From Queer Engineers to You: Insights into the Undergraduate-to-Graduate Transition in Engineering (WIP)

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Work in Progress: From Queer Engineers to You: Insights into the Undergraduate-to-Graduate Transition in Engineering

Introduction

Engineering has often been described as a discipline steeped in heteronormative and masculine traditions, frequently marginalizing people with identities that deviate from these norms [1], [2]. While the visibility of queer individuals in academic, see [3], public and professional domains is increasing, engineering education and employment opportunities continue to operate within frameworks that perpetuate underrepresentation and bias. For queer-identifying individuals, whose sexual orientation represents a non-visible minority identity, navigating hetero- and cis-normative structures can challenge traditional assumptions about masculinity in engineering and raise questions about how identity influences career progression. Despite these dynamics, little research has explored how queer engineering students transition from school to work [4].

This study addresses this critical gap by examining how queer-identifying engineering students navigate the transition from undergraduate to graduate school. Using the Pathways Theory of Progression [5] and an anti-deficit lens, we challenge deficit-based narratives about queer individuals in engineering, highlighting strengths, resilience, and adaptive strategies. By integrating collaborative inquiry through focus groups and reflections from four PhD candidates in engineering, the study captures the complexities of identity formation, visibility, and belonging within a traditionally heteronormative field. For the scope of this work-in-progress (WIP) paper, which is part of a larger study employing collaging and focus groups as data collection methods to investigate the undergraduate-to-graduate transition in engineering through queer lenses, this paper presents preliminary findings related to the research question: *How does identity formation, as explored through the Pathways Theory of Progression, influence LGBTQ+ engineering PhD students' academic and professional trajectories?* These findings are based on an initial IN Vivo coding [6] to analyze and describe the results from the first focus group interview.

This research highlights the structural barriers, such as underrepresentation, limited support systems, and implicit biases that hinder the inclusion of queer individuals in engineering. It emphasizes the agency and resilience of queer students, showcasing their successes in navigating these challenges. By focusing on visibility and identity recognition, the study underscores their importance in fostering belonging and value, while offering actionable insights for creating inclusive environments. Ultimately, it provides a foundation for administrative and practical improvements, promoting diversity, innovation, and an equitable culture within the engineering community.

Literature Review

To approach this topic appropriately from the context of the current body of literature, we conducted a literature review. In addition to the authors' relevant previous works, literature discussing the current climate for queer engineering students, and the benefits of explorations of marginalized identity through autoethnography were also included. One work that was particularly illuminating was the 2020 work from [7] that outlined the main themes in the current literature on the LGBTQ+ experience in engineering education. After doing an extensive literature review, they found the main themes to be the harsh climate faced by LGBTQ+ students, the diminutive myth of an LGB monolith, the emerging discussion of intersectionality, and evolving models to understand how LGBTQ+ students form their identities. The climate for queer students has been thoroughly

documented to be more difficult, especially so for transgender and gender non-conforming (TGNC) students. The space of engineering has historically been viewed as "apolitical", creating an environment that forces discussions about gender and sexuality to the sidelines. Incorporating more humanities into engineering has started to cause a shift in that perception, but there is still a long way to go. Even with consideration for the body of literature on LGBTQ+ social issues, there are many gaps when it comes to the experiences of queer people of color (QPOC) and TGNC students, who often "fall out" of statistics in large quantitative studies. This is a gap that is being filled by more qualitative research using methods like autoethnography that focus on the individual identities of marginalized queer students and amplify their stories and experiences. An example of a work like this is [8], which revealed the theme of intersecting positions of privilege and marginalization that many QPOC face. Identity is a complex subject that cannot be reduced to a one-fix-all solution when trying to improve the climate faced by queer students in engineering. Some identities are more visible than others, which was illustrated in [9] making certain identities more salient in different social and professional situations. This results in a different experience for queer students who are more "visibly queer" and cannot use protective heuristics like passing as cis-gender and/or heterosexual, as discussed in [10].

Positionality

Crystal (she/they) is a sixth-year graduate student pursuing a Ph.D. in the Electrical Engineering department at Stanford University. After being introduced to the field of engineering education in 2022 [11], she has been thoroughly investigating the literature as it relates to the intersectionality of marginalized identity and career pathways. As a queer Jamaican American first-generation low-income (FLI) alumna from the University of Miami, they were often the only Black and/or woman-identifying student in engineering coursework for the entirety of her undergraduate degree [9]. Shortly after starting graduate school, she came out as bisexual, leading to a new era of identity exploration for me. As she became more integrated into the Bay Area queer community, they started to realize the privileges they had in being "straight passing" that many of her peers did not have. Her goal is to investigate the different parts of her identity and think about how these have impacted her career choices in the past and looking forward to the future. They hope to help provide guidance to the relevant leadership to make a meaningful improvement in the retention of marginalized graduate students.

Kevin (he/him) is a fourth-year Ph.D. candidate at the School of Engineering Education at Purdue University, although he is currently based in Ithaca, NY at Cornell University. Kevin was born in Brooklyn, NY but grew up in Hormigueros, Puerto Rico. He was raised with a dual culture with his mom being Puerto Rican and his dad being a New Yorker. Kevin pursued industrial engineering and a mathematics teaching certification during his 7 years of undergraduate studies. He came out as gay the summer before commencing his undergraduate studies and has actively participated in LGBTQ+ affinity group spaces ever since. As a "white-passing" queer man, he has been afforded privileges while engaging with people of Latino and queer identities. Kevin has engaged in collaborative autoethnography in the past [12] and is familiar with the climate surrounding LGBTQ+ individuals in engineering education [13]. Kevin's main line of research is centered on acculturation and migration of U.S. colonial engineering migrants and hopes to continue to further our understanding of identity-related engineering migrant experiences in his research pursuit.

Animesh (he/they), a third-year Ph.D. student in Engineering Education, specializing in inclusive excellence. Born in Agartala, Tripura, and shaped by a military upbringing, Animesh identifies as a queer, international, first-generation college student passionate about creating equitable spaces in

engineering programs. With a background in Electronics and Electrical Engineering, their research focuses on the experiences of underrepresented groups, including queer and minoritized engineering students, as they transition from school to the workforce. Using an asset-based framework, Animesh explores the resilience, strengths, and resources of underrepresented students in engineering classrooms. Their commitment to dismantling systemic barriers is informed by their own experiences navigating intersecting identities, including socioeconomic challenges and their queer identity. Beyond research, Animesh serves as Vice President of Projects and Programs at o-STEM, advocating for inclusive research and resources to empower queer students in STEM. Their work aims to enhance retention, broaden participation, and foster equity in engineering education.

Yash (he/him), is a fifth-year Ph.D. student in Computing and Informatics, specializing in AI education and human-computer Interaction. Born in Hyderabad, India, Yash is an educational migrant to the United States and identifies as an international, first-generation college student passionate about creating equitable spaces in the computing and AI fields. With a background in Computer Engineering, Sociology, and business, his research focuses on the experiences of underrepresented groups, including queer and minoritized computer science students, as they interact with AI technologies and use them to learn. Using an asset-based framework, Yash explores student perceptions, sense of belonging, and attitudes of underrepresented students on AI technologies in the classrooms. His commitment to dismantling systemic barriers is informed by his own experiences navigating intersecting identities, including socioeconomic challenges and their queer identity. Beyond research, Yash serves as the technology focal point for the United Nations Major Group for Children and Youth, advocating for inclusive research and resources to empower students in STEM to engage with science policy and governance. His work aims to enhance civic engagement, broaden participation, and foster equity in STEM fields, see [14].

Research Design

We used collaborative autoethnography [15] to understand critical points in our pathway to becoming graduate researchers in engineering education. Collaborative autoethnography is useful in engineering education to capture experiences of individuals with many marginalized intersectional identities and explore the nuances of these intersections to describe identity development [12]. The flexibility of this methodology allows for the use of various data collection methods that elicit moments of reflexivity, dialogue, and trust between participants, producing richer data as emphasized by Chag et. al. [15] on page 61.

For this work-in-progress paper, we collected preliminary data through a two-hour Zoom focus group. Focus groups are effective for understanding the cultural norms of a group and generating broad overviews of issues that concern the group [16]. Kevin moderated the focus group for two questions, while Crystal moderated for one question. The moderators' primary roles included ensuring positive group dynamics and reminding participants not to analyze the data being shared during the data collection phase. Unlike traditional focus groups, the moderators also participated in answering the questions. All participants ensured we were in safe spaces during the virtual meeting. We built trust among participants by creating a group chat, holding three research design meetings prior to the focus group, and sharing personal information at the start of each meeting. We also used our positionality statements in this paper as a way to know more about each other, typically important to understand the role of identity in engineering education research studies [17]. During these meetings, we discovered a shared connection to India--Kevin indirectly through his husband,

Crystal through relatives, and Yash and Animesh having grown up and studied there. This shared connection further strengthened our collaborative bond.

The focus group protocol was co-created during these meetings, guided by pathway progression theory [5], and we selected four focus group protocol questions for this work-in-progress paper. This theory was selected because of its holistic view of the student as having agency to co-create the academic environment in collaboration with the major we choose, resulting in a change in the person pursuing the degree along with the degree program itself in an ideal case. It acknowledges that every path to degree completion is unique to the individual attempting to complete it, and examining the path taken by a student should take into account the varied identities held by each student coming into the space. In this work-in-progress paper, we focus on addressing the following research question: *How does identity formation, analyzed through the lens of the Pathways Theory of Progression in higher education, influence the academic and professional trajectories of LGBTQ+ engineering PhD students?*

We collected two main data streams during the focus group: transcripts of the recorded interview and field notes taken during the dialogue. We used an inductive approach inspired by Linberg & Korsgaard [6], [18], applying line-by-line coding to the data to generate initial codes grounded in participants' focus group discussions. Rather than forcing the data to align with a predefined theoretical framework, we allowed the participants' language and experiences to guide the analysis. For the scope of this paper, we report only on the first-cycle exploratory codes, which were constructed through a process of categorical thinking [19], that is, grouping responses based on recurring patterns, conceptual similarities, and shared concerns. This approach enabled us to remain close to the data while beginning to organize it into meaningful clusters that reflect participants' lived realities. Transcripts allowed us to review participants' responses to the protocol questions, while the field notes served as summaries and additional interpretations of what was being discussed. In this study, field notes were particularly valuable in capturing nuanced reflections and emergent themes. After the focus group, two of the authors wrote the findings for this work-in-progress paper, while the other two reviewed the findings for accuracy. This collaborative approach ensured that the analysis was thorough, reflective, and representative of the shared experiences and identities of the participants.

The focus group protocol questions we asked each other are as follows:

1.	Q: How have your LGBTQ+ identity and engineering identity evolved during your PhD journey?
2.	Q: Are there any specific moments during your PhD or professional interactions with faculty, peers, or industry, where you felt your identity strongly shaped your academic or career decisions? Can you share some examples? Follow Up: Where does engineering fall in all of this?
3.	Q: In what ways do you see your institution or department supporting or challenging your ability to express these identities?
4.	Q: What are some of the specific challenges and advantages that we perceive in our professional trajectory due to identity? Follow Up: When did you kind of get to the feeling that engineering was kind of more of a conservative space in some way or form?

Preliminary Findings

This focus group autoethnography explores the multifaceted journeys of identity negotiation experienced by Animesh, Kevin, Yash, and Crystal, each highlighting the interplay between personal and professional growth within the context of engineering and education, these stories are very different from one another. Animesh consolidated his intersecting identities as a queer international student while in school, using books as a medium to explore and understand these facets. His leadership in o-STEM, emphasized in his book contributions, reflects his commitment to fostering inclusive spaces for queer students in STEM. Kevin navigated his identity through the support of conferences like Out4Undergrad and a pivotal mentor who introduced him to engineering education. Initially viewing education and engineering as separate tracks, his mentor guided him to find their intersection, reshaping his perspective on his identity and career. Yash combined insights from books and mentorship to explore his identity, using these influences to delve into the negotiation of his role within the engineering and computing fields. Crystal discovered and embraced their identity upon entering graduate school, finding comfort in the queer community. Our reflections on social constructions of identity were deepened through interactions with Another queer researcher and experiences at an engineering education conference, which provided an especially welcoming environment. Together, these stories underscore the significance of mentorship, community, and self-reflection in shaping engineering identities.

Identity as a Catalyst for Academic and Professional Growth

Participants' LGBTQ+ identities played a pivotal role in shaping their academic and professional journeys, serving as both a source of motivation and a framework for decision-making. Animesh consolidated his intersecting identities as a queer international student through self-reflection and exploration, often using books as a medium to understand these facets. His leadership role in a queer-focused STEM organization exemplifies his dedication to creating inclusive spaces for others in similar situations. Similarly, Kevin experienced transformative moments through mentorship and participation in conferences such as Out4Undergrad, which enabled him to recognize the intersection of engineering and education, reshaping his perspective on both his career and identity. Yash, on the other hand, initially approached his academic work without directly addressing his identity but eventually integrated queerness into his research focuses after years of self-discovery and support from mentors. Crystal embraced their identity upon entering graduate school, finding a sense of belonging within the queer community. Their reflections highlight how academic settings can serve as pivotal spaces for personal growth and identity formation.

Mentorship, Representation, and Community as Essential Enablers

The presence of supportive mentors, visible role models, and inclusive communities emerged as critical enablers in participants' journeys. Animesh credited his advisor and committee members for fostering a sense of validation and introducing him to a network of queer professionals in engineering, which significantly enhanced his confidence and belonging. For Kevin, the guidance of a pivotal mentor provided clarity on how to integrate his intersecting identities into his academic and professional pursuits, while inclusive conferences offered a space for self-expression and connection. Both Yash and Crystal emphasized the power of community and representation. Interactions with other queer researchers and participation in welcoming conferences gave them the opportunity to see themselves in the field and inspired them to envision inclusive futures. These experiences underscore the importance of mentorship and representation in fostering a sense of belonging and validation.

Navigating Heteronormative and Gendered Norms in Engineering

Engineering's traditionally heteronormative and exclusive culture posed unique challenges for participants as they navigated their academic and professional pathways. Crystal observed how the framing of engineering as a prestigious and high-paying profession often reinforced traditional gender roles, complicating visibility for those in non-traditional relationships or identities. Kevin reflected on the challenges of balancing his queer and Latino identities in a discipline that lacked inclusive frameworks, striving to integrate these lived experiences into his research without exploiting them. Similarly, Animesh and Yash described feeling initial pressures to conform to the implicit norms of engineering, leading them to delay integrating their queerness into their professional identities. Over time, they found strength in supportive networks and representation, which empowered them to challenge these norms and incorporate their authentic selves into their academic work.

Intersections of Personal and Professional Identities

Participants highlighted the intricate interplay between their personal identities and professional aspirations, demonstrating how one informs the other. Animesh's leadership in a queer-focused STEM organization exemplifies how personal identity exploration can inspire professional initiatives that support broader communities. Yash described how books and mentorship frameworks helped him navigate his identity in the context of engineering and computing fields, ultimately shaping his research focus. Kevin credited mentorship and inclusive events for enabling him to explore the intersection of queerness and engineering education, producing meaningful work that reflected his dual identities. For Crystal, engaging with the queer community and participating in engineering education conferences provided a safe and welcoming environment for self-reflection and identity formation. These stories illustrate how identity negotiation is both personal and professional, underscoring the importance of spaces that encourage both aspects.

This study highlights the critical role of mentorship, community, and systemic change in shaping the identities and experiences of LGBTQ+ individuals in engineering. Participants' narratives reveal how their identities served as catalysts for personal and professional growth, influencing academic pursuits and career trajectories. Transformative moments, such as engaging with inclusive mentors, attending conferences, or stepping into leadership roles, empowered them to align their personal identities with professional aspirations and foster greater inclusivity within engineering spaces. However, navigating engineering's heteronormative culture, with its reinforcement of traditional gender roles and pressures to conform, presented significant challenges, particularly for individuals with intersecting identities such as being queer and a person of color. Mentorship, representation, and inclusive communities were critical enablers, offering validation, support, and opportunities for self-reflection and growth. These networks allowed participants to integrate lived experiences into their academic work, producing research that was both meaningful and impactful without exploiting their identities. Collectively, these findings underscore the need for systemic changes within engineering to dismantle exclusionary norms, prioritize inclusivity and representation, and create environments where diverse identities are celebrated, enabling personal identity and professional success to coexist and thrive.

Discussion and Conclusions

This study highlights the critical role of mentorship, community, and systemic change in shaping the identities and experiences of LGBTQ+ individuals in engineering, revealing how their identities served as catalysts for personal and professional growth. Transformative moments, such as engaging with inclusive mentors, attending conferences, or stepping into leadership roles, empowered participants to align their personal identities with professional aspirations and foster greater inclusivity within engineering spaces. However, navigating engineering's heteronormative culture, with its reinforcement of traditional gender roles and pressures to conform, presented significant challenges, particularly for individuals with intersecting identities such as being queer and a person of color. These findings underscore the evolving nature of identity formation, where limited exposure and societal norms often lead to confusion in understanding and expressing diverse identities. By approaching these discussions through a queer lens, researchers can explore the complexity and fluidity of identity, as exemplified by modern labels like Sapphic Achillean or participants who identified simply as queer without micro-labels. Such nuanced examinations can normalize and desensitize identity discussions within engineering, expanding the boundaries of representation and fostering environments where diverse identities are validated and celebrated. To achieve this, systemic changes within engineering must prioritize inclusivity and representation, ensuring the profession reflects and embraces the full spectrum of human identity.

Future work

We plan to ask each other the additional questions related to identity formation (2 questions), and pathway progression (4 questions) in subsequent focus groups and expand on the initial findings of this paper. The number of questions may evolve as we progress with the collaborative autoethnography methodology, given that collaborative autoethnography emphasizes an iterative rather than a linear research process [15, p. 24]. Additionally, we plan on using collage and journey maps as data elicitation methods in future focus groups. The career pathway progression focus groups involve recalling parts of our entire lives. We plan on adding additional data streams to grasp more important elements that contributed to our identity development as LGBTQ+ engineering education researchers. A notable limitation in any autoethnography is we are both data and instrument and we used an interpretivist philosophical tradition to engage in this research. Qualitative research is useful and best suited to understand complex aspects of people's experiences that cannot be reduced to a small number of variables. Therefore, conclusions from this data are not generalizable but can be transferable to people who share similar contexts as ours. This study dives deep into people's lived experiences, contributing to the broader literature on persistence of engineers navigating engineering pathways in a U.S. context [20] and outside a U.S. context.

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