level, self-efficacy is a proximal determinant of persistence and achievement, but it is shaped within the microsystem through feedback, expectations, and validation, most notably within advisor–student and peer relationships. These microsystemic processes are constrained by exosystemic conditions such as departmental funding structures, workload distribution, and tenure pressures. All actors operate within broader macrosystemic forces, including immigration policy and workforce dynamics, which impose constraints beyond local control.

Figure 1 illustrates these cross-level interactions. For example, a high-performing international student may encounter sudden visa restrictions (macrosystem), generating uncertainty and anxiety.

If the advisor lacks training or resources to address these concerns (microsystem), and institutional mental health or financial supports are limited (exosystem), the student's self-efficacy may erode, increasing attrition risk despite strong academic performance. This example highlights how disruptions at one level can cascade across the system.

Overall, the model emphasizes that graduate success depends on alignment across levels. Strengths at the individual or interpersonal level can be undermined by structural failures, while coordinated supports across systems reinforce persistence, belonging, and degree completion.

Gaps in the Literature and Future Research Despite substantial scholarship on engineering graduate student success, several critical gaps remain. (1) The literature is dominated by cross-sectional studies, limiting understanding of how key factors such as self-efficacy, mentoring quality, peer support, and impostor feelings evolve over time. Longitudinal research tracking students across stages of graduate training and into post-graduation careers is needed to identify when supports are most impactful and which experiences translate into long-term success. (2) Much existing work examines demographic dimensions in isolation. Intersectional studies that center overlapping identities remain sparse, constraining understanding of how compounded structural and cultural barriers shape graduate experiences. (3) There is limited causal evidence evaluating interventions. While mentoring programs, peer networks, and professional development initiatives are frequently recommended, few studies rigorously assess their effects on retention, time-to-degree, or well-being. More experimental or quasi-experimental evaluations are needed, including attention to unintended or adverse consequences. (4) Mental health remains under-theorized within engineering education research. Future work should treat mental health not only as an outcome but as a mediating mechanism linking climate, funding, and mentoring to persistence and performance. (5) Advisor perspectives are understudied. Research examining faculty incentives, constraints, and responses to mentor training, and how these shape advising quality, would inform more effective institutional policy. Relatedly, stronger links between graduate training experiences and long-term career outcomes remain largely unexplored and warrant sustained investigation.

Implications and Recommendations Synthesizing evidence across individual, interpersonal, institutional, and macrosystemic levels reveals several actionable recommendations for stakeholders in engineering graduate education.

Engineering Departments and Colleges Departments should reduce reliance on single-advisor models by formalizing multi-mentor structures (e.g., early-stage mentoring or thesis committees) to distribute academic and psychosocial support. Regular climate assessments, disaggregated by gender, race, and citizenship, are essential for identifying exclusionary dynamics and guiding intervention. Professional skills development (e.g., communication, leadership, project management) should be embedded into curricula through structured, credit-bearing mechanisms rather than left to informal advising.

Faculty Advisors Advisors should receive training in culturally responsive mentoring that accounts for how identity and structural constraints shape graduate experiences. Effective advising extends beyond technical supervision to include attention to well-being, normalization of setbacks, and deliberate support for self-efficacy through constructive feedback and consistent engagement.

Institutional Policymakers and Funding Agencies Institutions and funders should prioritize stable, multi-year funding and introduce transitional mechanisms that allow advisor changes without financial penalty. Proven fellowship and bridge programs that integrate funding, mentoring, and community-building should be scaled beyond pilot populations. Accessible, culturally competent mental health services, ideally embedded within engineering colleges, are critical for reducing stress-related attrition.

Macro-Level Policy and Industry Stakeholders At the macrosystemic level, immigration policies that provide stability and clear employment pathways are central to retaining international engineering talent. Expanded industry–academic partnerships can align graduate training with workforce demands through internships and applied research, strengthening professional identity and career clarity.

Overall, these recommendations underscore that improving engineering graduate student success requires coordinated action across levels; isolated interventions are unlikely to be effective without complementary structural support.

CONCLUSION

This review examined research on graduate student success in U.S. engineering programs through cognitive and ecological perspectives. The reviewed literature shows that success depends not only on individual attributes such as self-efficacy and motivation, but on their interaction with mentoring relationships, institutional structures, and broader policy and labor-market contexts. Advisor support, peer communities, funding stability, and departmental climate consistently shape persistence and well-being. These influences are interconnected, such that weaknesses at one level can undermine strengths at another. Improving graduate outcomes, therefore, requires coordinated, multi-level interventions rather than isolated individual- or program-level solutions.

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