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Someone Like You: Theorizing LGBTQ Participation in Engineering through Network Homophily and State Authenticity

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, Montana State University, Bozeman

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Abstract

This theoretical paper proposes a framework to understand LGBTQ participation in STEM that reveals how heterosexism and cissexism operate in engineering. We propose a framework that connects the low representation of LGBTQ students in engineering to experiences of inauthenticity that threatens their participation in engineering and motivation to persist in their studies. LGBTQ students' social networks in engineering are composed predominantly of people of different sexual and gender identities than them, whereas cisgender, heterosexual students have access to networks composed of peers who nearly entirely share these identities with them. A concept from social network theory, homophily describes how much one's social network is composed of people who are like oneself. Homophilous networks validate personal experiences and identities in ways that we anticipate foster a greater sense of authenticity within those environments.

Schmader and Sedikides posit within their State Authenticity as Fit to Environment model that authenticity is an essential human need induced in environments that are congruent with one's sense of identity. Experiencing state authenticity increases motivation and engagement within that environment; experiencing inauthenticity does the opposite. Heterosexual, cisgender students experience authenticity within engineering with little question, whereas LGBTQ students are more likely to experience inauthenticity which interferes with their participation in engineering fields.

Attention to state in/authenticity as a critical aspect of engineering learning environments may help shift these demotivating and disengaging environments for minoritized students like LGBTQ students who wish to pursue these fields of study. To better understand LGBTQ participation in engineering social network analysis could help unpack the relationship between the composition of engineering students' social networks, their experiences of in/authenticity, and different educational and vocational outcomes in engineering. This may also offer insight into how students organize their networks into environments where they are more likely to experience state authenticity. Implications for practice include helping LGBTQ students find community in engineering and other STEM fields through organizations like Out to Innovate and oSTEM.

Introduction

This theoretical paper proposes a framework to understand LGBTQ (lesbian, gay, bisexual, transgender, and queer/questioning) participation in STEM (science, technology, engineering, and mathematics) that reveals how heterosexism and cissexism operate in engineering. A growing body of research is demonstrating that LGBTQ people are more likely to leave engineering and other STEM fields than their cisgender, heterosexual counterparts [1-3]. This attrition is attributed to reasons that stem from a culture and climate in STEM that is hostile to

and invalidating of minoritized sexual and gender identities [4-6]. Engineering and other STEM fields have been clamoring to diversify their ranks for the past several decades on the promise that a diverse workforce is more innovative and better positioned to solve complex, social problems. Removing these systematic barriers to LGBTQ people's participation in engineering is essential for these fields to meet their goals to broaden participation.

In this paper, we advance a conceptual framework to understand how heterosexism and cissexism operate to impede LGBTQ participation in STEM through two primary conceptual mechanisms. The first of these is network homophily [7]. The concept of homophily emerged within social network theory which helps describe the relationship between social context and individual behaviors or outcomes. Homophily refers to how similar one's social network is to oneself as well as the benefits and drawbacks of network similarity to different personal outcomes. The second concept is state authenticity [8]. Authenticity is summarized as a psychological state that emerges when one experiences congruence between their sense of self and a given situation in which they are engaged. This state either draws one into that situation, or leads to avoidance of that situation, based on the degree to which authenticity is experienced.

We argue that heterosexual, cisgender (or cis-hetero) STEM students navigate mostly homophilous social networks within STEM which fosters a sense of state authenticity that likely motivates them to persist in their studies. Conversely, LGBTQ STEM students navigate primarily heterophilous social networks within STEM, networks composed of peers with different sexual and gender identities than them, which more likely leads to state inauthenticity, prompting conscious and unconscious avoidance behaviors regarding STEM fields. This difference means LGBTQ students become more conscious of how their sexual and gender identities diverge from their peers, while cis-hetero STEM students' sexual and gender identities may never become psychologically salient [9]. For cis-hetero STEM students then sexual and gender identities are seen as irrelevant in STEM environments, thereby erasing these differences which adversely affects the LGBTQ climate in STEM. The extent to which faculty and administrators can construct STEM environments that create community for and validate LGBTQ students, the better STEM departments will support broadening the participation of LGBTQ students in STEM.

LGBTQ Experiences in STEM

LGBTQ students experience a culture and climate in STEM that is rife with heterosexism and cissexism. Heterosexism refers to the notion that heterosexuality is the preferred or ideal arrangement of sexual and romantic attraction, denigrating any expression of sexuality outside that between one cisgender man and one cisgender woman [10]. Cissexism is similarly the notion that gender identity inherently emanates from assigned sex at birth, denigrating the identities and experiences of people whose gender identity is different from their assigned sex [11, 12]. Several studies have shown that the environment which LGBTQ people experience in STEM can be described as heterosexist and cissexist in either the denial that sexual and gender identity are relevant to STEM work, prejudice toward the participation of heterosexual and cisgender people in STEM over LGBTQ people, or outright hostility toward LGBTQ people in STEM fields [6, 13, 14].

LGBTQ people then exercise several strategies to navigate the conditions they face in STEM [14-16]. Many openly resist this climate and culture to claim a space within engineering and other STEM fields, and organizations such as oSTEM and Out to Innovate arose out of such advocacy [17, 18]. Others exercise strategies that downplay the prominence of their sexual and gender identities when engaged in STEM environments to manage the discomfort of others. These strategies can be as simple as "covering," or downplaying expressions of LGBTQ identity [19], overcompensation, or overperforming in one's chosen STEM domain to firmly establish credibility [14, 20], or passing as heterosexual/cisgender, hiding information about and expression of sexual and gender identities in STEM school settings. LGBTQ people themselves may see these strategies as either necessary to succeed or even as desirable depending on the extent to which they have internalized dominant narratives about the irrelevance of sexual and gender identity to STEM, a reflection of the ways LGBTQ people are prone to minimize harmful experiences pertaining to sexual and gender identity [21]. However, each of these strategies introduces additional psychological and emotional burden that can interfere with the cognitive resources needed to maintain motivation and succeed in a STEM major.

The most immediate of these consequences is that LGBTQ people are much more likely to consider leaving, and to leave, STEM than their cisgender, heterosexual counterparts [1-3]. In addition to this attrition, regardless of whether they leave, these conditions take a physical and psychological toll on LGBTQ people. LGBTQ people experience a greater degree of physical and psychological health issues as well as depression and suicidality than heterosexual, cisgender people [5, 22, 23], which are directly a result of experiencing a hostile climate. Further, LGBTQ identities and experiences have become quite politicized lately, especially those of transgender, nonbinary, and gender nonconforming (TGNC) people [24]. Politicians using TGNC communities for political stunts to advance their campaigns for higher office, legislation that puts the basic human rights of LGBTQ people up for debate, and the salience of LGBTQ issues in conversations around current political issues creates a broad environment that heightens general feelings of being unsafe among LGBTQ people, according to a recent poll [25]. In STEM, the fact that LGBTQ issues are politicized positions LGBTQ people as "political," and the introduction of LGBTQ issues into STEM as a "polluting" of the "pristine" environment needed for the most reliable STEM work [26, 27]. LGBTQ people are likely operating at a base line feeling of being "on the spot" and unwelcome when they enter new environments, like an engineering or other STEM department. Being a numerical minority also means feeling conspicuous in most spaces.

Network Homophily

Being a numerical minority, particularly in STEM where LGBTQ students are less likely to declare a major [28] , means LGBTQ people in STEM will most likely develop social networks composed of mostly people with sexual and gender identities different from them. In social network parlance, these networks would be described as heterophilous, or composed of more outgroup members than ingroup members [7]. Social network theory would hold that people tend to be drawn toward others with whom they share some common experiences or identities, and that shared similarity would have many positive effects on different outcomes achieved by those

individuals. And cisgender, heterosexual students possibly experience some motivation and validation from engaging in networks that are composed predominantly of people who share those experiences with them, though these benefits are likely quite latent and subconscious [29]. All college students are likely in some form of identity exploration or another [30]; exposure to difference within one's social networks would likely produce developmentally beneficial outcomes then. Further, some cisgender, heterosexual students may even be implicitly drawn to STEM because of seeing more people like them and less diversity than in other fields.

However, the lack of diversity in STEM social networks can also be limiting and/or detrimental to individuals who compose these networks and STEM fields as such. In a classical social network study, Granovetter argued that the weaker ties in our networks, or those people with whom we would share less in common, may be more important to accessing information that could be of benefit to us, such as job opportunities [31]. Heterophilous social networks within STEM then are important in the way they can encourage beneficial and perhaps reciprocal relationships and limit social closure to opportunity. Homophily in terms of sexual and gender identity may implicitly inform cisgender, heterosexual students of the notion that sexual and gender identity are irrelevant to STEM—these experiences are likely not salient for them because they share these traits with most of the members of their networks [8, 9]. STEM majors are also perceived to be "queer free" in that they tend to enroll much smaller proportions of LGBTQ students than non-STEM majors [28, 32]. If we consider how "birds of a feather flock together" in terms of social network theory [7], LGBTQ people would then be drawn to non-STEM majors where they find more LGBTQ people to find community.

Why then does this decision become a choice between being in STEM and finding LGBTQ community? On the surface, one might conclude that the higher concentration of LGBTQ people in non-STEM majors is either an interesting coincidence or the result of being more likely to engage LGBTQ topics in these majors. Being drawn to majors where one's experiences are affirmed or even engaged is one reason minoritized people, like women, leave STEM [33]. However, if sexual and gender identities were truly irrelevant to STEM work, LGBTQ people would not feel a parallel push out of STEM due to feeling as though they are not supposed to engage in these spaces. Utilizing an analysis grounded solely in social network theory only points to our likelihood of seeking out social situations where we might find relationships with people who share characteristics and experiences with us [7]. This perspective does not help point our attention toward the ways sameness and difference operate to structure our decision-making around engagement in different spaces like STEM learning environments and workplaces, which can have real material consequences for the outcomes we achieve in life. We turn to the State Authenticity as Fit to Environment model to help explain why sameness and difference matter, especially in engineering environments where it is commonly perceived that identity should not and does not matter.

State Authenticity as Fit to Environment

Authenticity is the psychological state of experiencing congruence between one's sense of self and a given environment [8]. Authenticity is recognized as a core human need that enables intrinsic motivation and demonstrates alignment between one's abilities and their sense of "true

self" [34, 35]. It also supports well-being [36]. People are thus motivated to seek out situations that afford a sense of authenticity through their perception of "fit" with that setting, and to avoid situations that lead to experiences of inauthenticity. Fit with an environment is then understood as occurring through environmental "cues" that increase one's fluency to navigate the environment smoothly in three distinct ways. State authenticity as fit to environment also resembles a separate construct, sense of belonging [37], which has become popular in understanding the experiences of minoritized students in engineering [e.g., 38]. One of the types of fit, social fit, is likened by the authors as reflecting sense of belonging within a given situation.

The first way people experience fit within an environment is through self-concept fit, or the extent to which the environment makes salient readily accessible aspects of one's sense of self [8]. For students in STEM, these cues can include photographs of space, a white board with math equations, or a chemistry wet lab. Self-concept fit is one reason LGBTQ students find Safe Zone placards on office doors to be validating of their experiences. Second, one also experiences fit through goal fit, or the alignment between structures in a given environment and a person's internal goals. In other words, the environment is constructed in a manner that is congruent with tasks they intrinsically hope to accomplish as well as their preference for how they approach those tasks. Finally, the third form of fit experienced in a given environment is interpersonal fit: to what extent is my understanding of who I am validated by others with whom I am interacting in a given environment? Schmader and Sedikides also frame this form of fit as belonging, or the extent to which I perceive myself as a part of the social group within a given situation [8]. People who experience higher levels of self-concept, goal, and social fit navigate situations with greater fluency, or lower cognitive friction, which results in state authenticity. People then are more likely to select environments and situations that lead to higher state authenticity and avoid those that cause one to feel inauthentic.

Schmader and Sedikides argue then that our social identities are a core source of information as to whether we fit within a given environment, particularly through the processes of self-concept and social fit [8]. Our environments are socially constructed, and these environments were typically set up by and for people in advantaged groups, and STEM learning environments are no exception. The default person who enters STEM is a man, white, cisgender, heterosexual, and not disabled, among a host of other advantaged social identities [29]. When people in advantaged groups participate in STEM, they experience low cognitive friction that enables greater fluency in navigating these environments [8]. STEM is more likely to cohere with their self-concept, so they experience less self-awareness in STEM environments. STEM is also more likely to align with the ways members of advantaged groups pursue goals, which supports their motivation to pursue STEM fields. Finally, members of advantaged groups are more likely to find others who share those same social identity memberships, which heightens their sense of social fit and belonging. Together, members of advantaged groups have greater access to state authenticity within STEM.

On the other hand, because of low sexual and gender diversity within engineering [1, 28], LGBTQ students are less likely to access this sense of authenticity within engineering. Schmader

and Sedikides argue that social identity threat can be activated within environments where a person may be devalued based on one or more of their social group memberships [8]. The three modes of fit can help explain ways state authenticity is undermined through social identity threat, leading to actions and decisions that leave one feeling inauthentic in a given environment and more likely to avoid that environment. Self-concept fit is undermined in situations that make a minoritized social identity salient in a manner that causes a person to become vigilant against confirming a negative stereotype. LGBTQ people may find themselves incredibly self-aware when they feel as though they are the only, or one of just a few, people like them in a given STEM environment.

Goal fit is undermined when people feel pressured to conform to particular norms or act in ways incongruent with their internal values [8], especially when dispelling social identity threat. LGBTQ people are often viewed as political or not serious in STEM [26]; in response to this threat, LGBTQ students may downplay their LGBTQ identities or overcompensate to "prove" their seriousness about STEM [13]. Social fit is undermined when one either expects to be invalidated by others or simply lack a sense of belonging within a given situation [8]. Experiencing less social fit leads one to avoid environments or settings where they experience this sense of misfit. LGBTQ students are already less likely to major in STEM [28, 32], possibly because of lessened social fit within STEM environments; organizations like oSTEM and Out to Innovate are thus especially important for LGBTQ STEM students to experience authenticity as they offer the social fit that academic departments may not [17, 18].

Taken together, people who want to experience state authenticity are likely to engage in "self-segregating" behaviors [39]. When viewed simply through a social network lens, one might conclude that the construction of one's social networks, and the decision to participate in different environments, is an exercise of agency to make decisions within one's best interest. However, when we also incorporate state authenticity into the picture, we reveal how these decisions, both in terms of constructing social networks and selecting environments in which to participate, are structured by the environment. In other words, STEM environments enable the participation of heterosexual, cisgender white men through the affordance of authenticity, and inhibit the participation of minoritized people like LGBTQ people through reducing fit with the environment and denying state authenticity. The approach and avoidance behaviors of LGBTQ people regarding STEM environments are thus an outcome of these conditions: not acts of agency, but rather self-preservation.

Achieving Authenticity in Practice

In seeking the response to stemming the attrition of LGBTQ people from engineering and other STEM fields, the framework presented in this paper helps draw attention away from keeping people in STEM and toward the construction of STEM environments themselves through the values and culture embedded within these environments that push minoritized people away. LGBTQ people, like many other minoritized people, likely experience a degree of inauthenticity when engaged in STEM [8]. This inauthenticity may stem from pressures to hide or cover one's LGBTQ identity [16], from demands to compartmentalize LGBTQ identities and experiences from STEM given the politicization of LGBTQ identities [26], or from outperforming peers to

establish a sense of seriousness in response to social identity threat [5]. LGBTQ people may simply feel a lack of belonging in STEM from not seeing many other people who share that experience in their learning environments. How can engineering education respond to provide learning environments that extend authentic participation to minoritized students in addition to advantaged students?

An immediate path toward providing more authentic participation would be for engineering and other STEM departments to help foster social fit for LGBTQ students. The recommendations here are not new and align both with prior research on the experiences of LGBTQ students as well as that of other minoritized students. The opportunity to find community among other LGBTQ people in STEM helps foster greater social fit through shared experience, and as mentioned, organizations like oSTEM and Out to Innovate help serve this need. The challenge facing departments, however, is the fact that LGBTQ students will always be outnumbered by their cisgender and heterosexual peers. These students will tend to experience STEM as a homophilous environment in which their sexual and gender identities will not be as salient as they are for their LGBTQ peers. Educators are challenged to imbue students with the notion that LGBTQ inclusion should be considered a professional norm in engineering.

The politicization of LGBTQ identities, however, makes this an incredibly challenging task. Many engineering students adhere to the ideology of depoliticization [26], that engineering should be an apolitical space to allow the best innovation to occur without the introduction of special interests. Others hold strong views on LGBTQ issues that are informed by social or religious perspectives which argue sexual and gender diversity are harmful to society and should be eradicated. Tying openness to diversity as a professional value, rather than requiring students change their fundamental beliefs, can be an entry point to helping students treat their LGBTQ peers differently. Focusing on behaviors, rather than beliefs, can also help as well, that treating their peers with respect is more important than whether they agree with them or not. Of course, most engineering faculty do not have the training or experience to foster these kinds of conversations either, though professional development in LGBTQ allyship (Safe Zone training) and intergroup relations could help faculty enter these conversations [40].

Engineering faculty can help improve self-concept fit by incorporating LGBTQ-inclusive elements into their learning environments, through diversity statements in syllabi, Safe Zone placards on office doors, and the inclusion of pronouns in one's email signature. Each of these symbolic steps helps interrupt the standard STEM learning environment which can appear to be "identity-neutral" or even "identity-free" by demonstrating explicit attention to LGBTQ inclusion. Sexual identity in particular can be difficult to discern in an individual, so it's difficult for any given instructor to know which students may be facing lower self-concept fit on the basis of sexual or gender identity. Visible symbols help reduce the uncertainty LGBTQ students may have about how welcoming or hostile the environment may be.

Faculty can also increase goal fit through considering the multitude of reasons for which students pursue engineering. Research has long showed that all students may have altruistic or socially beneficial reasons for which they are pursuing study in a STEM field, and that minoritized students are even more likely to pursue STEM to be able to help others over reasons such as a

well-paying salary, high-status occupation, or individual interest in the topic [41]. Learning about the reasons different students are pursuing STEM and tailoring content to show a wide applicability of STEM concepts to different problems helps students find goal fit with why they are studying STEM and how they prefer to learn STEM (e.g., independently, collaboratively, competitively). Fletcher and Everly offer a host of recommendations for supporting LGBTQ people in the workplace [42], many of which are applicable to the STEM learning environment as well.

Researching Authenticity in STEM

Viewing the experiences of LGBTQ STEM students through a framework of network homophily and authenticity leads to potential new directions for engineering education research as well. One promising direction for research then to better understand LGBTQ participation in engineering is social network analysis [43], which helps demonstrate the relationship between network composition and various affective and behavioral outcomes achieved by students. Egocentric social network analysis, which allows us to glimpse a small subset of students' social networks, can help reveal how the inclusion of certain people as central actors in one's network relates to greater or lesser authenticity within STEM. Whole network analysis can reveal the complex interrelationships among students within a department, college, or university, as well as how their location within the network is reflective of their social identity group memberships and leads to differential access to psychological states like authenticity.

The SAFE (State Authenticity as Fit to Environment) model itself offers both a conceptual framework for understanding how environments provoke authenticity as well as a path for operationalizing authenticity for research purposes [8]. Fletcher and Everly incorporated state authenticity into their study on LGBTQ experiences in the work environment, showing that LGBTQ people's well-being at work was supported by their sense of authenticity, which flowed from LGBT supportive practices that helped people be more likely to disclose LGBTQ identities, which in turn was also moderated by the extent to which LGBTQ identity was central for them [42]. State authenticity also offers promising new directions for research on broadening participation in STEM more generally in that the original paper argues that social identities are a primary source of information regarding how one fits into any given environment. Authenticity would be one factor among many to understand how people experience the climate in STEM and the kinds of practices that would enable a more diverse range of people to succeed in STEM.

Conclusion

Engineering and other STEM fields recognize the need to train and support a more diverse workforce to improve innovation and solve complex social problems. To do so, these fields must overcome the continued effects of historic (and contemporary) exclusion of and discrimination against people minoritized in STEM. LGBTQ people have long been minoritized in STEM, and efforts to better understand and improve their experiences have only gained traction in the past decade. This paper advances a conceptual framework to better understand the experiences of LGBTQ people in STEM to point to new directions for research and practice in meeting the needs of LGBTQ engineering students. Social network theory helps us understand the role that

demographic homogeneity in the engineering learning environment plays in shaping the experiences of LGBTQ engineering students, and state authenticity reveals a psychological need that advantaged people often take for granted that minoritized people typically do not enjoy in STEM. Together, these two frameworks not only help reveal how STEM is structured to benefit those in advantaged groups and repel people in minoritized groups, but also point to existing and new directions for research and practice to overcome these structural barriers. Engineering needs to transform into an environment where LGBTQ people can thrive through authentic participation if engineering fields hope to benefit in the myriad ways promised by professed vision and value statements throughout the field.

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