Nonbinary Engineering Students' Access to Resources Through Cis* and Trans* Alters

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Introduction and Literature Review

This research paper examines how cisgender and trans* individuals mirror and witness nonbinary engineering students using a new framework developed from Lin's network theory of social capital and Devor's witnessing and mirroring framework. In this work, we use the term "nonbinary" to refer to any individual who does not identify within the gender binary (e.g., men and women). We utilize "trans*" as a blanket term for identities under the transgender umbrella (e.g., transgender, nonbinary, gender non-conforming, agender, genderfluid).

Nonbinary and trans* individuals have been forgotten and ignored in much of the discourse on diversity, equity, and inclusion in engineering. Nonbinary and trans* students are rarely even the focus of research centering on LGBTQ+ student experiences in larger fields such as STEM education and higher education studies. Their exclusion can be attributed, in part, to the lack of data collected in large national datasets [1], [2], [3]. For instance, the National Science Foundation (NSF) has received multiple open letters requesting that NSF collect nonbinary and transgender identities in their Survey of Earned Doctorates and NSF Center for Science and Engineering Statistics surveys [4], [5], [6]. But the release of the 2024 Survey of Earned Doctorates revealed they had not heeded these calls; it also omits sexual orientation altogether [7], [8]. Ignoring the presence of nonbinary individuals within one's data contributes to a dearth of knowledge on the types of supports that can improve the persistence and wellbeing of nonbinary students [9, p. 64]. It is vital that the engineering education research community be inclusive of nonbinary students, and collecting data is a crucial part of such inclusion.

Nonbinary students in STEM have some of the lowest retention rates of marginalized communities—in part due to cisnormative, heteronormative, hostile STEM environments. It is well established that engineering culture "values behaviors and orientations consistent with the male gender role" [10, p. 406] and centers the cisgender and heterosexual experience [11]. In addition to navigating their identities in cis-heteronormative and masculine society and engineering spaces [12], nonbinary students in higher education experience frequent gender-based discrimination [11], microaggressions [13], and even fear of victimization in hostile environments [14]. Frequent exposure to hostile environments can result in nonbinary students experiencing heightened levels of minority stress [15], [16], isolation [17], depression and anxiety [18]. Unsurprisingly, trans* and gender nonconforming students have 10% lower rates of retention than cisgender and heterosexual peers, while LGBQ students have 7% lower rates of retention than cisgender and heterosexual peers [19].

It is well established that support networks created for cisgender students promote their persistence and retention—however, recent work has found that these support networks provide a reduced benefit for nonbinary and trans* students [20]. Networks found to be valuable to cisgender students include student chapters of professional organizations and other co-curricular activities, which provide persistence support for cisgender students through skill development, sense of community, access to role models, and professional networking opportunities [21], [22].

However, studies of identity-based (e.g., oSTEM, National Society of Black Engineers) and professional organizations (e.g., IEEE) found that nonbinary and trans* students experienced less support overall than their cisgender peers, in part due to the perpetuation of cisnormativity and heteronormativity within the organizations and the limited number of nonbinary individuals with whom to network [20], [23].

In contrast, networks that consist of nonbinary and trans* individuals contribute to the persistence of nonbinary students. Feelings of safety to be oneself, community, and shared opportunities play a role in this contribution [17]. In their work on the social networks of LGBTQ+ STEM students, Hughes et al. [24] found that LGBTQ+ students in STEM were more likely to be out to their close social network who provided personal and academic support than those in their extended social network. Similarly, Campbell-Montalvo et al.'s [25] work on sexual and gender minoritized students social capital and fit in STEM found that sexual and gender minoritized students sought support from individuals who either shared their marginalized identities or had other marginalized identities (e.g., individuals of color, women). From these similar-identity networks, nonbinary students access community-based supports through identity-based professional societies (e.g., oSTEM, National Society of Black Engineers, Society of Hispanic Professional Engineers) and science chapters (e.g., the American Chemical Society), that reduce isolation and increase access to professional resources, academic resources, and leadership skills [20]. Nonbinary students' reliance on similar-identity networks for personal and academic support underscores the different roles of cisgender and trans* alters in fostering their academic success and wellbeing [24, 25].

The objective of this study is to explore the supports embedded in the gender-diverse social networks of nonbinary engineering students. Specifically, we ask the question, *how are nonbinary engineering students receiving supports from cisgender and transgender alters that witness and mirror them as nonbinary engineers*? We are interested in *who* supports nonbinary engineers in their academic careers and *how* these individuals provide support that is affirming to nonbinary individuals using a framework we developed for understanding nonbinary individuals' social supports based on two existing frameworks.

Conceptual Framework

We propose a conceptual framework for exploring the supporting roles of cisgender and trans* alters using Lin's network theory of social capital [26] and Devor's witnessing and mirroring framework [27]. Lin's theory provides a broad understanding of how individuals access social capital through their social network; however, the mechanics of support differ based on the intersectional identities of the individuals. If researchers only ask about traditional, cisheternormative support networks, they may get the impression that nonbinary engineers have small, support-poor social networks. Akin to Yosso's [28] model of community cultural wealth, Devor's framework provides perspective on how nonbinary engineers receive support from their unique social networks of cisgender allies and trans* peers. In our study, Devor's and Lin's work intersect to underpin the types of emotional and career-driving supports provided by cisgender and trans* alters within a nonbinary engineering student's social network (Fig. 1).

As defined by Lin's network theory of social capital [26], social capital is the resources embedded in one's relationships; in our case, the *ego,* a nonbinary engineering student, accesses resources from *alters* in their social network, who are the individuals within in the ego's network who provide access to support. Based on Lin's [26] theory, individuals derive social capital from three sources: structural positions, network locations, and purposes of action. Structural positions refer to the position of the alter and their ability to leverage their position to access resources, and network locations refer to the social network's characteristics (e.g., density, heterogeneity, quality). Purposes of actions can be categorized into two types of supports, expressive and instrumental. *Expressive* supports contribute to the ego's emotional, physical, and mental health and often come from strong ties (e.g., family and close friends). *Instrumental* supports are goal-attainment supports that aid the ego in progressing in their academic or professional pursuits and can come from both strong and weak ties (e.g., faculty and managers) [26]. For example, a faculty member who checks in with a nonbinary student about their wellbeing and writes letters of recommendation using the student's name and pronouns would be providing both expressive and instrumental supports.

Devor's [27] witnessing and mirroring framework is most commonly used in public health and sociology, but has recently been adopted in higher education. Recent work by Dolan [17, p. 19] has "weaved a theoretical tapestry" showing how Devor's work can be the "weft" that intersects with other frameworks to underpin nonbinary students' experiences. The witnessing and mirroring framework [27] can be useful for understanding identity-specific expressive and instrumental supports.

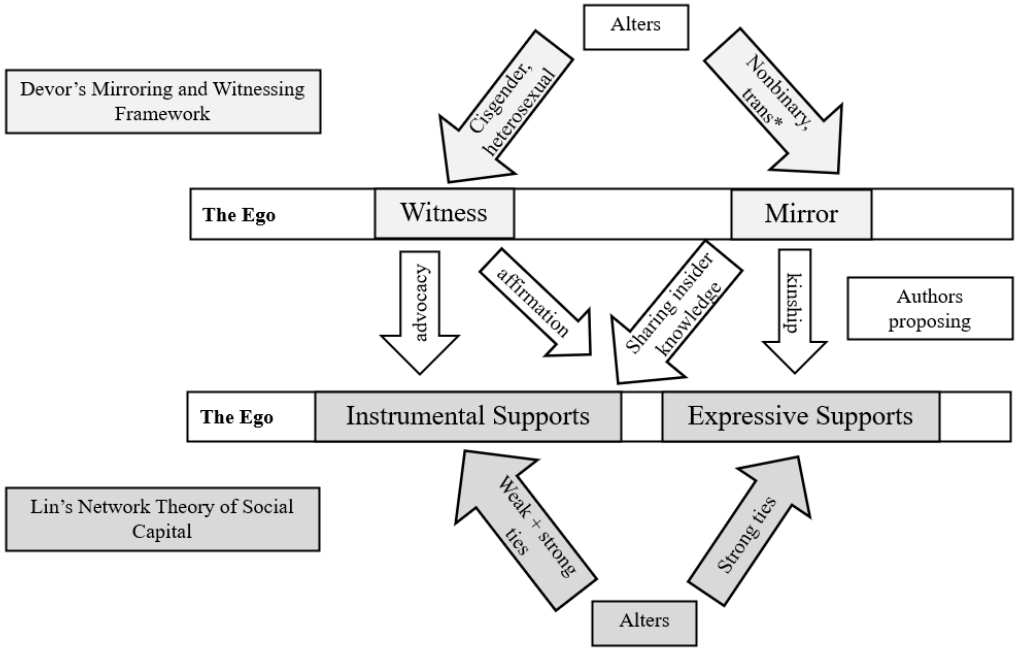

Fig. 1. Visualization of the authors' conceptual framework including Lin's network theory of social capital and Devor's witnessing and mirroring framework. Devor's contributions are in light gray, and Lin's contributions are in dark gray.

When a cisgender alter acknowledges a nonbinary engineering student as nonbinary, despite not sharing the experience of being nonbinary, they are *witnessing* that student for who they are. Cisgender alters can provide supports that specifically witness the student; for example, faculty can affirm of a nonbinary students' identity through correct pronouns and name and advocate for their identity on their behalf by encouraging others to do the same. Individuals can also purposefully fail to witness a student's identity, such as by refusing to use the correct pronouns or name; in this study we call such behavior "anti-witnessing."

When a nonbinary alter relates to and affirms a nonbinary engineering student over their shared identity, they are *mirroring* the nonbinary engineering student. Nonbinary alters can provide mirroring supports, such as emotional support rooted in nonbinary kinship or supporting their success through sharing insider knowledge related to being a nonbinary engineer. Much as alters can anti-witness, individuals can purposefully anti-mirror a nonbinary person's identity by assuming or inferring that they are a part of a community that they are not, or that they share identities they actually do not share. For example, a gender-based professional organization (e.g., women in engineering organization) may seek to include nonbinary individuals in their organization. While the intentions may be positive, nonbinary individuals may feel that being offered membership undermines their identity, although we did find an exception.

In essence, we utilize both Devor's and Lin's work to underpin the forms of instrumental and expressive supports that witness and mirror nonbinary engineering students from their social network with trans* and cisgender alters.

Method

A few notes about our nomenclature: Assigned gender at birth (AGAB) is utilized in the study to denote the birth gender of our participants, either assigned male or assigned female at birth (AMAB, AFAB), which do not represent their actual gender identities. Cis-heteronormativity is the expected normalcy of cisgender and heterogender roles, or cisgender norms (e.g., AFAB individuals wearing traditionally feminine clothing) [29]. Microaggressions are subtle behaviors and statements towards a targeted group, often unconsciously, that communicate hostility or derogatory beliefs [30].

Given the vulnerability required of participants in this study, we feel it is important to disclose our positionalities as researchers and how it influenced our research decisions. Both Adrian Gentry and Cole Thompson are nonbinary students completing doctoral degrees in engineering education from Purdue University. We both have backgrounds in engineering from large, research-intensive (R1) engineering-focused universities. Our interest in the social networks of nonbinary engineers stems from our own experiences as nonbinary engineers in hostile, unsupportive engineering environments.

Our lived experiences as nonbinary engineers have shaped our epistemologies and ontologies about nonbinary social networks, which have aided us in conceptualizing this study and discussing our findings. Our epistemologies, the way we understand and generate knowledge, have been influenced by our own experiences as nonbinary engineers. For example, our own experiences of *double consciousness*, the conflict between one's perception of themselves and

the marginalization inflicted by the dominant group, has prepared us to critically engage with our participants' double consciousness; in our study, participants experience double consciousness when navigating the world as how they know themselves to be nonbinary in a cisnormative society that actively anti-witnesses their identity [31]. Understanding nonbinary students' double consciousness enabled us to develop a conceptual framework for this study and identify themes inclusive of anti-witnessing and anti-mirroring experiences. Like participants in the study, we exist under the umbrella of nonbinary experience and share personal experiences of being nonbinary in engineering spaces. Our shared experience shapes what we can observe as researchers, both in our insider knowledge and how willing participants are to share their own experiences. We also strived to create an open environment where participants felt comfortable sharing the nuances of their gender identity and other personal identities (e.g., racial and neurodivergent) interweaved.

Kerrie Douglas and Julie Martin identify as cisgender female faculty in engineering education, and both are tenured at R1 institutions. As allies for our students who are members of the LGBTQ+ community, we encouraged the other authors to pursue their interest in this topic and provided instrumental support in the form of methodological and theoretical expertise during the research process and as critical friends in helping to edit this manuscript. Our motivation for this work is to support the student authors' success as researchers contributing to knowledge of this under-researched topic.

Participants and data collection

We recruited four nonbinary students from a larger study of engineering students' social capital and professional skills (Table I) to discuss their experiences of feeling supported or not supported as a nonbinary student. Participants selected pseudonyms which are used throughout.

Table I
Participant demographic information. [a, b]

Pseudonym	**Pronouns**	**Race / Ethnicity**	**AGAB**	**Description of Institution**
Elio	They/Them	Chinese	AFAB	Public, four-year research institution in the Southeastern US
Leon	He/They	Latino	AFAB	Public, four-year research institution in the Southeastern US
Zayn	They/Them	Latina	AFAB	Private, four-year, liberal arts institution on the US West Coast
Gwen Douglas	She/They	Hispanic	AFAB	Public, four-year, research institution in the Southern US

[a] All identities are self-identified.
[b] One participant self-identified as neurodivergent, and three of the four participants attended public four-year research institutions.

We conducted semi-structured interviews with the participants to discuss supports they received throughout their higher education experience from cisgender and trans* alters, as well as the impact of these supports on their persistence in engineering. The interview protocol was

developed by the first author in communication with experts in social capital research (examples in Table II). The first portion of the interview protocol focused on students' experiences being a nonbinary engineer and how they navigate their identity in engineering spaces. This portion of the interview elicited instances in which cisgender or trans* alters witnessed or mirrored nonbinary engineering students and the impact of this support on their mental health, academics, and career. The second portion of the interview protocol focused on the mirroring, witnessing, expressive, and instrumental supports available to the participant. We continued this portion of the interview with a name generator like that of Martin et al. [32] to elicit specific instances of supports that resonated with the participants. Follow-up questions to the initial name generator were used to determine the nuances of the interaction: how that person was connected to the participant, how their identity impacted the nature of support they were able to provide, and the lasting effect the interaction had on the participant.

Table II
Qualitative data collection alignment between topic and protocol

Topic	**Sample Questions**
Witnessing & mirroring	How have you been treated in educational and professional spaces? 1. How do cis/trans people treat you (differently) in these spaces? 2. What impact has the treatment had on you personally? On your career? When has your gender been highlighted or has stood out in your engineering major or work? Please tell me more about this. 3. What memories are most salient for you (regarding your gender being highlighted at work/school)? 4. How did you feel about that particular experience? 5. What was the result of that experience on you personally? On your career?
Name generator & critical incidents	I'd like you to think of someone who has supported you as a nonbinary person in your engineering major or career. Can you tell me about this person? Can you tell me about a specific time when they supported you? 1. When was a time that they affirmed you as a nonbinary person in engineering? How did their identity as a *cis/trans* person impact the way they supported you? 2. When was a specific time you felt like they *saw/affirmed you (cis)/resonated with you (trans)* as a nonbinary person?

Data analysis

A professional transcription service completed interview audio recordings. We then verified and cleaned the transcripts to remove any identifying information. The interview transcripts were then analyzed using *a priori* and emergent coding in Dedoose [33]. Adrian Gentry and Coleman Thompson coded two interviews collaboratively to calibrate and negotiate their codebook, then coded two interviews independently. Each author then coded and checked each other's work to support validity. A priori codes were based upon Lin's social capital and Devor's witnessing and mirroring frameworks. The a priori codes were witnessing, mirroring, expressive supports, and instrumental supports. We also performed limited negative case analysis through coding for

instances of anti-witnessing and anti-mirroring. Throughout the process, emergent coding was iterative, as we recoded interviews as new codes emerged and evolved. The coding structure is shown below in Table III.

Table III
Interview coding structure.

Primary Codes	**Witnessing**	**Anti-Witnessing**	**Mirroring**	**Anti-Mirroring**
Related Subcodes	Alter Position Alter Gender Type of Support	Alter	Alter Position Alter Gender Type of Support	Alter

Findings & Discussion

Professors and Faculty

Witnessing

One of the simplest and most common ways professors and faculty witnessed nonbinary engineering students was by respecting their preferred pronouns; respecting students' pronouns is especially impactful due to the structural positions faculty hold in the laboratory and classroom settings. Leon, Zayn, and Gwen Douglas shared experiences where they were happy that their professors gendered them correctly. For example, Leon described how they navigated the use of their chosen pronouns through their school's learning management software in one of their humanities classes:

> In one of my humanities classes, like I said, that's like, "Hey, I use 'they' pronouns, so feel free to use them whenever you want." ... But in [learning management software], you can put your pronouns next to your name now, so I have them there. It's just I guess an indirect way of coming out, but it's just like, "Hey, that's my name. Here are my pronouns."

When asked if they had received a positive response from faculty, Leon responded, "Well, yeah. When they refer to me as those pronouns, I'm just like, 'Yes. Another one for the [books].'" The professor's act of witnessing through affirmation was gratifying to Leon. When cisgender faculty and professors respect and affirm nonbinary students through correct use of preferred pronouns, they leverage their position of power to create an environment where nonbinary students feel safe, and others are discouraged from purposefully misgendering them. These actions are pertinent in spaces such as engineering departments, where cisnormativity is more prevalent [34]. Respecting a nonbinary individual's pronouns normalizes their identity in spaces where they are otherwise ostracized, resulting in a more welcoming environment and reducing the tolerance for misgendering and harassment in a cisnormative space.

Anti-witnessing

Anti-witnessing occurred when cisgender faculty intentionally or unintentionally misgender a nonbinary student despite being given the information to refer to the student correctly. Most anti-witnessing instances were committed by faculty who did not use their correct pronouns. Two participants, Zayn and Leon, shared that their pronouns are accessible through their learning management system, however faculty continued to misgender them. Zayn explains how they feel embarrassed by the misgendering and conflicted about correcting their professors misgendering:

> A lot of our professors are not good at pronouns and stuff, so I'm constantly misgendered despite the fact that [my institution] is like, "Oh, you can put your pronouns here." And I put my pronouns [on the learning management system] and they should show up on the [class] roster thing. But I just am always getting misgendered by profs, which sucks.… I am out at my school, and so everyone knows. And so, it's also embarrassing because everyone sees me just constantly getting misgendered. And it's also hard because it's that power dynamic of I don't want to be like, "Excuse me, you got my pronouns wrong." But … I am also scared … I don't know how they would react sometimes.

Zayn's experience highlights the internal conflict participants feel when individuals in positions of power, such as faculty and supervisors, do not witness their nonbinary identities. Zayn shares that their professors have access to students' pronouns through the school's learning management system, but the possibility remains that their professors have not taken note. While correcting the faculty may result in putting a stop to the misgendering, Zayn recognizes that correcting a professor comes with inherent risk of negative reactions and even retaliation. Additionally, Zayn experiences of having their identity publicly dismissed in front of peers are invalidating and embarrassing. The fact that Zayn and Leon have similar experiences at a progressive liberal arts institution and a more conservative research institution in the southern US, respectively, suggests the prevalence of anti-witnessing.

Mirroring

While nonbinary engineering faculty are sparse, one participant expressed the importance of mirroring supports from faculty and the meaningful effect this had on them [35]. At their private, four-year liberal arts college, Zayn reflected on the experience of having a nonbinary professor to look up to:

> I was so excited when [the nonbinary faculty member] came here, and I got to take a class with them last semester. And it's so nice just feeling like I see someone who is also nonbinary.

The participant went on the say:

> It means a lot. Just because it's like [nonbinary professor] [has] a very similar experience to me in that [they have] gone through the classes, [they] know what this field is like and how it's very male dominated. But not just male dominated, but also very heteronormative and cisgendered.

Due to the underrepresentation of nonbinary individuals in engineering spaces, having an alter in the field who shares the same gender identity is an uncommon and welcome experience for nonbinary students. Zayn developed a close relationship with the nonbinary professor based on their shared nonbinary identity. When asked to describe their relationship, Zayn recalled that they, "love talking with [the nonbinary professor]" and that they "have bonded and would consider [themselves] friends."

Zayn also emphasized the advantages of having a nonbinary faculty member, a person in a place of authority and respect, and the mirroring support they provided to each other:

> Also, it's nice because it is hard for me to correct people about my pronouns, but it's easy for me to correct people about other people's pronouns. So anytime someone was like, "Oh," and then use[d] the wrong pronouns, I was like, "Actually, they use they/them pronouns." So, it felt nice standing up. It is for me too, but also for them. And then … they were also a professor for a class that I was TAing and [the professor] saw that someone else was misgendering me. And then they also stood up for me, and it was just so nice.

Zayn shares the power of mirroring supports, specifically when advocating on behalf of their nonbinary professor and being advocated for by the professor. This excerpt provides a unique glimpse into the importance of mirroring supports within nonbinary relationships, in which, support can be mutual between nonbinary individuals, even when one individual may have more power or authority than another (i.e., faculty versus students). These mirroring actions, from both faculty and students, further the normalization of nonbinary identities in their engineering department through their ability to hold other faculty, students, and TAs accountable for their actions. However, while it is expected that the faculty's authority in the university setting would mean that they are more likely to be correctly gendered, this excerpt shows that all nonbinary individuals, regardless of being in a position of authority or power, may experience anti-witnessing [36], [37].

Supervisors, Coworkers, and Teaching Assistants

Witnessing

Participants described witnessing from supervisors in the form of creating an environment where they felt comfortable standing up for themselves in the face of harassment. For example, Elio shared:

> I have a great relationship with my boss. She was not my professor [i.e., Elio had never taken a course with her], but she was the lead professor for the course. And she is always like, "You can come to me for anything," and things like that. And she is a professor and she's great about that for every student, not just me. I can hold my coworkers [fellow TAs] accountable a little bit more if anything they're saying is like, "Whoa, [that's inappropriate]" [unlike] if I were in a team of engineers in a group project with 200 other students in the mechanical [engineering] space and a professor that I barely know.

Elio credited their professor with making it possible to hold other students to account if they say something offensive. They felt that it would be more difficult to address harassment in a more impersonal environment. Elio's supervisor provides witnessing through advocating for Elio's identity to be respected. As an authority figure over other TAs and the students in the class the supervisor has a particular ability to normalize Elio's nonbinary identity in the classroom. The supervisor's support helps normalize nonbinary identities in engineering and demonstrate intolerance for harassment against them.

Anti-witnessing

Coworkers and supervisors were the second most common relationships in which nonbinary students experienced anti-witnessing, often in the form of misgendering. Internships, TA positions and part-time jobs were all identified as contexts where students had to navigate their identity with managers and coworkers. Much as Zayn described advocating for their professor's pronouns, Elio advocated for a coworker's pronouns and experienced direct anti-witnessing:

> I actually had a conversation the other day with one of [the other] TAs where I was like, "So you use the wrong pronouns for my other coworker a lot. Would you consider changing that?"

Then they backtracked and clarified that they chose a less direct and confrontational approach:

> I was a little less direct than that. I was like, "Hey, just in case you didn't remember, blank's pronouns are they/them?" And he immediately was like, "I'm not going to remember that. And it's okay, they won't worry about it." And I was like, "'It would be nice, though. Is it that hard?" Yeah, that was upsetting to say the least.

In this example, Elio demonstrated witnessing from their coworker and their interlocuter demonstrated anti-witnessing, which Elio found upsetting both because of the disrespect directed at the coworker and, implicitly, at themselves.

Zayn also experienced anti-witnessing in their workplace from their coworkers, who used the correct pronouns consistently at the beginning of Zayn's internship but over time things changed:

> And it was really interesting because [my coworkers] fell off [using the correct pronouns], which was fascinating. I think as we got more comfortable, they started slipping up more and more, which I thought was really interesting. And I was like, "Oh, so you still don't see me as a nonbinary person, even as we get to know each other," which is kind of tough.

In this example, anti-witnessing occurred when Zayn's coworkers increasingly misgendered them over time. This example illustrates how anti-witnessing can be a vulnerable experience for nonbinary individuals, as it was upsetting for Zayn to learn that their coworkers affirmed their identity less over time. It is difficult to imagine why their coworkers showed them respect at first

and then abandoned the practice with time, and this difficulty may have accentuated Zayn's feelings of hurt.

Mirroring

Mirroring between nonbinary engineering students and coworkers occurred through kinship and a shared understanding of the difficulties in being nonbinary in the engineering field. Elio describes their experience when working with a nonbinary coworker at their college and how that impacted their ability to express their own gender identity:

> [Because of the nonbinary coworker,] I feel much more comfortable in my space presenting as myself, being a little more outward with my pronouns and things. ... They're very good to be around because it's nice to know that there's other people kind of like me that exist in this field. And they're very competent as an individual, and that also kind of reflects well on me, I think; I don't know, just like, "Oh yeah, we're in it together."

Elio's kinship with their nonbinary coworker allows them to feel more comfortable in expressing their gender identity when they are working together and knowing that they are not the only nonbinary person in engineering was reassuring. Kinship from other nonbinary individuals in the field is important in emphasizing that nonbinary individuals are not alone in the cis-dominated field of engineering. This kinship is only possible through Elio and their co-worker's shared nonbinary identity. Their similar experiences allow Elio and their co-worker to validate each other's identities and make each feel welcome in an otherwise cisnormative space.

Peers in Organizations

Mirroring

We expected to see mirroring solely between members of the nonbinary community; however, the participants did not mention any interactions with nonbinary peers in organizations. One participant described mirroring from peers in organizations in bonds formed based on shared experiences. Zayn experienced both mirroring and anti-mirroring when connecting with members of the Society of Women Engineers (SWE). They described the mirroring experience as thus:

> I'm in SWE because it's like, I do feel some sort of connection to other people who ... I grew up and had the female experience, still have the female experience. So, it's something that I do relate to.

They also said:

> [I]t's like [women in engineering] have a very similar experience to me in that you've gone through the classes, you know what this field is like and how it's very male-dominated. But not just male-dominated, but also very heteronormative and cisgendered in and of itself. And also the fact that I'm at SWE [conference], there is this really great solidarity of women in engineering

Zayn also acknowledged the instrumental advantages of being in SWE:

> Also, sometimes it's sad to say, but [I'm in the organization because of] the opportunities [it provides]. Coming here and being able to go to the career fair is huge and really important, and a way I can get a job because, I'm looking for a job. So just being able to have that network to reach out and be like, "Hey, we have this shared community." And the access to opportunities there is pretty big and pretty important."

Zayn feels a connection to the women in SWE is twofold: first, Zayn relates to their peers in SWE because prior to coming out, they lived the "female experience;" second, cisgender and heterosexual women and nonbinary individuals may share the experience of being marginalized in a field that is male dominated. Within SWE, Zayn experiences both expressive (i.e., emotional) support and instrumental (i.e., goal-attainment) support. Zayn expresses a kinship bond with women in SWE due to the shared understanding of the difficulties women face in male-dominated spaces. In addition, connections to women in SWE create opportunities for instrumental support, such as networking opportunities, job fairs, career development and full-time employment. These findings echo previous work, where Campbell-Montalvo et al. [20] found that nonbinary and trans* engineers reported similar levels of access to professional resources, leadership skills and academic resources.

Anti-Mirroring

It was far more common to experience being welcomed in engineering organizations based on shared cisgender identities as anti-mirroring. Zayn's experience of mirroring in SWE was highly attenuated:

> Just because it's like [women in engineering] have a very similar experience to me in that you've gone through the classes, you know what this field is like and how it's very male-dominated. But not just male-dominated, but also very heteronormative and cisgendered in and of itself. And also, the fact that I'm at SWE [conference], there is this really great solidarity of women in engineering … and I see myself somewhat liking the solidarity [in SWE], but also feeling super isolated in it. … Okay, yay. We have this solidarity of some people who aren't in the engineering narrative, and they try to be inclusive… I have my little badge; I have my pronouns [on badge]. But nobody uses them. Everyone I've talked to has gendered me as she/her, and I literally have [my pronouns on my name badge]. And it's like, "Oh, okay." So, I'm "welcomed here," but not.

Being told that they were welcome as a nonbinary person but nonetheless consistently being misgendered was very isolating for Zayn.

Gwen Douglas had a similar experience:

"I actually went to a couple of their [SWE] meetings last semester. They would say, 'Oh, but we are inclusive and that's fine.' There were other fem or non-fem people there, but also at the same time, it's just to me, when our general language is still the we, but you want to be inclusive, that's just... Again, I don't fit in."

For Gwen Douglas, for the time being at least, the tradeoffs were not worth spending time at SWE. Being nonbinary in a women-based engineering organization seemed to create a certain cognitive dissonance. While the organizations have indicated that they are inclusive of nonbinary members, both participants highlight that their participation in the organization centers their "womanhood" rather than their nonbinary identity.

Classmates and Friends

Witnessing

Participants described witnessing by classmates and friends through affirmation of the nonbinary students' identities and respecting their pronouns. Zayn recalled:

> I would say most of my positive experiences are when I'm with people, peers, people who are my age, and just feeling respected there, of people ... Like I'm on a group project right now, and everyone there is very good about using my pronouns. And if someone slips up, they immediately are like, "Oh, they." And so yeah, and just feeling that respect within my groups is really nice.

Zayn values the recognition and validation of their identity by their classmates. Such support was important to participants. Naturally, classroom interactions between nonbinary students and their cisgender classmates are commonplace, and these relationships are tied to their academic success. Therefore, positive interactions with and validation from peers can create a welcoming and safe environment for nonbinary students to participate and learn. Because the majority of students in engineering are cisgender and because engineering has a cisnormative culture [35], their recognition of nonbinary student identities and affirmation through correct use of pronouns was vital.

Anti-witnessing

Leon, Zayn, and Gwen Douglas shared their experiences of coping with anti-witnessing from peers by accepting pronouns other than they/them or by transitioning away from multiple sets of pronouns (i.e., she/hers and they/them) to a singular set of pronouns (i.e., they/them). Gwen Douglas, who accepts both she/hers and they/them, shared that they cope by being fluid with their sense of self and acknowledging others may not perceive them as they perceive themselves:

> I was a little bit more shell-shocked [when returning to in-person classes after the COVID-19 pandemic], and it made so much more of a difference under my skin to feel like the people didn't respect how I was using my pronouns or my name. … But some parts of me just eased off from that. And I think that that's where more of my fluidity became relaxed. . . Now it doesn't feel as hyper specific, so I just feel like, "Okay, well, maybe it is okay." … If they see me as AFAB and that's how they want to project, I can choose. [I] can choose when it is that I want to correct somebody or when it is that it's, "Hey, actually this [this is how I would like to be recognized]." And sometimes it does feel more important than other times.

Choosing when to remind others of their preference for they/them pronouns was universal among participants. It was also common to correct peers and not those with power over them and instead to cope with multiple sets of pronouns. Modifying expectations, as Gwen Douglas described when they said, "maybe it is okay," was a common way to cope with misgendering. On the other hand, participants felt more empowered to correct peers who misgendered them more frequently or who they interacted with more frequently.

Mirroring

The most frequent instances of mirroring we saw were between the participants and their nonbinary friends. Elio, Leon, and Gwen Douglas shared experiences that speak to such bonds. Gwen Douglas's best friend, who had been in their life for over 17 years, was nonbinary and an engineer. They described this friend as "like a family member." Mirroring occurred when the friend "involve[d] [themself] in their own advocacy, and so that always helps [me] to find the right language that I want to [use to] also advocate for myself."

When prompted to discuss a salient moment where their friend affirmed them as a nonbinary individual, Gwen Douglas remembered an extracurricular collegiate engineering competition:

> I show up and I am seen as the only girl on the team but it's like, I know, and again the president [of the club] knows that that's not how I identify. So, I think that [the friend's] encouragement of like, "Hey, you should just stick with it. Don't worry about the judges or when it gets to the competition date and all that" [was a moment of affirmation].

Gwen Douglas's nonbinary friend encouragement to persist in engineering extracurricular work despite being misgendered and perceived as a woman by other students and judges meant a lot to them. After being asked what their friend's support meant to them, Gwen Douglas described another dimension. They said that sometimes people are their own worst critics, implying that they are like that themselves, and that their friend played the role of "taking a little bit of that load off and being able to just have somebody else that says, 'I see you. I'm here for you.' That is enough sometimes." They noted that sometimes it is simply having "the worthiness of our experience that gets to be [recognized and] shared." As this suggests, nonbinary friends supporting other nonbinary friends through kinship and understanding of shared experiences makes it easier for nonbinary students to persist through difficulties they face due to identity in the engineering space.

Anti-Mirroring

Participants occasionally experienced anti-mirroring from cisgender, heterosexual, and LGBTQ+ peers, who assumed the participants' experience was similar to their own cisgender, heterosexual, or even nonbinary experience. Gwen Douglas shared their frustration with navigating how friends viewed them:

> [S]ometimes I've had to correct [my friends] to be like, "Hey, I get that that's how you see yourself but that's not how I see myself, so that doesn't apply or that doesn't work for me or that won't work for me because that's just not... That doesn't fit in." It's different

> because of the way that they perceive me, not in the way that I perceive myself. And I think that, again, sometimes they might even see me as just 'one of the guys.' And I'm like, "Oh, you're so wrong. I am not.'"

Participants described having to navigate their gender with their cisgender and nonbinary peers who assume that they share experiences. In this unique instance, Gwen Douglas shares that their nonbinary friend conflates their experience of being nonbinary as the same—not understanding that affirmation looks different for each nonbinary person. For example, Gwen Douglas's friends assume that their AFAB friend wants to be affirmed by being "one of the guys," but this is not affirming for Gwen as they do not align with either gender. Gwen's interactions show how nonbinary experiences can be nuanced and varied between individuals within the community, and that overgeneralizations and assumptions can create an uncomfortable environment for nonbinary students.

Conclusions and Future Research Directions

This study explores the roles of cisgender and trans* alters in the experiences of nonbinary engineering students. By developing a conceptual framework that incorporates elements of Lin's network theory of social capital, a common theory used to study engineering student's supports, and Devor's witnessing and mirroring, a trans* specific framework from public health and sociology, we have demonstrated how nonbinary students receive instrumental and expressive supports from cisgender, trans* and nonbinary individuals. Nonbinary students' experienced support from alters that identified as nonbinary or trans* and from cisgender peers, faculty, and members of engineering professional organizations. These supports take the form of witnessing (acknowledging and affirming the student's identity) and mirroring (relating to and affirming the student's identity). Nonbinary students also experienced anti-witnessing and anti-mirroring from cisgender faculty, professors, supervisors, and peers in professional organizations through misgendering and assumed shared experience. Overall, our research demonstrates how cisgender professors, faculty, peers, and supervisors can positively or negatively impact nonbinary students' sense of belonging based on their actions, and how faculty, peers, and members of professional organizations can advocate on behalf of and empathetically support these students.

Future work should explore the application of the conceptual framework with a larger and more diverse sample of nonbinary engineers (e.g., more representation from AMAB individuals, Black individuals, individuals at private institutions or individuals in northern/eastern states). Such research will provide further insight into the relationship between an alters' gender and types of support provided to nonbinary students. In addition, we anticipate a nuanced conversation around intersectionality and assigned gender-at-birth as the diversity of participants increases.

Implications

In this study, we proposed multiple ways that cisgender and LGBTQ+ allies may support nonbinary engineering students and document the ways in which they fail to provide support. We proposed a new conceptual framework for understanding nonbinary students' social networks that researchers can use to guide their own research on the supports that set nonbinary students up for success and the ways in which peers, organizations, and faculty harm nonbinary students.

Cisgender faculty and peers comprise the majority of the engineering community and play a central role in normalizing nonbinary students' identities. Faculty and peers can use their influence as cisgender individuals to advocate on behalf of marginalized nonbinary students. We found interactions between cisgender alters and nonbinary engineering students were influential in developing a nonbinary students' comfort and confidence in their outness and a sense of belonging in the engineering field. Based on our findings on witnessing supports, we call on cisgender faculty and students to take an active role in affirming nonbinary engineering students through correct and consistent pronoun usage, being receptive to students when they share their identity, and advocating for students by correcting incorrect pronoun usage and establishing expectations for a trans* inclusive space.

LGBTQ+ faculty, peers, and identity-based organizations all in some ways supported nonbinary engineers' wellbeing and confidence and should do so more. Our findings indicate that mirroring from LGBTQ+ faculty and members of professional organizations were important in providing expressive support and normalizing the nonbinary students' identities in their engineering departments. Based on these findings, we encourage LGBTQ+ faculty and members of professional organizations to advocate on behalf of nonbinary peers and to learn about the nuances that distinguish the nonbinary experience from the cisgender and LGBTQ experience. To nonbinary engineers of all career stages reading our work, we encourage you to continue to be your authentic self and find close networks of advocates and allies that affirm you in your identity.

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