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Redefining first-year engineering education through the lens of belonging and peer leadership

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Abstract

This Complete Research paper describes efforts to support students entering an undergraduate electrical and computer engineering (ECE) program from diversified matriculation pathways through a peer mentoring program embedded in the first-year curriculum. The myriad entry points to this specific engineering program (changes in major, transfers, career changes, stop-outs, etc.) punctuate that *first-year-in-engineering* may not be synonymous with *first-time-in-college*. As enrollment patterns continue to change across higher education, it is imperative that engineering programs are prepared to support students and the variety experiences and needs they bring to the classroom. In this work, we investigate the ways that peer mentorship affects sense of belonging and discipline identity for students from varied matriculation points.

Introduction

As higher education institutions foster increasingly diverse undergraduate populations, it is imperative that student success initiatives purposefully develop students' sense of belonging within an institution, a campus, a peer community, and an academic discipline. Belonging is a critical dimension of student success affecting a student's degree of academic adjustment, persistence, and post-graduate aspirations, while also contributing to institutional benchmarks like retention and degree completion [1]. Additionally, the decline in the number of traditional-age college students after 2025, a result of the ever-looming post-Great Recession "birth dearth," calls on higher education to reconsider what "first-year" belongingness within college contexts means as enrollment strategies expand to include non-traditional adult learners and the focus shifts from recruiting new students to supporting current students [2].

The student belonging imperative only intensifies as science, technology, engineering, and math (STEM) programs come to value the necessity of recruiting faculty and students from a wide array of backgrounds and perspectives to adequately solve the technological and social issues of a modern society. For students of color and women, sense of belonging, or lack thereof, is a prevailing contributor to STEM interest and academic outcomes in environments where individuals are likely to feel marginalized, unsupported, or unfamiliar [1, Ch. 3], [3]. First-year engineering programs must be reimagined into malleable interventions that can meet the needs of a diversifying student body and adapt to shifting enrollment patterns. Centering sense of belonging within the priorities of *first-year-in-engineering* interventions is key.

Recognizing the importance of cultivating student belonging, the School of Electrical and Computer Engineering (ECE) at Georgia Tech employs a multifaceted approach to develop discipline identity and improve the undergraduate program culture by strengthening opportunities for student engagement, supporting student well-being, and building student agency in their own academic planning and degree pathways. *ECE Discovery Studio*, a required one-credit hour discipline-specific extended orientation course, is central to the School's holistic approach to student success in the absence of an institute-level general first-year engineering program. All undergraduate electrical engineering (EE) and computer engineering (CmpE)

majors are required to take *ECE Discovery Studio*, ideally within the first academic year entering the program regardless of matriculation pathway, which may be true first-year students, transfers from another university, non-traditional students returning from a stop-out, change-of-majors, career changers, and dual-degree engineering students.

Given the diversity of entry points to ECE's undergraduate program and sizeable enrollment ranging from 150 to 225 students per semester, the *ECE Discovery Studio* program relies heavily on the utilization of Peer Leaders (PLs), a cohort of 15 to 20 upper-level EE and CmpE students selected to a stipend-eligible academic-year-long fellowship. The Peer Leader Fellowship (PLF) is facilitated in parallel to *ECE Discovery Studio* with the goal of providing easily accessible mentorship from students who have gone through similar experiences and have common academic interests within the expansive ECE curriculum. Each PL is assigned a mentee group of 10 to 15 *ECE Discovery Studio* students and the course is designed to promote networking among small groups through interactive studio activities, peer reviews, team projects, and individualized assignment feedback. Throughout the semester, PLs engage in a Peer Leader Practicum, also led by *ECE Discovery Studio* instructors, to prepare for upcoming studios, normalize grading procedures, and develop mentorship strategies. The practicum also provides a vitally important space for instructors to learn about the successes and struggles of ECE students through PL insights and develop individualized interventions for at-risk or off-course students.

If *ECE Discovery Studio* is the hub of the School's student success initiatives, Peer Leaders are the interconnected spokes that form a bridge to incoming students. To this end, this study is motivated by the following inquiry: *How does peer mentorship contribute to a sense of belonging within a discipline and an institution for first-year engineering students?*

Background

A Brief Origin Story of ECE Discovery Studio

In Fall 2021, the School of Electrical and Computer Engineering launched a reconfigured undergraduate curriculum after several years of development— an intensive process that involved a student needs assessment, a review of best practices in engineering curriculum design, collecting industry insights, an external accreditation review, and an inventory of the field's technical interest areas (TIAs) and courses [4]. Electrical and computer engineering are broad disciplines with seemingly endless career paths, and the School's undergraduate curriculum mirrored this expansiveness. While this breadth presented opportunities for interdisciplinary collaboration and ample job prospects, students found it challenging to draw connections between coursework and career trajectories, discern the fundamental differences between EE and CmpE, and effectively combine upper-level courses to develop a focused engineering skillset.

The School designed and adopted a threaded curriculum [5] that established easily navigable curricular pathways, of which students pick two concentrations to complete their EE or CmpE degree. Each thread, organized into coherent themes informed by TIAs and industry feedback, provides students with a menu of within-major upper-level electives beyond a subset of required core classes [6]. The curriculum offers five unique EE threads, three unique CmpE threads, three shared EE/CmpE threads, and three CmpE threads that are offered in collaboration with Georgia

Tech's College of Computing for both Computer Science (CS) and CmpE majors. Figure 1 depicts the thread organization across degree options. The School's highly customizable undergraduate curriculum now boasts 29 thread combinations for EE majors and 21 thread combinations for CmpE majors.

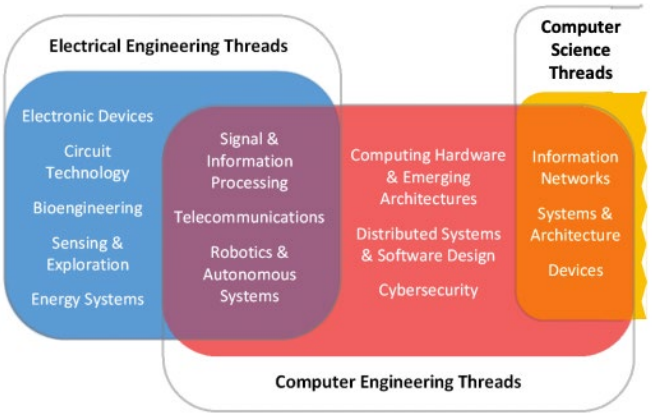

Fig. I Electrical Engineering Threads, Computer Engineering Threads, and Computer Science Threads [6]

ECE Discovery Studio originated during the curriculum redesign to address three compounding student needs; (1) the new threaded curriculum afforded students incredible flexibility to design their own degree, but they might not have the discipline foundation and academic planning skills to navigate the curricular choices available [7], (2) students would need to explore the broader fields of real-world electrical and computer engineering to building an understanding of their relevant career options [7], and (3) student feedback revealed a need and desire for professional communication instruction earlier than the existing junior-level communication requirement [4]. The resulting course is a unique fusion of career development, academic planning, professional communications, extended campus orientation, and engineering design [7].

ECE Discovery Studio was piloted during 2020-2021 academic year, a year ahead of the official threaded curriculum launch. Amid the backdrop of the global pandemic, the course pilot was restricted to an online-hybrid mode delivery during the first two semesters, Fall 2020 and Spring 2021. Even though *ECE Discovery Studio* underwent drastic adaptations from the originally conceptualized in-person design, a course evaluation was conducted during first semester of implementation as is standard procedure for new courses in ECE.

During the 2021-2022 academic year, as *ECE Discovery Studio* was delivered in-person as intended, course instructors also calibrated the course design in response to areas-of-improvement identified in the pilot-semester evaluation. While the unintended remote pilot-year presenting major setbacks for the imbedded peer mentorship model, it also ultimately informed the permanent use of several virtual or asynchronous studio activities that provided richer interactions between PLs and their small groups [7]. Additionally, a Peer Leader Handbook was developed as a complement to the Peer Leader Practicum to provide readings on peer mentorship, grading rubrics, small group discussion prompts, and workshop facilitation guides.

In its third year of implementation, the 2022-2023 academic year, Georgia Tech exceeded its planned first-year enrollment growth raising *ECE Discovery Studio's* roster to more than 225

students. To contend with increased capacity, the PL program was reconfigured as an undergraduate fellowship offering additional leadership training and a semesterly stipend in exchange for an academic-year commitment, rather than a single semester. PL applicants were incentivized by the fellowship model and course instructors have less turnover to contend with between the fall and spring semesters.

In Support of Peer Leadership

It is imperative that undergraduate engineering programs incorporate person-centered strategies that acknowledge differences in students' basic needs to improve the quality of learning for all [8]. ECE operationalizes a view of student success holistically in terms of student agency in their degree decision, self-perceived ability to persist, and satisfaction in the college experience, which can be attributed to a sense of belonging [9]. Tinto's theory of student departure and Astin's theory of student involvement are two of the most widely used theories in higher education research on student outcomes. Tinto's theory of student departure [10], [11] is a multidimensional approach to understanding longitudinal student persistence, while Astin's involvement theory [12] posits that active involvement in various academic and social activities positively influence students' learning and development.

ECE set out to create opportunities to encourage student involvement academically, professionally, and socially. In highly competitive contexts, peers are often portrayed as opponents or sources of negative "peer pressure" [13]. More often, however, peers are sources of positive social influence, particularly in college contexts where peer role models have been found to propel inexperienced students to higher levels of academic performance and personal development [14]. *Mentored* students are not the only benefactors of positive outcomes associated with peer leadership; the power of peer leadership has been found to promote career success and student learning for the mentor and contribute to positive change in the university where the program takes place [13]. Recognizing the great potential of peer leadership as the School envisioned a rich, comprehensive undergraduate experience, *ECE Discovery Studio* presented the perfect avenue to incorporate peer networking that did not require students to opt in and was rather incorporated structurally into a required curricular component.

Theoretical Framework

To understand the contribution of peer mentorship on first-year engineering students' belongingness, we draw on scholarship on social capital theory, belongingness, and engineering role identity. These theories shaped our data collection and analysis procedures.

Social capital describes the resources that are cultivated or made available through social networks. Following other scholarship in engineering education research on social capital [15] we focus on social capital at the individual level [16]. Each student brings with them a social network to their undergraduate studies, although the extent to which that network is equipped to support them through their engineering studies might be variable [17]. Lin distinguishes between the availability, accessibility, and activation of resources in a social network [17]. The goal of the *ECE Discovery Studio* peer leadership program is to inject a source of social capital into students' network that is both available (i.e., the resource exists) and accessible (i.e., the student

feels they can operationalize the resource). Peers are particularly valuable because fellow students are more approachable and less threatening [18], making peers a more accessible form of support.

In this project, we seek to understand the activation of social capital from peer leaders, or the extent to which students use the new addition of their peer leader to their social network to help meet their goals. To that end, we collaboratively developed a list of five ways in which students might use their peer leaders: (1) help completing *ECE Discovery Studio* assignments, (2) help building community at Georgia Tech, (3) help finding opportunities at Georgia Tech, (4) help navigating difficult situations, and (5) learning from someone with similar experiences. This list was incorporated into our quantitative and qualitative data collections to understand the extent to which students use these (or other) forms of resources.

We specified belonging into three domains: belonging to engineering, belonging to the university, and belonging in the *ECE Discovery Studio* classroom. Belonging to engineering refers to students' connection to a generalized engineering discipline and is linked connected to students' engineering identity [19], [20]. University belongingness offers interesting insights for transfer, dual-degree, and non-traditional students because these students may have additional or conflicting sources of belongingness to other programs. Both disciplinary and campus belongingness have been powerful tools to understand student retention in engineering [21], [22]. To complement this scholarship, we wanted to understand how students described their belongingness within *ECE Discovery Studio*. We adapted survey items from [23] to fit the classroom-specific focus.

Engineering role identity is the extent to which a student describes themselves as taking on the role of an engineer (whatever the student understands that role to be). Engineering role identity has three components: interest, performance/competence, and recognition [20], [24]. Together, these components suggest that a student is more likely to see themselves as an engineer when they are interested in what they are learning, when they feel like they are competent at engineering, and when they feel like others also see them as an engineer [25]. Engineering identity is tied to belongingness in engineering, and so the theory offers an important perspective in understanding the experiences of students in *ECE Discovery Studio* as they interact with peer leaders.

The data collection and analysis methods described below from a mixed methods research study. Below, we detail the alignment between the theoretical concepts described in this section and the specific survey questions and focus group interview protocols used during data collection.

Methods

The overarching research question driving the investigation is, *"How does peer mentorship contribute to a sense of belonging within a discipline and an institution for first-year engineering students?"* To answer this question, a mixed methods investigation is underway using surveys and semi-structured focus groups from three student populations. Data was collected from February 2023 through May 2023. All plans were reviewed and approved by the appropriate Institutional Review Board (IRB).

Participants and Recruitment

Study participants were members of two distinct student populations: *ECE Discovery Studio* students enrolled during the Spring 2023 semester and Peer Leaders who were engaged in *ECE Discovery Studio* during the same semester. The distinct participant groups, coupled with varied data collection techniques, should yield data that is both rich enough and plentiful enough for triangulation of findings from both the mentee and mentor perspectives.

Participant recruitment occurred through email solicitation to either complete the survey (students) or express interest in joining a focus group (PLs). Current students and PLs were invited to participate in the study from a neutral member of the research team that is neither associated with *ECE Discovery Studio* nor management of the PL cohort. This strategy helped ensure that students did not feel pressured to participate or bias their responses.

Surveys

Current students were invited to participate in two surveys anonymously, conducted online using Qualtrics at the beginning and end of the semester. These surveys provided quantified measures of students' belongingness, engineering identity, and skills developed in *ECE Discovery Studio* course content and learning goals. The specific constructs and items are listed in the appendix. The use of two survey time points helped capture any potential attitude changes throughout the duration of the course. Students were not provided an incentive to complete the survey, so the survey was designed to be completed in two minutes or less. Because the surveys are anonymous, the last four digits of students' phone numbers were requested in the survey to link beginning- and end-of-semester responses of the same student.

Descriptive statistics were used to identify any trends in students' attitudes, as well as the most common types of peer leader support (both what students think they will want and what support was ultimately provided to them). As we discuss in the Results section, we received sufficient responses in Survey 1 to warrant analysis about statistical significance. The response rate in Survey 2 was lower, which also affected our ability to generate matched data across time points. The 11 cases of matched data are useful as a starting point to investigate the effects of a mentorship-intensive first-year engineering program, but the data are not well suited for generalizations.

Focus Group

To complement the student perspective, a focus groups was conducted with current PLs. The goal of the PL focus group was to address their role in helping *ECE Discovery Studio* students, motivations for becoming a peer mentor, prior challenges they face, and recommendations for future peer leader training. The focus group was recorded and transcribed. The focus group was conducted by members of the research team not currently associated with *ECE Discovery Studio* nor the PL program to avoid undue influence. The protocol is included in the appendix. Thematic qualitative analysis was employed to identify major findings that emerge related to peer mentorship strategies for supporting first-year engineering students.

Results

Survey 1

Survey 1 was distributed in February 2023, shortly after current students selected their Peer Leader for the semester in *ECE Discovery Studio*. The survey obtained 50 valid responses out of 164 registered students (30.5% response rate). Of those students, 35 (70%) were true first-year students, with 5 change of majors (10%), 1 dual degree student (2%), 2 students reentering college after time away (4%), and 6 transfer students (12%). True first-year students are slightly overrepresented in the sample compared to the course population, in which only 54% of students are currently in their first year of college.

Students were asked about the type of support they would like to receive from their peer leaders, with the ability to select more than one form of support. The most common type of support was, "Help finding opportunities at Georgia Tech," which was selected by 41 of the 50 students (82%). Table 1 presents a distribution of types of support between true first-year students and all other matriculation pathways. While the samples sizes are too small to support tests of statistical significance, initial findings suggest interesting avenues to pursue in the other forms of data collection. Specifically, fewer students from alternative matriculation pathways wanted to learn "from someone with similar experiences to me" compared to true-first year students. A greater proportion of students from alternative matriculation pathways indicated that they wanted "help navigating difficult situations."

An interesting trend in the data is differences within the construct of Belonging in *ECE Discovery Studio*. This construct consisted of three items measured on a five-point anchored numeric scale. Two of the survey items are "I feel comfortable in *ECE Discovery Studio*" (n = 48, mean = 3.85, SD = 0.922) and "I feel supported in *ECE Discovery Studio*" (n = 48, mean = 3.88, SD = 0.937). However, the third item, "I feel that I am similar to other ECE Discovery Studio students" (n = 48, mean = 3.23, SD = 1.242), had a significantly lower mean compared to the other two Belonging in *ECE Discovery Studio* items. The unpaired t-test value comparing the third item to the previous two questions is 0.0010 and 0.0013, respectively. Although group size prevented statistical inference, the mean for true first-year students was 3.5 (n = 35, SD = 1.02), while the mean for all other matriculation pathways was 2.57 (n = 15, SD = 1.5). Further, two students of the 50 skipped the Belonging in *ECE Discovery Studio* questions (and only those questions). These results point to the need for deeper qualitative investigations into how students interpret their experiences in a first-year engineering class.

TABLE 1
TYPES OF DESIRED SUPPORT BY MATRICULATION PATHWAYS

	Total (n = 50)	True First-Year Students (n = 35)	All other matric. Pathways (n = 15)
Help finding opportunities at Georgia Tech	41 (82%)	31 (89%)	10 (67%)
Learning from someone with similar experiences to me	36 (72%)	29 (83%)	7 (47%)
Help completing ECE Discovery Studio Assignments	23 (46%)	16 (46%)	7 (47%)
Help navigating difficult situations	20 (40%)	11 (31%)	9 (60%)
Help building a community at Georgia Tech	15 (30%)	11 (31%)	4 (27%)
Any other types of support (please list)	3 (6%)	3 (9%)	0 (0%)

Survey 2

In this section, we first discuss the aggregate responses to Survey 2 before addressing potential trends for students with matched data for both Survey 1 and Survey 2. Survey 2 had a lower response rate, with 23 valid responses out of 164 enrolled students (14%). This response rate was despite similar recruitment practices and may indicate students' limited bandwidth at the end of the semester. Of those students, 14 (61%) were true first-year students, with 2 change of majors (9%), 1 dual degree student (4%), 1 student reentering college after time away (4%), and 5 transfer students (22%).

Students were asked about the types of support that they received from their Peer Leaders, although this question was different from Survey 1 in that the question asked about actual experienced support versus the support students would like to receive. Table 2 presents the distribution for types of support, which maintains some distinction between true first-year students and all other matriculation pathways, although sample sizes are small. A major change between Survey 1 and Survey 2 was that no students reported that they experienced help navigating difficult situations, a support that 60% of alternative matriculation pathway students were interested in receiving. Although this finding may be indicate an opportunity to investigate the type of support that PLs are able to offer, we also recognize that, due to the phrasing of the question, this finding may be because students did not experience difficult situations that they needed assistance navigating.

TABLE 2
TYPES OF RECEIVED SUPPORT BY MATRICULATION PATHWAYS

	Total (n = 23)	True First-Year Students (n = 14)	All other matric. Pathways (n = 9)
Help finding opportunities at Georgia Tech	18 (78%)	13 (93%)	5 (55%)
Learning from someone with similar experiences to me	14 (61%)	10 (77%)	4 (44%)
Help completing ECE Discovery Studio Assignments	19 (82%)	13 (93%)	6 (67%)
Help navigating difficult situations	0 (0%)	0 (0%)	0 (0%)
Help building a community at Georgia Tech	6 (26%)	5 (36%)	1 (11%)
Any other types of support (please list)	1 (4%)	1 (7%)	0 (0%)

The trend regarding the statement "I feel that I am similar to other Discovery Studio students" was not as prevalent in Survey 2 compared to Survey 1. The mean for true first-year students was 3.69 (n = 14, SD = 1.11) and was 3.33 for all other matriculation pathways (n = 9, SD = 1.22). When combining all pathways, the average score for this item (mean = 3.55) was lower compared to the other two items addressing belonging in *ECE Discovery Studio* (4.18 and 4.09), although we did not conduct a statistical test due to low sample size. Compared to Survey 1, all scores related to belonging in *ECE Discovery Studio* increased in Survey 2.

Of the 11 instances of matched data, students either remained unchanged or increased in their rating related to the statement, "I feel comfortable at Georgia Tech" (Survey 1 mean = 4.09, Survey 2 mean = 4.60). Conversely, students either remained unchanged or decreased in their rating related to the statement "I am interested in learning more about engineering" (Survey 1 mean = 4.82, Survey 2 mean = 4.10). All other items had a mix of students with increased scores and students with decreased scores. The most variable option (i.e., had the highest standard deviation) was the item, "I feel like an engineer now."

Peer Leader Focus Group

Six current Peer Leaders participated in the focus group, representing a variety of matriculation pathways and tenure within ECE themselves including traditional first-year entries from diverse communities in- and out-of-state, transfer students from in- and out-of-state, and students at the end of ECE's five-year BS/MS program. Focus groups participants also represented varying degrees of longevity within the peer leader program from more than three semesters returning PLs to first semester PLs.

Overall, the PLs expressed a generally positive outlook on the peer leader program and the preparation provided through the practicum. The PLs expressed value for the newly developed *Peer Leader Handbook*, and they expressed that time spent in weekly team meetings was productive and time well-spent preparing for the upcoming session of *ECE Discovery Studio*. Microsoft Teams was confirmed as an effective medium for collaboration, remote meeting facilitation, asynchronous communication, and file sharing. Thematic analysis was performed by all three coders producing intercoder reliability across several emergent themes regarding PL training, motivations, and challenges. The following section integrates those themes into a holistic discussion about the findings.

Discussion

When unsupported holistically, students often do not reach their potential to succeed. To address the need for individualized support that cultivates belonginess and connectedness in a large academic program, peer leadership is an important component of *ECE Discovery Studio*. Preparing for the fourth academic year of implementation, *ECE Discovery Studio* and the PL Fellowship continue to evolve and adapt to the needs of the School and its increasingly diverse student body. Findings from this study, which are centered in the perspectives of students and their peer leaders, will deepen our understanding of the student experience in terms of the peer mentor relationship.

Shared student experiences, such as matriculation pathways, are a key dimension under investigation in the relationship between students and their PLs. In conversation with current PLs, several themes emerged to better understand the dynamics of peer mentorship with the School and shape the preparation delivered in the *Peer Leader Practicum*—these focal areas are PL empowerment, knowledge holder self-identity, differentiated mentorship, PLs as educational partners, and challenges of mentee engagement. Study findings will inform modifications to the training techniques employed in the *Peer Leader Practicum* and integration of PLs in *ECE Discovery Studio*. Recommendations for program improvements are outlined next and aligned to thematic findings.

Peer Leaders are Empowered

From their decision to apply for the fellowship, to week-to-week interactions with their small groups of mentees, the PLs are confident in their ability to make a positive impact on their peers. Interestingly, this is almost always referenced in the context of one-on-one interactions and relationships with their students, not at the school level or in discussions about their role driving student culture.

A downside to the confidence the PLs bring to their role is that they do not recognize the overlap of skills between "leadership" and "mentorship." Within their training, PLs found a great deal of value in reading scholarly work concerning *peer* leadership but did not recognize the connection to discussions and activities about their own leadership style and development. One quote from the focus group exemplifies the disconnect between mentorship and leadership:

> *"I was just gonna say, the only thing I did find interesting was there was one article on like, the power of peer mentorship, and I think it's… like, that's very motivating for, I think, us to read or like understand. Like, maybe at the start to understand, like, what the impact you could have in your role. It's very motivating and very, like, 'Okay, I understand like, what my role is and how it can help.'"*

The article referenced is a collection of excerpts from the book "Peer-to-Peer Leadership: Transforming Student Culture" by Aaron Thompson, Greg Metz, and Joseph B. Cuseo. Content sections summarized include *Why Peer Leadership Matters in the 21st Century*, *The Importance of Social Capital*, *The Power of Peer Leadership*, and *Positive Outcomes Associated with Peer Leadership*. In the content referenced as the most impactful reading of the practicum, leadership is undeniably linked to peer mentorship, yet the connection was missed in PL reflection. As the *Peer Leader Practicum* further develops, activities and discussions should reinforce the importance of leadership development within the practice of peer mentorship.

Peer Leaders Self-Identify as Knowledge Holders

Peer Leaders view themselves as keepers of knowledge about Georgia Tech and the School; they are compelled to help students navigate the abundant resource landscape on campus. Organizationally, Georgia Tech is a rather decentralized institution, which presents barriers to engagement with student services. Peer Leaders believe that they possess valuable knowledge,

and that they would be able to translate that knowledge to useful advice and guide their mentees to services. An added dimension of this knowledge holder identity is that Peer Leaders also see themselves as a conduit between unique mentee concerns and needs that only another student can meet.

Peer Leaders are Creating Differentiated Mentorship Approach

Within their identity as knowledge holders, PLs recognize and appreciate the diversity of experiences and matriculation pathways among ECE's students. PL's own matriculation experiences and challenges therein are a significant motivation compelling their peer mentorship. PLs possess an awareness that this diversity of experience must be reflected in their mentorship practice, and they express a degree of comfort differentiating their approach to meet student needs. It would be beneficial to incorporate best practices for differentiated mentoring into the skills developed within the PL cohort.

Peer Leaders See Themselves as Educational Partners

Many PLs return to the cohort for several semesters and have been engaged in *ECE Discovery* Studio since the inception of the course. Throughout course iteration, PLs have been a vital partner in gathering student input and providing feedback on the functionality of class activities. *ECE Discovery Studio* and the *Peer Leader Practicum* are therefore perceived to be in a dynamic interchange of sorts. PLs view *ECE Discovery Studio* as malleable or "under development." Any falter in their function as peer mentors is disassociated from their own leadership development or practicum shortcomings and is rather interpreted as an indicator of change needed within *ECE Discovery Studio*. As *ECE Discovery Studio* is well established, now entering its fourth academic year of implementation, it will be beneficial to incorporate reflection into the practice of PLs to bolster their success and effectiveness in their mentorship role. Reflective mentorship will further empower PLs to take ownership over their development rather than assuming any challenges of their position are due to the "newness" of the educational reform.

Much of the focus group was spent discussing the PLs perceptions of successes and shortcomings of *ECE Discovery Studio*, rather than their own experiences and training needs. Many of the PLs suggestions for changes to *ECE Discovery Studio* are linked to intentional pedagogical decisions or more the systemic issues of curricular complexity, enrollment management processes, and classroom reservation challenges on a space-restricted campus. As *ECE Discovery Studio* and the *Peer Leader Practicum* come to be recognized as an established curricular initiative, program directors will benefit from shifting the tone of educational partnership between PLs and course instructors from co-designers to school-insiders. Time should be spent during the practicum to discuss pedagogical decisions and organizational structures, especially as it pertains to fostering belonging across several entry points to the School. Additionally, if the PLs are perceiving the early evening class time as a barrier to student engagement, they should be empowered with information related to the challenges of classroom scheduling and encouraged to share this context with their students.

Peer Leaders are Challenged when Student Engagement Wanes

PLs are quite sensitive to the ebbs and flows of student engagement—both of individual mentees and whole-class trends (for example, studio sessions prior to campus holidays). PLs would benefit from specific training to recognize waning engagement as an early indicator of student crisis and preventative strategies to reengage mentees through effective peer-to-peer mentorship.

Conclusion

Survey 1 results suggest that students from alternative matriculation pathways may desire different forms of support from peer mentorship. Survey 1 results also suggest that first-year engineering students' sense of belonging in the classroom may be shaped by perceived similarity to the other students in their class – a factor that may be complicated for non-traditional students. These findings were also supported by Survey 2, with some interesting opportunities for future work related to students' expectations for support versus their received support, as well as changes in their attitudes and self-images related to engineering. The focus group findings suggest opportunities to assist Peer Leaders in developing differentiated mentorship approaches and reflect on their own development as leaders and mentors.

These findings will be help inform ongoing evidence-based improvements to the training provided in the *Peer Leader Practicum*. The outcomes of this Complete Research paper will also inform varied approaches to student support based off the specific needs of a particular point-of-entry to ECE. Improvements to *ECE Discovery Studio* and the Peer Leader Fellowship will be made thoughtfully with an evolving definition of *first-year-in-engineering* in mind to better support engineering students during their matriculation year. Findings may also have value to similar programs who are interested in supporting students through peer mentorship. Further work on this project will continue data collection and analysis to develop a full list of recommendations for engineering educators.

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Appendix

TABLE 2
SURVEY CODEBOOK

Question Category	Question	Scale	Source
Anonymous Linker		Write-in	Self-developed
Matriculation Pathway	What is your path to ECE (and ECE 1100)? • True first-year student • Transfer student • Dual degree student • Change of major • Switched to ECE threaded curriculum • Reentering college after time off All responses except "True first-year student" provided with write-in box to elaborate	Select one	Self-developed
Credits (Survey 1 only)	How many credits are you taking this semester at Georgia Tech?	Write-in	Self-developed
Belonging	We would like to know about how you feel that you fit in engineering and belong in your engineering community. Engineering • I feel comfortable in engineering • I feel like I belong in engineering • I enjoy being in engineering University • I feel comfortable on Georgia Tech's campus • I feel I am part of the Georgia Tech's community • I fit in with Georgia Tech students	1-5 anchored numeric scale (1 = not at all, 5 = very much so)	Adapted to fit context, from [23]

	ECE Discovery Studio • I feel comfortable in ECE Discovery Studio • I feel that I am similar to other ECE Discovery Studio students • I feel supported in ECE Discovery Studio		
Engineering Identity	To what extent to you agree or disagree with the following statements: • I feel like an engineer now • I will feel like an engineer in the future • I see myself as an engineer • My parents see me as an engineer • My instructors see me as an engineer • My peers see me as an engineer • I have had experiences where I was recognized as an engineer • I am interested in learning more about engineering • I enjoy learning engineering • I find fulfillment in doing engineering • I am confident that I can understand engineering in class • I am confident that I can understand engineering outside of class • I can do well on exams in engineering • I understand concepts that I have studied in engineering • Others ask me for help on engineering topics	1-5 anchored numeric scale (1 = strongly disagree, 5 = strongly agree)	From [20]
ECE Discovery Studio Skills	How confident do you feel about each of the following tasks? • Understand the electrical and computer engineering curriculum • Identify potential career pathways for myself • Develop a competitive resume • Obtain internship or co-op offers • Seek out opportunities at Georgia Tech	1-5 anchored numeric scale (1 = not at all confident, 5 = very confident)	Self-developed

	• Obtain a degree in electrical and computer engineering at Georgia Tech		
Peer Leader Resources	Survey 1: What do you want out of a peer mentor in ECE Discovery Studio? Survey 2: What support did your peer leader in ECE Discovery Studio provide? • Help completing ECE Discovery Studio Assignments • Help building a community at Georgia Tech • Help finding opportunities at Georgia Tech • Help navigating difficult situations • Learning from someone with similar experiences to me • Any other types of support (please list)	Select all that apply Write-in provided for "any other types of support"	Self-developed
Peer Leader Satisfaction (Survey 2 only)	How satisfied are you with your experiences with your peer leader in ECE 1100?	5 point Likert scale (Very Satisfied, Satisfied, Neutral, Dissatisfied, Very Dissatisfied)	Self-developed
Peer Leader Description (Survey 2 only)	Briefly, how would you describe your experience with your peer leader?	Write-in	Self-developed

TABLE 3
PEER LEADER FOCUS GROUP PROTOCOL

1. Prior Experiences
    a. "What brought you to study ECE at Georgia Tech?"
    b. "What do you remember about your time in ECE Discovery Studio, if you took it?"
    c. "What was your relationship with your peer mentor like?"
2. Reasons for being a peer leader
    a. "What were the major reasons that you joined the peer mentor fellowship?"
3. Experiences as a peer leader
    a. "How do you see your role in supporting new ECE students in ECE Discovery Studio?"
    b. "What are some of your effective mentoring practices?"
    c. "What are some challenges that you've faced as a peer leader?"
    d. "Do any of you have any victories or success stories you want to share?"
    e. "Were you surprised by anything as a peer leader?"
4. Training
    a. "What are some tips you would share to future peer leaders?"
    b. "Do you have any suggestions to improve the peer leader training?"
5. Final Thoughts
    a. "Is there anything else you want to share?"
    b. "Is there anything you were surprised I didn't ask about?"