Exploring the Discipline-Based Identities of LGBTQ Students in STEM

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1.0 Background

The purpose of this work-in-progress (WIP) paper is to explore how LGBTQ STEM students integrate their sexual and gender identities with their discipline-based identities in STEM fields. LGBTQ students in STEM often face significant barriers, including unsupportive and hostile environments, harmful biases, heteronormative STEM spaces, and marginalization, as well as a lack of understanding of their experiences both inside and outside the classroom [1-4]. These challenges make LGBTQ students less likely to be open about their identities with STEM peers, which can negatively impact their sense of authenticity, belonging, and persistence in these fields [5]. Such barriers can hinder professional formation, as LGBTQ students may struggle to reconcile their sexual or gender identities with the dominant norms and cultures of STEM disciplines, creating tensions and identity threats for these students navigating multiple marginalized identities.

While some studies have investigated the role of support systems, such as LGBTQ-inclusive policies and mentorship programs, in fostering more inclusive environments [6], there is limited insight into how LGBTQ students navigate the process of developing their discipline-based identities, such as science or engineering identities. For example, the intersection of queer identities with STEM's perceived objectivity often creates tension, a dynamic further exacerbated by neoliberal politics within STEM environments [7, 8]. Thus, a significant gap remains in understanding how LGBTQ students integrate their sexual and gender identity with their discipline-based identity development, a step towards fostering inclusive, equitable, and diverse environments which are essential for supporting the professional role identity formation of LGBTQ students.

2.0 Theoretical Framework

The theoretical framework guiding this study is grounded in Godwin's engineering identity framework [9]. This framework was developed from frameworks describing physics, math, and science identities [10, 11], as a way of understanding students' motivation to choose and persist in engineering [11-13]. Engineering identity examines how students come to see themselves as engineering people, through dimensions of their interest in engineering, recognition as an engineer by themselves and others, and their perceptions of their competence and performance in engineering. For this study, we apply these dimensions in a manner encompassing any STEM field.

This framework has been applied in diverse contexts, such as apprenticeships [14] and undergraduate education [12], making it particularly suitable for examining how identity development intersects with systemic barriers. It has also been used to explore the conflicts that engineering students experience at the intersection of multiple, and often minoritized, identities [15]. Research suggests that developing a strong engineering identity is crucial for students' belonging and retention in STEM education and careers [14, 16]. Along these lines, we

anticipate that the narratives of LGBTQ students might reveal a sense of tension or disconnect between their personal identities and their roles within science or engineering fields, as they navigate systemic barriers that impede their ability to integrate their multiple identities into a cohesive and authentic sense of self.

3.0 Methodology

This study achieves its purpose through a narrative inquiry approach to capture key events through which participants make meaning of their emerging identities. Narrative inquiry provides a unique lens to explore identity formation as a dynamic and context-dependent process, shedding light on the challenges, tensions, and moments of growth that shape their experiences [17]. This approach not only gives voice to LGBTQ students but also offers valuable insights into the social and cultural factors that influence their identity development. LGBTQ undergraduate students in STEM majors were recruited for this study, which encompasses two interviews over the 2024-25 academic year. To date, 29 students, 13 of whom are engineering majors, have participated in their first interview, which focused on their science or engineering identities. We plan to conduct second round interviews with these participants in the coming spring, which will focus on possible selves [18].

Open-ended, semi-structured interviews lasted approximately 30-60 minutes in length and were transcribed, with one exception for a participant who wished not to be recorded. The transcripts were summarized and then analyzed using a combination of deductive and inductive approaches [19]. Transcript data was first categorized according to Godwin's model for engineering identity, into interest, recognition, and performance/competence [9]. Within these categories, transcript data was inductively analyzed to identify subcategories based on how participants experienced these three dimensions. For this paper, we present our analysis of the recognition dimension as it pertained most to participants' LGBTQ identities, though as the study develops, connections between this dimension and the others will be explored further.

4.0 Preliminary Results

Participants' self-recognition as science or engineering people varied to a degree in terms of the extent to which they recognized themselves as such and on what bases they made these judgments. Some participants felt strongly about their discipline-based identities, and others felt less confident, anticipating their confidence will increase as they continue their studies. In describing the perceptions of others, participants generally felt peers, instructors, and family members also saw them as science or engineering people. Only in a few exceptions did we hear examples of parents who may have doubts about their science or engineering abilities, individual professors who held biases against women or LGBTQ people in the field, or peers who they may not know well and thus are unsure of their perceptions.

What seemed unique here regarding recognition as a science or engineering person, though, was the way being LGBTQ affected the perceptions of others regarding students' place in their field. This theme broke down into three subthemes: representation, attitudes of others, and acceptance as an LGBTQ person in STEM. First, the low representation of women, queer, and trans people in STEM undermined students' perceptions about being accepted within their

fields over the long term. One nonbinary participant commented, "Sometimes it does really feel like a guy's space, they'll be joking around and I'll be like, 'I didn't find that very funny.' Yeah, so sometimes I definitely feel maybe a little bit othered, but it's like, you know." Representation was the area where participants felt the greatest change was needed within their field, hoping that faculty and students in their fields would become more diverse in terms of gender and sexuality.

Second, the attitudes of those around them in STEM, though often supportive, also at times revealed persistent biases about LGBTQ people or outright avoidance of LGBTQ topics within the field. For instance, one participant said, "I've noticed that there's a lot of acceptance with queer women in geology, and of course I'm really happy about that, but I also think that there is a certain lack of understanding when it comes to pretty much any other queer identity in geology," later speaking specifically about knowing queer men who have struggled to disclose their identities within the field. Other participants mentioned an avoidance within their departments around discussing issues pertaining to LGBTQ experiences, personal identities, and other social issues. Together, these attitudes and the low representation of LGBTQ people can make it difficult for LGBTQ people then to participate in STEM in an authentic manner that would sustain them through their careers.

These two experiences then informed students' anticipation of others' acceptance of them as LGBTQ people in STEM. The ignorance or misunderstanding they encountered in their interactions with others, or the outright avoidance of LGBTQ issues within their departments, led participants to doubt their acceptance now or later in industry. Fortunately, in most cases, being open and even advocating for LGBTQ inclusion led to positive outcomes. One nonbinary participant, seeing that an application to join an honors society only provided two gender options on the form, reached out to the chapter leadership who replied, "Oh my God, I'm so sorry about that. I will get the people managing the site to add that option on. We were super late on that." Although participants generally felt like those around them readily recognized them as science or engineering people, what stood out about their experiences was the extent to which they could be recognized and accepted as LGBTQ science or engineering people, which could allow them to authentically participate in STEM.

5.0 Discussion

The purpose of this study was to better understand how LGBTQ STEM students navigate the intersection of their discipline-based STEM identities with their LGBTQ identities. Through our analysis of data pertaining to their recognition by others as science or engineering people, we found that others' reactions to their LGBTQ identities could interrupt this process. Even though these findings offer some insight into the implications of the LGBTQ climate in STEM, these findings also reveal how the hegemonic scientist or engineer is implicitly cisgender and heterosexual. Previous work has shown the ways science or engineering identity formation is gendered and/or racialized [11, 15, 20, 21], and this study adds sexual orientation as well as a broader understanding of gender identity to that conversation. That said, authentic learning experiences centered on diversity, equity and inclusion can help students develop a sense of belonging and positive STEM identities [22].

6.0 Future Work

Our immediate next steps are to complete analysis on our data pertaining to students' interest in STEM and their perceptions of their performance and competence within their STEM fields, both to uncover what may be unique about LGBTQ student experiences with these dimensions of STEM identity and how the three dimensions connect to each other. We will also be performing second-round interviews with participants in spring 2025 to discuss how they imagine their future possible selves in STEM, to uncover what they hope and fear about their future STEM trajectories.

Our sample is also quite diverse among other dimensions of identity, including race and ethnicity, disability, and STEM field. Disability was quite prominent in participants' discussion of their perception of their performance in STEM, given how disabling STEM learning environments can be. Exploring the intersectionality of LGBTQ identities with these other forms of oppression was important to the design of our study which we anticipate engaging as we complete data collection.

7.0 Conclusion

LGBTQ students in STEM face significant barriers to their participation, leading to inequitable outcomes that disproportionately impact LGBTQ communities [23-25]. These impacts harm individuals through the process of being pushed out of a field they desire to enter for no reason other than their identities [26-29], as well as broader communities and societies by limiting the diversity of talent called upon to solve important problems. This work-in-progress paper presented preliminary findings from our study on the relationship between STEM and LGBTQ identities to uncover how LGBTQ students navigate STEM discipline-based identity formation, focusing on the ways being LGBTQ impeded others' recognition of participants as scientists or engineers.

Being LGBTQ does not inherently conflict with engaging in STEM work, but others' presumptions of the hegemonic scientist as heterosexual and cisgender can serve as a barrier to full, authentic participation in STEM. As anti-DEI (diversity, equity, and inclusion) efforts permeate the sociopolitical atmosphere throughout the United States, our study continues to point to the continued need for DEI work to help make working and learning spaces more inclusive for LGBTQ students. Otherwise, we risk limiting the resources available to solve some of society's thorniest problems well into the future.

References

[1] R. A. Miller and M. Downey, "Examining the STEM climate for students with disabilities," *Journal of Postsecondary Education and Disability,* vol. 33, no. 2, pp. 169-181, 2020, Art no. EJ1273676.

[2] N. K. M. Marosi, L. Avraamidou, and M. López López, "Queer individuals' experiences in STEM learning and working environments," *Studies in Science Education,* pp. 1-39, 2024, doi: 10.1080/03057267.2024.2313903.

[3] Y. Shao, "Key Patterns of LGBTQ Experiences in STEM: From Institutional Barriers to Transnationality," *Lecture Notes in Education Psychology and Public Media,* vol. 7, no. 1, pp. 371-376, 2023, doi: 10.54254/2753-7048/7/20220889.

[4] J. B. Freeman, "Measuring and resolving LGBTQ disparities in STEM," *Policy Insights from the Behavioral and Brain Sciences,* vol. 7, no. 2, pp. 141-148, 2020, doi: 10.1177/2372732220943232.

[5] B. Hughes and S. MGWatson, "In/authenticity in STEM Social Networks: How "Out" are LGBTQ Students with their Peers in STEM?," presented at the 2023 ASEE Annual Conference & Exposition Proceedings, 2023.

[6] E. V. Patridge, R. S. Barthelemy, and S. R. Rankin, "Factors impacting the academic climate for LGBQ STEM faculty," *J. Women Minor. Sci. Eng.,* vol. 20, no. 1, pp. 75-98, 2014 2014, doi: 10.1615/JWomenMinorScienEng.2014007429.

[7] R. E. Friedensen, E. Kimball, A. Vaccaro, R. A. Miller, and R. Forester, "Queer science: Temporality and futurity for queer students in STEM," *Time & Society,* vol. 30, no. 3, pp. 332-354, 2021, doi: 10.1177/0961463x211008138.

[8] A. Mattheis, D. C.-R. De Arellano, and J. B. Yoder, "A model of queer STEM identity in the workplace," *J. Homosex.,* vol. 67, no. 13, pp. 1839-1863, 2020, doi: 10.1080/00918369.2019.1610632.

[9] A. Godwin, "The development of a measure of engineering identity.," presented at the ASEE Annual Conference and Exposition, New Orleans, Louisiana, June 26, 2016. [Online]. Available: https://peer.asee.org/26122.

[10] Z. Hazari, G. Sonnert, P. M. Sadler, and M.-C. Shanahan, "Connecting high school physics experiences, outcome expectations, physics identity, and physics career choice: A gender study," *J. Res. Sci. Teach.,* pp. n/a-n/a, 2010, doi: 10.1002/tea.20363.

[11] H. B. Carlone and A. C. Johnson, "Understanding the science experiences of successful women of color: Science identity as an analytic lens," *J. Res. Sci. Teach.,* vol. 44, no. 8, pp. 1187-1218, 2007, doi: 10.1002/tea.20237.

[12] A. Godwin and W. C. Lee, "A cross-sectional study of engineering identity during undergraduate education," 2017.

[13] A. D. Patrick, M. Borrego, and A. N. Prybutok, "Predicting persistence in engineering through an engineering identity scale," *International Journal of Engineering Education,* vol. 34, no. 2A, pp. 351-363, 2018, doi: 10.15781/T2ZC7SB9J.

[14] E. Liquete, E. Dekoninck, and G. Wisker, "Using Narrative Enquiry to Investigate the Development of Students' Engineering Identity in a Degree Apprenticeship," presented at the DS 110: Proceedings of the 23rd International Conference on Engineering and Product Design Education (EPDE 2021), 2021.

[15] M. R. Kendall and C. Joslyn, "Navigating and reconciling identity interference and values conflicts associated with our engineering identities: A conceptual framework," presented at the 2021 IEEE Frontiers in Education Conference (FIE), 2021.

[16] L. Mann, R. Howard, A. Nowens, and F. Martin, "Professional identity: A framework for research in engineering education," presented at the Australasian Association for Engineering Education Conference, Yeppoon, Australia, 2008. [Online]. Available: https://hdl.handle.net/10018/27305.

[17] J.-H. Kim, *Understanding narrative inquiry: The crafting and analysis of stories as research*. Los Angeles: SAGE, 2016, pp. xx, 341 pages.

[18] H. Markus and P. Nurius, "Possible selves," *American Psychologist,* vol. 41, no. 9, pp. 954-969, 1986, doi: 10.1037/0003-066x.41.9.954.

[19] J. W. Creswell and C. N. Poth, *Qualitative inquiry and research design: Choosing among five approaches*. Sage publications, 2017.

[20] C. Seron, "Rethinking the intersectionality of race, gender, and class identity," in *Diversity in Practice*, 2016, pp. 173-197.

[21] K. Bodnar, T. L. Hofkens, M.-T. Wang, and C. D. Schunn, "Science Identity Predicts Science Career Aspiration Across Gender and Race, but Especially for Boys," (in en), *International Journal of Gender, Science and Technology,* vol. 12, no. 1, pp. 32-45, 04/23 2020. [Online]. Available: https://genderandset.open.ac.uk/index.php/genderandset/article/view/675.

[22] A. Singer, G. Montgomery, and S. Schmoll, "How to foster the formation of STEM identity: studying diversity in an authentic learning environment," *International Journal of STEM Education,* vol. 7, no. 1, 2020, doi: 10.1186/s40594-020-00254-z.

[23] J. Maloy, M. B. Kwapisz, and B. E. Hughes, "Factors influencing retention of transgender and gender nonconforming students in undergraduate STEM majors," *CBE—Life Sciences Education,* vol. 21, no. 1, 2022, doi: 10.1187/cbe.21-05-0136.

[24] B. E. Hughes, "Coming out in STEM: Factors affecting retention of sexual minority STEM students," *Science Advances,* vol. 4, no. 3, 2018, doi: 10.1126/sciadv.aao6373.

[25] E. A. Cech and T. J. Waidzunas, "Systemic inequalities for LGBTQ professionals in STEM," *Science Advances,* vol. 7, no. 3, 2021, doi: 10.1126/sciadv.abe0933.

[26] E. A. Cech and T. J. Waidzunas, "Navigating the heteronormativity of engineering: The experiences of lesbian, gay, and bisexual students," *Eng. Studies,* vol. 3, no. 1, pp. 1-24, 2011/04// 2011, doi: 10.1080/19378629.2010.545065.

[27] M. Reggiani, J. D. Gagnon, and R. J. Lunn, "LGBT + academics' and PhD students' experiences of visibility in STEM: more than raising the rainbow flag," *Higher Education,* 2023, doi: 10.1007/s10734-023-00993-2.

[28] N. Alexander *et al.* (2022). Increasing inclusion & competency in STEM: Understanding LGBTQ+ history, barriers, and heteronormativity. Available: https://doi.org/10.32942/osf.io/d38va

[29] J. L. Linley, K. A. Renn, and M. R. Woodford, "Examining the ecological systems of LGBTQ STEM majors," *J. Women Minor. Sci. Eng.,* vol. 24, no. 1, pp. 1-16, 2018, doi: 10.1615/JWomenMinorScienEng.2017018836.