

From Diversity to Inclusion: Centring the Voices of Undergraduate Engineering Students

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Résumé de l'article

Certains programmes de premier cycle en ingénierie au Canada font état de 30 à 40 % de femmes inscrites. La théorie du point de bascule de Kanter soutient que les femmes sont moins réduites au rôle de « jetons » quand elles constituent au moins trente pourcent de la population d'un groupe. D'autres chercheurs ont constaté que, dans des situations comparables, les femmes continuent d'être victimes de discrimination, d'hostilité et de concurrence. Cette étude critique fournit des preuves supplémentaires contre l'idée d'un point de bascule en matière d'équité, en se concentrant sur les expériences d'étudiants de premier cycle traditionnellement sous-représentés dans une faculté d'ingénierie comptant trente-cinq pour cent de femmes inscrites. Une analyse thématique réflexive des expériences partagées par les femmes, les étudiants racisés, les étudiants 2SLGBTQ+ et les étudiants ayant un statut socioéconomique inférieur a révélé des cas de discrimination, des perceptions variables des capacités et un accès inéquitable aux services de soutien, à la communauté et aux rôles de leadership sur le campus. Par conséquent, les établissements doivent reconnaître les expériences intersectionnelles des étudiants et œuvrer à changer la culture du campus en plus de leurs efforts de diversité.

FROM DIVERSITY TO INCLUSION: CENTRING THE VOICES OF UNDERGRADUATE ENGINEERING STUDENTS

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Abstract

Some Canadian undergraduate engineering programs report 30–40% of enrolled students are women. Kanter's tipping point theory argues that women become less tokenized when they make up 30% of a group's population. Other scholars have found that in comparable situations, women continued to experience discrimination, hostility, and competition. This critical study provides further evidence against a tipping point for equity by centring the experiences of traditionally underrepresented undergraduate students studying at a faculty of engineering with 35% women undergraduates enrolled. Reflective thematic analysis of experiences shared by women, racialized students, 2SLGBTQ+ students, and students from lower socio-economic statuses found instances of discrimination, varying perceptions of capabilities, and inequitable access to support, community, and on-campus leadership roles. Therefore, institutions need to acknowledge the intersectional experiences of students and work toward changing campus culture in addition to diversity efforts.

Keywords: inclusion, diversity, intersectionality, undergraduate engineering education, student experience

Résumé

Certains programmes de premier cycle en ingénierie au Canada font état de 30 à 40 % de femmes inscrites. La théorie du point de bascule de Kanter soutient que les femmes sont moins réduites au rôle de « jetons » quand elles constituent au moins trente pour cent de la population d'un groupe. D'autres chercheurs ont constaté que, dans des situations comparables, les femmes continuent d'être victimes de discrimination, d'hostilité et de concurrence. Cette étude critique fournit des preuves supplémentaires contre l'idée d'un point de bascule en matière d'équité, en se concentrant sur les expériences d'étudiants de premier cycle traditionnellement sous-représentés dans une faculté d'ingénierie comptant trente-cinq pour cent de femmes inscrites. Une analyse thématique réflexive des expériences partagées par les femmes, les étudiants racisés, les étudiants 2SLGBTQ+ et les étudiants ayant un statut socioéconomique inférieur a révélé des cas de discrimination, des perceptions variables des capacités et un accès inéquitable aux services de soutien, à la communauté et aux rôles de leadership sur le campus. Par conséquent, les établissements doivent reconnaître les expériences intersectionnelles des étudiants et œuvrer à changer la culture du campus en plus de leurs efforts de diversité.

Mots-clés : inclusion, diversité, intersectionnalité, formation d'ingénieur de premier cycle, expérience étudiante

Introduction

Women (Engineers Canada, 2020b; Franklin, 1985), racialized students—in particular Black and Indigenous students (Blosser, 2020; Burke et al., 2021; Engineers Canada, 2021; Fletcher et al., 2017)—and 2SLGBTQ+ students (Cech & Rothwell, 2018; Cech & Waidzunas, 2011; Hughes,

2017) are all typically underrepresented in engineering education. Because the underrepresentation of women in engineering has received the most attention over the decades (Blickenstaff, 2005; Franklin, 1985; Rincón & George-Jackson, 2016), the number of women in engineering programs has been used as a marker of diversity. Post-secondary engineering programs have adopted Engineers Canada's

benchmark of 30% women as a goal for their diversity efforts (Engineers Canada, 2020b; Franklin, 1985), with some universities having reached enrolments of 30–35% women in their undergraduate engineering programs. The Engineers Canada *30 by 30* campaign set out to have 30% of licensed engineers be women by 2030 because 30% has been argued to be a “universally held ‘tipping point’ for sustainable change” (Engineers Canada, 2020a).

Some scholars have tied sexism and the unwelcoming environment for women in engineering to the underrepresentation of women in the field (Blickenstaff, 2005; Franklin, 1985; Rincón & George-Jackson, 2016), while others believe it is a result of a systemic culture based on the inequitable belief that engineering is meritocratic and apolitical (Cech, 2013; Seron, 2018). Studies have shown that engineering programs are also not inclusive for Black students (Berhane et al., 2020; Blosser, 2020; Fletcher et al., 2017), Indigenous students (Smith et al., 2014), and 2SLGBTQ+ students (Cech & Waidzunus, 2011; Hughes, 2017), and that these students may struggle to find a sense of belonging in engineering. Furthermore, since racialized women (Ong et al., 2020) and racialized 2SLGBTQ+ students (Berhane et al., 2020; Cech & Rothwell, 2018) often experience discrimination and othering while studying engineering, a deeper examination of the use of tipping point theory using the voices of underrepresented students is needed.

Tipping point theory has only been applied to gender equity in engineering program enrolment, likely because other demographic data (e.g., race, sexual orientation, socio-economic status, etc.) are not typically collected and/or published by Engineers Canada or post-secondary institutions in Canada. Few Canadian engineering education researchers also consider aspects of identity other than gender. However, Black feminists have proven that broad, non-intersectional movements, like the *30 by 30* campaign, most benefit white, affluent, straight, able-bodied, cisgender women, and often exclude racialized women, 2SLGBTQ+ women, poor women, women with disabilities, and many other intersections of identities and power (Davis, 1982; Smith, 2000; Taylor, 2017). Black feminists argue for an intersectional approach, which acknowledges that individuals with different identities experience multiple forms of oppression differently (Collins, 2009; Crenshaw, 1991). Therefore, intersectional dynamics of privilege and oppression within the dominant group culture likely need to be considered in addition to increased diversity.

There has been little research on whether reaching 30% women enrolled in engineering programs has changed the

experiences of engineering students. By centring the experiences of traditionally underrepresented students studying in a faculty of engineering where 35% of undergraduate students were women, this study sought to better understand: (1) the lived experiences of traditionally underrepresented engineering students at a faculty that had over 30% women enrolled, and (2) whether these experiences support a proposed tipping point for equity at 30%. For this study, I took an intersectional approach and considered race, sexual orientation, socio-economic status, and gender. This approach expands the scope of previous studies on tipping point theory and contributes to the literature on the intersectional experiences of traditionally underrepresented engineering students in Canada.

The Tipping Point of Gender Equity

Rosabeth Moss Kanter first proposed a tipping point for gender equity in her book *Men and Women of the Corporation* (1977). Kanter (1977) argued that when corporate environments are 15–35% women, women gain access to power and can change group dynamics and culture. Building off Kanter’s work, Dahlerup (1988) found that as the number of women in Scandinavian politics increased, they were more able to form supportive alliances and influence policy development even before reaching binary gender parity. Dahlerup (1988) theorized that this change occurred when women made up 30% of the group’s population. However, she noted that the exact ratio where group dynamics shifted is difficult to identify and that factors like societal attitude must also be considered (Dahlerup, 1988).

Since the proposal for a tipping point in gender equity there has been a widespread uptake by activists and institutions to meet this goal. Affirmative action for binary-gender diversity is widely used in many sectors (Childs & Krook, 2008). In my experience as a student affairs professional and engineering educator who has worked in engineering admissions, practices grounded in affirmative action, such as admissions quotas, are not common, if employed at all. However, institutions have made significant investments in outreach initiatives to increase the number of women studying engineering through programs like Go ENG Girl (Ontario Network of Women in Engineering, 2022).

Critiques of a Tipping Point for Gender Equity

In contradiction to Kanter’s findings, studies of male-dom-

inated fields have found that discrimination, hostility, and competition increased as the number of women increased (Lewis & Simpson, 2012; Paxton et al., 2007; Rosenthal, 1998). Instead of disrupting the dominant culture, women upheld and reinforced existing group norms to gain more favour within male-dominated groups (Lewis & Simpson, 2012). Men continued to hold the most power and were more likely to promote women who distanced themselves from other women and adopted more stereotypically masculine behaviours, which resulted in some women adapting to the dominant culture to gain power (Lewis & Simpson, 2012); therefore, a tipping point of 30% may not account for the women who assimilate to the dominant culture. Other scholars argue that more research examining how power dynamics change within a group is needed instead of focusing on when change occurs (Childs & Krook, 2008). By identifying members of the group with traditionally more power and dominance, the responsibility for changing group dynamics is shifted away from members who are traditionally underrepresented (Childs & Krook, 2008). These findings further suggest that changes to group culture could occur regardless of the number of traditionally underrepresented people within the group.

Methods and Participants

In undertaking this critical phenomenological study, I centred the experiences of oppression and power to identify and change injustices (Guenter, 2019) at a faculty of engineering where 35% of the undergraduate students were women to explore whether a tipping point of equity had influenced the lived experiences of traditionally underrepresented engineering students. To examine the multiplicative effects of power and oppression experienced by participants due to their gender, race, sexual orientation, and socio-economic status, I used intersectional analysis (Collins, 2009; Crenshaw, 1991).

After research ethics board approval and with participant written consent, I collected qualitative data from 19 undergraduate engineering student participants through an online survey. I asked participants to describe their experiences in engineering education and how their identity has or has not influenced these experiences. At the end of the survey, participants could opt into an individual interview. Nine of the participants completed an interview. I collected survey and interview data from October 2019 to February 2020; the stories shared reflected in-person student experiences both in and out of the classroom. Participants could

decline to answer any of the survey or interview questions, and participants were able to withdraw at any time during the study. I used the Braun and Clark (2006, 2013) method for reflexive coding to code the survey and interview data and interview in NVivo. Through a thematic analysis of the coded data, I found three themes: (1) evidence of continued sexism in the student experience, (2) group members upholding the dominant culture, and (3) the intersectional experiences of traditionally underrepresented men.

For each participant, one or more aspects of their self-declared identity would be considered traditionally underrepresented in engineering education. Participants were enrolled in a range of years of study, from first year to fourth year, and in nine different engineering disciplines. Year of study and engineering discipline were not disclosed in this article to help maintain participant privacy. Table 1 provides a summary of the participant identities and their pseudonyms.

Researcher Positionality

My positionality as a researcher is informed by the privileges and oppressions I experience in the normative socio-political power structures that exist in Western culture. As a white, straight, able-bodied, cis-woman settler of European descent, with an invisible disability, from an upper-middle socio-economic background, I am afforded privileges because of my whiteness, socio-economic status, heteronormativity, and perceived ability. These privileges are not all shared by all participants in this study. I am a student affairs professional who has primarily worked in engineering education, but I have never been an engineering student. I recognize that I am attempting to better understand and share the experiences of students that are different from my own. During this study, I worked to decentre my privileges by being transparent with participants about the purpose of this study and how their stories would be used. Participants had autonomy over how they participated and what they shared. I used a reflexive approach to data analysis to ensure my biases were acknowledged throughout the research process.

Findings and Discussion

The findings from this study align with previous critiques that argue against tipping point theory. Participants described experiences of sexism and their stories provided examples of how traditional power dynamics and cultural norms were upheld, despite being enrolled at a faculty of engineering

Table 1

Summary of Participant Identities Including Gender, Race, Sexual Orientation, Disability, and Socio-Economic Status

Pseudonym	Race/Ethnicity	Gender	Sexual Orientation	Disability	Socio-Economic Status
Aimee	Southeast Asian	Woman	Straight	No	Lower-middle
Alicia	Black	Woman	Straight	No	Middle
Ashley	White	Woman	Straight	No	Upper-middle
Carlos	Latinx	Man	Chose not to disclose	Yes – Invisible Disability	Middle
Catherine	White	Woman	Straight	No	Upper
Chris	White	Transgender man	Pansexual	No	Upper-middle
Haima	South Asian	Woman	Straight	Yes – Invisible Disability	Middle
Jianyu	East Asian	Man	Gay	No	Upper-middle
Kelly	White	Woman	Pansexual	No	Middle
Kiran	South Asian	Man	Straight	No	Lower-middle
Laura	White	Woman	Straight	No	Upper-middle
Mae	Black	Woman	Straight	No	Upper-middle
Michael	Black	Man	Straight	No	Lower
Sarah	White	Woman	Questioning	No	Upper-middle
Shreya	South Asian	Woman	Straight	No	Lower-middle
Soomin	East Asian	Woman	Questioning	Yes – Invisible Disability	Upper
Vanessa	Black	Woman	Bisexual	Yes – Invisible Disability	Middle
Zak	Chose not to disclose	Man	Straight	No	Lower-middle
Zoe	South Asian	Woman	Straight	No	Middle

where 35% of the undergraduate students were women. In addition, traditionally underrepresented men described intersectional experiences of marginalization. These findings suggest that more work is needed beyond increasing gender diversity if the desired goal is to increase inclusivity and equity in the undergraduate engineering student experience.

Experiences of Sexism in Engineering Education

Women in this study described experiences of sexism on campus. These findings are similar to other critiques of tipping point theory where sexism persisted and even increased after the tipping point of gender equity was reached (Paxton et al., 2007; Rosenthal, 1998). Aimee and Laura discussed feeling shocked and uncomfortable when they

heard that a professor made a joke about a woman being raped to a classroom full of students. This professor behaved this way despite the increased presence of women on campus and this suggests that change in diversity has not resulted in a culture change at this faculty.

Sexism was also described in peer-to-peer interactions. Laura said women were discouraged from participating in activities in her program's common room, making the space less welcoming to women. As a result, Laura and some of her peers avoided the student common room altogether. When they tried to start an identity-based affinity group to provide a more supportive space for women in the program, the men in the program reacted by making a similar group as a joke. As Laura described, "[the affinity group] has been hated on by male students...it's not like confrontational it's just undermining the requests and the needs of students." However, I would argue the response from the men in this program was confrontational, as it blatantly mocked, othered, and marginalized their experiences as women in their engineering program.

The need for an affinity group indicates that women students were not able to fit in or find needed support from the available community (Berhane et al., 2020; Blosser, 2020; Cech & Rothwell, 2018; Hughes, 2017). The need for affinity groups contradicts tipping point theory, which argues that, at 35% of the group, women should have access to the in-group experience and be able to build supportive relationships (Dahlerup, 1988; Kanter, 1977). Instead, Laura's experiences indicated that women in this program were excluded and othered, similar to studies that found that men may fight to maintain their power (Lewis & Simpson, 2012) increasing hostility and competition toward women in the group (Paxton et al., 2007; Rosenthal, 1998). Laura and Aimee's experiences of sexism demonstrated that there seemed to be few consequences for sexist behaviour, and implied that the dominant culture continued to allow for sexism to occur, despite the gender diversity in the student community at their faculty.

Sexism and Social Identity Threat

Social identity threat puts certain identities at risk of being devalued in a certain context (Steele et al., 2002). In engineering education, women who interact with sexist men can feel devalued and uncertain (Logel et al., 2007). Not all women in this study described sexist behaviour; however, many described impacts of social identity threat, including the need to prove themselves, feeling less capable, ques-

tioning their accomplishments, and feeling like assumptions were made about their intelligence due to their gender. For example, Soomin said, "As a female, I feel that I must work harder than my male counterparts to show my skillset and prove that I can fit in." Similarly, Aimee shared that:

As a woman of minority race in the program, I do feel that I have to prove myself more to show that I deserve to be in this program. This has led me to be quiet of the marks I receive or avoid asking for help because I'm afraid of looking weak in front of the men in my program. The women I've met in the program who are verbal about the difficulties they face in the program have received backlash from the men, and I get frustrated with it.

Catherine described how she thought others made assumptions due to her gender: "I do think some people may subconsciously assume things about my intellect, interests, opinions because of how I look." As a result, she questioned whether she had earned her scholarship or received a scholarship because of her gender. Haima also questioned her capabilities as an engineering student, saying that she "felt less capable because of my identity." These narratives indicate men continued to hold a place of power within this faculty that women compared themselves to, instead of having equal access to power, as would be expected according to tipping point theory.

Another indication that sexism was part of the student experience in this study was in the advice Ashley gave to future students: "Know that you are here for a reason, and you deserve to be here just as much as anyone else. You are smart, your opinions are valid, so don't be afraid to share them." The need to uplift other women and remind them that they deserve to be engineering students, and that they are smart with valid opinions implies that Ashley may have witnessed or experienced behaviour where her or her peers' abilities have been questioned or denigrated by others. The narrative of questioning capability, needing to prove oneself, and the desire to uplift other women indicates women were likely still marginalized and othered because of their gender.

In addition, these experiences indicate that the impact of sexism is intersectional. Soomin and Aimee's experiences align with the literature that demonstrates that racialized women experience racism and sexism intersectionally in engineering (Ong et al., 2020). Studies on ableism in post-secondary education describe how systems for receiving accommodations in post-secondary education

often promote stigma and secrecy, othering students with disabilities (Dolmage, 2017). Haima might be questioning her capabilities because of the intersectional impacts of her gender, race, and disability, which supports an argument for more intersectional approaches to creating inclusive campuses in engineering education; increasing gender diversity and addressing sexism alone may not address the impacts of intersectional social identity threat.

Unequal Representation in Engineering Education

Sexism was also observed in narratives that exemplified how gender diversity was not equitable across engineering disciplines. Sarah said that the efforts to recruit more women into engineering had not yet translated to more women professors or graduate students in her discipline. For Sarah, it was “harder to visualize a future path for yourself without immediate models.” In her interview, Sarah shared that she was almost halfway through her degree and had never had a woman professor or teaching assistant. She understood that these changes take time, but this experience highlights how, in many ways, engineering education is still not diverse, and that students recruited into engineering may not have role models who look like them at this time. Therefore, better pathways to connect women students to role models are needed.

The proportion of women studying engineering varies by discipline in Canada, and these differences can impact the success of women students (Sweeney, 2020). The differences of diversity between engineering disciplines could be in part due to the influence of faculty members whose own conscious and unconscious biases of gender (Blosser, 2017) and race (McCoy et al., 2017) may influence student perceptions of, and the culture within, different engineering disciplines. While institutions consider how to better support students who may not have role models who look like them on their campuses, institutions also need to address implicit and explicit biases to ensure more consistent results across disciplines.

Hypervisibility: The Intersection of Sexism and Racism

Finally, sexism appeared in this study as hypervisibility. In Vanessa’s survey responses, when asked how her identity advantaged and disadvantaged her in engineering education, she replied “attention” to both questions. With a single word, Vanessa was able to express how hypervisible she was as a Black woman studying engineering. Racialized

women often experience hypervisibility on predominantly white campuses and can attract unwanted attention in the form of surveillance and/or by being asked to do more labour while representing their gender and race in equity initiatives or through other unwanted leadership roles (Blosser, 2020; Mirza, 2015; Ong et al., 2020). Vanessa described similar pressures placed on her as a Black woman engineering student; when asked how her identity impacted her experience, she wrote the following in her survey response:

More pressure feels like I’m representing everyone who looks like me and if I act off or perform badly then it’s like I’m disappointing everyone who looks like me including myself because now there’s a bad impression of who we are to other people who think we all act the same as opposed to me just having a bad day.

Vanessa also said her visibility could be an advantage, which may be due to increased opportunities she was able to access. Shreya, a South Asian woman, similarly said, “It is actually better because I am a woman, and there are more opportunities.”

Increased access to opportunities does align with tipping point theory; however, Vanessa’s experiences of hypervisibility resulting in increased attention and pressure indicated that she continued to be tokenized and othered, directly contradicting Kanter’s (1977) theory, which would argue that Vanessa should be a full-group member and no longer tokenized. Vanessa’s hypervisibility could be in part because engineering is not only traditionally male but also white, and as a Black woman, Vanessa was marginalized because of her race. Therefore, diversity efforts focused on women broadly have not decreased her visibility as an engineering student because they have not considered the impacts of race or how racism occurs in the dominant culture of engineering education.

Upholding the Dominant Culture

Students in this study described how students in the program upheld the dominant normative culture. Aimee shared that all her friends were men and that she tried to fit in more than other women. She said, “I can tell the women are very quiet in this program, so I try to be different from that and be friendly or engage more in conversation...to show that I’m capable of anything.” In groups where men control the dominant culture, women, like Aimee, may try to distance themselves from other women and adopt cultural norms to gain

ingroup access (Lewis & Simpson, 2012). In this example, Aimee was rewarded with friendship and felt included by her peers. Even though this outcome is positive, it speaks to the need for women to adapt to the existing group culture or risk exclusion. Aimee's story indicates that women continue to seek equity in this program despite women making up 35% of students enrolled. This story supports the argument to determine how culture shift occurs and who is positioned within the group to lead cultural change (Childs & Krook, 2008).

One of the participants, Zak, was aware that he had the power to lead change in his design team. Zak held a leadership position on a student-led design team, and he tried to recruit women into similar leadership positions. Zak made these efforts because he believed in creating more equitable opportunities for women. However, men are more likely to recruit and promote women in leadership positions who adopt the cultural norms of the group, blocking group efforts for cultural change (Lewis & Simpson, 2012); this could be why, despite the increase of women studying at this faculty of engineering, sexism and other forms of discrimination continued to occur. Institutions need to expand their scope beyond access to engineering education and consider access to opportunities after admission, acknowledging and working to dismantle barriers to leadership opportunities.

Traditionally Underrepresented Men and Intersectionality

The focus on women seems to have resulted in a lack of research about the experiences of traditionally underrepresented men in undergraduate engineering programs in Canada. However, literature from the United States demonstrates that some racialized men (Berhane et al., 2020; Blosser, 2020) and 2SLGBTQ+ men (Cech & Rothwell, 2018; Hughes, 2017) have been traditionally underrepresented and marginalized. Similarly, men in this study also felt excluded and othered due to their race, sexual orientation, socio-economic status, and, in one case, gender.

In critiques of tipping point theory, women were more likely to be given power if they adapted to the dominant culture (Lewis & Simpson, 2012). But what about men who were excluded from the dominant culture? Michael's experiences as a Black man in engineering indicated the same could be true for racialized men. Michael felt excluded from the dominant peer group because he was Black, and that his race limited his access to peer-selected lead-

ership roles. He described not wanting to, or being unable to, adapt to the white culture in his program when he said, "My race has inherently impacted my desire to get involved in certain activities I don't holistically feel a part of since the demographic is more geared towards a majority of white students." Similar to Laura, Michael was not interested in adapting to the dominant culture. Instead, he was able to find community in a Black engineering student group. His gender did not preclude his need for a safer, more inclusive space outside the dominant culture, indicating that being part of the majority gender does not result in gaining access to all student experiences available.

Other men who felt excluded from the dominant culture felt they needed to hide parts of their identity. For example, Kiran felt "intimidated" when he started studying engineering because he was one of the few students from a "blue-collar" family in his program. He shared, "I struggled early on with feeling like I didn't belong and that I wasn't meant to be an engineering student. I also found it harder to connect with other students initially." He also experienced discrimination when students joked disparagingly about Uber drivers, not knowing his father was a taxi driver. Due to these experiences, Kiran did not share his socio-economic status with his peers.

Similarly, Jianyu recognized that, as an East Asian man, he shared the racial and gender identity of many of his peers. However, he felt that "being semi-openly gay" influenced his experiences, saying, "I just probably would just have had some different experiences had I been straight." Jianyu shared that it took him a long time to come out as a gay man at school, and still only disclosed this information to his friends because engineering was "majority-male." Chris also described being privileged because he was a white cis-passing transgender man. In his survey response Chris said:

The parts of me that have shaped my experience in engineering in the most unique ways are being bisexual and transgender. Especially with being trans, since I'm not out to most people, lots of it is internal.... I've also become aware of some exclusionary attitudes, mostly not directly though, from other students.

Like Jianyu and Kiran, Chris did not feel comfortable sharing parts of his identity that were less visible with his peers. Similar to how women receive more power if they adopt cultural norms and uphold the dominant group culture (Lewis & Simpson, 2012), these findings indicate the same may be

true for some marginalized men who are looking to maintain the privileges their gender affords them.

Carlos was a Latino student, who described himself as white passing. Carlos was cis-gendered, straight, and from a middle socio-economic status, and also described experiences that further supported this argument. Unlike his peers, Carlos believed identity should not matter in his undergraduate engineering program, and stated that he had never experienced any discrimination. It seems that his race and gender afforded Carlos certain privileges, allowing him to exist in the dominant culture more seamlessly than some of his peers. This narrative also indicates that the dominant culture in engineering education is not only male but also white, heteronormative, and affluent, providing evidence for more intersectional approaches in efforts to diversify and increase inclusion in engineering education.

If racialized men, 2SLGBTQ+ men, and men from lower socio-economic statuses do not have equitable access to the dominant group culture, it is unlikely that increasing the number of women in engineering will result in equity for women who are racialized, 2SLGBTQ+, and from lower socio-economic statuses. Again, this demonstrates a need for more research that can identify who has the power to change group dynamics and how change to group culture occurs (Childs & Krook, 2008). The experiences of traditionally underrepresented men and women in this study indicate that increased binary gender diversity alone will likely not result in increased equity or inclusivity.

Mitigating Discrimination and Better Supporting Traditionally Underrepresented Students

Although students in this study experienced marginalization and discrimination, many also spoke positively about the opportunities available to engineering students. For instance, Zoe “had an opportunity to do a summer internship” that allowed her to learn about “machine learning, artificial intelligence and various technologies” related to a network software course she was taking. Other students participated in design teams and clubs that afforded community building and professional development. Michael, Kiran, and Zak said that these experiences increased their learning. As Laura describes, her extracurriculars gave her “many positive experiences working with faculty members, other students, and members of the community at large.” Similarly, Aimee felt welcomed by her peers during orientation week.

It is possible that, a decade ago, studying engineering would have been out of reach for these students because of their gender, race, and/or socio-economic status. These stories demonstrate the need for diversity initiatives and that they can be successful when students are able to find supportive connections within the campus community. However, the need for affinity groups and the described barriers for access to mentors showed that access to community was still not equitable for all students, and therefore, educators need to do more to create inclusive learning environments in faculties of engineering.

The findings from this study indicate that faculties of engineering and post-secondary institutions more broadly need to take an intersectional approach to their equity, diversity, and inclusion initiatives. It is not sufficient to focus on one aspect of identity or form of discrimination at a time, making others wait for their turn to be included. So how do educators move forward and help shift the culture in engineering education?

I asked participants in this study to share how they felt their university could do more to support them. Kelly wanted more efforts to increase diversity in specific engineering disciplines that were still predominantly populated by men. Mae also wanted more Black students in her engineering program. Kiran voiced in his survey and interview that he wished he had more access to mentors who shared his race and background. The wants of these students speak to how diversity efforts for women and engineering education broadly may be limited. An intersectional approach that considers gender and discipline, race, and/or socio-economic status would likely better serve more underrepresented students.

This study demonstrates that traditionally underrepresented students continue to be marginalized, excluded, and othered, even though they have gained access to engineering education, which indicates implementing support for specific groups of students would be beneficial. For example, Chris wanted better support specifically for 2SLGBTQ+ students. While he appreciates the community his peers have created, he would like to see more mental health supports, discussion groups, and career resources specifically for 2SLGBTQ+ students. He wanted his university to take more concrete actions that acknowledge the challenges 2SLGBTQ+ students face in engineering, suggesting the resources available to him are not serving him as well as they should be.

Studies have found that Black and 2SLGBTQ+ students often find their community outside the dominant culture

and in identity-based affinity groups (Berhane et al., 2020; Blosser, 2020; Cech & Rothwell, 2018; Hughes, 2017), and this was also true of students who participated in this study. Alicia and Mae, two Black women, both described finding community with students who were like them. Michael shared how he found community in the Black engineering student group at his university, which helped him “reach out to other Black students and connect with the larger Black community” at his university. Chris, Kelly, and Sarah described finding a strong community in the 2SLGBTQ+ engineering student group at their university. Chris noted, in one of his survey responses, that the 2SLGBTQ+ group was “created out of necessity” by students who were feeling isolated and alone. Students in this study sought out communities with students who shared aspects of their identities that continue to be underrepresented in engineering education. While the culture in engineering continues to privilege white cisgender men, the students in this study voice a need for resources and communities for racialized and/or 2SLGBTQ+ students. These students deserve more equitable access to supports and community to thrive in educational systems that were not built for them.

At an even more fundamental level, institutions need to listen to traditionally underrepresented students even if their campuses are seemingly diverse. Aimee had ideas about what her university could do, but did not know how or where to share them. She said, “I hope they reached out more to us and listen to what we have to say in private. There’s a lot of amazing ideas we have, but we do feel that as a minority, we have nowhere to share it, so it leads to us being quiet.” Colleagues often ask me, “But what can I do to foster inclusivity?” and these findings suggest that engaging in dialogue and listening to students could be a place to start.

These responses demonstrate that faculties of engineering could do more to acknowledge the challenges some students face and work to take specific actions to better support these students. More intersectional recruitment efforts, resourcing the creation of affinity groups, and, most importantly, actively seeking out, acknowledging, and listening to student experiences will help faculties of engineering move toward creating more inclusive practices and communities instead of only increasing one aspect of diversity.

For equity, diversity, and inclusivity initiatives to be effective, senior academic administration and individual faculty members must act to implement change (Whittaker & Montgomery, 2014). In addition, if the behaviours of individuals do not align with values of the institution, then equity, diversity, and inclusivity initiatives will be counterproductive

and ineffective (Allen-Ramdial & Campbell, 2014). Faculty members and senior administrators must lead and invest in a realignment of values and behaviours for diversity initiatives to be successful (Allen-Ramdial & Campbell, 2014). Therefore, for initiatives like the ones suggested by students in this study to be effective, faculty members must take an interest in actively working toward culture changes on campus that will better support traditionally underrepresented students.

Limitations

This study does not include all perspectives from traditionally underrepresented students in engineering education. There were no transgender women, non-binary students, students with visible disabilities, or Indigenous students who participated in this study, and their perspectives, stories, and experiences are a significant gap in the findings of this article. The participant sample was also limited in that it only considered students in a specific faculty at one institution, and therefore may not reflect the experiences of engineering students at other institutions or students studying subjects outside of engineering. Nevertheless, the stories shared by participants in this study articulate important narratives regarding the experiences of some traditionally underrepresented students in programs that have seen an increase of diversity. These narratives contribute to the literature on the experiences of underrepresented students studying engineering in Canada. The findings in this study can be used by practitioners, both within engineering programs and education more broadly, to develop and implement policies and programming to better support traditionally underrepresented students in post-secondary education in Canada.

Conclusion

A tipping point for binary gender equity implies that change will occur through access and representation, and that this change will be equal for all. However, this article supports previous research, which indicates that discrimination, othering, and exclusion will continue on even in faculties of engineering that have crossed the “tipping point” for gender equity without further efforts to change the dominant culture beyond changing diversity. For diversity and equity initiatives to be effective they must be intersectional and work to change persistent normative practices on campuses. Post-secondary institutions in Canada and future research

need to consider how culture change occurs, instead of using diversity as a metric for when inclusion will occur.

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