

LGBTQ Network Homophily and Sense of Belonging in STEM Majors

Abstract

The purpose of this research study is to test whether LGBTQ network homophily predicts higher sense of belonging among LGBTQ students, and if this relationship differs between STEM and non-STEM majors. Network homophily describes how sameness and difference within a person's social network provides access to different types of resources, and we hypothesize that LGBTQ STEM students have access to fewer LGBTQ sources of support than their peers outside of STEM. The study comprised 315 LGBTQ students from four U.S. research universities nationally. In this sample, 66% of participants were STEM majors, and 29% identified as transgender, gender nonconforming, or nonbinary (TGNC).

Multiple regression analyses were performed to test the effect of being a STEM major and homophily within students' social networks on sense of belonging. Results demonstrated several nuances in the relationship between network homophily and sense of belonging. Cisgender LGBQ students reported significantly higher sense of belonging than their TGNC peers. LGBTQ students relying exclusively on cis-hetero sources of academic support reported lower belonging than those with at least some LGBTQ network members. Few differences were observed between STEM and non-STEM students, meaning that gender identity and network homophily play a stronger role in sense of belonging than being a STEM major. Overall, these findings support the conception of homophily as an indicator of a supportive STEM learning environment for LGBTQ students, fostering equitable education. This emphasizes the need for targeted support mechanisms within academic disciplines to enhance the persistence and success of LGBTQ students in higher education.

Introduction

LGBTQ people and identities have become political targets recently, and most especially transgender, nonbinary, and gender nonconforming people, as state legislators have introduced hundreds of bills policing gender identity and expression in the past year alone [1]. This level of politicization has been associated with an increase in anti-LGBTQ violence [2], on the heels of several major national victories for LGBTQ rights in the past decade [3]. As such, many LGBTQ people have heightened concern regarding their participation in society, in spite of social attitudes steadily trending toward greater LGBTQ acceptance for the past several decades [4].

This state of affairs is especially troubling for folks working to broaden the participation of LGBTQ people in engineering and other STEM fields. LGBTQ experiences and identities are stigmatized in STEM disciplines due to the perception that science and engineering are inherently apolitical in their work [5]—the politicization of LGBTQ people is perceived to introduce politics inappropriately into the STEM work environment and threaten the objectivity of the STEM enterprise. However, the contributions of LGBTQ scientists and engineers are

needed to maximize the benefits that STEM can offer to society and to provide the important role models that motivate future LGBTQ scientists and engineers to enter these fields and offer their talents. In other words, retaining LGBTQ STEM professionals can be conceptualized as a recursive feedback loop: as the number of LGBTQ people contributing to STEM increases, the more likely they will build community and develop a greater sense of cohesion within these fields, and the more likely more LGBTQ scientists and engineers will stay within these fields.

Aligning to the above context, our study argues that sense of belonging is an important intermediate outcome supporting students' positive academic and career outcomes in higher education [6]. Belonging is considered a basic psychological need [7, 8], as it is essential to forming and reconstructing strong identification with others, and with the learning context [9], elevating continued motivation and contributing to persistence in higher education [10, 11]. Several factors have been identified to influence sense of belonging among LGBTQ students, including, sexual identity, outness, university messaging, meaningful social interactions [12], perceived discrimination and school LGB friendliness [13], and campus climate perceptions [14]. This study takes the position that homophily within social networks of LGBTQ students may provide valuable insights in understanding their sense of belonging along both STEM and non-STEM majors. However, no research has investigated the role of LGBTQ network homophily, that is, the tendency for individuals to form ties with others who share similar experiences such as LGBTQ identities in their social networks [15], in predicting a heightened sense of belonging while examining any variations by field of study.

The purpose of this study then is to test the relationship between sense of belonging in one's major and network homophily for LGBTQ students, comparing STEM students to non-STEM students. Our hypothesis is that including more LGBTQ peers in one's social network likely builds a sense of belonging in one's major, but that LGBTQ students in STEM may rely on fewer LGBTQ peers for support than their non-STEM counterparts due to the lower likelihood that LGBTQ students select STEM majors [16]. We argue that, although simply knowing other LGBTQ people does not automatically lead to greater support, having more LGBTQ people in one's network can increase a sense of validation and decrease feelings of isolation that should lead one to experience a greater sense of belonging in their chosen field and ultimately persist toward their academic goals.

Literature Review

Homophily can be conceived as an indicator of a STEM learning environment in which LGBTQ students can have a fair shot at receiving an equitable education. Inclusive learning environments that enable open identification as LGBTQ, offer social support, and provide a warm climate will lead to increased LGBTQ participation in STEM fields. Specifically, Barthelemy and colleagues found the presence of LGBTQ inclusion in physics is just as important as, if not more important than, the absence of exclusion in predicting a higher likelihood of persisting in a physics job or major [17]. Reggiani et al. found STEM PhD students and early-career academics were no more comfortable openly identifying as LGBTQ than mid- and senior-career academics due to the normative values shaping STEM fields, a lack of role models, and implicit pressure not to openly identify as LGBTQ [18]. Support outside of learning

environments is also important; Snapp and collaborators provided evidence that sexuality-related support from family, friends, and the community often has unique and overlapping contributions for young adult adjustment as in places like work/academic environments [19]. Finally, Reggiani et al. also found that compared to other challenges such as hostility and harassment, the invisible labor of navigating outness and visibility often goes unnoticed and unaddressed [18]. The consequence of dealing with such excess emotional labor is loss of progress that LGBTQ academics could be making by spending their cognitive resources engaging in research opportunities and career progression [20]. However, when LGBTQ academics do come out, the visibility in heteronormative institutions can lead to discrimination which can only be reasonably interpreted as an unfair disadvantage.

Sense of belonging has been explained as a student's sense of being valued, included and accepted [21]. Belonging, a basic human need for students in the university context, has been elaborated as students' subjective feelings of connection and integration with their institution and campus environment [9, 10]. Belonging, as a psychosocial construct, is based on students' perceptions of involvement of their learning environment as influenced by their interpersonal relationships [22, 23]. Numerous studies have predicted that a strong sense of belonging among higher education students is linked to various positive outcomes. Self-confidence, increased motivation, higher academic engagement, and achievement are all correlated with a stronger sense of belonging [9, 10, 22, 24]. Beyond academic outcomes, the literature emphasizes a range of psychological and socio-emotional advantages associated with an enhanced sense of belonging including reduced stress levels, heightened self-esteem, enhanced emotional management skills, and the formation of positive interpersonal relationships [23].

In the case of LGBTQ students, their encounter of hostile and heteronormative climates in STEM [25-27], leads to a higher proportion of them opting out of their majors [28-30]. A potential saving factor for LGBTQ students to persist or remain in their major is their sense of belonging [31, 32], and finding healthy, homophilous ties that encourage, acknowledge and validates their belonging. The presence of LGBTQ-inclusive policies has shown to positively correlate with increased feelings of belonging and reduced instances of discrimination and bias [33]. Moreover, the significance of visible support structures, including LGBTQ resource centers and mentorship programs helps in creating an inclusive campus climate [34]. Even though efforts have been slightly slow, the exploration of LGBTQ students' sense of belonging in higher education has been of great concern for policy makers and researchers with many studies and national dialogues emphasizing the significance of fostering an inclusive environment that promotes a positive sense of belonging for LGBTQ students, recognizing the impact it has on their academic success, mental health, and overall well-being as they are recognized as valid contributors to the scientific and engineering workforce.

Conceptual Framework

The conceptual framework for this study hypothesizes that homophily within one's social support network can lead to a greater sense of belonging within a social group [35]. Sense of belonging was introduced to the field as a more appropriate way of conceptualizing the participation of racially minoritized college students in predominantly white institutional settings than social integration which implied the need for a degree of assimilation to succeed [36, 37].

Sense of belonging can be operationalized as social cohesion, or the extent to which a person experiences mutual trust and reciprocity within some social unit, such as a university. Sense of belonging implies the experience of holding memberships in multiple social groups, which is congruent with the multifaceted nature of identity and the need for minoritized students to be able to belong simultaneously in multiple social groups.

Network homophily is thus hypothesized to predict a higher level of sense of belonging because students with more homophilous networks will have more people who share experiences with them in those networks [15]. Social network theory asserts that our social context, as observed through the various relationships we have with others in social groups, influences our behaviors, attitudes, and outcomes achieved in life [38]. Networks reflect our access to resources and support across multiple domains, and we frequently rely on different network actors, and perhaps different networks altogether, for different kinds of resources and support [39]. Homophily arises in our social networks as we tend to form relationships with people who are similar to us in important ways. Homophily can be a limiting characteristic within our networks, as diverse networks can be sources of diverse information [40], but for minoritized people, homophily can be an important source of support within social networks. For example, LGBTQ people can find validation and identity support through connections with other LGBTQ people [41], which would be important for STEM students who may have a bit more difficulty finding other LGBTQ people within STEM majors [16].

Methods

The purpose of this study was to test how network homophily on the basis of sexual orientation and gender identity in LGBTQ students' social networks predicts their sense of belonging in their majors, and if this effect differs between STEM and non-STEM students. This study used an egocentric social network analysis approach, which aims to understand how one's social context influences various experiences, behaviors, attitudes, and other outcomes [38]. The sample for this study was drawn from four research universities geographically dispersed across the United States. Although the survey was administered widely to students at these universities, for this study we only included LGBTQ students. In our sample are 315 LGBTQ students, of whom 92 (29%) were transgender, nonbinary, or gender nonconforming (TGNC). Sexual orientation and gender identity demographics for the sample are provided in Table 1. 210 students in the sample, or 66%, were STEM majors.

Table 1. Sample demographics (N=315)

Sexual orientation	n	%
Asexual or ace spectrum	36	11.43
Bisexual or pansexual	156	49.52
Gay or lesbian	70	22.22
Queer	25	7.94
Heterosexual	5	1.59
Questioning	20	6.35
Not listed	3	0.95

Gender identity		
Nonbinary	35	11.11
Genderqueer	12	3.81
Gender nonconforming	7	2.22
Man or male	55	17.46
Woman or female	182	57.78
Questioning	20	6.35
Not listed	4	1.27
Transgender		
No	277	87.94
Yes	38	12.06
STEM		
No	107	33.75
Yes	210	66.25

The instrument used to collect data for this study was a two-part survey that gathered data on students' social networks and their college experiences. The first part featured a name generator where students were prompted to identify up to 6 people they rely on for personal and academic support (3 in each domain), as well as information about their relationships with those individuals. The second part focused on college experiences and affective outcomes, including sense of belonging in their major [36], identification with their chosen field of study [42], and commitment to their major [43]. Participants received a \$10 gift card for completing the survey.

The primary dependent variable for this study is Hurtado and Carter's measure of sense of belonging [36], adapted for belonging in their major. Student scores on this measure were calculated through exploratory factor analysis on the three items that compose the measure, using factor loadings to produce a weighted sum of the three items. The reliability for sense of belonging in the major was $\alpha=.8810$ and all three items loaded at .75 or higher. The primary independent variable for this study was LGBTQ network homophily, calculated using Krackhardt and Stern's EI homophily index [44]. This index measures homophily as the difference between the number of in-group and out-group ties as a proportion of network size. Considering LGBTQ network members as in-group members, we computed homophily separately for students' personal and academic networks and recoded these scores into a three-level categorical variable indicating complete homophily (all in-group members), complete heterophily (all out-group members), and mixed. Several independent variables from the study were selected as control variables based on prior literature.

We ran three models for this study; one model to observe the main effects of all independent variables selected for this study and two models to test whether network homophily differed for STEM students within each network domain (academic and personal). We used ordinary least-squares regression for these models, with cluster-adjusted standard errors to account for variance at the school level.

Results

The results are presented in Table 2. Sense of belonging in one's major was, on average, high for this sample. Students reported a mean score of 8.75 (SD=2.42) on the composite scale for this factor, ranging from 2.47 to 12.36. The regression models, however, demonstrated some differences in sense of belonging based on homophily or heterophily in students' networks. In the main effects model, one homophily term was significant: LGBTQ students whose sources of academic support were all cis-hetero reported a lower sense of belonging in their major than those with at least some LGBTQ sources of academic support. A similar effect was observed for sources of social support as well, regarding the difference in sense of belonging for students with wholly cis-hetero sources of personal support, though the coefficient was only marginally significant in the model. Further, these findings are likely reflective of cisgender LGBQ students specifically; the strongest predictor in the model was the indicator variable for transgender, nonbinary, and gender nonconforming (TGNC) students. TGNC students already tended to report a lower sense of belonging in their major than cisgender LGBQ students.

Table 2. Regression model predicting sense of belonging in one's chosen field, main effects

	B	SE	t	p	sig
Constant	-0.990	1.714	-0.58	0.604	
TGNC (trans, nonbinary, gender nonconforming	-0.435	0.065	-6.68	0.007	**
STEM major	-0.638	0.428	-1.49	0.233	
Academic network homophily					
Homophily (ref: mixed)	0.152	0.561	0.27	0.805	
Heterophily	-0.322	0.058	-5.55	0.012	*
Personal network homophily					
Homophily (ref: mixed)	-0.215	0.281	-0.77	0.499	
Heterophily	-0.466	0.166	-2.8	0.068	
Interest in chosen field	0.360	0.082	4.37	0.022	*
Recognition as a science person	0.135	0.073	1.85	0.161	
Performance/competence in chosen field	0.136	0.026	5.24	0.014	*
Commitment to major	0.175	0.150	1.16	0.329	
Attended a conference	-0.104	0.297	-0.35	0.749	
Member of oSTEM or similar	0.541	0.350	1.55	0.22	
Member of other LGBTQ student org	-0.306	0.211	-1.45	0.243	
Member of major-related club or org	0.651	0.320	2.03	0.135	
Member of other club or org	-0.018	0.313	-0.06	0.957	
Held a leadership role	0.145	0.275	0.53	0.635	
Worked on campus	-0.051	0.244	-0.21	0.849	
Worked off campus	-0.311	0.093	-3.34	0.044	*
First-generation student	0.271	0.259	1.05	0.372	
Year in school	0.087	0.036	2.42	0.094	
R-squared		=	0.3115		

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

Among the college experiences that predicted sense of belonging in the major, the competence/performance dimension of field-based identity was the strongest predictor of sense of belonging in one's major, followed by the interest dimension and then being employed off campus. Bearing in mind that the competence/performance and interest dimensions were adapted to be interpreted within any student's given field, it makes sense that perceiving one to be performing well in a field and having a strong interest in that field would both be associated with feeling a sense of belonging in that field. Working off campus follows other findings that show off-campus employment can reduce a students' sense of connection to their campus, a problem that educators and administrators should consider in finding ways to keep students who must take off-campus jobs connected with their campus communities as well.

Table 3. Regression model predicting sense of belonging in one's major, with interaction term for academic network homophily

	B	SE	t	p	sig
Constant	-1.135	1.713	-0.66	0.555	
TGNC (trans, nonbinary, gender nonconforming	-0.427	0.081	-5.25	0.013	*
STEM major	-0.441	0.539	-0.82	0.473	
Academic network homophily					
Homophily (ref: mixed)	0.858	0.641	1.34	0.273	
Heterophily	-0.188	0.112	-1.68	0.191	
Interaction STEM major X academic network homophily					
STEM X homophily	-1.225	1.290	-0.95	0.412	
STEM X heterophily	-0.200	0.191	-1.05	0.372	
Personal network homophily					
Homophily (ref: mixed)	-0.255	0.330	-0.77	0.496	
Heterophily	-0.466	0.153	-3.05	0.055	
Interest in chosen field	0.359	0.081	4.43	0.021	*
Recognition as a science person	0.134	0.072	1.85	0.161	
Performance/competence in chosen field	0.135	0.027	5	0.015	*
Commitment to major	0.178	0.153	1.16	0.33	
Attended a conference	-0.120	0.283	-0.42	0.701	
Member of oSTEM or similar	0.520	0.348	1.49	0.233	
Member of other LGBTQ student org	-0.308	0.226	-1.36	0.267	
Member of major-related club or org	0.625	0.349	1.79	0.172	
Member of other club or org	0.008	0.314	0.03	0.981	
Held a leadership role	0.139	0.276	0.5	0.649	
Worked on campus	-0.006	0.226	-0.02	0.982	
Worked off campus	-0.300	0.089	-3.36	0.044	*
First-generation student	0.273	0.258	1.06	0.368	
Year in school	0.085	0.039	2.21	0.114	

R-squared	=	0.3143
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Note: * p<.05, ** p<.01, *** p<.001

Little changed in these main effects when the interaction terms were tested in the second and third models. In the model testing the interaction between homophily in one's academic support network and being a STEM major, shown in Table 3, the coefficient for complete heterophily was no longer significant. In the model testing the interaction between homophily in one's personal support network and being a STEM major, shown in Table 4, all the same main effects coefficients are significant and in the same direction as the model without interaction terms. In general, few differences were observed between STEM and non-STEM LGBTQ students regarding the effect of homophily within their networks. Rather, heterophily among sources of academic support had the biggest effect for students, and cisgender LGBQ students tend to experience higher sense of belonging in their majors than TGNC students.

Table 4. Regression predicting sense of belonging in one's major, with interaction term for personal support network homophily

	B	SE	t	p	sig
Constant	-1.072	1.604	-0.67	0.552	
TGNC (trans, nonbinary, gender nonconforming	-0.435	0.071	-6.13	0.009	**
Academic network homophily					
Homophily (ref: mixed)	0.112	0.582	0.19	0.859	
Heterophily	-0.319	0.066	-4.81	0.017	*
STEM major	-0.495	0.479	-1.03	0.378	
Personal network homophily					
Homophily (ref: mixed)	0.111	0.624	0.18	0.87	
Heterophily	-0.184	0.285	-0.65	0.563	
Interaction STEM major X personal network homophily					
STEM X homophily	-0.478	1.327	-0.36	0.742	
STEM X heterophily	-0.439	0.247	-1.78	0.173	
Interest in chosen field	0.360	0.080	4.48	0.021	*
Recognition as a science person	0.138	0.069	2.01	0.139	
Performance/competence in chosen field	0.136	0.025	5.36	0.013	*
Commitment to major	0.169	0.151	1.12	0.345	
Attended a conference	-0.085	0.317	-0.27	0.807	
Member of oSTEM or similar	0.545	0.332	1.64	0.199	
Member of other LGBTQ student org	-0.312	0.201	-1.55	0.218	
Member of major-related club or org	0.669	0.314	2.13	0.123	
Member of other club or org	-0.031	0.316	-0.1	0.929	
Held a leadership role	0.147	0.287	0.51	0.644	
Worked on campus	-0.057	0.211	-0.27	0.806	
Worked off campus	-0.316	0.085	-3.72	0.034	*
First-generation student	0.267	0.286	0.93	0.419	

Year in school	0.085	0.051	1.66	0.196
R-squared	=	0.3133		

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

Discussion

The purpose of this study was to see how homophily in LGBTQ students' social networks along the lines of having close network members who are also LGBTQ predicted their sense of belonging in their major, especially for STEM majors. In short, being a STEM major did not significantly predict sense of belonging for LGBTQ students in their majors, at least in terms of being a main effect. In other words, LGBTQ STEM students did not report a different sense of belonging in their majors than their non-STEM peers. This finding is incredibly encouraging given what we know about how LGBTQ students experience the climate in STEM [27], as well as the fact that LGBTQ students are less likely to major in STEM in the first place [16]. We should test differences in major within STEM as well, given other research that has shown variation in LGBTQ students' experiences across STEM majors [45], but for this analysis we were concerned about having too small of subsample sizes for meaningful comparisons.

We did observe a few differences regarding homophily in students' networks. In both the main effects model and the model testing the interaction between being a STEM major and homophily in one's personal support network, students reporting completely heterophilous academic support networks also reported a lower sense of belonging. This means that, relative to having an academic support network consisting of both LGBTQ and cis-hetero people, having an academic support network of only cis-hetero people is associated with a diminished sense of belonging in one's major. Regardless of being a STEM major, then, LGBTQ students experience more belonging in their majors when they have other LGBTQ people they can rely on for academic support. What is interesting, though, considering this finding is that membership in oSTEM or another LGBTQ student organization was not related to greater sense of belonging. Not to say that these experiences aren't important, but perhaps it's the connections formed within these settings that matter a great deal more than just membership alone.

Three factors were also consistently significant across our models as well. Two dimensions of science identity were significant—interest and performance/competence—as was having worked off campus. Students who express more interest in their fields and who perceive their performance and competence in their fields higher report higher levels of sense of belonging in their majors. These two coefficients are not terribly surprising but rather offer some support for the validity of our data, on top of helping confirm that identity and belonging are related. More interesting is having worked off campus: prior research has shown that working off campus can erode other academic outcomes as it reflects time not invested in academic endeavors [46] and concern about financing college [47]. Although it may be beneficial for students to either have opportunities to work on campus, rather than off, or better financial aid to meet their needs, the reality of college financing may also put engineering departments in the position of accommodating students who have to take off-campus employment in support of reaching their academic goals.

Conclusion

The politicization of LGBTQ people broadly threatens their sense of belonging in engineering and other STEM departments where pressures to separate the personal from the technical abound. Knowing other LGBTQ people, and relying on them for support, might serve as a buffer against this climate, bolstering their sense of belonging in STEM, their engineering and/or science identities, and their ultimate completion of a STEM degree in service of moving on into industry. This study tested whether LGBTQ homophily in LGBTQ students' social networks predicted their sense of belonging in their majors, and if this effect differed for STEM majors. No differences were observed between STEM and non-STEM majors, though relying completely on cis-hetero people in one's academic support network was associated with a lower sense of belonging. Shared experiences, especially in academic settings where one might feel pressured to compartmentalize lived experiences from academic work, can be important to help students feel less alone and more likely to find their place within their chosen field, whether that be engineering or another profession.

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