Engineering Students’ Experiences of Socially-mediated Exclusion and Inclusion: Role of Actors and Discourses

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**Background** – In the Department of Mechanical Engineering, the underrepresentation of female students and racialized minorities is consistently pronounced in its undergraduate enrolment. The department is placed within an engineering school that has been actively implementing equity, diversity and inclusion (EDI) strategies, from high school outreach to undergraduate research, extracurricular events, peer mentorship and unconscious bias training for hiring committees. A larger study on the design learning in our program has led to a smaller study of EDI-related student experiences and perspectives from both the dominant and minority groups in Mechanical Engineering.

**Purpose/Hypothesis** – This paper aims to help enhance institutional EDI efforts by identifying the role of adults and peers in the engineering students’ experiences of exclusion and inclusion. Three questions are posed: (1) What pre-university experiences create barriers to pursuing engineering? (2) What helped youth pursue and enter engineering programs? (3) In what ways do the current engineering students experience inclusion or exclusion in their program?

**Design/Method** – Thematic analysis and rhetorical analysis were applied to the student interview data collected in 2018, as part of a larger study on engineering design education in our Department of Mechanical Engineering (2015-2019). Questions directly regarding EDI were incorporated into the semi-structured, in-depth interview design in 2018, as a result of the preliminary findings in previous years. Four male and three female undergraduate students in Mechanical Engineering participated in the individual, audio-recorded, 90-120 minute interviews in 2018.

**Results** – Engineering students of both dominant and underrepresented identities experienced different forms of exclusion before university. Students who successfully entered engineering programs had key adult figures who provided the emotional support and information resources needed in order to uptake, and see oneself as able to succeed in, the opportunities that lead to an engineering degree and career. During university, the role of peers’ behaviour, perception, and discourses became pronounced factors in either a sense of belonging or push out effect.

**Conclusions** – We recommend that the strategies toward an inclusive culture include: (1) Staff and faculty skills to actively enhance the collective social capital network for all students; (2) Shaping a plural and diverse dominant images of engineers by their recognition in the curriculum and discourses; and (3) Behavioural approach to diversity, in developing expectations and skills to establish mutual respect among peers.
1. Introduction

Underrepresentation of population groups sharing certain demographic background – e.g. gender, race, ethnicity, socioeconomic status, ability, age – has been an important topic of study under the institutional commitment to equity, diversity and inclusion (EDI) in our engineering school. In an ideal world, the EDI programs could focus on maximizing the value of having individuals contribute and learn from different abilities, histories, perspectives, values, personalities, and the like. However, we are situated within the troubling broad patterns of persistent systemic inequalities and stereotype biases that continue to privilege some and disadvantage many others by their socially constructed identities - historically associated with particular socially constructed identities such as gender, race, immigration history, socioeconomic class, ability, and more. Especially given the very diverse demographics of the local population surrounding our institution, the lack of proportionate representation of diversity in our program’s undergraduate cohorts signals the presence of systemic barriers. This motivates us to investigate the mechanisms and processes by which individuals can be excluded or included in our engineering programs. The goal of having a better representation of many people groups is, in our context, synonymous to the goal of replacing the barriers that excluded underrepresented groups with actively inclusive practices.

Therefore the mechanisms of exclusion merit detailed investigations. Without understanding how individuals are being treated to shape a collectively patterned set of experiences, we run the risk of confusing the socially constructed identities (e.g. gender and race) as some innate ‘traits’ that are responsible for the individuals’ exclusion from engineering education (see Pawley’s problematization of individualized theories in the study of diversity [1]). For example, many studies have unpacked the mechanisms that unequally affect individuals based on gender in engineering [1]–[6]. These highlight the role of people’s behaviour in interactions and institutionalized processes, linked to many sources of perception including dominant images and narratives about engineers and engineering (e.g. beliefs about who has legitimate membership, gendered view of task types and their hierarchy in value).

Simultaneously, in order to avoid disregarding the agency of underrepresented individuals, we also seek to examine the mechanism and enablers of inclusion in the midst of systemic inequalities. For example, the role of social capital in first generation college students’ experience in engineering [7], can have parallels for gender, race, ethnicity, and/or immigration status. The meaningful differences in how women and students of color utilize different types of cultural capital [8] then provide us with more granularity in the processes of inclusion that the institution can actively support towards student persistence in engineering education [9].

The third area of examination is retention. Given the existing imbalance in representation among faculty, staff and students, we need to understand the potential push out and retention factors that might affect underrepresented students.

We take on a critical theory perspective on the study of the mechanisms of inclusion and exclusion, in the local experiences of our engineering students. We start with the acknowledgment that people of many backgrounds and diverse characteristics have excelled and contributed to the advancement of engineering, across the globe. Members of each ‘identity group’ are far from being homogeneous in their characteristics and perspectives.

Our institution desires to respond to the changing experiences and perspectives of our students in a timely manner. In order to support the continuous improvement of our institution’s EDI strategies, and to enhance the faculty’s ability to mentor students and establish an inclusive culture, we posed the following questions:
1. Have the students experienced any difficulties in pursuing postsecondary education in mechanical engineering?
2. What helped the students find their way into our engineering program?
3. In what ways do the current mechanical engineering students experience inclusion or exclusion in their program?

2. Methodology

2.1 Data Collection Procedures

In our larger study on design education and program improvement (2015-2019), a research assistant visited design course classrooms each year to recruit participants to a survey. One of the survey questions asked about the students’ interest in interview participation. Those who provided their email addresses in the survey were invited to an interview conducted near the end of the Winter semester or during the summer.

Following the interview findings regarding team project experience (2016), we posed new questions about peer relations in 2017. Findings from the 2017 interviews revealed topics related to equity, diversity and inclusion (EDI). New questions were included in 2018 interviews to explore EDI-related experiences and discourses. This paper focuses on the data from students who were interviewed in 2018. In summer 2018, the first author met with 4 male and 3 female students, to examine issues linked with inclusion and exclusion. This led to a greater understanding of the issues linked with gender, socioeconomic status, and race, as well as the discursive tensions around inclusion and peer relations. The interviews were audio-recorded and transcribed verbatim. Summaries of interview transcripts were created by coding each paragraph with its key themes and concepts. Memos were generated to describe emerging relationship between concepts.

Table 1. Participant Demographics, 2018 Interview Participants

<table>
<thead>
<tr>
<th>Pseudonym</th>
<th>Sex</th>
<th>Age Group</th>
<th>Program Level Completed by Summer 2018</th>
<th>Undergraduate Level*</th>
<th>Racialized as Non-White?</th>
<th>Underrepresented in the School?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cupcake</td>
<td>Female</td>
<td>20s</td>
<td>Second year</td>
<td>Junior</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Golden</td>
<td>Male</td>
<td>20s</td>
<td>Second year</td>
<td>Junior</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Iced Tea</td>
<td>Female</td>
<td>20s</td>
<td>Fourth year</td>
<td>Senior</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>John</td>
<td>Male</td>
<td>20s</td>
<td>Fourth year</td>
<td>Senior</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Snow</td>
<td>Male</td>
<td>20s</td>
<td>Fourth year</td>
<td>Senior</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Sunshine</td>
<td>Female</td>
<td>20s</td>
<td>Second year</td>
<td>Junior</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Tim</td>
<td>Male</td>
<td>20s</td>
<td>Second year</td>
<td>Junior</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

*Junior = Student has completed 1-2 design courses; Senior = Student has completed 3-4 design courses

Interviewees’ demographic information are included in Table 1 because of their importance on data analysis. In order to ensure anonymity, however, some background details (such as program level and age at the time of interview) have been removed or offered in categories/ranges. The interview data do not represent the entire student cohorts at our school. Data collection was
limited by the participant availability during the summer. Nevertheless, the in-depth interviews provided an opportunity to explore student perspectives on EDI at a greater depth, highlighting useful constructs for further investigation and allowing a deeper understanding of the problem of under-representation.

Excerpts from student interviews are labelled by their pseudonym and paragraph number on their interview transcripts. All included emphases were added manually.

2.2 Analytic Procedures

Adopting a critical perspective, we assume the following principles: problematize status quo, look at the use of language as clues to how ways of thinking and behaviour are structured, look for existing mechanisms of inequality, and look for creative alternatives for a more just/equitable outcome.

First, in order to describe what mechanisms of exclusion exist and become significant in student experiences, we looked for student accounts of their direct experiences (e.g. of barriers to full participation in engineering education). Students also reflected on their observations on the contrast between exclusion and inclusion. This resulted in the identification of: the location of representation gap that became influential; socially-mediated mechanisms that actually lead to excluding individuals.

Second, in order to explain the behaviours that contribute to the exclusion that under-represented students experience, we examined the discourses that were revealed in the student data. Discourses include rhetorics or themes that structure how we think about a topic, what issues become visible and invisible, which actors become visible and invisible, how the actors are portrayed. We examined both the participants’ own perspectives, as well as the discourses they noticed in their social environment. This resulted in the identification of the contentions around: the rhetoric of choice, of merit, and of success in engineering education.

Here we also present our positionalities, as they influence the way we interpret and the tools we use to analyze data. We are both first generation immigrants who pursued higher education in Ontario. We identify with the privilege associated with our educational attainment, and the influence we carry in our teaching roles. Ha (Author 1) is a racialized Asian female, and Harris and Czekanski (Authors 2 and 3) are identified as white male. We have participated in the unconscious bias training through our previous roles in hiring committees. We also adopted the Inclusion Lens tool to organize a national conference hosted at our institution. Author 1 has a multidisciplinary background with a master’s in Educational Contexts; Author 2 leads the general first year programming, Teaching Assistant development programs, as well as educational research projects; Author 3 has 9 years of managing design teams in industry after completing his degrees in Mechanical Engineering. We have completed certificate programs on teaching and learning that touch on the philosophy of education, instructional skills, and specific applications in engineering and science education. We organized conference panels on EDI themes. We have participated in engineering outreach, through workshops (Author 1) and through summer research program with female high school students (Author 3). Thus we have all benefited from and been participating in some of our engineering school’s EDI initiatives.
3. Findings & Discussion

Two types of representation gap were discussed by the participants: (1) representation gap in the student cohort, and (2) representation gap in the generally perceived role models in engineering. These two types were connected to the experiences of exclusion and inclusion in engineering education, both before and after entering university (Table 2). The most striking feature of the students’ experiences of exclusion and inclusion was that they are socially mediated. The influence of representation gap in the socially mediated mechanisms of exclusion, affecting both the pre-university and undergraduate engineering students, are discussed in the first two sections below.

Table 2. Experienced Barriers and Enablers for Pursuing Engineering Education

<table>
<thead>
<tr>
<th></th>
<th>Pre-University</th>
<th>During University</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barriers</td>
<td>• Guidance counselor advised against pursuing engineering (John)</td>
<td>• Isolation from peers (Snow)</td>
</tr>
<tr>
<td></td>
<td>• Isolation from peers (Snow)</td>
<td>• Microaggression by peers (Iced Tea)</td>
</tr>
<tr>
<td></td>
<td>• Critical attitudes and narratives from peers towards female students (Cupcake)</td>
<td>• Critical attitudes and narratives from peers towards female students (Cupcake)</td>
</tr>
<tr>
<td></td>
<td>• Lack of exchange outside cliques in class (Golden)</td>
<td>• Lack of exchange outside cliques in class (Golden)</td>
</tr>
<tr>
<td>Enablers</td>
<td>• Parents shared information about engineering and encouraged pursuing engineering (John)</td>
<td>• Parents understanding the demands and stressors, responding supportively to needs (John)</td>
</tr>
<tr>
<td></td>
<td>• Parents and community fully believed in the youth’s ability to succeed in higher education (Snow)</td>
<td>• Core group of friends for constructive feedback and learning (Tim; Snow)</td>
</tr>
<tr>
<td></td>
<td>• Peers pursuing engineering, taking relevant courses early (John)</td>
<td></td>
</tr>
</tbody>
</table>

The findings are organized in three sections. The first section examines the role of adults who hold key resources required for a student’s educational pathway to engineering. We find the asset-based approach to inclusion particularly useful, viewing the youth’s relationship to resourceful adults as their social capital network. We make recommendations on enhancing the collective social capital of engineering students overall, and viewing the engineering school outreach programs as a strategy to also enhance the social capital of marginalized youth. We also found that the generally perceived dominant images of engineers (i.e. male, non-black) can influence the behaviours of key adult agents of exclusion and inclusion. This strengthens the rationale for unconscious bias training of hiring committees and senior leadership; We also recommend the similar awareness in the general engineering faculty and staff, for their important mentorship role to the students (part of their supportive social capital network).

The second section examines the role of peers in either promoting inclusive collaboration or contributing to the push out factors of under-represented engineering students. We make recommendations for a behavioural-approach to diversity to address push out behaviours. Representation gap in the student cohort can amplify the effect of existing male-dominated image of engineers, in that new rhetorics are used to reinforce the dominant images and justify
push out behavior towards female students. Therefore, the under-represented students’ struggle with these rhetorics, and their alternative discourses, receive important attention in this section.

We do not assume that the described experiences below are uniform experiences of all students in our local community nor our institution.

3.1 Socially Mediated Barriers and Enablers to Pursuing Engineering: Role of Adults

3.1.1 Social Capital
Before entering university, the important agents of this social mediation were key adults who act as resources and influences for young people, such as parents or guidance counselors. These adults can greatly enable youth’s participation in relevant opportunities, by emotional support, information, decision support.

John provides the most detailed example of the enabling as well as discouraging influence of the adults. First, his parents were of great support before and during university:

"My parents were supportive and everyone else was supportive, my parents could see that this was the profession for me. They saw that I love to take stuff apart and see what makes things work [...] ‘OK, this is a good profession and this is something we think he can obtain.’ And they’ve helped me. They motivated me and helped me get here. [...] I told [my parents] I want to become an engineer and they’re just all happy for it." (John, 23-24)

John describes how parents’ knowledgeability with engineering education can be of great resource to students in university:

"[...] a lot of students, I know their parents are engineers [...] [These] students can rely on their parents, and their parents have gone through everything so they can better understand [...] their own child’s struggles. [...] if they haven’t gone that route themselves they might not be as equipped or knowledgeable for their kid. [...] they know what the student’s going to deal with and what the child is going to be, the problems that they’re going to face and the motivations that they’ll need." (John, 17-18)

Parents, who maintain regular contact with the student, can hold conversations around the commonly experienced challenges in engineering education and intentionally respond in ways that would help the student stay resilient. Existing theories of resilience highlight the importance of the human ecosystem (e.g. health, physical environment, material resources, relational network, intrapersonal strengths) required to overcome crises, high-stress transitions, or negative situations. Besides the transition into a university environment, there may be unique features about engineering programs (e.g. heavy course load, particular ways of assessment and instruction, projects that depend on teamwork, different starting levels in programming) that add levels of stress. Learning to learn inevitably involves transformational change in the learner. Adults have a role to play in enhancing students’ resilience through failures and disappointments.

In order to make engineering education an available option for a high school graduate, similar adult support and knowledgeability may reasonably be expected. John explains why an early planning is essential:
[...] if you want to go into engineering, you had to think of this like **years in advance**, you had to start taking the courses, the right level courses, so if you want to go to college or university. And so those are the first choice and then [...] what discipline do you want to go into, do you want to go into engineering [...] I think that that might be a problem that, that community [underrepresented local community] they’re not well informed of engineering and professionally becoming an engineer, so just because it’s not stressed at a specific time in their youth, it’s going to affect later on where they can like literally, they don’t have the choice because they haven’t taken the appropriate steps to get there. (John, 15)

There is an information asymmetry amongst the high school students, as John as noticed. The knowledge of closely involved adults - of these required ‘choices’ for pre-university academic pathways, and of the support required to help students stay resilient through university – may be considered a ‘social capital.’ One gains a resource-rich environment to have in-tact families who have higher education and the financial means to allow regular parental involvement and support.

Julie Martin [7], through narrative analysis, studied the role of education personnel in helping disadvantaged students succeed. There are information and resources being received in routine exchanges, without formalized programs or mobilization, especially more so in resource-rich networks. Marginalized group students may not necessarily be part of the resource-rich networks, but the staff and faculty can play an important role in enhancing the collective social capital of all students, especially the marginalized [8], [10].

### 3.1.2 Dominant Images, Perceived Competence, Pressure into or away from Engineering

Prior to university, there is yet another layer to the role of adults: their beliefs about who should pursue and succeed in engineering. While John’s parents believed he could succeed in engineering, his guidance counselor thought differently:

> It was my guidance counselor who did think that [I couldn’t do engineering] – obviously she’s wrong. But it is, I guess it can be very demotivating. That one person thinks that you cannot become this. **Just because my marks were not that good at that time. But I had changed them around. [...] One guidance counselor saying that I couldn’t, they didn’t see me going to university**, he said. **I remember that day was very discouraging. But that was one person saying no, where I still had other people saying yes. So that’s different for me. But other people, like I said, they’re in a world of people just saying no to them. That would be a completely different thing [...] ‘OK, you know, it’s not like I have to beat one person, I got to beat everyone and everyone is thinking the opposite.’ So I do think that would affect them negatively and they wouldn’t take this route [...]”** (John, B21-B22)

The impact of an adult’s opinion about the youth’s future, is significant on the youth’s ‘choice’ – The ability to see oneself succeeding may be an important source of courage required in their commitment to pursue a career or higher education. This places great responsibilities on the adults, to examine when and why they show support or encouragement, to whom. Here we come to two issues regarding our perception affecting our role in exclusion and inclusion: Evaluation of **competence**, and the **dominant image** of engineers.
Competence deals with whether one has the capacity to succeed in engineering, and thus given the opportunity to engage in engineering. Dominant image deals with the identity characteristics of who is considered as ‘normally expected’ to be in engineering. Each of these can be problematic; The issue becomes more complex when the two become linked as synonymous.

Cupcake’s observation offers an example of ‘bias’ working to unequally exclude/include female and male students in the academic path towards engineering:

“So I went to an all girls high school [that was near an all boys school], it was like a brother and sister school. So my memory is that boys’ science classes were all a lot bigger than the girls. And the girls, a lot of them would take art instead. Art’s fine, but they take a lot of what people considered ‘easier’ classes. … physics and chemistry and bio were all a choice. But I think the guys may have been more peer pressured into it… The curriculum is the same because there are lots of options in [Grades] 11 and 12. […]

“[…] I don’t think it's a natural thing that like guys are better than girls at science. So it must be more like a peer pressure or just a social norm that they all take the science classes, but not all the girls take the science class.” (Cupcake, 26, 28)

Unconsciously accepted dominant images shape our thinking about who belongs, who has unquestioned access, who is viewed with suspicion, which barriers are accepted as normal, and which groups are excused from the responsibility to address EDI problems. Existing representation gap can actually justify the barrier-creating behaviour, which in turn reinforces the representation gap. All lead to missed opportunities or active discouragement out of engineering.

### 3.1.3 Conclusion and Recommendation

Combined, the adults play a systemic barrier. Interest from the local community or immediate family, along with the confidence of key adults in young individual’s life, can have a powerful effect on young people’s resilience and motivation to pursue or stay in engineering education. Existing unconscious bias training (as the authors have received in their institution) include recognizing the discriminatory actions or reactions and their associated biases.

The practical action of sharing social capital, then, would enhance the collective social capital, to counter systemic barriers [7]. This would need to be accompanied by actively countering the biased dominant images of who we expect to succeed and consider a normal fit to engineering. Formal roles that hold any kind of access to social resources or opportunities, may need to be especially mindful of how systemic discriminatory biases and inequalities play out in the local, individual behaviours. Those who hold social capital, may have the opportunity and a greater responsibility to share and increase the shared level of social capital [10].

### 3.2 Exclusion and Inclusion in Peer Learning

During university, two types of peer-mediated experiences of exclusion were highlighted: Isolation and microagression.
3.2.1 Isolation

Some students experienced or observed difficulty in engaging with peers for collaborative learning, feeling excluded or unwelcomed by smaller groups that formed in the cohort. Peer learning has an important place in engineering education, and yet there can be small groups peers that do not engage beyond their circle throughout their whole program:

 [...] Imagine you’re alone in a class and you can’t communicate with anybody for an assignment. You see how difficult it is. [I know] now because I’ve experienced it. I don’t have my [usual close] friends in my last semester [because they went on co-op], I never spoke to them. I never get feedback on an assignment. [...]” (Snow, 27)

 [...] all the friends cluster or all the smarter kids cluster together and people who [need to] acquire new skills or learning opportunities for development are left behind them. [...] (Golden, 21)

In a school where peer learning is valued highly, and where the curriculum involves many projects that inherently require collective intelligence, the exclusion from a supportive peer network can be devastating. Snow was unaware of the experiences of isolated students until he himself was left without his small circle of close friends. Experiencing what it is like to not have them around (due to internship), two sides of the issue became evident: the isolation of individuals, and the ignorance of those who have their smaller circles established. Snow then extends this experience to an empathic connection to what female students might be experiencing:

 [...] I remember there was this other black girl from Nigeria in Mechanical [Engineering]. But she [left] after first year. I tried to speak to her, she said the program was hard, this was not what she wanted to do. But I’m thinking that there were still some other things that she brought up, too. Because first of all, you feel isolated. [...] Do you understand the message that was, looking around, and if I was the only girl here and maybe that’s how it would’ve been for me. I [wouldn’t] have anybody to bounce ideas off of. If I’m confused [about] an assignment, I can’t talk to my peers [...] (Snow, 27, 29 & 31b)

We don’t interact with people always [either]. It’s not our fault [the guys], but have you made any efforts to make sure that they feel welcome in the class. [...] You need to work in groups. Everybody has a group [...] that they speak to discuss the questions. But if you’re alone, if you’re the only girl alone. [...] (Snow, 27, 29 & 31b)

 [...] Then I said, Ok, we think it’s easy being a female in engineering, do not speak to anybody when you have assignments, and [when] you’re not sure about [something], don’t tell anybody. Just be alone. Because most times even when you do have questions you want to bounce an idea off somebody, [that] first somebody is going to think that you want to copy their work, that you don’t put in much effort. [...] [Even though] you can’t just assume that’s what the person wants to do. (Snow, 27, 29 & 31b)

Snow recognizes that each person has the power to make another person feel welcome in the class. Snow recognizes a lack of ownership over the peer learning environment in a class, an unwillingness to interact or extend care beyond the comfortable group of friends. The pain of feeling alone seems to be more than just isolation, but also in being seen as different (unfit), with
the threat of negative reputation should one try to break out of the ‘expected’ state of isolation. Cupcake’s experience confirmed Snow’s observation: “You asked one question and then they start to treat you like you don’t know what you’re doing” (Cupcake, 34). Also, the narrative that being female is ‘easy’ works to justify the male peers’ self-expectation of never making an effort to interact or get to know their female peers.

Ignorance to the isolation experience of peers is a concern, but one that could be considered accidental. On the other hand, the construction of an image of underrepresented students as undeserving of respect or inclusion, takes on an oppressive nature. The threat of ‘confirming’ a negative image of poor work ethic, reinforces status quo on the part of male student behavior, and punishes the female student behavior that goes against dominant group expectations. Snow recognizes the extra burden this places on an individual to simply carry on the normal tasks: “[...] You just assume, ‘Oh they’re not smart. They’re not putting much work.’ No, they might have to actually put in more work because of those barriers they weren’t able to overcome [...]” (Snow White, 27, emphasis added). Peer relations, including behaviours and expectations, can create an environment that opposes the successes and wellbeing of an individual, demanding more work to stay on the course that would be a lot easier otherwise. This leads to the examination of the other types of peer-mediated exclusion: microaggression.

3.2.2 Microaggressions

When individuals are tied together in a group project, exclusion took on a less subtle form of microaggressions. Behaviour of some male students towards their female peers, was discussed by Iced Tea in 2017, which motivated the purpose of the investigation in 2018:

[…] I got a weird vibe of them trying to pick fights with me. Then he would start spewing facts, not answering my question. He maybe tried to intimidate, it was a power play. I wasn’t a fan of it. [...] I think not accepting the random bits of shutdown, [by] saying “Hey you’re acting like a jerk, shutting them down, criticism for no reason isn’t acceptable.” Sometimes he thought I was challenging him just because I was clarifying. Unnecessary animosity.
(Iced Tea as S7 in 2017, 56 & 59)

Iced Tea experienced perhaps the most overt ‘shutdown’ from one of her male peers in a design project team. There was an assertion of his dominance in a way that Iced Tea was expected to submit to, in a way that other peers were not subject to the same expectation. Disagreements and discussions are a regular part of any team experience. The most difficult conflicts did not arise from disagreements, but from disrespect and hostility.

Cupcake also shared her experience, which had a more subtle form of microaggression:

[…] They just, because I'm a girl, it's kind of like, 'oh well you can do this.' Like they'll sort of take the lead. It is a guy and just because, I don't know, they don't think I know what I'm doing […] So, um, [I] kind of say like ‘You do this, and I'll take that.’ And that's [how I dealt with it] sort of way. (Cupcake, 21-22)

Both Iced Tea and Cupcake had the skills and resilience to resist another peer’s dominating behaviour. Iced Tea had a less confrontational experience in redefining expectations and also
assuming decision making role over task delegation, proactively taking on tasks that she found meaningful, valued and challenging.

Evidence that particular male student behaviours are hostile towards female students only, is also observed by Snow, a male student. He comments on the ongoing derecognition of female students in a male-dominated environment, despite her repeated demonstration of competence over the years:

“There was this other girl in my class, she’s not graduated yet, she said that even though throughout her three years, it feels like every group project she still has to prove herself that she is wanting to be in this group, after several [years], you still have to prove yourself, [it’s] still a pattern” (Snow, 30).

Snow White notices the absurdity of having to repeatedly prove one’s competence, or being repeatedly seen as incompetent, when the cohort has known each other for years. The findings agree with literature that there is an overtly unequal treatment of female identity in the engineering school environment [6], [11]. Wolfe and Powell’s work [6] on engineering student perceptions (and reactions towards) gender-typical speech acts in teamwork, shed interesting insights. Male engineering students were significantly harsher than other groups on female typical speech acts. The actual sex of the speaker did not matter; it was the tone or behavioural nuances associated traditional forms of femininity, which often define the stereotyped images imposed on women (and men, by the stereotyped notion of masculinity).

The unequal treatment is the key here. A female-associated trait, e.g. the voice or verbal nuances [6], becomes the basis of contempt, dismissal, disinterest, or negative labelling. Those seen as closer to the dominant image – in this case, male or ‘masculine’ – are not subject to the same levels of scrutiny or expectation of disrespectful treatment. There are no ‘objective,’ consistent standards and expectations placed on all members of the student cohort. It is simply accepted as the cultural norm that the minority groups will be treated differently than the rest. Rhetoric of competence or work ethics are used to defend the status quo that is unequally hostile towards minority students, that works to undermine and erase recognition of their actual competence, work ethic, and achievements.

3.2.3 Competence and Deservedness

“[…] I don’t know if this is true, but from what I’ve heard, [the school] will let girls in with lower averages […] even if that’s just a rumour, guys will look at girls and say, ‘Oh, she probably didn’t even do well enough to get in, and I did.’ […] [The guys] would treat [the female peers] like belittle them, because they don’t deserve to be there.” (Cupcake, 24)

The notion of ‘deservedness’ is very unsettling. Ultimately this challenges our commitment to see all our students as legitimate members of the school community: “If you’re here, you deserve to be here” (second year male undergraduate student, in a 2017 interview). There is a big difference between telling someone “you should,” “you can”, or “you deserve to.” Should we decide which group gets access to engineering? Who gets to decide? What is our responsibility as already included members of the engineering education community, towards students who do not have the same privilege as we do?
3.2.4 Overperforming to be Accepted/Included

The ‘low competence’ label created for female students, and the accepted derecognition behavior from peers as ‘normal’ part of engineering culture, has created a phenomenon of ‘overachieving’ female students. Cupcake responds to the biased and disrespectful assumptions about women, in an effort to reverse the narrative, by explaining how women may be more competent than men to be included in this male-dominated environment:

I think the girls in the program are much like, I don't know if this is true if you look at everyone’s grades, but I think that for a girl to go into engineering she has to be very confident and especially competent in her skills and like not a pushover. I just think that guys are, like males will be pushed more into engineering fields like say high school guidance counsellors and those kinds of things where if a guy isn't so good at science in general, people are usually like, ‘oh, you can do it.’ Like ‘don't, don't worry about it.’ And then for girls it's like, ‘oh well maybe you should just go into something else.’ And I, I think that we've discussed this a lot in class also in professionalism, so that was one of the focuses on the way that guys are just pushed into these sort of jobs and girls are not. But it is changing. (Cupcake, 25)

A recent study [12] also captures the coexistence of outperformance and devaluation of women in undergraduate engineering and science programs. This contradiction becomes an interdependent pair in a discriminatory system. The marginalized must over-qualify and outperform, in order to be considered for the same opportunities that are already open to the privileged. Obtained this way, the granted recognition celebrates the overachieving anomalies of the disadvantaged group, and works to justify the system’s unfair double standards - the marginalized group must prove its legitimacy and merit for inclusion, when their privileged counterparts are demanded to answer no such challenge.

John, as seen earlier, certainly did not think his poor grades at one point kept him from performing better the following year and also from succeeding in engineering education. And yet, ‘lower grades’ is the narrative that affects female students who are being discredited in their actual academic achievements. Discrepancy from the facts is one problem, and the selective use of ‘grades’ rhetoric on women than men, should help us discern that the rhetoric has little to do with the actual concerns with ‘competence’ of someone to succeed in engineering. Rather, it may be a changed form of ‘no woman deserves to pursue engineering, or should be allowed promotion and recognition in engineering’, simply switching the female sex label to ‘low grades’ label. The truthfulness of that label does not matter, as long as the logic of ‘label justifies treating labelled individuals as less competent and less deserving, regardless of their actual achievement sand contributions.’

3.2.5 Onus of Perception Management

Anyone can be subject to an experience of microaggression. Without condoning their experience, we recommend that any microaggression training also include negotiation skills, interaction skills, and civil confrontation skills to identify and call out (instead of being a bystander) disrespectful behaviours. Cupcake says it’s quickly resolved by showing firm assertiveness,
negotiating leadership. Even though she manages fine, she does notice quiet female students who may not be exhibiting the same behaviour, and the onus is back on the woman to change male peers’ perception of women:

“I think it definitely helps to have confidence and kind of explain to them, I know what I’m doing, I can do this. And then once they see that and usually isn’t a problem anymore. It’s just, I think sometimes when I think a girl at the beginning say more shy but she's not used to being in a group of like being the only girl. Then she might not speak up, but I think once you showed them that sort of confidence, then they're like, okay, we're all on the same page here. And then so just took a little extra effort to, to balance the perception, the expectations I think.” (Cupcake, 23)

Similarly, for immediate measure of perception management, Wolfe and Powell suggested that female students avoid certain speech acts to manage peer perception and behavior in interactions. But there are long-term, more fundamental issues here: (2) both women and men pressured to adopt a dominant behavior; (3) continue to limit the understanding of masculinity/femininity. (We can see how the gendered labelling of certain behaviours and values, which should be espoused by all, has negative effect on male individuals, too: men who exhibit this behavior are also disrespected, if not also criticized as not being of normal masculinity.) The results may include: putting the onus of care solely on the women, instead of fostering all individuals to engage in helpful, caring behaviour; excusing dominating behavior and disrespect; and/or losing the value of collaborative and shared-recognition behavior from the project team, team leadership, culture of the school.

The onus definitely should not be placed solely on the under-represented students, but become shared by all members of the student cohort and instructional staff.

3.2.6 Limits to Learning Behaviour

Interestingly, the demand for an ongoing proof of one’s legitimacy (rejection until proven otherwise, conditional belonging for individuals who are already members of an institution) limits the learning experience of the male students as well.

“[…] from my experience also with after a test and then you hear what people say and then you find out later how they actually did on the test. Guys, a lot of times, will think they did so well and then [turns out they did not]. I mean this goes both ways. Like sometimes I think I did well in them, [and] I don't. But usually I think girls might just express more uncertainties in general and not want to say, oh I did well. Even if even if you think you did well. […]” (Cupcake, 33)

“I just feel like females come off as more insecure sometimes or act more insecure. Even if they know what they're doing and then the males will be the opposite where they will act more secure, even if they don't know what they're doing from my experience. So I find that I'm very likely to ask the question if there's, if I know exactly what I'm doing, but there's one little thing I need help with. I'll ask for help, but then. And that might make me look like I don't know what I'm doing as all. When really it's just like I need a little bit of help. But I think a lot of times males, will not ask, they won't ask for any help because they don't want to come off as insecure or they think they can make it off and get it right anyways.
In this example, one of the key behaviours in learning – asking questions – is constructed as ‘incompetence.’ Thus, fearing rejection or judgment as ‘insecure,’ a student can refrain from acknowledging what they don’t know and seeking input (critical behaviours in inquiry, learning). Ironically, the behavior that was interpreted as undeserving (the fact that ‘weakness’ construction legitimizes harsh treatment, is another matter), is now interpreted as strength. Here, Cupcake takes the discussion beyond behaviour and perception management, into redefining the shared meanings around the school norms (including behaviour, perception, values, and relations).

Table 3. Problematic Behaviours and Discourses Experienced by Under-Represented Students

<table>
<thead>
<tr>
<th>Types of Disrespectful Behaviour</th>
<th>Problematic Constructions Identified by Students</th>
<th>Student Response to Counter Disrespect and Establish Recognition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assigning someone second-class roles</td>
<td>• Peers positioned in relations of dominance • Unequal freedom &amp; responsibility in behaviour • Unequal recognition • What counts as strength &amp; valued behaviour</td>
<td>• Assert one’s own choice of project tasks, assert oneself as an active decision maker rather than passive • Extra effort to demonstrate competence to the peers</td>
</tr>
<tr>
<td>Ignore/dismiss input, overt aggression to force conflict or silence</td>
<td>• Disrespect upheld be exclusive ‘legitimacy’ of groups against dominant images of engineers</td>
<td>• Confront misbehaviour, focus on changing the group work process</td>
</tr>
<tr>
<td>Present someone as incompetent, regardless of merit</td>
<td></td>
<td>• Highlight the unmerited advantages the privileged group has, and the extra work that the marginalized group has taken on to overcome barriers • Managing peer perception, image maintenance</td>
</tr>
</tbody>
</table>

4. Conclusions

For engineering students in both the dominant and underrepresented groups, their pre-university experiences included those that strongly resisted the youth’s pursuit of engineering. Key adults such as guidance counselors, teachers, and parents could have a forceful impact on how the youth sees oneself as able to succeed in engineering, as well as on how the youth accesses and participates in opportunities that would make engineering an available educational and career path.
Key adult figures could also actively encourage the self-perception and uptake of opportunities. This form of support, whether in emotional support or provision of information and accountability, was crucial to the youth’s successful entry into the engineering program.

Adults, especially parents, also continued to play a support role during university. University staff and faculty may consider actively taking up the resource role (i.e. confidence, information, accountability) to increase the collective social capital of their student cohorts. The institution can also strengthen the message that recognizes and clarifies the expectation that all students will succeed and make meaningful contributions in their learning environment.

The role of peer behaviour, perception and discourse is particularly prominent in the retention and push out experiences of engineering students. Faculty and staff should take great care in their role of co-establishing a respectful and inclusive culture in and out of the classroom.

It is especially inspiring to highlight the resilience, critical awareness and creative thought of engineering students who have experienced different forms of exclusion. They may be key sources of insight and creativity in advancing EDI programs and discourses in our institutions. Empowering a partnership model with students is expected to be far more effective than employing a deficiency model that treats underrepresented students as passive subjects.
5. References


