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Exploring First Generation Engineering Technology Students Acquisition of the Engineering Identity

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Abstract

This paper presents quantitative findings from a National Science Foundation (NSF) funded study examining First-Generation (FG) and Continuing-Generation (CG) students in Engineering Technology (ET) programs. Using data from the Engineering Identity and Belonging Survey administered nationally in fall 2024 and 2025 (n = 205), the study investigates group-based differences in academic preparation, confidence, help-seeking behaviors, social capital, and engineering identity.

Results indicate that FG students reported significantly lower exposure to advanced geometry and physics prior to college yet demonstrated academic confidence comparable to or exceeding that of CG peers over time. Help-seeking behaviors were largely similar across groups, with peers serving as the primary source of support; however, FG students were significantly less likely to utilize academic advisors or family-based academic and career support. Despite these gaps, FG students reported strong perceptions of belonging within their ET programs and were significantly more likely than CG students to report peer recognition as engineers.

Overall, the findings highlight the resilience of First-Generation Engineering Technology students and underscore the central role of peer networks in supporting identity development and persistence. These results inform institutional efforts to strengthen advising structures and expand access to social capital within Engineering Technology programs.

Introduction

Engineering Technology programs, offered through both two-year and four-year pathways, continue to expand in response to workforce demand for practice-oriented engineering professionals. These programs prepare graduates for applied engineering roles across a wide range of industries and, in many states, provide pathways to professional engineering licensure. In fact, graduates of Engineering Technology programs are eligible to pursue professional engineering licensure in the majority of U.S. states, often following career trajectories comparable to those of graduates from Engineering Science programs, albeit through state-specific requirements.

Despite the growth and increasing relevance of Engineering Technology programs, research on student experiences within these programs remains limited. Much of the existing engineering education literature centers on Engineering Science programs, with findings frequently generalized to Engineering Technology contexts without empirical examination. This gap is particularly consequential given the distinct curricular structures, pedagogical emphases, and student populations that characterize Engineering Technology programs.

To address this gap, the present study examines the experiences of First-Generation and Continuing-Generation students enrolled in Engineering Technology programs using data from the Engineering Identity and Belonging Survey [1], [2]. The survey was administered nationally during the fall semesters of 2024 and 2025, with the majority of respondents drawn from two public-serving universities in North Carolina. Designed to capture students' academic preparation, confidence, help-seeking behaviors, perceptions of belonging, and sources of academic and career-related support, the instrument enables a comprehensive examination of persistence-related experiences within Engineering Technology.

A total of 205 undergraduate Engineering Technology students consented to participate, with approximately one quarter identifying as First-Generation college students. The sample also reflects common characteristics of Engineering Technology populations, including high rates of employment during the academic year. These contextual factors are important for interpreting how students navigate academic demands and access support within their programs.

Using descriptive statistics and one-way analyses of variance, this study investigates patterns in student experiences and examines whether differences emerge between First-Generation and Continuing-Generation students across key dimensions of identity, belonging, confidence, and support. The results highlight areas of convergence and divergence between groups, offering empirical insight into how generational status shapes Engineering Technology students' experiences. By aligning student-reported experiences with measures of identity and belonging, this work advances understanding of persistence in Engineering Technology and provides evidence to inform program-level interventions aimed at supporting diverse student pathways.

Literature Review

First-Generation Students in Engineering

Prior research has consistently shown that First-Generation college students (FGS) in engineering face structural and cultural barriers that impede persistence, including challenges with academic integration, early gatekeeping STEM courses, and heightened stress and mental health concerns [3], [4], [5]. These barriers are often compounded by limited pre-college preparation and disproportionate representation from low-income backgrounds, contributing to lower persistence and completion rates in engineering pathways [6], [7].

Despite these challenges, studies also document key factors that support FGS success in engineering, including motivation, self-efficacy, and strong familial and institutional support systems [6], [8], [9]. Faculty recognition, mentoring, and participation in first-year communities have been shown to strengthen students' sense of belonging and confidence, particularly when educators value the lived experiences FGS bring to engineering programs [10], [11], [12]. These findings underscore the importance of shifting from deficit-based narratives toward asset-oriented perspectives on FGS persistence.

Engineering Identity and Persistence

Engineering identity, defined by students' interest, perceived competence, and recognition within the field, is a well-established predictor of persistence in engineering education [13], [14]. Prior studies demonstrate that engineering identity development is shaped by environmental and cultural factors, including departmental climate, peer interactions, and institutional context [15], [16]. A strong sense of community, particularly at minority-serving institutions, has been linked to positive identity development and improved retention [15].

For FGS, engineering identity is closely tied to belonging and persistence. When students view themselves as legitimate members of the engineering community, they demonstrate greater effort and intention to remain in the field [17]. However, existing research has largely examined identity in relation to outcomes such as grit or belonging, with limited attention to the specific mechanisms that support identity development among FGS, particularly within Engineering Technology programs.

Social Capital as an Asset

Social capital, defined as access to networks, relationships, and resources, has been shown to influence persistence across engineering populations [18], [19]. Research suggests that access to social capital varies across demographic groups and plays a meaningful role in students' navigation of engineering education [20]. For FGS, institutional agents, peers, and mentoring relationships are especially important sources of social capital [21], [22].

While earlier studies often emphasized the relative lack of social capital among FGS, more recent work has begun to challenge deficit framing by highlighting how FGS actively build and leverage networks to support their success [22]. This shift provides a foundation for examining how social capital interacts with engineering identity development to support persistence.

Study Contribution

Building on this body of work, the present study examines the intersection of engineering identity and social capital among First-Generation students in Engineering Technology programs. By focusing on peer interactions, participation in curricular and extracurricular activities, and access to institutional supports, this study extends prior research by foregrounding the assets FGS bring to engineering education. Using mixed methods, we aim to provide a more nuanced understanding of the pathways through which identity and social capital contribute to persistence and success, addressing gaps in the literature related to Engineering Technology contexts and First-Generation student experiences.

Methodology

In the fall semesters of 2024 and 2025, the Engineering Identity & Belonging Survey was administered to undergraduate Engineering Technology students nationwide, but most of the respondents were from two public-serving universities in North Carolina. The survey was

designed to capture students' academic preparation, confidence, help-seeking behaviors, perceptions of belonging, and sources of academic and career-related support within the Engineering Technology major.

A total of 205 students consented to participate and completed the survey. Approximately one quarter of respondents (24%) identified as First-Generation college students, defined in this study as students who were the first in their families to *attend* college. The majority of respondents identified as male (73%). In addition, most respondents (69%) reported working during the academic year, with the largest proportion indicating employment of between 10 and 29 hours per week. These demographic characteristics provide important context for interpreting students' academic experiences and support-seeking behaviors.

Following survey administration, both descriptive and inferential analyses were conducted to examine patterns in responses and to identify potential differences between First-Generation and Continuing-Generation Engineering Technology students. Descriptive statistics were first used to summarize response distributions across key survey items. To assess whether observed differences between groups were statistically meaningful, a series of one-way analyses of variance (ANOVA) were conducted. These analyses tested for group-based differences across measures related to academic preparation, confidence, perceptions of belonging, help-seeking behaviors, and sources of support. Statistical significance was evaluated at conventional alpha levels (0.05).

Together, these analytic approaches allowed for an examination of both the prevalence of key experiences among Engineering Technology students and the extent to which those experiences differed by generational status.

Findings

While First-Generation Engineering Technology students reported lower overall exposure to advanced mathematics and science coursework prior to college compared to their Continuing-Generation peers in the major, most of these differences were not statistically significant. Two notable exceptions, however, point to meaningful disparities in academic preparation. Within the Engineering Technology major, only 6% of First-Generation students reported exposure to advanced geometry before college enrollment, representing a 12–percentage point gap relative to Continuing-Generation students ($p = .05$). A similar and slightly larger disparity emerged in advanced physics exposure, with a 15–percentage point gap that was also statistically significant ($p = .05$). These findings suggest that, although broad patterns of pre-college preparation appear similar across groups, First-Generation students may enter Engineering Technology programs with less exposure to specific coursework foundational to the discipline.

Despite these gaps in academic preparation, First-Generation students did not report lower confidence at the outset of their college experience. On the contrary, at the beginning of enrollment, First-Generation students were slightly more likely than their Continuing-Generation

peers to report feeling "*Very confident*" in their ability to succeed in an Engineering Technology degree (38% versus 33%), although this difference was not statistically significant. Over time, this initial difference dissipated. By the time surveys were completed, both groups reported similarly high levels of confidence, with nearly identical proportions indicating they felt "*Very confident*" in their ability to succeed (First-Generation: 53%; Continuing-Generation: 54%). Taken together, these findings suggest that early confidence among First-Generation students is maintained over time, even as initial advantages relative to Continuing-Generation peers narrow.

When students encountered academic challenges within the Engineering Technology major, help-seeking behaviors were largely similar across groups, with peers serving as the most frequently cited source of support. Approximately 70% of both First-Generation and Continuing-Generation students indicated that they would talk with friends or other students when facing academic difficulty. In contrast, substantially fewer students reported that they would reach out to faculty members (Continuing-Generation: 39%; First-Generation: 42%). Utilization of academic advisors was lowest overall, and here a statistically significant group difference emerged. Only 4% of First-Generation students reported that they would seek support from an academic advisor, compared to 15% of Continuing-Generation students ($p = .05$). This pattern suggests that formal advising structures may be particularly underutilized by First-Generation students during moments of academic challenge.

Although most help-seeking behaviors were comparable across groups, a more pronounced disparity emerged in the use of family-based support. Only 11% of First-Generation Engineering Technology students reported that they would talk with a parent, sibling, or other family member when experiencing academic difficulty, compared to 26% of Continuing-Generation students, representing a statistically significant 15–percentage point gap ($p < .05$). Additionally, although not statistically significant, First-Generation students were more likely to report responding to academic challenges by increasing their study time rather than seeking support from others (First-Generation: 79%; Continuing-Generation: 64%). This pattern may reflect a tendency among First-Generation students toward self-reliance when facing academic difficulty.

Students' perceptions of belonging and connection within the Engineering Technology major further contextualize these patterns. Respondents were asked to indicate their level of agreement with three statements related to belonging and climate: feeling comfortable being oneself, feeling valued by faculty and staff, and feeling like part of the Engineering Technology community. While differences between First-Generation and Continuing-Generation students were not statistically significant, First-Generation students reported higher levels of agreement across all three measures. Notably, 73% of First-Generation respondents indicated that they felt like part of the Engineering Technology community, exceeding the rate reported by their Continuing-Generation peers by 12 percentage points. These findings suggest that, despite entering with lower exposure to advanced coursework and reporting less family-based support, First-Generation students experience a strong sense of connection within their academic community.

To further examine how these perceptions of community and connection develop, the final phase of this project will explore students' experiences through individual interviews. These interviews are designed to illuminate the nuanced ways in which community is formed within Engineering Technology programs, as well as the institutional and interpersonal factors that support or hinder students' sense of belonging.

Looking beyond academic experiences, both First-Generation and Continuing-Generation students reported clear post-graduation intentions. The majority of respondents in both groups indicated plans to pursue careers in the engineering industry (First-Generation: 87%; Continuing-Generation: 82%), while approximately one-fifth expressed interest in graduate education. Only a small proportion of students in either group reported uncertainty about their post-graduation plans, suggesting a high level of career clarity across both populations.

Students also rated the quality of their interactions with faculty, peers, and student organizations as overwhelmingly positive or somewhat positive, with no statistically significant differences between groups. However, more nuanced differences emerged when examining the nature of these relationships. Faculty were most frequently identified by both groups as individuals who challenged students to perform at their personal best, whereas academic advisors were more likely to check on academic progress. Peers, while less frequently described as challengers or monitors of progress, played an important role in encouragement, with more than 40% of respondents indicating that peers within the Engineering Technology program supported their academic success.

Table 1.

General Support Offered by Parents and Family Members

Support Offered	Student Type	%	p
Challenges me to do my personal best	First-Generation	38%	0.09
	Continuing-Generation	52%	
Checks on my progress	First-Generation	42%	0.05
	Continuing-Generation	58%	
Encourages me about my studies	First-Generation	49%	0.11
	Continuing-Generation	62%	

Note. First-Generation Engineering Technology were significantly less likely to indicate that a parent or other family member checked on their academic progress compared to their Continuing-Generation peers in the major (p= 0.05)

Consistent with earlier findings, significant gaps emerged in parental and family engagement. First-Generation students were significantly less likely than Continuing-Generation students to report that parents or family members checked on their academic progress, provided guidance related to course selection, or facilitated access to networking opportunities. Similar disparities appeared in conversations related to health and well-being. Although peers within the major were most likely to notice and inquire about students' stress and health, First-Generation students reported significantly lower levels of health-related check-ins from parents or family members ($p < .05$).

Table 2.

Academic Setback Support by Parents and/or Family Members

Topics Discussed	Student Type	%	p
Discusses school & academic career decisions	First-Generation	47%	0.09
	Continuing-Generation	60%	
Helps me with course selection	First-Generation	4%	0.01
	Continuing-Generation	20%	
Suggests networking opportunities	First-Generation	11%	<0.01
	Continuing-Generation	31%	
Supports me with other resources	First-Generation	49%	0.51
	Continuing-Generation	54%	

Note. First-Generation Engineering Technology students were significantly less likely than their Continuing-Generation peers to report discussing academic disappointments with their parents or family members ($p < 0.05$).

Table 3.

Health Support Offered by Parents and Family Members

Discussions Raised	Student Type	%	p
Your mental or emotional health?	First-Generation	42%	0.24
	Continuing-Generation	52%	
Your physical health?	First-Generation	30%	0.01
	Continuing-Generation	51%	
Asked about your levels of stress?	First-Generation	34%	0.01
	Continuing-Generation	55%	

Note. First-Generation students report significantly lower levels of health-related check-ins from parents or family members compared to their Continuing-Generation peers ($p < 0.05$)

These differences persisted when students reflected on responses to academic setbacks. First-Generation students were significantly less likely to discuss disappointments with parents or family members or to report that family members asked how their classes were going. In contrast, Continuing-Generation students were more likely to report receiving encouragement from family during periods of academic struggle. For First-Generation students, support during these moments came primarily from faculty and peers within the major, with academic advisors again playing a limited role.

Table 4.

Academic & Career-Specific Supports by Parents and/or Family Members

Support Offered	Student Type	%	p
Disappointments you've had?	First-Generation	17%	<0.01
	Continuing-Generation	39%	
Difficulties you've faced?	First-Generation	47%	0.45
	Continuing-Generation	53%	
Asked how classes were going?	First-Generation	55%	<0.01
	Continuing-Generation	77%	
Encouraged you to keep going when you struggled?	First-Generation	42%	0.02
	Continuing-Generation	62%	

Note. Compared to their Continuing-Generation peers, First-Generation Engineering Technology students were significantly less likely to report receiving family-based guidance related to course selection or access to networking opportunities ($p < 0.05$).

Patterns of career-related support mirrored these findings. Students in both groups primarily discussed career and professional goals with faculty and peers within their major, while academic advisors were infrequently consulted for career guidance. Additionally, a significant gap emerged in family engagement around career exploration. Only 18% of First-Generation students reported discussing family members' professional work, exploring career pathways, or being introduced to professionals in the field, compared to 30% of Continuing-Generation students ($p < .05$).

Table 5.

Career Support Offered by Parents and/or Family Members

Topics Discussed	Student Type	%	p
Talked to you about their own work as professionals in their field	First-Generation	21%	0.09
	Continuing-Generation	29%	
Gave you information about the type of work that professionals in your field do	First-Generation	17%	0.01
	Continuing-Generation	30%	
Talked to you about career options with your major	First-Generation	23%	<0.01
	Continuing-Generation	41%	
Introduced you to people in their professional network	First-Generation	15%	0.51
	Continuing-Generation	24%	

Note. First-Generation Engineering Technology students were significantly less likely than their Continuing-Generation peers to report discussing academic disappointments with their parents or family members ($p < 0.05$).

Despite these disparities in family-based academic and career support, First-Generation students reported strong perceptions of professional recognition. Over three-quarters of First-Generation students indicated that their parents saw them as engineers (76%), a figure that increased to 84% for faculty perception. Most notably, First-Generation students were significantly more likely than their Continuing-Generation peers to report that fellow students saw them as engineers (89%; $p < .01$). While Continuing-Generation students were more likely to report affirmation from parents and faculty, these findings underscore the central role of peer recognition in shaping First-Generation students' professional identity.

Table 6.

Seen as an Engineer

	Student Type	%	p
My parents see me as an engineer.	First-Generation	76%	< 0.001
	Continuing-Generation	96%	
My instructors see me as an engineer.	First-Generation	84%	< 0.001
	Continuing-Generation	92%	
My peers see me as an engineer.	First-Generation	89%	< 0.01
	Continuing-Generation	86%	

Note. First-Generation students experience significant gaps in parental and faculty recognition of their engineering identity compared to Continuing-Generation students, even as they report higher peer affirmation within their major ($p < 0.001$).

Finally, when examining self-perceptions of competence and academic ability, First-Generation students again demonstrated notable strengths. Across multiple measures: confidence applying engineering concepts, belief in performing well on exams, resilience following academic setbacks, and being perceived by others as a source of help, First-Generation students reported slightly higher levels of agreement than their Continuing-Generation peers. Although these differences were not statistically significant, the consistency of this pattern is striking. Even in the context of lower family-based support and weaker perceptions of faculty recognition, First-Generation Engineering Technology students expressed strong confidence in their abilities. This pattern suggests a form of academic resilience that may play a critical role in their persistence and success. Understanding the origins and mechanisms of this resilience will be the focus of the final qualitative phase of this inquiry.

Discussion

This study examined differences in academic preparation, confidence, help-seeking behaviors, perceptions of belonging, social capital, and engineering identity between First-Generation and Continuing-Generation Engineering Technology students. Collectively, the findings complicate deficit-oriented narratives of First-Generation students by revealing a pattern of resilience, strong peer-supported identity development, and sustained confidence despite gaps in pre-college preparation and family-based support.

Consistent with prior research on First-Generation students in STEM, FG ET students reported lower exposure to certain advanced mathematics and science coursework prior to college, particularly advanced geometry and physics [4]. These gaps are noteworthy given the applied and technical foundations of Engineering Technology curricula and may influence early academic experiences. However, these preparation differences did not translate into lower confidence or diminished sense of belonging. In fact, FG students entered their programs with confidence levels comparable to or slightly higher than those of CG peers, and this confidence was maintained over time. This finding challenges assumptions that lower pre-college preparation necessarily leads to lower self-efficacy and suggests that FG students may draw on alternative forms of capital or prior experiences to support their academic persistence.

Patterns of help-seeking behavior further illuminate how FG students navigate Engineering Technology programs. Across both groups, peers emerged as the primary source of academic support, underscoring the central role of peer networks in ET student success. However, FG students were significantly less likely to seek support from academic advisors or family members when encountering academic challenges. This reduced utilization of formal advising structures and family-based support aligns with social capital theory, which suggests that First-Generation students often have less access to institutionalized and familial forms of capital relevant to navigating higher education. Instead, FG students appeared more likely to respond to academic difficulty through self-efficacy [23] and self-reliance, such as increasing study time [6].

Despite these disparities in access to family-based academic and career support, FG students reported a strong sense of belonging within their ET programs. Across all measures of belonging and climate, FG students reported equal or higher levels of agreement than their CG peers. This sense of connection may be attributed to the applied, collaborative, and cohort-based nature of many Engineering Technology programs, which may foster inclusive peer communities. Importantly, FG students were significantly more likely to report that their peers viewed them as engineers, even as they reported lower levels of recognition from parents and faculty. This finding highlights peer recognition as a critical mechanism for engineering identity development among FG ET students and aligns with prior work emphasizing recognition as a core component of identity formation.

The patterns observed in family-based support further contextualize these findings. FG students were significantly less likely to report that parents or family members checked on their academic progress, assisted with course selection, facilitated networking opportunities, or engaged in conversations about health, stress, and academic setbacks. These gaps persisted across academic and career domains, reinforcing the notion that FG students navigate their educational pathways with fewer familial resources tied specifically to higher education and engineering careers. Yet, despite these limitations, FG students consistently reported strong self-perceptions of competence, resilience following setbacks, and confidence in applying engineering concepts. This consistency suggests that FG ET students may develop adaptive strategies and internalized resilience that support persistence in the absence of traditional forms of social capital.

Taken together, these findings suggest that Engineering Technology programs may provide an environment in which First-Generation students can thrive through peer-supported identity development and strong community connection, even when other supports are less accessible. At the same time, the underutilization of advising structures and limited family engagement points to opportunities for targeted institutional interventions.

Conclusion

This study contributes to the limited body of research focused specifically on Engineering Technology students by examining how generational status shapes academic preparation, identity development, social capital utilization, and persistence-related experiences. The findings demonstrate that First-Generation Engineering Technology students are not defined by academic deficits but rather by resilience, sustained confidence, and strong peer-based engineering identities.

While First-Generation students reported lower exposure to certain advanced pre-college coursework and reduced access to family-based academic and career support, they experienced a strong sense of belonging within their programs and high levels of peer recognition as engineers. These factors appear to play a critical role in supporting confidence and persistence. The results suggest that peer networks and program-level community structures are particularly influential sources of social capital for First-Generation students in Engineering Technology.

From a practical perspective, these findings highlight the importance of strengthening advising visibility, clarifying the role of academic advisors, and intentionally connecting First-Generation students to institutional resources early in their academic careers. Additionally, faculty and administrators should recognize the central role of peer affirmation in engineering identity development and consider programmatic strategies that support collaborative learning, mentoring, and cohort-building within Engineering Technology programs.

More broadly, this work underscores the need to include Engineering Technology pathways more fully in engineering education research. By centering the experiences of First-Generation students, this study advances an asset-based understanding of persistence and success in Engineering Technology and provides empirical evidence to inform inclusive practices that support diverse student pathways across engineering education.

Current Progress

We are currently in the process of qualitative data collection and analysis. This data will be presented in future papers, outlining the entirety of the project and the conclusions found.

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References

[1] G. Dietz and J. Bullington-Miller, "WIP: Exploring First Generation Engineering Technology Students Acquisition of the Engineering Identity," in *2024 ASEE Annual Conference & Exposition Proceedings*, Portland, Oregon: ASEE Conferences, Jun. 2024, p. 48303. doi: 10.18260/1-2--48303.

[2] D. G. Dietz and J. C. Bullington-Miller, "WIP: Exploring First Generation Engineering Technology Students Acquisition of the Engineering Identity- Phase 1," 2025.

[3] A. Katrevich and M. S. Aruguete, "Recognizing Challenges and Predicting Success in First-Generation University Students," vol. 18, no. 2.

[4] G. Bettencourt, C. A. Manly, E. Kimball, and R. S. Wells, "STEM Degree Completion and First-Generation College Students: A Cumulative Disadvantage Approach to the Outcomes Gap," *Review of Higher Education*, vol. 43, no. 3, pp. 753–779, 2020, doi: 10.1353/rhe.2020.0006.

[5] M. J. Stebleton, K. M. Soria, and R. L. Huesman, "First-generation students' sense of belonging, mental health, and use of counseling services at public research universities," *Journal of College Counseling*, vol. 17, no. 1, pp. 6–20, Apr. 2014, doi: 10.1002/j.2161-1882.2014.00044.x.

[6] L. L. Burnett, "Characteristics Associated with Persistence and Retention among First-Generation College Students Majoring in Science, Technology, Engineering, or Math," Ed.D., The University of Alabama, United States -- Alabama, 2017. Accessed: Feb. 08, 2024. [Online]. Available: https://www.proquest.com/docview/2018294199/abstract/4FFA34BC424B88PQ/1

[7] M. E. Thompson, "Grade Expectations: The Role of First-Year Grades in Predicting the Pursuit of STEM Majors for First- and Continuing-Generation Students," *The Journal of Higher Education*, vol. 92, no. 6, pp. 961–985, Sep. 2021, doi: 10.1080/00221546.2021.1907169.

[8] K. A. Allen, M. L. Kern, D. Vella-Brodrick, L. Waters, and J. Hattie, "What schools need to know about belonging: A meta-analysis," *Educational Psychology Review*, vol. 30, no. 1, pp. 1–34, 2018, doi: 10.1007/s10648-016-9389-8.

[9] P. O. Garriott, R. L. Navarro, and L. Y. Flores, "First-Generation College Students' Persistence Intentions in Engineering Majors," *Journal of Career Assessment*, vol. 25, no. 1, pp. 93–106, Feb. 2017, doi: 10.1177/1069072716657533.

[10] M. Ahmed, T. J. Muldoon, and M. Elsaadany, "Employing Faculty, Peer Mentoring, and Coaching to Increase the Self-Confidence and Belongingness of First-Generation College Students in Biomedical Engineering," *Journal of Biomechanical Engineering*, vol. 143, no. 121001, Sep. 2021, doi: 10.1115/1.4051844.

[11] E. Liptow, K. Chen, R. Parent, J. Duerr, and D. Henson, "A Sense of Belonging: Creating a Community for First-generation, Underrepresented groups and Minorities through an Engineering Student Success Course," in *Paper presented at the ASEE Annual Conference & Exposition Proceedings*, New Orleans, Louisiana: ASEE Conferences, Jun. 2016, p. 26439. doi: 10.18260/p.26439.

[12] J. M. Smith and J. C. Lucena, "Invisible innovators: how low-income, first-generation students use their funds of knowledge to belong in engineering," *Engineering Studies*, vol. 8, no. 1, pp. 1–26, Jan. 2016, doi: 10.1080/19378629.2016.1155593.

[13] A. Godwin, "The Development of a Measure of Engineering Identity," *ASEE Annual Conference & Exposition*, Jan. 2016, doi: 10.18260/p.26122.
[14] A. Godwin and W. Lee, "A Cross-sectional Study of Engineering Identity During Undergraduate Education," in *2017 ASEE Annual Conference & Exposition Proceedings*, Columbus, Ohio: ASEE Conferences, Jun. 2017. doi: 10.18260/1-2--27460.
[15] L. N. Fleming, K. C. Smith, D. G. Williams, and L. B. Bliss, "Engineering identity of Black and Hispanic undergraduates: The impact of minority serving institutions," in *ASEE Annual Conference & Exposition*, 2013.
[16] K. L. Tonso, "Teams that Work: Campus Culture, Engineer Identity, and Social Interactions," *Journal of Engineering Education*, vol. 95, no. 1, pp. 25–37, 2006, doi: 10.1002/j.2168-9830.2006.tb00875.x.
[17] D. Verdin and A. Godwin, "Exploring Latina First-Generation College Students' Multiple Identities, Self-Efficacy, and Institutional Integration to Inform Achievement in Engineering," *Journal of Women and Minorities in Science and Engineering*, vol. 24, Jan. 2018, doi: 10.1615/JWomenMinorScienEng.2018018667.
[18] P. Bourdieu, "The Force of Law: Toward a Sociology of the Juridical Field Essay," *Hastings L.J.*, vol. 38, no. 5, pp. 805–813, 1987 1986.
[19] Lin, Fu, and Hsung, "The Position Generator: Measurement Techniques for Investigations of Social Capital," 2001.
[20] J. Skvoretz *et al.*, "Pursuing an engineering major: social capital of women and underrepresented minorities," *Studies in Higher Education*, vol. 45, no. 3, pp. 592–607, Mar. 2020, doi: 10.1080/03075079.2019.1609923.
[21] J. Martin, "The Invisible Hand of Social Capital: Narratives of First Generation College Students in Engineering," *International Journal of Engineering Education*, vol. 31, Sep. 2015.
[22] J. P. Martin, D. R. Simmons, and M. K. Miller, "Exploring the theoretical social capital 'deficit' of first-generation college students: Implications for engineering education," *International Journal of Engineering Education*, vol. 3, no. 4, pp. 822–836, 2014.
[23] J. M. Dennis, J. S. Phinney, and L. I. Chuateco, "The Role of Motivation, Parental Support, and Peer Support in the Academic Success of Ethnic Minority First-Generation College Students," *Journal of College Student Development*, vol. 46, no. 3, pp. 223–236, 2005.