2023 Annual Conference & Exposition
Baltimore Convention Center, MD | June 25 - 28, 2023
The Harbor of Engineering Education for 130 Years
ASEE
Paper ID #39301

In/authenticity in STEM Social Networks: How ”Out” are LGBTQ Students with their Peers in STEM?

Dr. Bryce E. Hughes, Montana State University - Bozeman

Bryce E. Hughes is an Associate Professor in Adult and Higher Education at Montana State University. His research interests encompass diversity and equity in engineering education, with a focus on LGBTQ students. He was recently awarded an NSF CAREER grant to study the experiences of LGBTQ undergraduates in STEM fields. He holds a Ph.D. in education from the University of California, Los Angeles, an M.A. in student development administration from Seattle University, and a B.S. in general engineering from Gonzaga University.

Sidrah MGWatson

In/authenticity in STEM Social Networks: How "Out" are LGBTQ Students with their Peers in STEM?

Abstract

The purpose of this research paper is to test the difference in likelihood that LGBTQ students are open about their sexual or gender identities to peers in STEM than other members of their networks. LGBTQ students face pressures in STEM to hide their sexual and gender identities, which threatens their ability to experience state authenticity within STEM, or a congruence between their social identities and the environment. Incongruence would lead LGBTQ students to leave STEM majors at higher rates which undermines efforts to broaden participation in engineering.

We used egocentric social network analysis to test differences in the likelihood that LGBTQ students are "out" to different members of their networks. We hypothesized that LGBTQ students are less likely to be out to peers in STEM than other members of their networks because of the culture and climate within STEM. Experiencing continued incongruence between one's social identity and one's environment, more common for minoritized individuals than others, can become a barrier to continued participation within that environment. Outness therefore serves as an indicator of how comfortable LGBTQ students are in STEM as an early predictor of whether they will persist in STEM.

Results indicate participants were less likely to be out to peers in STEM than other peers. When we took whether the participant was a STEM major into consideration, the picture became less clear. Among STEM majors, participants reported being less likely to be out to their peers in STEM than other network members, but none of these factors were significant in a full-factor, mixed-effects regression model. These results suggest some degree of inauthenticity experienced by LGBTQ people with their peers in STEM, though the situation may be improving.
These results implicate the role of climate in STEM through LGBTQ students' relationships with their peers. If they feel they must be less open about their sexual or gender identities with peers in STEM, LGBTQ students are likely not experiencing a level of state authenticity within STEM that would retain them within these fields. Educators should consider how academic environments are construed to provide a supportive climate that allows LGBTQ students to be open and that sets expectations for all students to respect and welcome the contributions of their LGBTQ peers.

Introduction

The purpose of this research paper is to test the difference in the likelihood that LGBTQ (lesbian, gay, bisexual, transgender, and queer or questioning) students are open about their sexual or gender identities to peers in STEM (science, technology, engineering, and mathematics) than other members of their social networks. Healthy relationships with one's peers require an appropriate level of personal disclosure to develop trust [1]. Many students often discuss their families and romantic interests with their peers, similar how to many of us might share information about our spouses and children with our colleagues. These pieces of information establish points of commonality and difference that help us relate to each other, which facilitates our ability to work together toward some common goal.

For heterosexual, cisgender students in STEM, the routine disclosure of information that reveals their gender identity or sexual orientation, like information about potential romantic interests, is quite benign [2]. However, LGBTQ students typically face pressures in STEM contexts to hide their sexual and gender identities. On the surface, the attitudes of peers in STEM indicate that sexual orientation and gender identity should be considered irrelevant to science and engineering pursuits, but this resistance is typically grounded in a culture of depoliticization in STEM [3], or that the revelation of minoritized sexual and gender identities "spoils" the "purity" of the "objective" STEM environment by introducing politics [4]. Further, many people in STEM, and in society at large, are still uncomfortable around people with minoritized gender and sexual identities [5]. As a result, LGBTQ students continue to report chilly, and often hostile, climates in STEM [6, 7], as well as hiding or covering their sexual and gender identities when interacting with peers in STEM settings [8, 9].

The problem is that this set of conditions leads to disparate participation and success in STEM fields between people who are LGBTQ and people who are heterosexual and cisgender [10]. LGBTQ students are more likely to leave STEM majors [11, 12], and LGBTQ STEM professionals are more likely to consider leaving STEM careers [10]. If sexual orientation and gender identity are somehow irrelevant to STEM, why would such inequities persist? One likely explanation is that pressures to hide or cover one's LGBTQ identity denies that individual the experience of state authenticity in STEM [13], or to experience a congruence between their social identities and the environment. Incongruence would lead LGBTQ students to leave STEM majors at higher rates which undermines efforts to broaden participation in engineering.

The purpose of this study then is to test whether LGBTQ students in STEM are more likely to be open about their LGBTQ identities with their peers in STEM relative to other members of their networks. We use egocentric social network analysis to analyze a subset of students' social networks based on the people from whom they receive the most academic and personal support [14]. We hypothesize that LGBTQ students are less likely to be open with their peers in STEM, relative to other members of their networks, as even some of the most academically supportive people in their networks operate within the same culture of depoliticization around discouraging the sharing of information about minoritized gender and sexual identities. This study will help better understand the culture within engineering and other STEM fields through parsing the student social context and its impact on their mental well-being.

Literature Review

Although no study has specifically focused on how likely LGBTQ students in STEM are to be open about their sexual and gender identities with their peers in STEM, the literature points to a conclusion that LGBTQ students would be less likely to disclose, especially relative to other contexts in their lives. Several studies have documented how LGBTQ STEM students experience the climate in stem as heteronormative and cisnormative [6, 15, 16], meaning that being heterosexual and cisgender are taken for granted and expected within STEM. This perception is observed through overt behaviors, such as resistance or hostility when LGBTQ identities and experiences are disclosed, and covert behaviors, like implicit demands to keep sexual and gender identity masked while engaged in science or engineering work [8, 9]. These conditions lead LGBTQ students to compartmentalize minoritized sexual and gender identities when engaging in STEM contexts, which exacerbate feelings of isolation and alienation within these spaces. However, this compartmentalization is a primary explanation for why LGBTQ students would be less likely to be out with their STEM peers than other members of their networks.

The unwillingness to disclose one's LGBTQ identities seems to set up a self-reinforcing feedback loop: LGBTQ students also report being less likely to find a sense of community in STEM [7, 17], another consequence that also contributes to a lower likelihood of being out. Individual LGBTQ students encounter an unfriendly climate in STEM which causes them to either be less open about their sexual and gender identities in STEM or leave STEM altogether, LGBTQ students considering which major to select may be drawn to non-STEM majors due to seeing more people like them in those majors [18], and LGBTQ students disproportionately major in non-STEM majors [19]. To interrupt this circuit, organizations like oSTEM (out in Science, Technology, Engineering, and Mathematics) and Out to Innovate have made great strides to construct LGBTQ communities in STEM [20, 21], and changes in social attitudes around the acceptability of minoritized sexual and gender identities has also made a difference [5], but the problem has not been fully rectified. Or at least we presume it has not, as the collection of data on minoritized sexual and gender identities is still not a routine, systematic process by which we can monitor these disparities [22].

Finally, LGBTQ people who experience a more negative climate in STEM are less likely to disclose their sexual and gender identities to their peers/colleagues [23]. This point seems quite obvious, yet data collected across the STEM workforce have shown that experiencing a poorer climate is related to a lower likelihood of being out, and that lower likelihood of being out is associated with a greater likelihood of leaving a STEM field [10, 24]. Some may argue that managing one's exposure to stigma through covering or hiding minoritized sexual and gender identities is a minor point and possibly self-protective. Still, the constant concern about the potential of being exposed to stigma is far more distressing than considering alternative options where such management is unnecessary [25]. LGBTQ people recognize that identity disclosure is an ongoing process given the norms and expectations of heterosexuality and cisgender identity in society [2]. Covering or hiding one's sexual and gender identity can often mean dodging personal questions or outright lying when asked casually about one's home life [26]. The ability

to simply disclose routine personal information then means the ability to fully participate in STEM majors and careers.

The research bears this point out as well. For as frequently as people claim that sexual orientation and gender identity are irrelevant to STEM, working without the added psychological burden of managing disclosure of one's identity and experiences leads to positive outcomes [25]. Most notably, LGBTQ STEM faculty who are out to their colleagues are just as productive as their heterosexual, cisgender colleagues, whereas those who are not able to be out are less productive [27]. As mentioned earlier, LGBTQ people in STEM who report being more out to their colleagues are also less likely to consider leaving STEM [10, 23, 24]. In academic departments, when LGBTQ STEM faculty are more likely to be out, LGBTQ students feel more supported within these departments and can identify role models which motivates them to persist in their studies [28]. Experiencing a sense of belonging appears to be a factor promoting LGBQ student persistence in a STEM major not observed with heterosexual students [29]. Taken together, LGBTQ STEM students are probably less likely to be out to their peers in STEM, and it would be to their benefit if the structures and conditions within STEM enabled them to be open about their minoritized sexual and gender identities.

Theoretical Framework

Being open about minoritized sexual and gender identities is important because this openness offers a sense of authenticity that helps LGBTQ people experience congruence between their sense of who they are and the environments in which they interact with others [30]. This sense of congruence signals to LGBTQ people that their valued aspects of who they are, such as their sexual and gender identities, are also validated by those around them within any given situation. This sense of alignment between self and environment is referred to as state authenticity [13], which is invoked through an experience of "fit" within a given environment. The theoretical framework guiding this study then is the State Authenticity as Fit to Environment (SAFE) model, which helps explain differences between privileged and minoritized groups regarding their approach and avoidance behaviors with respect to a particular environment or social situation.

Schmader and Sedikides argue that people make decisions about the situations they will enter or avoid based on their concern for experiencing authenticity within those environments [13]. One central aspect of experiencing authenticity is a congruence, or "fit," between who they are as a person and the environment or situation in which they find themselves. Cues in the environment help individuals determine how they "fit" within that situation through three distinct experiences of fit: self-concept fit through seeking situations that cohere with salient or core aspects of identity, goal fit through situations that promote the attainment of one's goals, and social fit through validation of one's sense of self by others with whom they interact within that situation. Together, these three aspects of fit enhance or diminish one's ability to navigate that environment fluently which leads to heightened or lessened experiences of state authenticity in the environment [13]. People who experience greater authenticity are more likely to engage in situations that afford authenticity, and vice versa for those who do not. For this study, we theorize that outness to others can serve as a proxy for understanding the degree to which LGBTQ students experience state authenticity within different environments. We presume that

LGBTQ students pursuing STEM majors out of an interest in a STEM career will already be predisposed to approach STEM environments due to goal fit with these environments. However, whether LGBTQ students experience self-concept or social fit may determine avoidance behaviors that may ultimately lead them to abandon a STEM major and their STEM career goals. The disclosure of LGBTQ identity to others then reflects both higher self-concept fit and social fit in that LGBTQ students can be their "true selves" in STEM environments and have their LGBTQ identities validated by their peers. The decision to compartmentalize LGBTQ identities within STEM environments reflects social identity threat posed by a lack of self-concept and/or social fit. Given what prior research has indicated about the LGBTQ climate in STEM, then, these environments would be expected to pose more social identity threat than many other environments, leading to state inauthenticity and a greater propensity toward leaving STEM. We hypothesize then that LGBTQ STEM students will be less likely to be out with their STEM major peers than other members of their social networks, which does not bode well for their desire to pursue a STEM major as a pathway to a STEM career.

Methods

The purpose of this study was to determine if LGBTQ students are less likely to be out to their peers in STEM than other members of their social networks, and how being a STEM major may moderate this difference. For this study, we conducted an egocentric social network analysis to gather data on students' social context and how it relates to individual behaviors and outcomes, such as the likelihood of having disclosed LGBTQ identity to others in their networks. Grounded in social network theory, or the proposition that one's behaviors and outcomes are shaped by social context, social network analysis is a research methodology aimed at capturing information about social networks and other variables of interest [14]. An egocentric social network analysis measures the characteristics of individuals' social networks, seeking information about a subset of an individual's entire social network, which is appropriate for studying how network characteristics influence individual outcomes.

The sample for this study included 230 LGBTQ undergraduates attending three research universities dispersed geographically across the United States, reflecting approximately 60% of the overall sample of students who completed the survey. (Cis-hetero students were not included in this analysis due to the focus on outness.) Two universities were located in urban settings and one in a rural setting; one was located in the Pacific southwest, one in the northeast, and one in the Rocky Mountain region. About half of the sample identified as bisexual or pansexual, one-quarter as gay or lesbian, 11% as asexual or ace spectrum, 7% queer, and 7% questioning. Sixty-eight students indicated a minoritized gender identity, reflecting 17% of the overall sample, of whom nearly half identified as transgender, nearly one-third as nonbinary, 15% as genderqueer, 6% as gender nonconforming, and 22% as questioning (these percentages overlap as transgender identity was asked separately from gender identity). Seventy-two percent of the sample indicated majors classified as STEM.

The survey itself comprised two parts. The first part of the survey gathered data on students' social networks. This social network survey began with a name generator to identify a subset of students' social networks. Participants were asked to identify three people who provided them

the greatest amount of support within two domains, personal support and academic support. Although six network members may appear to be an infinitesimal fraction of their overall networks in terms of representativeness, the assumption is that these network members play an outsized role in students' context and the small size minimizes the amount of burden on the respondent to provide information about their network members [14]. Most egocentric analyses ask participants to consider no more than eight members of their networks at maximum to minimize cognitive burden and survey fatigue. They were then asked to provide information about these network members, to the best of their ability, to characterize their relationships with them and to provide information about the demographic makeup of their networks. Students also provided demographic information about themselves, including their sexual and gender identities, majors, and other routine demographic information.

The second part of the survey gathered data on college experiences and outcomes, though we only used data from the social network part of the survey for this study. The entire survey was validated through multiple student cognitive interviews to test for various burdens or potential failure points, as well as expert review by five experts in survey design, social network analysis, and engineering identity. We requested that the identified experts provide feedback on measure aspects of social networks (part 1), existing measures or measure aspects of social networks (part 2), as well demographic and experience items regarding your assessment of features like relevance, inclusion, wording, questions, and so on. They reviewed the survey for validity of the set of items, potential that items introduce cognitive burden, and the various places failure might occur during the cognitive process.

The dependent variable for this study was outness, measured using an item that asked students if each member of their network knew that they identified as LGBTQ, a dichotomous variable indicating "yes" or "no." The independent variables used in this analysis then were whether students were STEM majors and whether network members themselves were STEM majors. For this analysis, the set of network members was reduced down solely to those network members who were college students; network members who held other roles were not included. This reduction led to the inclusion of 747 network members across the analytic sample of 230 participants.

The analysis proceeded in two stages. First, we tested the bivariate relationship between whether the network member was a STEM major and whether the participant was out to that network member through a cross-tabulation. We then regressed likelihood of being out to a network member on whether that network member was a STEM major through a mixed-effects logistic regression model, which accounts for the nested nature of the data [31], that network members were "nested" within participants. In the second phase, we added the variable indicating whether the participant was a STEM major. We ran a disaggregated cross-tabulation to look within each category (STEM versus non-STEM) to test the relationship between the network member being a STEM major and knowing the participant identifies as LGBTQ. We followed this up with a full-factor, mixed-effects logistic regression model to test whether being a STEM major, the network member being a STEM major, and/or the interaction between these two factors predicted the likelihood the network member knew the participants' LGBTQ identity.

Limitations

Our data are limited in a few significant ways that need to be considered when reading and interpreting our results. First, we cannot claim these data to be representative of the population at large as these data came from students drawn from random samples at three universities who agreed to complete these surveys. Granted, due to limitations in LGBTQ data collection nationally [22], it's difficult to determine just what "representative" means in this context, these data are meant to be utilized for within-sample contrasts rather than interpreted as reliably representative data on the overall population of LGBTQ STEM majors. Second, the statistical relationships presented in this paper reflect associations between variables rather than assured causal relationships indicating active disclosure or withholding of personal information because of one's peers being in STEM majors. In other words, our data may reflect patterns that suggest LGBTQ students are less likely to share their LGBTQ identities with peers in STEM, but our analysis does not "prove" these students specifically withhold this information from peers because they are in STEM. Further, one cannot assuredly interpret a student's response about a network member not knowing their LGBTQ status as definitive, nor that the student is actively withholding that information from that person. Finally, embedded within these data are biases common to all social science survey research, including social desirability, the ability to recall information accurately, and willingness to participate in the survey. These biases may mean that the absolute values of our analysis could be biased in one direction or another, but that these biases would influence contrasts and correlations to a much lesser degree.

Results

First, we tested whether students were more or less likely to be out with their peers who are STEM majors. We first ran a cross-tabulation with a chi-square test to determine this difference descriptively, and the cross-tabulation was significant, $\chi^2(1)=8.90$, $p<.01$. Participants reported being out to 61.1% of their peers who were STEM majors as opposed to 71.9% of other members of their networks. The results of all of our cross-tabulations are presented in Table 1, below. To adjust our estimate of this effect due to the nested nature of the data, network members nested within participants, we ran a mixed-effects logistic regression model predicting likelihood of being out to network members. The coefficient for a network member being a STEM major, relative to other network members, was negative and significant, b=-0.74(.23), $p<.01$. From a bivariate sense, it appears that LGBTQ students are less likely to be out with their peers in STEM.

Table 1. Proportion of network members to whom participants are out, overall and disaggregated by STEM major

	Non-STEM peer	STEM peer	sig
All (n=747)	71.9%	61.1%	**
Non-STEM (n=184)	72.2%	63.2%	
STEM (n=563)	71.7%	60.7%	*

Note: * p<.05, ** p<.01, *** p<.001

Second, we wanted to test to see if likelihood of being out peers who are STEM majors differed by whether the participant was a STEM major. We ran two cross-tabulations, disaggregated by STEM major, to see if students in each group were more or less likely to be out to peers in STEM. For non-STEM majors, the cross-tabulation was not significant, $\chi^2(1)=1.70$, p=.193. Non-STEM majors were out to about 63.2% of their STEM major peers and 72.2% of their other network members. The cross-tabulation for STEM majors, however, was significant, $\chi^2(1)=6.12$, p<.05. STEM majors were out to approximately 60.7% of their STEM major peers and 71.7% of other members of their networks. We then tested both of these factors together in a mixed-effects, full-factor logistic regression model. Where the effect for STEM peers among STEM majors was significant in our bivariate analysis, no effects were significant in the full regression model.

Table 2. Mixed-effects logistic regression models predicting outness (N=230; n=747)

		B	SE	sig
Model 1	Constant	1.412	0.227	***
	STEM peer	-0.740	0.231	**
Model 2	Constant	1.280	0.358	***
	STEM major	0.231	0.444	
	STEM peer	-0.355	0.441	
	Interaction term	-0.529	0.523	

Note: * p<.05, ** p<.01, *** p<.001

Discussion

The purpose of this study was to test whether LGBTQ students were less likely to disclose their LGBTQ identities to peers in STEM majors than other peers, and whether being a STEM major themselves moderated this difference. In other words, would our hypothesis that LGBTQ students are less likely to disclose to STEM peers because of the climate in STEM hold up? The results paint a nuanced picture that is mostly encouraging, but also reveals work that needs to be done to improve the LGBTQ climate in STEM.

From the descriptive results, two important points stand out. First, participants reported being out to the majority of peers they consider to be their most important sources of personal or academic support. Even when disaggregated between STEM and non-STEM peers, in both cases, participants on average reported more than 60% of their network members knowing that they identified as LGBTQ. Comparing STEM to non-STEM majors, the difference is almost negligible. These findings reflect a stark distinction from some of the earliest research on LGBTQ students in STEM which was suggestive of a climate where most LGBTQ STEM students would keep their LGBTQ identities to themselves in STEM settings [8, 9, 17]. Obviously, one major distinction with this study is participants were asked about network members they rely on most for support, which one might presume are people to whom they would be more willing to disclose regardless. However, it's encouraging to see that participants

tend to be open with people they rely on most for support as this kind of interpersonal support can be critical in supporting students' academic success [32].

On the other hand, the descriptive results do point to a difference in the ways participants manage information about their LGBTQ identities within their social networks. Whether this is an active choice or a subconscious process, the proportion of non-STEM peers that participants reported being out to was approximately 10 percentage points more than STEM peers. Interpreted through the lens of state authenticity [13], and the dimension of social fit in particular, it would seem that participants still felt a bit more validated in being LGBTQ from their non-STEM peers than their STEM peers. If participants felt more social fit with non-STEM peers, they may then engage in more approach behaviors toward non-STEM environments, and either consciously or subconsciously avoid STEM environments. The bivariate analysis, and the mixed-effects model testing only whether a peer was a STEM major, were both suggestive that this distinction may be the case even more broadly. Yet in the second model, testing both the difference between STEM and non-STEM participants regarding their STEM and non-STEM peers, none of the factors were significant. These differences seem to have some practical significance in terms of the size of the effects in the modeling but are not large enough to conclude with great confidence that these differences are statistically significant.

Implications for Research

This study holds important implications for research, in terms of research on LGBTQ students in engineering and other STEM fields as well as methodological implications for how we study minoritized student experiences to monitor progress toward equity. Toward the former, this study shed light on the experiences of LGBTQ students in ways that lends support for continued work in this area. Public pressure is increasing for researchers, governmental agencies, and nonprofit organizations to collect data on and monitor inequities facing LGBTQ communities, including in STEM [22], and this study helped show what we can learn about different student experiences by collecting this data and using it for disaggregation in analysis. Future research should consider how further disaggregation could provide even more information about student experiences; our sampling approach included an oversample of LGBTQ students to conduct within group analysis such as we presented. Further oversampling could lead to greater insights through understanding the nuances of students with different LGBTQ identities within these communities.

Methodologically speaking, social network analysis is not widely used in educational research as a method for understanding the influence of social context on minoritized student experiences yet offers a new set of tools to understand the complex interrelationships between individual and contextual factors affecting student outcomes [14]. In this case, we were able to model the relationship between the characteristics of members of students' networks and their likelihood of having shared their LGBTQ identities with those network members. However, egocentric social network analysis is limited in the fact that only a very small subset of a student's network can be sampled before a survey quickly becomes too burdensome to complete. These analyses could be extended by modeling how social context shapes individual student attitudes, behaviors, and other outcomes, as well as testing whether this context differs between students in privileged versus minoritized social identity groups. Whole network analysis also presents new

opportunities for understanding the process of minoritization in STEM by modeling the characteristics and dynamics of networks within STEM departments/colleges at individual universities [14]. A whole network analysis of the membership of an oSTEM chapter, for example, may be incredibly revealing as to how students respond to their environment through decisions to disclose (or not) their LGBTQ identities.

Implications for Practice

Encouragingly, our findings suggest that any difference in students' likelihood of being out to peers in STEM compared to other members of their networks may not be statistically significant. Given prior research on the LGBTQ climate in STEM, this lack of significance may reflect changes over time in terms of what LGBTQ students experience in their classes. That said, the observed difference in students' likelihood of being out to their peers in STEM compared to their other network members was still nearly ten percentage points across the board. Given we were only able to sample a small subset of students' networks, this difference may paint a rosier picture than what students experience in reality, which warrants further consideration by practitioners who care about making engineering and other STEM learning environments more LGBTQ-inclusive. How and why might LGBTQ students decide to disclose their sexual and gender identities within STEM environments in ways that supports their full, authentic participation? Practitioners should consider ways they can signal to students they are safe people in whom to confide through taking steps that make their support of LGBTQ students more visible. These steps could include participating in Safe Zone training and posting a placard showing they completed the training, including diversity statements that demonstrate commitment to LGBTQ inclusion in their syllabi, and following through on conversations with students about their experiences in making discernible changes to departments or other environments.

As such, this study proposes the notion that a tangible indicator of LGBTQ validation is the willingness of an LGBTQ student to disclose that identity to others in a particular environment. When students recognize that their experiences will be welcomed, and they do not actively engage in hiding those aspects of themselves, they find greater congruence between being in STEM and being LGBTQ which enables them to follow through with their educational and professional goals. That said, the solution here is not to encourage LGBTQ students to disclose their identities to improve the climate—individual students' decisions regarding when and how to come out should be on their own terms and only for their own well-being. And coming out can be an incredibly meaningful, beneficial process for LGBTQ students! Institutionally speaking, though, the likelihood students will disclose could be considered an outcome, an indicator, of the climate, and that the problem is with the climate itself, or the system within a STEM department, which is where the solution should be located as well. In what ways do engineering and other STEM departments explicitly silence discussion around sexual orientation, gender identity, and other forms of difference [33]? In what ways are students implicitly (and explicitly) hindered from being open about being LGBTQ when engaged in STEM learning environments? This calls those in power in STEM to attend to the broader climate that causes this push which is an implication that the climate needs remediation and amending these systemic consequences are

not the responsibility of the individual. Department leaders, university administrators, and engineering faculty can all play a role in reshaping the learning environment in STEM to become more LGBTQ-inclusive. In the case of this study, one opportunity is through shaping the attitudes and perceptions of all budding engineers to recognize that LGBTQ inclusion should be upheld as a professional value in the field regardless of any individual's political or religious beliefs. Departments do not need to change students' beliefs, but they can implore students to treat each other with respect and dignity.

Conclusion

Innovation requires the contributions of a diverse array of professionals, and solving complex problems is easier with a diverse array of inputs into framing issues. The engineering profession has long recognized the need to diversify its ranks in order to meet societal needs, yet much room remains with respect to addressing different demographic disparities that have plagued engineering fields for several decades. LGBTQ people are less likely to major in, and more likely to leave, engineering and other STEM fields due to the climate experienced within these fields that denies them a sense of full, authentic participation. This study helped demonstrate that LGBTQ students may be less likely to experience state authenticity in STEM observed through a lower likelihood of being out to peers in STEM. If engineering professional societies like the American Society for Engineering Education implore all engineers to uphold respect, inclusion, and integrity as professional values, the engineering formation process must imbue cis-hetero students with the commitment to extend their LGBTQ classmates the respect needed for all potential engineers to practice engineering with a sense of state authenticity.

Acknowledgements

This material is based upon work supported by the National Science Foundation under Grant No. 2046233. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

References

[1] L. M. S. Goguen, M. A. Hiester, and A. H. Nordstrom, "Associations among Peer Relationships, Academic Achievement, and Persistence in College," *Journal of College Student Retention: Research, Theory & Practice,* vol. 12, no. 3, pp. 319-337, 2010, doi: 10.2190/CS.12.3.d.

[2] F. R. Dillon, R. L. Worthington, and B. Moradi, "Sexual identity as a universal process," in *Handbook of Identity Theory and Research*, S. J. Schwartz, K. Luyckx, and V. L. Vignoles Eds. New York, NY: Springer New York, 2011, pp. 649-670.

[3] E. A. Cech and H. M. Sherick, "Depoliticization and the structure of engineering education," in *International Perspectives on Engineering Education*, S. H. Christensen, C. Didier, A. Jamison, M. Meganck, C. Mitcham, and B. Newberry Eds. Cham, Switzerland: Springer International, 2015.

[4] M. Blair-Loy and E. A. Cech, *Misconceiving merit: Paradoxes of excellence and devotion in academic science and engineering*. Chicago: University of Chicago Press, 2022.

[5] Pew Research Center, "Majority of public favors same-sex marriage, but divisions persist," Pew Research Center, Washington, DC, May 14 2019. [Online]. Available: https://www.people-press.org/

[6] R. A. Miller, A. Vaccaro, E. W. Kimball, and R. Forester, "“It’s dude culture”: Students with minoritized identities of sexuality and/or gender navigating STEM majors," *Journal of Diversity in Higher Education,* vol. Advance online publication, 2020, doi: 10.1037/dhe0000171.

[7] 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.

[8] 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.

[9] B. E. Hughes, ""Managing by not managing": How gay engineering students manage sexual orientation," *J. Coll. Stud. Dev.,* vol. 58, no. 3, pp. 385-401, 2017, doi: 10.1353/csd.2017.0029.

[10] 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.

[11] 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.

[12] 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.

[13] T. Schmader and C. Sedikides, "State authenticity as fit to environment: The implications of social identity for fit, authenticity, and self-segregation," *Personality and Social Psychology Review,* vol. 22, no. 3, pp. 228-259, 2018.

[14] C. McCarty, M. J. Lubbers, R. Vacca, and J. L. Molina, *Conducting personal network research: A practical guide* (Methodology in the social sciences). New York, NY: The Guilford Press, 2019, p. pages cm.

[15] E. A. Cech and W. R. Rothwell, "LGBTQ Inequality in Engineering Education," *Journal of Engineering Education,* vol. 107, no. 4, pp. 583-610, 2018, doi: 10.1002/jee.20239.

[16] A. E. Haverkamp, A. Butler, N. S. Pelzl, M. K. Bothwell, D. Montfort, and Q.-L. Driskill, "Exploring transgender and gender nonconforming engineering undergraduate experiences through autoethnography," in *ASEE Annual Conference and Exposition*, Tampa, FL, June 2019.

[17] K. F. Trenshaw, A. Hetrick, R. F. Oswald, S. L. Vostral, and M. C. Loui, "Lesbian, gay, bisexual, and transgender students in engineering: Climate and perceptions," in *2013 IEEE Frontiers in Education Conference*, Oklahoma City, OK, 2013. [Online]. Available: <Go to ISI>://WOS:000330839100259. [Online]. Available: <Go to ISI>://WOS:000330839100259

[18] T. D. Forbes, "Queer-free majors?: LGBTQ + college students' accounts of chilly and warm academic disciplines," *Journal of LGBT Youth,* pp. 1-20, 2020, doi: 10.1080/19361653.2020.1813673.

[19] M. Greathouse, A. BrckaLorenz, M. Hoban, R. Huesman, S. Rankin, and E. B. Stolzenberg, "Queer-spectrum and trans-spectrum student experiences in American higher education: The analyses of national survey findings," Rutgers University, Newark, NJ, 2018.

[20] oSTEM, "About oSTEM," *oSTEM,* n.d. [Online]. Available: http://www.ostem.org/.

[21] NOGLSTP. "NOGLSTP is Out to Innovate." National Organization of Gay and Lesbian Science and Technical Professionals. https://noglstp.org/ (accessed February 24, 2023).

[22] J. B. Freeman, "STEM disparities we must measure," *Science,* vol. 374, no. 6573, pp. 1333-1334, 2021, doi: 10.1126/science.abn1103.

[23] J. B. Yoder and A. Mattheis, "Queer in STEM: Workplace experiences reported in a national survey of LGBTQA individuals in science, technology, engineering, and mathematics careers," *J. Homosex.,* vol. 63, no. 1, pp. 1-27, 2016, doi: 10.1080/00918369.2015.1078632.

[24] R. S. Barthelemy, B. E. Hughes, M. Swirtz, M. Mikota, and T. J. Atherton, "Workplace climate for LGBT+ physicists: A view from students and professional physicists," *Physical Review Physics Education Research,* vol. 18, no. 1, 2022, doi: 10.1103/PhysRevPhysEducRes.18.010147.

[25] Fa.

[26] K. Yoshino, *Covering: The hidden assault on our civil rights*. New York City: Random House (in English), 2006.

[27] J. Nelson, A. Mattheis, and J. B. Yoder, "Nondisclosure of queer identities is associated with reduced scholarly publication rates," *Plos One,* vol. 17, no. 3, 2022, doi: 10.1371/journal.pone.0263728.

[28] K. M. Cooper, S. Brownell, and C. Gormally, "Coming out to the class: Identifying factors that influence college biology instructor decisions about revealing their LGBQ identities in class," *J. Women Minor. Sci. Eng.,* vol. 22, no. 3, pp. 261-282, 2019, doi: 10.1615/JWomenMinorScienEng.2019026085.

[29] B. E. Hughes and S. Kothari, "Don't be too political: Depoliticization, sexual orientation, and undergraduate STEM major persistence," *J. Homosex.,* pp. 1-28, 2021, doi: 10.1080/00918369.2021.1996101.

[30] L. Fletcher and B. A. Everly, "Perceived lesbian, gay, bisexual, and transgender (LGBT) supportive practices and the life satisfaction of LGBT employees: The roles of disclosure, authenticity at work, and identity centrality," *Journal of Occupational and Organizational Psychology,* vol. 94, no. 3, pp. 485-508, 2021, doi: 10.1111/joop.12336.

[31] S. W. Raudenbush and A. S. Bryk, *Hierarchical linear models: Applications and data analysis methods*, 2nd ed. (Advanced quantitative techniques in the social sciences, no. 1). Thousand Oaks, CA: SAGE, 2002.
[32] M. J. Mayhew *et al.*, *How college affects students, volume 3: 21st Century evidence that higher education works*. Newark, NJ: Wiley, 2016, p. 1 online resource (787 p.).
[33] J. Ward and D. Winstanley, "The absent presence: Negative space within discourse and the construction of minority sexual identity in the workplace," (in en), *Human Relations,* vol. 56, no. 10, pp. 1255-1280, 2003/10/01/ 2003, doi: 10.1177/00187267035610005.